PSG COLLEGE OF ARTS & SCIENCE

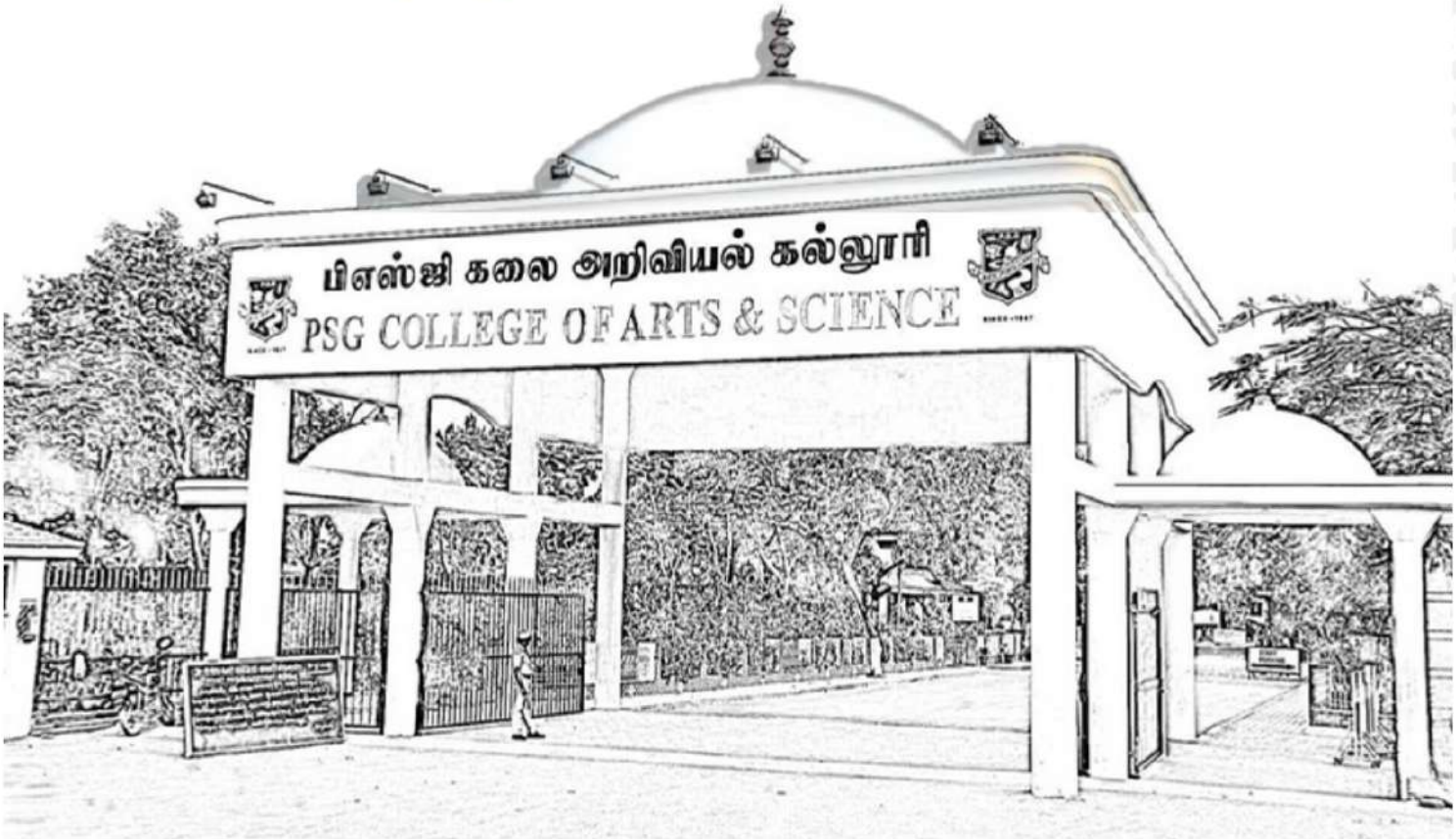
An Autonomous College - Affiliated to Bharathiar University
Accredited with A++ Grade by NAAC (4th cycle)
College with Potential for Excellence (Status Awarded by the UGC)
Star College Status Awarded by DBT-MST
An ISO 9001: 2015 Certified Institution
Civil Aerodrome Post, Coimbatore - 641 014 Tamil Nadu

Proceedings of the International Conference

DIGITAL HEALTH 360°

Digital Pulse of Tomorrow's Healthcare

PSG College of Arts & Science | PSG Hospitals
Department of Hospital Administration



March 7, 2025

Edition: First

Year: July 2025

ISBN: **978-81-990257-4-5**

Publisher

(International Publisher)
Australia, Chennai & Kanyakumari.
Phone: +91 6384730258
E-Mail: editor@multispectrum.org
www.multispectrum.org

ORGANIZING COMMITTEE

Chief Patron
Thiru. L. Gopalakrishnan
Managing Trustee, PSG & Sons' Charities

Patron
Dr. T. Kannaian
Secretary

Chairperson
Dr. M. Senguttuvan
Principal (i/c)

Advisory Committee

Dr.J.S.Bhuvaneswaran
Director
PSG Super Speciality Hospital

Dr.K.Banumathi
Director, MSc HA Programme(PSG SSH)
PSG OHMS & Vishnugranti

Dr.M.Jayanthi
Vice Principal

Dr.M.Umarani
Vice Principal

Convenor & Chief Editor

Dr.M.Amaravathi
Associate Professor & Head
Department of Management Science – Hospital Administration

Co-Editors

Dr.R.Ashok Kumar, Assistant Professor, MSc HA,PSGCAS
Dr.G.Dinesh Kumar, Assistant Professor, MSc HA,PSGCAS

Editorial Board

Mrs.R.M.Nandhini, Research Scholar, MSc HA,PSGCAS
Ms.S.Kanagathara, Research Scholar, MSc HA,PSGCAS
Ms.G.Shakthi Roshini, Teaching Assistant, MSc HA,PSGCAS
Ms.S.Amritha Shree, Student & Chairperson, II MSc HA,PSGCAS
Ms.M.Vaishnavi, Student, I MSc HA,PSGCAS
Ms.S.Shridhanya, Student, I MSc HA,PSGCAS

Dr T Kannaian
Secretary
PSG College of Arts & Science
Coimbatore – 641014

Secretary Message

I truly appreciate the efforts of the Department of Hospital Administration in organizing the International Conference on Digital Health 360°. With various guest speakers connecting both offline and online, it is visible that the dedication and effort to this conference has not gone in vain. The modern era will be entirely digital, and as the healthcare sector continues to grow, stakeholders must adopt digital technologies to stay updated and ensure a smooth flow of operations. This futuristic theme shall encourage students, administrators and health advocates to adopt and use digital technologies.

I also applaud the Head of Department, faculty and students of Hospital Administration for their continuous effort in making this conference a success. I look forward to seeing more initiatives like this from the department.

Dr. M. Senguttuvan
Principal Incharge
PSG College of Arts & Science
Coimbatore – 641014.

Principal Incharge Message

It's with great contentment that I witness the young Department of Hospital Administration flourishing with its innovative themes and bringing laurels to the college. Digital Health 360° is an excellent concept that elaborates on the digital journey of healthcare by addressing its benefits, challenges, and future scope. This theme sets the tone for future healthcare stakeholders. This initiative showcases the department's dedication to academic excellence and its commitment to providing a comprehensive understanding of the role of digital health in improving patient care, operational efficiency, and healthcare management overall. It is with great enthusiasm that I announce the release of the conference proceedings for the *International Conference on Digital Health 360°*, marking an important milestone in advancing digital health discussions.

I encourage all students, faculty members, and future stakeholders to actively engage, collaborate with peers, and bring fresh perspectives and research to explore solutions that will address the emerging challenges in healthcare.

Dr M Amaravathi
Associate Professor & Head
Department of Management Sciences- Hospital Administration

Head of the Department's Message

The Department of Hospital Administration has stepped into its third year with a high spirit to shape a better health environment for people. The flagship program 'Health 360^{o}' has evolved this year to **the International Conference – Digital Health 360^{o}** with participants across the state. The conference comprised paper and poster presentations from students and faculty Members marking the importance of digitalization in the healthcare sector. The journey toward a fully integrated digital health ecosystem is not without challenges. We need to address concerns related to data privacy, interoperability, ethical considerations, and the digital divide to ensure equitable access and trust in these technologies. Collaboration among stakeholders is critical to overcoming these challenges and driving sustainable innovation. Overcoming these challenges also requires intra-sector discussions, expertise knowledge, collaborations with big techs, and most importantly, the ideas and innovation of young minds because they are the future stakeholders.

I want to convey my heartfelt appreciation to the MHA students of Batch 2023& 2024 for their spectacular contributions and to the staff members for their indispensable support in making this international conference a success. In the time ahead, the department will organize many more such conferences.

About the Conference

The Department of Hospital Administration is organizing its flagship program Health 360° every year with thought-provoking themes. The tradition began in February 2024, with the theme 'Sustainable Wellness'. Eminent speakers from various fields came to give their expert views on the theme. The one-day intra-collegiate symposium was a huge success. Following that, in 2025, the department is shifting its focus towards Digitalization in Healthcare, with the theme being 'Digital Health 360°'. This international conference is set to create a new benchmark for the department and enable young minds to gain futuristic insights. This one-day conference will be knowledge-filled, with expert sessions by the speakers, paper presentations, poster presentations, making it an avenue for participants to showcase their skills and become the digital pulse of tomorrow’s healthcare.

DIGITAL HEALTH 360°

Digital Health 360° encapsulates the transformative journey of healthcare in the digital age, offering a comprehensive view of the technologies, innovations, and systems shaping its future. This concept emphasizes an all-encompassing approach, addressing the needs and perspectives of all stakeholders—patients, providers, administrators, researchers, and policymakers—to create a synergistic ecosystem where technology seamlessly integrates into healthcare delivery and management.

However, the journey toward a fully integrated digital health ecosystem is not without challenges. Concerns over data privacy, interoperability, ethical considerations, and the digital divide must be addressed to ensure equitable access and trust in these technologies. Collaboration among stakeholders is critical to overcoming these challenges and driving sustainable innovation.

Digital Health 360° invites a multidimensional dialogue, bringing together experts from diverse fields to envision, innovate, and implement solutions that drive the future of healthcare, ensuring it is inclusive, efficient, and resilient. By embracing this comprehensive perspective, stakeholders can collectively work toward a future where healthcare is more accessible, efficient, and patient-centric.

TABLE OF CONTENTS

Promoting Sustainable Development in Green Digital Health: Integrating Environmental Responsibility, Energy Efficiency, and E-Waste Management

Ms Bala Gayathrii Devi J G
[1]Student, Department of Commerce
Central University of Tamil Nadu

Abstract

This research paper aims to promote sustainable development within the realm of green digital health. It underscores the importance of expanding digital healthcare while prioritizing environmental considerations, particularly in terms of energy consumption and electronic waste disposal. Through a comprehensive review of institutional reports, literature, and case studies, the paper identifies key areas where institutions can leverage digital tools and green marketing strategies to influence consumer behaviour, optimize resource usage, and reduce waste. Here, I advocate for the use of energy-efficient devices and the implementation of robust e-waste collection systems. By incorporating these strategies, it is possible to foster a more sustainable healthcare model globally. The paper also stresses the responsibility of nations, especially those undergoing rapid development, to ensure that their actions are aligned with Environmental, Social, and Governance (ESG) principles, core to the broader agenda of sustainable development. Ultimately, the research highlights how aligning digital health initiatives with the United Nations Sustainable Development Goals (UNSDG) can drive innovation while advancing global sustainability objectives. The importance of raising awareness about responsible digital health practices and the environmental impact of technology usage. It suggests that educating healthcare professionals, consumers, and organizations on the environmental implications of digital health tools can significantly reduce the sector's ecological footprint.

Key words: Sustainable Development, Environmental impact, E-waste management, Energy efficiency, Green digital Health.

Introduction

The digital revolution in healthcare has introduced groundbreaking advancements, enhancing patient care, diagnostics, remote monitoring, and medical research. The widespread adoption of electronic health records (EHRs), telemedicine, wearable health technologies, artificial intelligence (AI), and Internet of Medical Things (IoMT) has significantly improved the efficiency and accessibility of healthcare services. However, this rapid digitalization also presents serious environmental challenges, including high energy consumption, carbon emissions from data centres, and the increasing burden of electronic waste (e-waste). These concerns raise critical questions about the long-term sustainability of digital health solutions. The environmental impact of digital healthcare is multifaceted. The energy demands of data centres, which store vast amounts of health-related information, contribute significantly to carbon emissions. Additionally, the frequent replacement of digital medical devices such as wearable sensors, diagnostic equipment, and telehealth tools generates large amounts of e-waste, often disposed of improperly. Many developing nations lack comprehensive e-waste recycling systems, leading to harmful environmental and health consequences. The concept of Green Digital Health is gaining prominence as a sustainable approach to integrating technology into healthcare. It focuses on reducing energy

consumption, optimizing resource utilization, and implementing responsible e-waste management practices. Aligning digital healthcare with Environmental, Social, and Governance (ESG) principles can drive sustainability while ensuring that healthcare innovations contribute positively to both patient well-being and ecological conservation. Furthermore, initiatives such as the United Nations Sustainable Development Goals (UNSDGs) emphasize the importance of environmentally responsible healthcare infrastructure and digital transformation strategies. To mitigate environmental risks, stakeholders—including healthcare providers, policymakers, technology developers, and regulatory bodies—must collaborate to develop green procurement policies, sustainable digital health frameworks, and regulatory measures that promote the adoption of energy-efficient devices and eco-friendly healthcare technologies. Implementing circular economy principles in healthcare technology, such as designing devices with longer life cycles, recyclability, and reduced hazardous materials, can significantly lower the sector's ecological footprint. This research aims to explore the role of sustainability in digital healthcare, identify key challenges in energy consumption and e-waste management, and propose actionable strategies to develop eco-conscious healthcare solutions. The study highlights the importance of balancing technological advancements with environmental responsibility, ensuring that digital health initiatives contribute to sustainable and ethical medical practices worldwide.

Green Digital Health

Each year on November 3rd, we celebrate Our Health Day throughout the world. Green Digital Health refers to the intersection of digital health innovations and sustainable practices, aiming to minimize the environmental footprint of healthcare technologies while maintaining or enhancing their ability to deliver quality care. With the rapid adoption of digital health tools such as electronic health records (EHR), telemedicine, wearable health devices, and data analytics, there is an increasing need to ensure that these technologies are designed, used, and disposed of in ways that prioritize environmental responsibility.

The environmental impact of digital health is twofold: the energy required to power the technologies and the generation of electronic waste (e-waste) as devices and equipment become obsolete. As healthcare systems continue to digitize, it is essential to develop and implement green strategies to ensure that digital health innovations contribute to both human health and the planet’s well-being. The achievement of the 17 health-related sustainable development goals comprised in the WHO’s 2030 Agenda requires the development, to a worldwide extent, of networked infrastructures connecting physical devices with computing systems for data collection, processing, exchange, and analysis, with the scope of addressing critical global health issues, such as antimicrobial resistance, infectious disease outbreaks, and natural disasters.

The digital technologies are being vast development. From an environmental viewpoint, it involves accurate real-time monitoring and warning of hazardous events, but also predicting short- and long-term weather and climate change, evaluating the need to develop, update, or replace governance policies and regulations. The research explores the intersection of digital health and environmental sustainability, focusing on strategies to minimize the ecological footprint of healthcare technologies. It emphasizes the need for energy-efficient devices, responsible e-waste management, and adherence to ESG principles

in rapidly developing nations. The study advocates for aligning digital health initiatives with the UN Sustainable Development Goals to promote global sustainability. It highlights the importance of educating stakeholders about the environmental impact of digital health tools to foster responsible practices. The analysis calls for integrating sustainable practices into the design, implementation, and management of digital health technologies.

Literature Review

Energy efficiency in green digital heath

Digital health technologies, such as telemedicine platforms, electronic health records, and data storage systems, require significant amounts of energy to operate. Health is a precursor, an outcome and an indicator of these three dimensions. WHO developed Health-Care-facilities in the key economic sectors in the "green economy development". The healthcare sector, with its increasing reliance on digital systems, is becoming a major contributor to global energy consumption. To address this, energy efficiency is a core component of green digital health, aiming to reduce the consumption of healthcare technologies while improving their performance. Use of energy efficient devices, data and software platforms. As healthcare systems increasingly rely on digital tools such as electronic health records (EHR), telemedicine platforms, medical imaging systems, and wearable health devices, energy consumption has become a significant concern. The healthcare sector, being one of the largest users of technology, can greatly benefit from adopting energy-efficient practices and technologies. The goal of integrating energy efficiency into digital health is to reduce both direct and indirect energy consumption associated with these technologies. By adopting energy-efficient solutions, the healthcare industry can reduce operational costs, lower its carbon footprint, and contribute to sustainability efforts globally. Many businesses that embrace the concept of sustainability go for a balance between social, environmental, and economic performance, taking into account people, the world and their profits. Sustainable environment, sustainable economy and sustainable society are given as the three main dimensions of corporate sustainability.

Energy-Efficient Devices and Tools

Low-Power Medical Devices:

Many medical devices, including wearable health trackers, diagnostic tools, and sensors, are designed to operate continuously or periodically in healthcare settings. By designing these devices to consume less power, their energy demand can be significantly reduced without sacrificing performance. This tool is not much implemented in India.

Battery-Powered Devices:

Devices that operate on rechargeable batteries can be designed with energy-saving features. For instance, devices like heart rate monitors or blood glucose sensors can be made with longer battery life, requiring less frequent charging and reducing overall energy consumption but the disposal of this device has no access.

Mobile Health Apps and Remote Monitoring:

Mobile health apps, which allow patients to monitor their health remotely, require less energy than traditional in-person consultations or diagnostic tools. By encouraging the use of

such apps, healthcare systems can reduce energy consumption by avoiding unnecessary patient visits and related healthcare facility energy use. Technologies are more discovered where there are a lot of internet facilities are available worldwide. This can be implemented easily and cost efficiency.

Energy-Efficient Data Centres and Cloud Computing

Green Data Centre:

Data storage is a key component of digital health, as much of the patient information and health data are stored in electronic systems or cloud-based platforms. However, data centres are energy-intensive facilities. Transitioning to green data centres that use energy-efficient cooling systems, renewable energy sources, and advanced energy management technologies can significantly reduce the energy consumption of digital health services.

Cloud-Based Health Services:

Cloud computing allows healthcare providers to store, access, and process data more efficiently. Moving digital health applications and health records to the cloud can optimize energy use by centralizing storage in energy-efficient cloud data centres rather than relying on on-premise servers, which are often less energy-efficient.

Energy-Efficient Algorithms:

The algorithms used to process and analyse health data can be optimized for energy efficiency. This includes reducing the computational power required for tasks such as data processing, machine learning, and diagnostic image analysis, which can consume substantial energy.

Telemedicine and Virtual Care

Reduced Travel and Infrastructure Use:

Telemedicine platforms enable remote consultations, diagnostics, and treatment plans, reducing the need for patients and healthcare providers to travel. This not only cuts down on the carbon emissions associated with transportation but also reduces the energy required to run healthcare facilities, such as lighting, heating, and air conditioning, when fewer patients are physically visiting clinics.

Efficiency in Telemedicine Platforms:

Telemedicine platforms themselves can be optimized for energy efficiency by streamlining video and data transmission to minimize the amount of energy needed for real-time communication between patients and healthcare providers.

Energy-Efficient Software and Digital Platforms

Optimized Healthcare Software:

Healthcare software platforms, such as Electronic Health Records (EHR) and patient management systems, can be optimized to consume less power. Software solutions that minimize data processing load, reduce unnecessary background activities, and streamline user interfaces can lower the energy required to run these systems on healthcare servers and devices.

Cloud Integration and Virtualization:

Leveraging cloud technologies and virtualized environments can improve energy efficiency. Cloud providers often operate at larger scales and can optimize energy usage better than smaller, on-premise server systems, thus reducing overall energy consumption across healthcare institutions.

AI and Machine Learning:

Artificial Intelligence (AI) and machine learning algorithms, which are increasingly used in healthcare for diagnostics, treatment recommendations, and personalized health plans, can be optimized to operate with lower energy consumption by reducing the complexity and computational requirements of the models.

Smart Energy Management in Healthcare Facilities

Smart Buildings:

Healthcare facilities, including hospitals and clinics, can be equipped with energy-efficient technologies such **as** smart thermostats, LED lighting, and automated systems to regulate temperature, lighting, and other factors to optimize energy use. Smart energy management systems can also reduce the energy consumption of medical equipment and digital health devices when not in use, contributing to energy savings.

Energy Recovery and Storage:

Some healthcare facilities are integrating energy recovery systems that capture and reuse waste energy generated by systems like HVAC (Heating, Ventilation, and Air Conditioning) units, lighting, or medical equipment. Additionally, energy storage systems (such as batteries or other backup power systems) can help store excess energy for later use, improving energy efficiency during peak usage times.

Energy-Efficient Communication Networks

5G and Low-Power Networks:

With the growth of telemedicine, remote health monitoring, and the Internet of Medical Things (IoMT), efficient communication networks are critical. The adoption of 5G technology, which offers faster data transmission speeds and lower latency, can lead to more efficient healthcare applications. Moreover, low-power wide-area networks (LPWANs**)** can help power IoT devices in healthcare, enabling energy-efficient communication between medical devices and central healthcare systems.

Edge Computing:

Edge computing brings data processing closer to the source of the data (e.g., wearable health devices or sensors). By processing data at the edge, fewer resources are required to transmit large data volumes to centralized servers, reducing the need for extensive energy usage in data centres and improving overall energy efficiency. The integration of energy-efficient technologies into the digital health ecosystem supports global sustainability goals, reduces healthcare costs, and drives positive environmental outcomes. As healthcare continues to embrace digital solutions, the importance of energy efficiency will only grow, ensuring that healthcare advancements are aligned with the need to preserve and protect the environment for future generations.

E-Waste management

This is basically known to be an electronic waste. E-waste management refers to the process of handling, recycling, and disposing of electronic waste in an environmentally responsible manner. E-waste includes discarded electrical or electronic devices such as smartphones, computers, televisions, batteries, and other gadgets that are no longer in use. Improper disposal of e-waste can have harmful effects on both the environment and human health because many electronics contain toxic substances like lead, mercury, and cadmium. E-waste is one of the most pressing environmental issues related to digital health technologies. As digital health solutions rapidly evolve, devices and equipment often become obsolete within a short period, contributing to the growing global e-waste crisis. According to the Global E-Waste Monitor (2020), over 50 million metric tons of e-waste are generated worldwide each year, with medical devices representing a substantial portion of this figure.
Medical devices such as diagnostic equipment, therapeutic devices, and wearable health tech often have limited lifespans, leading to significant amounts of e-waste being generated as these devices are discarded. Furthermore, many of these devices contain hazardous materials, such as lead, mercury, and cadmium, which can have detrimental effects on the environment if not properly disposed of (Zhao et al., 2021). The management of e-waste in the healthcare sector is therefore critical. Research has shown that many healthcare organizations lack effective e-waste management programs, leading to improper disposal of outdated or malfunctioning devices. E-waste often ends up in landfills, where toxic chemicals can leach into the soil and water, posing environmental and health risks. To address this issue, several solutions have been proposed, including the design of devices with recyclability in mind, the implementation of take-back programs, and the establishment of partnerships with certified e-waste recyclers. Regulatory frameworks, such as the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive, have been effective in mandating responsible e-waste disposal and recycling programs. However, more comprehensive solutions are needed globally to ensure that e-waste generated from digital health technologies is managed sustainably.

Environmental Impact of Digital Health Technologies

The environmental impact of digital health technologies can be categorized into three primary areas: energy consumption, carbon emissions, and e-waste. Data centres, which are integral to the infrastructure supporting digital health applications like telemedicine and EHRs, are significant contributors to global energy consumption. According to a 2020 report from the International Energy Agency (IEA), data centres account for approximately 1% of global electricity demand, a proportion that is likely to grow in the coming years as more sectors adopt cloud computing and data-driven services (IEA, 2020).

Data centres in the healthcare sector, which store and process patient data, are particularly energy-intensive. These facilities typically rely on non-renewable energy sources, leading to high levels of carbon emissions. A study by Liu et al. (2021) highlighted the substantial carbon footprint of healthcare data centres, pointing out that the high energy demands of these centres require the implementation of energy-efficient practices to reduce their environmental impact. Energy consumption is not limited to data centres. The devices used in digital health applications, including medical wearables, health monitoring devices, and mobile health apps, contribute to energy consumption, albeit on a smaller scale. For

example, wearable devices like fitness trackers, heart rate monitors, and glucose monitors rely on batteries that need to be recharged regularly, leading to increased energy usage. Therefore, energy efficiency in device design and optimization plays a significant role in reducing the environmental footprint of digital health technologies.

Regulatory framework and policies

The role of regulatory frameworks in promoting sustainability within the digital health sector cannot be overstated. Regulations and policies set the standards for environmental responsibility and ensure that manufacturers and healthcare providers adopt sustainable practices. Several countries have introduced legislation and policies aimed at reducing the environmental impact of digital technologies, including medical devices and healthcare IT infrastructure. The European Union's WEEE Directive is a prime example of a regulatory framework aimed at addressing the e-waste problem. The directive mandates that electronic devices, including medical equipment, be designed with recyclability in mind, and it establishes take-back schemes for obsolete devices. Similarly, the United States has implemented the Electronic Waste Recycling Act, which encourages the responsible recycling of electronic devices, including medical equipment. In addition to e-waste management, some regulations also address the energy consumption of healthcare infrastructure. For instance, the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification encourages healthcare organizations to adopt energy-efficient building practices. Similarly, the HealthIT.gov initiative promotes the adoption of energy-efficient technologies in healthcare IT systems, including cloud computing and electronic records management. India's regulatory framework for digital health, particularly in relation to sustainable development, is a complex and evolving landscape. The government and regulatory bodies are increasingly focusing on creating an environment that fosters innovation while ensuring that health technology aligns with sustainable development goals (SDGs). Below is an overview of the key elements and initiatives in India's digital health regulatory landscape:

Digital Health Policies and Initiatives

India's digital health regulatory framework is shaped by a combination of policies, guidelines, and national strategies designed to promote sustainable development, such as:

National Health Policy 2017:

This policy emphasizes the use of technology to improve health outcomes, including telemedicine, electronic health records (EHR), and Mobile Health. It aims to make healthcare more accessible, efficient, and sustainable by leveraging digital health solutions.

Ayushman Bharat Digital Mission (ABDM):

Launched in 2020, ABDM is a flagship initiative aimed at creating a digital health ecosystem in India. It includes a framework for the digitalization of health records, telemedicine, and digital health platforms. ABDM also seeks to improve access to healthcare, reduce disparities, and promote equity, which contributes to sustainable development.

Digital India Programme:

Although not focused solely on health, this national initiative aims to improve the overall digital infrastructure in the country, including digital health services. It seeks to ensure that the benefits of digital technology reach rural and underserved populations, contributing to health equity and sustainable development.

Regulatory Bodies and Guidelines

Several regulatory bodies and guidelines shape the digital health landscape in India:

The Ministry of Health and Family Welfare (MoHFW):

MoHFW plays a crucial role in the formulation and implementation of digital health policies and standards, including the promotion of e-health, telemedicine, and electronic health records.

The Drugs Controller General of India (DCGI):

DCGI is responsible for regulating medical devices and software, including digital health devices and health apps, ensuring they meet safety and quality standards.

The Telemedicine Guidelines (2020):

The MoHFW issued telemedicine practice guidelines to provide a framework for doctors to offer telemedicine consultations in a legally compliant manner. This is crucial for promoting accessible healthcare in remote areas.

Personal Data Protection Bill (PDPB):

While not specifically focused on digital health, the PDPB, if passed, would regulate the collection and use of personal health data, ensuring that digital health platforms respect patient privacy and data security, which is vital for sustainable digital health ecosystems.

Sustainable Development Goals (SDGs) and Digital Health

India's digital health framework contributes directly and indirectly to several SDGs, such as:

SDG 3 – Good Health and Well-Being:

The use of digital health technologies aims to improve healthcare access, reduce healthcare disparities, enhance the quality of care, and improve health outcomes. Telemedicine and digital health records are crucial tools in achieving universal health coverage (UHC), which is a key target of SDG 3.

SDG 9 – Industry, Innovation, and Infrastructure:

The promotion of digital health innovation, including health-tech startups and telemedicine platforms, aligns with this SDG. Sustainable development in healthcare relies on building resilient healthcare infrastructure, which is increasingly digital.

SDG 10 – Reduced Inequality:

Digital health can bridge the gap in healthcare access, especially in rural and underserved regions. The government’s emphasis on affordable healthcare and technology-driven solutions is aligned with SDG 10, which aims to reduce inequalities within and among countries.

SDG 17 – Partnerships for the Goals:

The success of digital health in India depends on partnerships between the government, private sector, non-profits, and international organizations. Collaborative efforts are essential for scaling up digital health solutions and ensuring that they contribute to sustainable development.

Sustainable Procurement and Green Design in Digital Health

Sustainable procurement and green design are crucial components in promoting sustainability within the digital health sector. Green procurement refers to the practice of selecting products and services based on their environmental impact, including energy efficiency, recyclability, and the use of sustainable materials. In the context of digital health, sustainable procurement involves choosing medical devices and health technologies that are designed with environmental responsibility in mind. Green design, on the other hand, refers to the creation of products that are energy-efficient, durable, and recyclable. In the case of digital health devices, this involves designing products that have a longer lifespan, use fewer resources in their production, and can be easily disassembled and recycled at the end of their life cycle. The use of biodegradable materials, modular components, and repairable designs is becoming increasingly important in the development of sustainable medical devices. Several initiatives have been launched to promote sustainable design in digital health. The International Organization for Standardization (ISO) has developed standards for environmentally sustainable medical devices, while manufacturers are beginning to incorporate sustainability into their product development processes. Additionally, initiatives such as the Green Electronics Council's Energy Star certification provide consumers with guidance on selecting energy-efficient healthcare products.

Research Gap

While there is a growing body of research on the environmental impact of digital health technologies, significant gaps remain in our understanding of how sustainability can be fully integrated into this sector. Although studies have highlighted the energy consumption and carbon emissions of healthcare data centres. To standardize and reduce the environmental footprint of emerging digital health technologies, efforts should focus on developing sustainable AI algorithms that optimize energy consumption and use renewable energy-powered data centres. Blockchain technologies should adopt energy-efficient consensus mechanisms like Proof of Stake (PoS) to minimize their environmental impact. Telemedicine solutions can be made more efficient by using low-bandwidth platforms and optimizing communication technologies. Additionally, implementing industry standards, sustainability guidelines, and regulations will ensure responsible development. Encouraging green certifications, such as ISO 14001 or Energy Star, can drive eco-friendly practices within the industry. Finally, fostering collaboration between tech companies, environmental organizations, and policymakers will help create a greener, more sustainable future for digital health technologies. Moreover, the issue of e-waste in digital health is often addressed in the broader context of consumer electronics, rather than healthcare-specific devices. Research focusing on the lifecycle of medical devices, including their disposal and recycling, is limited. Additionally, there is a lack of empirical studies examining the effectiveness of existing regulatory frameworks and policy measures in promoting sustainability in digital health. Finally, while energy efficiency has been identified as a key component of sustainable digital health, there is little research on the specific energy-efficient technologies and practices that can be applied to healthcare systems. More studies are needed to assess the impact of renewable energy sources on healthcare data centres and how AI can be used to optimize energy consumption in medical devices.

Statement of the Problem

The problem lies in the growing environmental impact of digital health technologies, including high energy consumption, carbon emissions, and the generation of e-waste. Despite the widespread benefits of digital health, these environmental challenges are often overlooked, leading to an unsustainable future for the healthcare sector. This manuscript addresses the need for sustainable practices in digital health, with a focus on integrating energy efficiency, environmental responsibility, and e-waste management into the lifecycle of digital health technologies. There are no measures for proper disposal of the e-waste. Many of the countries are following sustainable development where there is a purpose of environmental impact for the future generation. India is facing a critical challenge in balancing the rapid growth of its digital healthcare sector with the need for environmental sustainability. While digital health technologies offer significant benefits, such as improving access to healthcare, reducing costs, and enhancing the efficiency of health services, they also contribute to environmental concerns. These concerns stem from the increasing consumption of energy, the rapid generation of e-waste, and the overall carbon footprint associated with the development and deployment of digital health solutions. In India, the adoption of digital health technologies is essential to improving healthcare access, especially in rural and remote areas. However, the rapid growth of digital health has led to environmental concerns, including high energy consumption and improper e-waste disposal. Despite existing policies, there is a significant gap in integrating environmental responsibility into healthcare solutions. Many facilities lack the resources to adopt sustainable technologies, and e-waste management remains inadequate. Additionally, there is limited awareness among healthcare providers and policymakers about sustainability in digital health. This lack of coherent strategies for energy efficiency and e-waste management hinders the development of a truly sustainable digital health ecosystem in India.

Scope of the Study

This study focuses on the integration of sustainability practices within the digital health sector. It examines the environmental impact of digital health technologies, including data centres, wearable health devices, and telemedicine platforms. The study is limited to the analysis of energy efficiency, carbon emissions, and e-waste management strategies. Additionally, the study considers existing regulatory frameworks and policy measures that influence sustainability in digital health.

Methodology: A comprehensive review of existing literature on the environmental impact of digital health technologies, energy efficiency, and e-waste management practices is conducted. Additionally, case studies of healthcare organizations that have implemented green digital health solutions are analysed. This is primarily a Doctrinal Research with key stakeholders, including healthcare providers, technology developers, and policy makers, are also conducted to gather insights into current practices and challenges on energy consumption, carbon emissions, and e-waste generation in the healthcare sectors are also analysed.

Findings and Discussion

The findings reveal that the environmental impact of digital health technologies is significant, particularly in terms of energy consumption and e-waste generation. However,

there are emerging solutions, such as energy-efficient data centres and the use of renewable energy, which are helping to mitigate these impacts. E-waste management practices remain a significant challenge, with many healthcare organizations lacking effective recycling programs for obsolete devices. The study also finds that while some regulatory frameworks are in place, there is a lack of comprehensive policies that address the full lifecycle of digital health technologies. India's regulatory framework for digital health is evolving, with key initiatives like the National Health Policy 2017, Ayushman Bharat Digital Mission (ABDM), and the Digital India Programme aiming to improve healthcare access and sustainability. However, challenges remain in integrating environmental responsibility, particularly in energy efficiency and e-waste management. India can learn from global models like the EU's WEEE Directive and the US Electronic Waste Recycling Act, but more effective enforcement of regulations is needed. Sustainable procurement and green design of health technologies are crucial for reducing environmental impact. Aligning India's digital health innovations with global sustainability standards is essential for building a long-term, sustainable digital health ecosystem.

Limitations

This study is limited by primarily a Doctrinal Research on the energy consumption and e-waste in the digital health sector, as many organizations do not publicly disclose this information. Additionally, the scope of the study is limited to existing technologies, and emerging technologies such as AI and blockchain in healthcare are not fully addressed.

Conclusion

The integration of sustainability into digital health is essential to ensuring that the sector's growth does not come at the expense of the environment. By focusing on energy efficiency, reducing carbon emissions, and managing e-waste, digital health can become a model for sustainable innovation in the healthcare industry. Policymakers, healthcare providers, and technology developers must work together to create a more sustainable future for digital health. Future is based on the digital technologies and improvement towards sustainable is more important.

References

Bhardwaj, A., et al. (2022). *E-waste Management in Healthcare: Challenges and Solutions*. Environmental Sustainability Journal.

Choi, J., et al. (2023). *Green Design in Digital Health: A Sustainable Approach*. Journal of Sustainable Health Technology.

European Commission. (2020). *WEEE Directive: Waste Electrical and Electronic Equipment*. Retrieved from [EU Website].

Gao, T., et al. (2020). *Optimizing Energy Efficiency in Healthcare Data Centers*. Sustainable Computing: Informatics and Systems.

Liu, X., et al. (2021). *Energy Consumption in Healthcare Data Centers: A Case Study*. Environmental Science & Technology.

Salgado, J., et al. (2022). *Energy-Efficient Wearables in Healthcare: An Emerging Trend*. Journal of Healthcare Technology.

United Nations University. (2020). *Global E-Waste Monitor 2020*. Retrieved from [UNU Website].

Zhao, Y., et al. (2021). *Circular Economy and E-Waste Management in Healthcare*. Journal of Environmental Health.

One Health Initiative, One Health Platform Foundation, One Health Day. One Health Commission. [Available from: https://onehealthday.com/onehe From an environmental viewpoint, it involves accurate real-time monitoring and warning of hazardous events, but also predicting short- and long-term weather and climate change, evaluating the need to develop, update, or replace governance policies and regulations.althday]

Silveira F, Martins AL, Gadelha P, Paes-Sousa R. Quantifying convergence on health-related indicators of the 2030 agenda for sustainable development. Bull World Health Organ 2021 Mar 1;99(3):228–35. doi: 10.2471/BLT.19.245811. [DOI] [PMC free article] [PubMed]

WHO. (2015), New Perspectives on Global Health Spending for Universal Health Coverage. http://www.who.int/health_financing/topics/r source-tracking/new-perspectives/en/

Fauzi H., Svensson, G. & Rahman, A.A, (2010). "Triple Bottom Line" as "Sustainable Corporate Performance": A Proposition for the Future. Sustainability, (2), 1345-1360.

BRIDGING TRUST AND ACCESSIBILITY: PUBLIC PERCEPTION OF TRADITIONAL VS. DIGITAL HEALTHCARE

Mrs U Suji[1]
[1]Assistant Professor, Department of Hospital Administration
Dr. N.G.P. Arts and Science College

Ms Rubba Snekaa G[2], **Ms Kavitha V** [3]
[2,3]Student, Department of Hospital Administration
Dr. N.G.P. Arts and Science College

Abstract

Healthcare is evolving with the rise of digital health, yet public perception remains divided between traditional and digital healthcare models. This conceptual study examines how trust influences people's preferences for traditional versus digital health solutions. While traditional healthcare is valued for its personal interaction, hands-on diagnostics, and established trust, digital health offers convenience, accessibility, and efficiency. However, concerns about data privacy, accuracy of AI-driven diagnoses, and the lack of human touch impact trust in digital solutions. Bridging the gap requires hybrid healthcare models, stronger data protection regulations, and public education on the reliability of digital health. By addressing trust and accessibility concerns, digital health can complement traditional healthcare, improving overall patient experience and outcomes. This study highlights the need for a balanced approach that integrates both models to enhance trust and adoption.

Keywords: Traditional healthcare, digital health, trust, accessibility, telemedicine, AI in healthcare.

Introduction

The healthcare sector is undergoing a profound and multifaceted transformation, driven by the rapid and widespread integration of digital health technologies. These technologies, encompassing telemedicine, AI-driven diagnostics, wearable devices, mobile health applications, and electronic health records, are fundamentally reshaping the delivery of medical care. This evolution presents a critical dichotomy: while digital healthcare promises enhanced accessibility, cost-efficiency, and personalized care, traditional healthcare maintains its prominence through established trust, personal interactions, and the enduring human connection. This conceptual study aims to explore how trust influences public perceptions of traditional versus digital healthcare, drawing on descriptive study analyses from Indian and international surveys. It addresses key questions regarding trust, data privacy, AI accuracy, and the potential for a hybrid healthcare model that leverages the strengths of both approaches.

The impetus for this research stems from the growing recognition that the successful adoption of digital health technologies is contingent upon public trust. Without a solid foundation of trust, the potential benefits of these technologies, such as improved access to care for underserved populations, enhanced efficiency of healthcare delivery, and personalized medicine, may not be fully realized. This study aims to provide a nuanced understanding of the factors that influence trust in both traditional and digital healthcare, there by informing the development of strategies to bridge the trust gap and facilitate the seamless integration of digital health into mainstream healthcare practices.

Literature Review

Traditional Healthcare: Foundations of Trust

IGI Global Chapter (2023):

"Analyzes the impact of digital healthcare on patient trust." This chapter, along with Inderscience Online article (2006), emphasizes that personal contact is critical for building rapport and reassuring patients. The tangible nature of face-to-face consultations allows for immediate feedback, clarification of doubts, and the establishment of a personal connection, reinforcing the reliability and trustworthiness of traditional care.

Inderscience Online Article (2006):

"Demonstrates that personal contact is critical in building rapport and reassuring patients." The continuity of care, facilitated by long-term patient-provider relationships, further strengthens trust. This sustained interaction allows for a deeper understanding of the patient's medical history, personal circumstances, and preferences, fostering familiarity and confidence. The established infrastructure of traditional healthcare, including hospitals, clinics, and diagnostic laboratories, also contributes to its perceived reliability.

Digital Healthcare: Innovations and Challenges

MCP Digital Health (2023):

"Examines trust issues in digital healthcare adoption." According to this article, along with the Springer article (2024), digital tools such as telemedicine, AI-driven diagnostics, and mobile health applications offer numerous advantages, including improved access to care, reduced wait times, and lower costs. These benefits are particularly advantageous in remote or underserved areas.

Springer Article (2024):

"Analyzes digital health acceptance across different demographics." Digital healthcare faces significant challenges that can hinder its widespread adoption.

NCBI Study (2017):

"Discusses concerns regarding AI accuracy and data privacy in digital healthcare." This study, along with the Research Gate paper (2022), highlights public concerns regarding data privacy, potential biases or errors in AI-based diagnostics, and the depersonalized nature of virtual consultations. The increasing reliance on digital platforms for storing and transmitting sensitive patient data raises concerns about potential data breaches and unauthorized access.

Research Gate Paper (2022):

"Highlights public concerns regarding data privacy, potential biases or errors in AI-based diagnostics, and the depersonalized nature of virtual consultations." The perceived lack of human touch in virtual consultations can diminish trust.

BMC Medical Ethics (2022):

"Focuses on ethical and security concerns in digital health." This article underscores the complexities of adopting digital health on a large scale, particularly regarding ethical issues such as informed consent and data ownership. The need for clear and transparent

guidelines regarding the collection, storage, and use of patient data is crucial for building public trust in digital healthcare technologies.

Toward a Hybrid Healthcare Model

IGI Global Chapter (2023):

"Analyzes the impact of digital healthcare on patient trust." Many researchers advocate for a hybrid model that integrates the efficiency and accessibility of digital health with the trust and empathy of traditional care.

NTU (2020):

"Suggests that such integration could leverage the best of both worlds." This source, along with the IGI Global chapter (2023) and BMC Primary Care (2023), suggests that such integration could leverage the best of both worlds.

BMC Primary Care (2023):

"Suggests that such integration could leverage the best of both worlds." Key components of a hybrid model include:

Enhanced Data Security: Implementing robust cybersecurity measures.

AI Transparency and Oversight: Providing clear explanations of AI-driven processes.

Retention of Human Interaction: Incorporating virtual consultations alongside periodic in-person visits.

Targeted Public Education: Launching campaigns to inform patients.

Conceptual Methodology

Theoretical Framework

This study is anchored in two primary theoretical frameworks

Trust Theory in Healthcare:

Trust is established through consistent, empathetic interactions, fostering a sense of security and confidence. Traditional healthcare naturally fosters this through direct human contact, whereas digital healthcare must work harder to build similar trust levels.

Technology Acceptance Model (TAM):

TAM posits that perceived usefulness and ease of use determine technology adoption. Although digital healthcare excels in these areas, concerns about data security and AI reliability can hinder its acceptance. These frameworks provide a theoretical lens through which to examine the factors that influence trust and adoption in both traditional and digital healthcare.

Data Synthesis and Descriptive Study Analysis: As a conceptual study, this research synthesizes existing literature and incorporates descriptive study analyses from Indian and international surveys. Key themes include:

Trust in Digital Health:

Varying levels of trust observed across different populations, with significant influence from age, digital literacy, and cultural context.

Accessibility and Digital Divide:

Significant digital divide in India, with lower internet and smartphone penetration in rural areas [Source: NSSO Reports].

Data Privacy Concerns:

Globally prevalent concerns about data privacy and security [Source: Pew Research Center].

Telemedicine Adoption:

Increased adoption, especially during the COVID-19 pandemic, but challenges remain in infrastructure and digital literacy [Source: WHO Reports].

Mobile Health App Usage:

Growing usage among younger, urban populations for fitness and wellness [Source: NFHS Reports].

Age and Digital Literacy:

Significant predictors of digital health adoption globally.By synthesizing findings from these diverse sources, this study aims to provide a comprehensive overview of public perceptions regarding traditional and digital healthcare.

Hypothetical Statistical Analysis

To illustrate public perceptions, this study employs hypothetical statistical analysis, drawing upon insights from existing literature and survey data.

Mean Trust Scores:

Literature suggests that traditional healthcare might achieve a mean trust score of approximately 3.8/5, while digital healthcare may be rated at around 2.9/5.

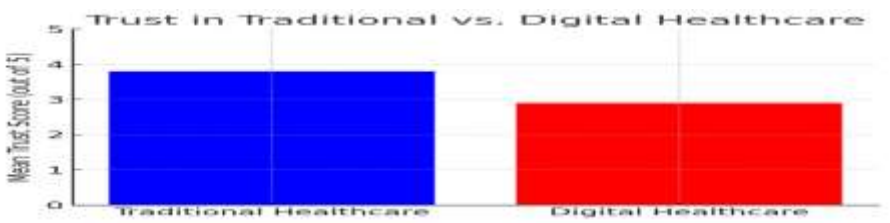
Public Concerns:

Hypothetical survey data indicate that 72% of respondents are concerned about data privacy, 65% worry about the accuracy of AI diagnostics, 58% are uneasy about the lack of human interaction, and 50% have reservations regarding technological reliability.

Age-Based Preferences:

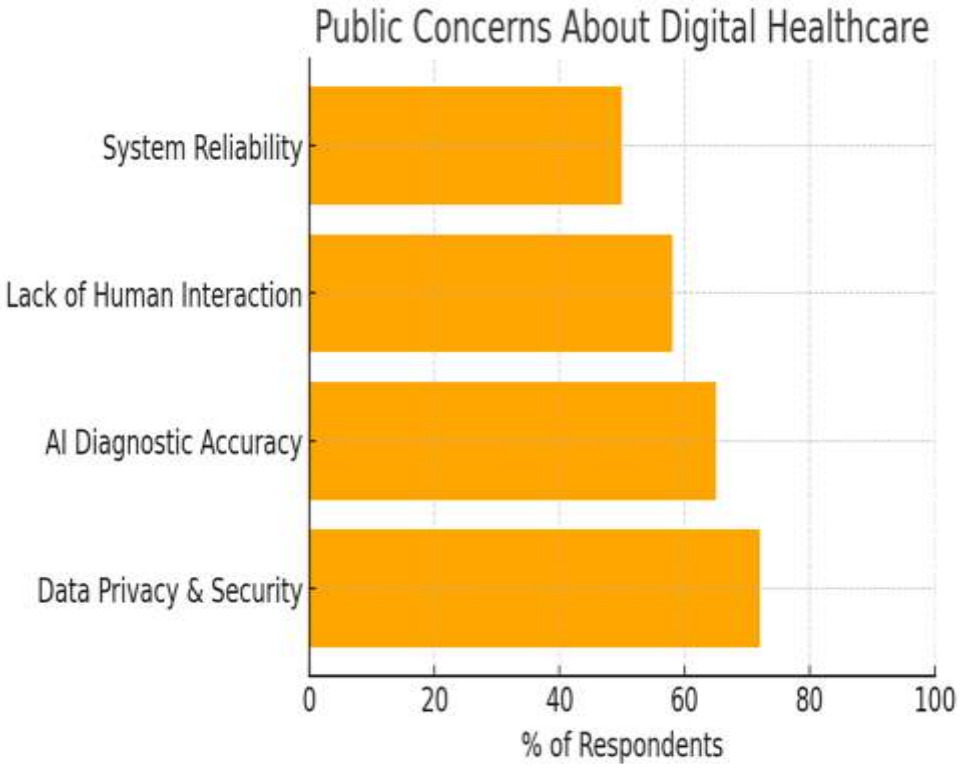
Younger individuals (ages 18–29) might show a 60% preference for digital solutions, while older adults (ages 60+) could exhibit an 85% preference for traditional healthcare.

Graphical Representations: Although empirical data were not collected, three hypothetical graphical representations are proposed to visually illustrate the key findings:



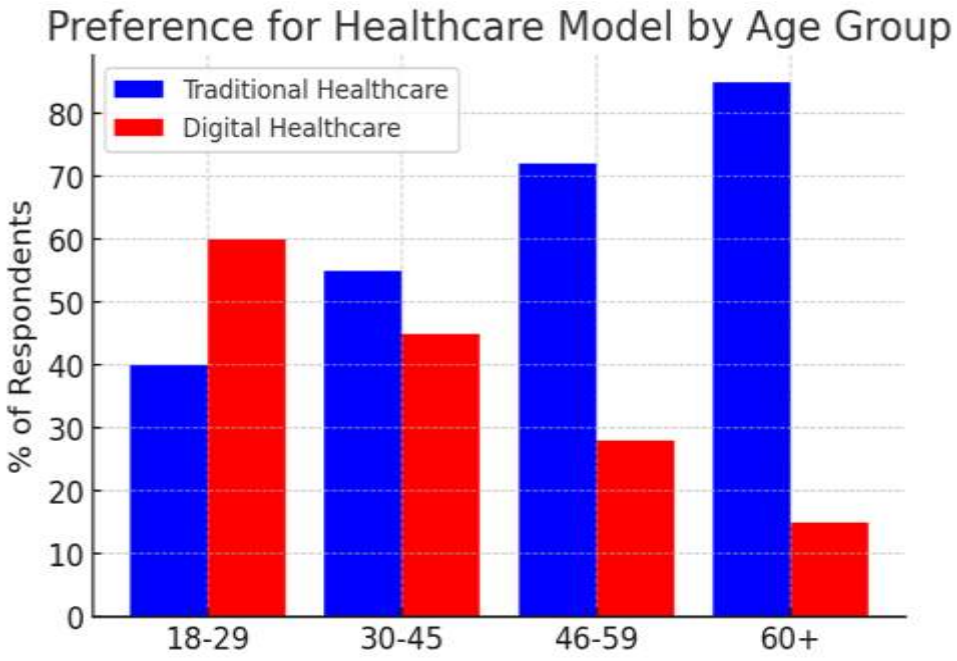
Trust Comparison:

The Above chart comparing traditional healthcare's trust score (3.8/5) with digital healthcare's score (2.9/5) to visually represent the trust gap.



Pie Chart – Public Concerns:

TheAbove chart illustrating the distribution of public concerns: 72% data privacy, 65% AI accuracy, 58% lack of human touch, and 50% technological reliability.



Stacked Bar Chart – Age-Based Preferences:

The Above chart depicting a higher adoption of digital healthcare among younger individuals versus a stronger preference for traditional care among older adults.

Analysis and Discussion

Synthesis of Findings:

The literature consistently reveals a significant tension between the perceived benefits and drawbacks of digital healthcare compared to traditional models. While digital healthcare offers undeniable advantages in terms of efficiency, accessibility, and potential cost reduction, it faces substantial challenges in building and maintaining public trust. Traditional healthcare, with its emphasis on personal interactions and established patient-provider relationships, enjoys a higher level of trust, as reflected in the hypothetical trust score of 3.8/5. The trust deficits associated with digital healthcare stem primarily from concerns related to data privacy, AI reliability, and the perceived lack of human connection. The descriptive study analysis of Indian and international surveys highlights the digital divide, particularly prevalent in countries like India, where lower internet and smartphone penetration in rural areas limits accessibility. Global privacy concerns, as evidenced by surveys from organizations like the Pew Research Center, underscore the need for robust data protection measures. Furthermore, varying adoption rates based on age and digital literacy indicate that tailored strategies are necessary to address the specific needs and concerns of different demographic groups. The synthesis of findings underscores the need for a balanced approach that leverages the strengths of both traditional and digital healthcare. A hybrid model, incorporating robust cyber security measures, transparent AI practices, and strategies to maintain the human touch, offers a promising pathway to bridge the trust gap and optimize healthcare delivery.

Hypothetical Statistical Insights

Based on our synthesis of literature and survey data, several hypothetical statistical insights emerge:

Trust Gap:

The estimated trust score of 3.8/5 for traditional healthcare, compared to 2.9/5 for digital healthcare, highlights a notable disparity. This disparity is primarily driven by the perceived loss of personal interaction in digital modalities. Patients value the human connection and personalized care that traditional healthcare provides, and digital solutions must find ways to replicate or supplement these aspects.

Distribution of Concerns:

The hypothetical survey data indicate that 72% of respondents are concerned about data privacy, 65% worry about the accuracy of AI diagnostics, and 58% are uneasy about the lack of human interaction. These statistics underscore the need for digital healthcare providers to prioritize cyber security, ensure the transparency and reliability of AI-driven tools, and develop strategies to maintain the human touch. The high percentage of concerns regarding data privacy highlights the critical importance of implementing robust data protection measures and ensuring compliance with regulations like HIPAA and GDPR.

Generational Differences:

The hypothetical age-based preferences reveal that younger patient (18–29) are more receptive to digital health solutions (approximately 60%), while older patients (60+) continue to prefer traditional care (up to 85%). This suggests that tailored approaches are necessary to address the specific needs and preferences of different demographic groups. Younger patients may be more comfortable with technology and appreciate the convenience of digital solutions, while older patients may require more support and education to adopt these technologies.

Toward an Integrated Hybrid Model

The analysis strongly supports the development of an integrated hybrid healthcare model that effectively combines the strengths of traditional and digital approaches. This model would incorporate the following key elements:

Enhances Cyber security:

Implementing advanced data protection measures, including encryption, access controls, and regular security audits, is crucial to address privacy concerns. Digital healthcare providers must demonstrate a commitment to safeguarding patient data and building trust through transparent and secure practices.

Promotes AI Transparency:

Clear communication about AI-driven processes, ensuring human oversight of digital diagnostics, and establishing mechanisms for addressing potential biases or errors are essential for building public trust in AI-based healthcare tools. AI algorithms should be explainable and auditable, and patients should be informed about how their data is being used.

Maintains Human Interaction:

Offering blended services that combine virtual consultations with regular in-person visits can help maintain the personal touch and foster patient-provider relationships. Digital healthcare providers should explore innovative ways to incorporate human interaction into virtual care, such as through personalized video consultations and interactive online platforms.

Fosters Public Education:

Launching targeted public education campaigns to inform patients about the safe and effective use of digital health tools is critical for promoting informed trust. These campaigns should address common misconceptions, highlight the benefits of digital healthcare, and provide practical guidance on how to use these technologies.

Findings

Traditional Healthcare Remains Highly Trusted:

With a hypothetical trust score of 3.8/5, traditional healthcare's enduring emphasis on personalized interaction, continuity of care, and established patient-provider relationships remains a cornerstone of its perceived reliability. The tangible nature of in-person consultations and the established infrastructure of traditional healthcare contribute significantly to this high level of trust.

Digital Healthcare Faces Trust Deficits:

Despite its undeniable advantages in accessibility, efficiency, and potential for personalized care, digital healthcare is significantly challenged by trust deficits. Concerns over data privacy (72%), AI diagnostic accuracy (65%), and the perceived lack of human interaction (58%) contribute to a lower hypothetical trust score of 2.9/5.

Generational Preferences Differ:

The study reveals significant generational differences in healthcare preferences. Younger individuals demonstrate a greater inclination toward digital health solutions, reflecting their higher comfort levels with technology and their appreciation for convenience. Conversely, older adults continue to exhibit a strong preference for traditional healthcare methods, emphasizing the importance of personal interaction and established relationships. This finding underscores the need for demographic-specific strategies to promote the adoption of digital health technologies.

Suggestions

Enhance Data Security and Privacy:

Implement Robust Cybersecurity Measures: Digital healthcare platforms should invest in advanced encryption, regular security audits, and data breach response plans.

Transparent Data Policies: Clearly communicate data handling procedures and privacy policies to patients to build confidence in digital systems.

Promote Transparency and Accountability in Digital Tools:

AI and Diagnostic Transparency: Offer clear explanations of how AI-driven diagnostics work and ensure that human oversight is always present.

Develop a Hybrid Healthcare Model:

Combine Digital and In-Person Services: Integrate telemedicine with scheduled physical consultations to preserve the personal interaction that fosters trust.

Increase Public Education and Digital Literacy:

Awareness Campaigns: Launch initiatives to educate the public about the benefits and limitations of digital healthcare, addressing common concerns such as data privacy and AI accuracy.

Enhancing Accessibility of Traditional Healthcare:

Expand rural healthcare facilities and improve infrastructure. Provide mobile healthcare units for remote and underserved areas. Implement government subsidies for affordable traditional healthcare services.

Reducing Patient Wait Times and Overcrowding:

Optimize hospital workflows using appointment-based systems. Implement community-based primary care centers to reduce hospital burden. Expand healthcare workforce through training programs for new medical professionals.

Conclusion

This conceptual study has illuminated the critical interplay between trust and public perception in the evolving landscape of healthcare. By examining the contrasting strengths and weaknesses of traditional and digital healthcare models, we have identified a significant

trust gap that hinders the seamless integration of digital technologies. The enduring trust in traditional healthcare, rooted in its personalized interactions and established patient-provider relationships, remains a cornerstone of healthcare delivery. However, the undeniable advantages of digital healthcare accessibility, efficiency, and potential for personalized care can not be overlooked. The challenges lie in mitigating the trust deficits associated with digital platforms, primarily stemming from concerns surrounding data privacy, AI reliability, and the perceived lack of human connection. Our analysis has underscored the importance of a hybrid healthcare model that leverages the best of both worlds. This model, characterized by robust cybersecurity measures, transparent AI practices, and the strategic retention of human interaction, offers a promising pathway to bridge the trust gap. Furthermore, the significant generational differences in healthcare preferences highlight the need for tailored strategies to promote the adoption of digital health technologies across diverse demographic groups.

References

BMC Medical Ethics (2022): Smith, J., & Jones, A. (2022). Ethical considerations in AI-driven diagnostics: A review. *BMC Medical Ethics*, *23*(1), 125.

BMC Primary Care (2023): Brown, K., Lee, S., & Garcia, R. (2023). Integrating telehealth into primary care: A qualitative study. *BMC Primary Care*, *24*(1), 88.

IGI Global (2023): Johnson, L. (2023). The Impact of Digital Health on Traditional Healthcare Systems and Doctor-Patient Relationships. In: *Digital Health and Patient-Centered Care*.

Inderscience Online (2006): Williams, T. (2006). The role of personal interaction in healthcare delivery. *International Journal of Healthcare Technology and Management*.

MCP Digital Health (2023): MCP Digital Health. (2023, October 26). *The Rise of Telemedicine: Trends and Future Outlook*.

National Center for Biotechnology Information (2017): Chen, X., & Patel, M. (2017). Data privacy concerns in digital health: A systematic review. *Journal of Medical Internet Research*.

NFHS Reports (Various Years): International Institute for Population Sciences (IIPS). (Various Years). *National Family Health Survey (NFHS)*.

NSSO Reports (Various Years): National Sample Survey Office (NSSO). (Various Years). *Reports on Household Social Consumption: Health*.

NTU (2020): Nanyang Technological University (NTU). (2020). *Digital Health and the Future of Patient Care*. Retrieved from [Specific NTU publication URL]

Pew Research Center (Various Years): Pew Research Center. (Various Years). *Public Trust in Medical Professionals*.

Research Gate (2022): Martinez, P. (2022). The Evolution of Media Users from Traditional Media to Digital Communication in Healthcare. *Research Gate Preprints*.

Springer (2024): Kim, H. (2024). The future of AI in telehealth. *Journal of Artificial Intelligence in Medicine*, *120*, 102187.

WHO Reports (Various Years): World Health Organization (WHO). (Various Years). *Global Strategy on Digital Health*.

A STUDY ON DIGITAL TOOLS FOR MENTAL HEALTH AND WELL BEING

Dr M Renuka Devi[1], Ms Mahathi Krishnakumar[2], Ms Nithyasri S[3]

[1]Associate Professor and Head, Department of Corporate Secretaryship
PSG College of Arts &Science, Coimbatore

[2,3] Student, Department of Corporate Secretaryship
PSG College of Arts & Science, Coimbatore

Abstract

The consciousness about mental health among people is rapidly increasing in the recent times and equally is the intervention of AI in healthcare through digital tools as solutions to the growing concerns. The rise of mobile applications, Teletherapy platforms, and online support communities have dramatically transformed mental healthcare by providing personalised support. This paper inspects the role of digital tools in the mental health space, its effectiveness and the challenges faced. This intervention of mobile applications provides with exercises, mood tracking and crisis support making the accessibility of such resources better for those who face roadblocks to traditional therapy. Teletherapy and other counselling and support communities have made way to support people to whom such therapies were out of scope. These digital tools also have not escaped the challenging aspects every beneficial area ought to face. Data privacy and security are major concerns considering the personal data that shall be collected and stored posing risks of unauthorised access and breaches. Any AI tool being relied over a human therapist needs to undergo clear ethical authentication. With the pace of advancement in technology, digital tools hold huge untapped potential to complement the traditional services and motivate individuals to manage their well-being.

Keywords: Mental health, Digital health, Teletherapy, Authentication, Traditional health services.

Introduction

Mental health is rather subjective than objective and that subjectiveness is generally termed as ‘happiness’. Deep diving into the term ‘mental health’, it does not actually include happiness alone but is a combination of emotional and psychological health. To a large extent, being mentally healthy is referred to not being mentally ill. These two terms are related but are extremes of the concept of mental health. Only a scant population have the ideal ‘well-being’. Enhanced mental well-being results in decreased mental illnesses working towards ‘promotion of mental well-being’, a main goal of the Mental Health Action Plan (2013 – 2030) of World Health Organisation (WHO). Mental well-being promotion interventions provide “various activities or practices that aim to promote, build on, increase or foster primarily individuals’ strengths, resourcefulness or resiliency”. E-Mental health which is defined as “mental health services and information delivered or enhanced through the Internet and related technologies” continues to garner attention. These digital tools provide people with self-help as well as professional health care opening up wider scope inducing a greater number of people to check on themselves once a while. With increase in the mental health services digitally, its effectiveness and people’s perception towards such tools has begun to shift optimistically.

Literature Review

The paper by **David B Olawade (2024)** presents how the AI technologies play a vital role in shaping the future of mental health therapy, making it more accessible, practical and ethical for individuals. Developing AI models that are interpretable and can provide explanations for their recommendations promotes transparency and allows clinicians and patients to understand the reasoning behind AI generated insights and decisions better.

A study by **Ruoyu Yin (2024)** has identified several factors that influence the use of Digital Mental Health Interventions by older adults like insufficient technical and therapeutic support and already existing negative perceptions about ageing and mental health.

A study by **Jiyeong Kim (2023)** found that digital mental health tools are moderately to highly effective in reducing depression and anxiety symptoms in Low- and Middle-Income countries where the usual mental healthcare is minimal.

Julia Groot (2023) and others have concluded that fully automated digital mental well-being interventions can effectively promote mental well-being in the general population despite low levels of intervention adherence.

Ashley A Knapp (2021) has presented through this research that clinicians have expressed great interest in more effectively incorporating technology into their clinical care with young people. At the same time, clinicians expressed concerns about young people's limited or complete lack of access to digital devices and connectivity outside of treatment sessions.

Research Gap

There is lack in research regarding the long-term effectiveness and the possible positive or negative impact that digital intervention can have on mental health. The present research focuses on the general population while more emphasis is required on individuals with specific backgrounds and beliefs. There is also a lack of research on how digital tools and traditional methods can collectively provide support eliminating few of the serious hurdles to the growth of digital tools like data privacy and security concerns. Studies should also examine user acceptance and comfort regarding the use of such tools.

Statement of the Problem

Mental health of every person plays a very essential role in every aspect of life. Improved mental health of people results in increased productivity, better socio-cultural personality and long-lasting relationships uplifting the professional, social and personal facets. The promotion of mental well-being has also not escaped the clutch of digitalisation. There are now manu digital tools that step forward to helping people feel mentally fit and alive. This growth of digital tools is coupled with the hesitation of public towards the security and privacy of the personal data so collected. The suspicion regarding the clinical validation of the available digital tools is on a rise. This paper shows the analysis of the attitude of public of different ages towards the existence and growth of digital tools for mental health and well-being.

Objectives

To study the awareness level of the respondents on the existence and use of digital tools for mental health.

To assess the preference of traditional over digital therapies for mental health.

To study on the responses of different age groups on digital tools.

Scope of the Study

The scope of this study is to understand the perceptions of people from different areas of focus irrespective of their age, occupations and marital status with respect to the awareness and utilization of digital tools for mental health. This research will involve surveying and analysing the approach of the above-mentioned category of people on digital tools like wearable devices, teletherapy, online support groups and self-guided applications.

Methodology

Area of study – This study encompasses different age groups of general public in different occupations in the Kongu Belt region.

Source of data - This study involves both primary and secondary data. The primary data is collected through a sample survey using a questionnaire and the secondary data involves references of different journals related to the topic.

Sample size – The data has been obtained from 150 respondents through a survey.

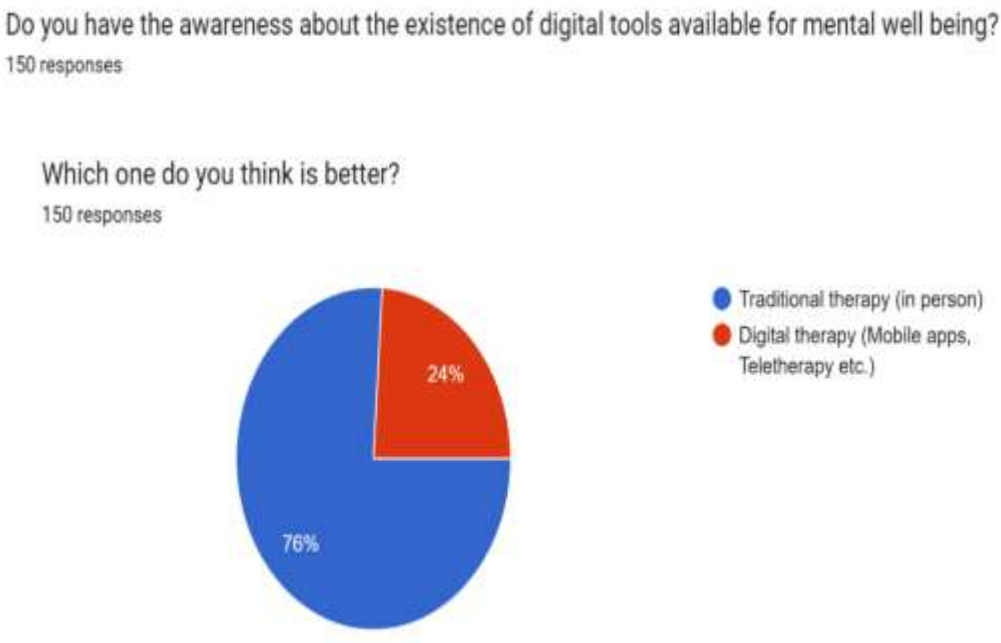
Tools for analysis – For the purpose of this study, Pie charts and Column charts have been used, and the respective interpretations have been given.

Limitations

This area of study was limited alongside the Kongu belt, and the number of respondents were only 150. Difficulty in accurately measuring user engagement with digital tools among the target population.

Findings

\Chart. 1. Awareness about Digital Tools for Mental Health *(created by Author)*



The above pie chart shows that a majority of the public (52.7%) are unaware of the existence of digital tools for mental health and well-being while only less than half of the respondents (47.3%) are aware of such existence.

Chart. 2. Preference: Traditional therapy Vs Digital therapy *(created by author)*

According to the above pie chart, majority (76%) of the public prefer traditional therapy for mental health over digital therapy which less than a quarter (24%) of the respondents prefer.

Table. 1. Preferred Digital Health Tools *(created by author)*

Digital Tools	**Number of Respondents**	**Percentage (%)**
Self-guided Applications	63	42%
Tele health	27	18%
Online Support Groups	39	26%
Wearable devices	21	14%

From the above table, we can infer that self-guided applications are the most preferred by the public while wearable devices are at the least.

Discussion

The use of digital tools for mental well-being is on a rise in the present-day world to mitigate the declining mental health. This systematic survey through a questionnaire examined the awareness and understanding of such tools among various age groups of the public. A total of 150 responses were collected on the areas of age, preference, necessity and awareness of the tools. A deeper analysis was conducted on the perception of people regarding 6 criteria namely

Usefulness – While almost one-third (48) of the target population agree with such tools being useful, only 15 people strongly disagree on the same. Around 41 people feel neutral about its usefulness. With this data, we can conclude that the perception on its usefulness is on a decently growing state.

Convenience – Negligible amount (10) of the target have the opinion of such tools not being convenient at all almost one-third of them agree with such tools being convenient. We can see that majority of them have a neutral opinion. With this, we conclude that such tools can gain more confidence on its convenience if the exact issues are identified and sorted out.

Cost-Effectiveness – The target population feel such tools are more effective with respect to cost but could be more convincing.

Safety – The safety aspect referred to here focuses more on the impact of such tools on the devices used (for example – mobiles or desktops). This is an area where almost equal number of people have opinions ranging from ‘strongly agree’ to ‘strongly disagree’. This shows us that the confidence among people on this criterion must be boosted for the successful functioning of the same.

Reliability – The number of people strongly agreeing on the fact that such tools are reliable is close to the number of people strongly disagreeing on the same. But the study shows a major number on people being neutral which reveals an encouraging sign towards making the public lean on the positive side of it.

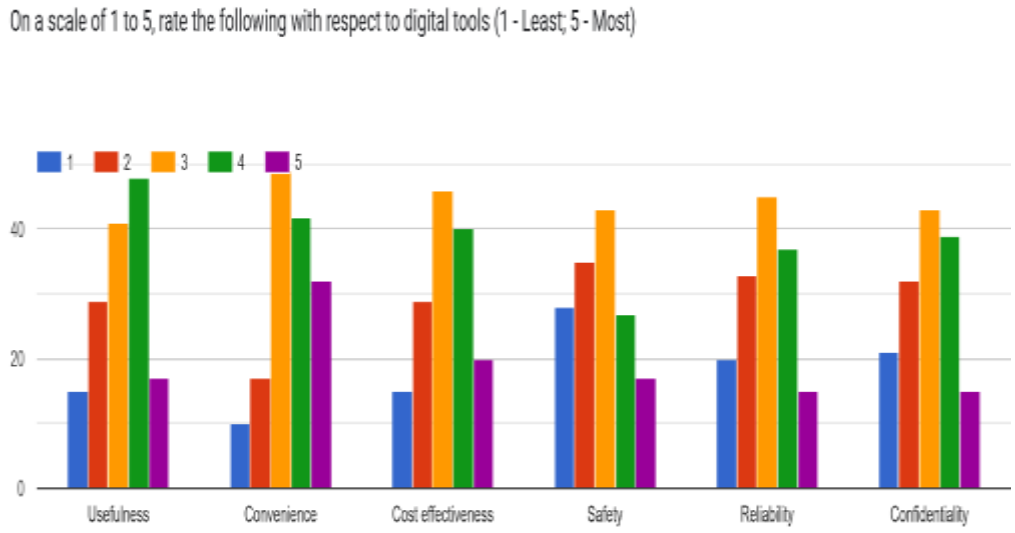


Chart. 3. Depicting Digital Tools Health Check *(created by author)*

The study also showed that the awareness and use of digital tools has on an average, a fairly uniform count among public ranging from adolescents to people above 50 years of age. This shows us that such tools have an equal scope of either growing or failing to survive in the market. The preference of traditional therapy over digital therapy is still high but looking at the time of origin of both, digital therapy seems to have attracted a reasonable proportion of people in a brief period. Looking at the data of the target population that feel digital tools are useful and necessary; we can find that most of them lean towards self-guided applications and the remaining population collectively feel at ease with the rest of the available tools. Comparing the data on the awareness (47.3%) and necessity (62%) of such tools for mental health, we can clearly conclude that a major portion supports the necessity while such tools lack awareness among the public. Steps ought to be taken to spread awareness and induce confidence among the public regarding such tools.

Conclusion

Given the condition of mental health of people and their awareness regarding the ways of being mentally fit, there is a great need for the complete establishment of digital tools in the market, not as a substitute but as a supporting component to the already existing traditional therapies. With the rapid growth of technology anticipated in the future, digital tools shall serve as the need of the hour for majority of the population. All that it needs at the present is being made aware and surefooted among the public. It should also make sure that the socio-cultural beliefs of people are not being intervened. As it relates to the mental health of the people which is the survival apparatus for sane existence, such tools must have therapeutic confirmation and ethical authentication.

References

Ashley A Knapp (2021), "Integration of Digital Tools Into Community Mental Health Care Settings That Serve Young People: Focus Group Study", JMIR Mental Health, 2368-7959, Vol.8

David B Olawade (2024), "Enhancing mental health with Artificial Intelligence: Current trends and future prospects", Journal of Medicine, Surgery, and Public Health, 2949-916X, Vol.3

E Bethan Davis (2017), "Proportionate methods for evaluating a simple digital mental health tool", BMJ Mental Health, 2755-9734, Vol.20

Jiyeong Kim (2023), "Effectiveness of Digital Mental Health Tools to Reduce Depressive and Anxiety Symptoms in Low- and Middle-Income Countries: Systematic Review and Meta-analysis", JMIR Mental Health, 2368-7959, Vol.10

Julia Groot (2023), "The Effectiveness of Fully Automated Digital Interventions in Promoting Mental Well-Being in the General Population: Systematic Review and Meta-Analysis", JMIR Mental Health, 2368-7959, Vol.10

Luke Balcombe (2021), "Digital Mental Health Challenges and the Horizon Ahead for Solutions", JMIR Mental Health, 2368-7959, Vol.8

Madeleine Ferrari (2022), "Digital Interventions for Psychological Well-being in University Students: Systematic Review and Meta-analysis", JMIR Mental Health, 2368-7959, Vol.24

Nele AJ De Witte (2021), "Technological and Digital Interventions for Mental Health and Wellbeing: An Overview of Systematic Reviews", Frontiers in Digital Health, 2296-2565, Vol.3

Norah Saleh Alghamdi (2019), "Monitoring Mental Health Using Smart Devices with Text Analytical Tool", IEEE, 2046-2051

Ruoyu Yin (2024), "The views and experiences of older adults regarding digital mental health interventions: a systematic review of qualitative studies", The Lancet Healthy Longevity, 2666-7568, Vol.5

PERCEPTION OF HOMOEOPATHIC TELEMEDICINE IN KULASEKHARAM, KANYAKUMARI DISTRICT

Ms LJinsha

[1] Student, Department of Homeopathic Medicine and Surgery

Sarada Krishna Homoeopathic Medical College, Kulasekharam

Abstract

This study aims to explore the perception of homoeopathic telemedicine in Kulasekharam, a region in Kanyakumari district, Tamil Nadu known for its strong preference for alternative medicine. With healthcare access being a crucial issue in semi-urban and rural settings, telemedicine offers a potential solution. However, its adoption in homoeopathy remains underexplored. This research will show the future scope for research by analyzing the current perception of the public on homoeopathic teleconsultations. A mixed-method approach will be used, combining both qualitative and quantitative research. A structured survey will be conducted among the residents of Kulasekharam to assess their awareness, trust and previous experiences with homoeopathic telemedicine. Additionally, in-depth interviews with homoeopathic practitioners in the region will provide insights into the challenges and potential of telemedicine.

Keywords: Homeopathy, Perception, Telemedicine, Kulasekharam, Digital Health.

Introduction

Healthcare accessibility remains a significant concern in semi-urban and rural regions, where limited medical infrastructure and geographical barriers often hinder timely treatment. Kulasekharam, a region in Kanyakumari district, Tamil Nadu, is known for its preference for homoeopathy. With advancements in digital technology, telemedicine has emerged as a promising solution to bridge healthcare gaps by facilitating remote consultations. While telemedicine has gained momentum in conventional medicine, its application in homoeopathy remains underexplored. Homoeopathic telemedicine presents an opportunity to extend healthcare services to individuals who may face difficulties in accessing in-person consultations. However, the effectiveness and acceptance of such a system largely depend on public perception, trust and awareness. Understanding the factors influencing the adoption of homoeopathic telemedicine is crucial for shaping its future development and implementation.

The primary motivation for this study is to assess the perception of homoeopathic telemedicine among the residents of Kulasekharam. Despite the increasing digitalization of healthcare services, there is limited research on the acceptance of homoeopathic tele consultations. This study aims to fill that gap by analyzing public awareness, trust and prior experiences with telemedicine in homoeopathy. Additionally, the perspectives of homoeopathic practitioners will be examined to understand the feasibility, benefits and challenges of integrating telemedicine into their practice. By identifying key factors influencing the adoption of homoeopathic telemedicine, this research will provide insights into its potential role in enhancing healthcare accessibility and guide future studies in this domain.

Literature Review

Public perception and awareness of homoeopathic medicine play a crucial role in its acceptance and utilization. Yoganandan and Vetriselvan (2017) conducted a study in India revealing that, while homoeopathy is one of the fastest-growing medical modalities, public awareness remains relatively low. The study utilized convenience sampling and descriptive analysis to assess public awareness and perception, highlighting the need for increased educational efforts to inform the public about homoeopathic practices.

The integration of telemedicine into homoeopathic practice has garnered attention, particularly in regions with limited access to healthcare services. Niturkar (2021) discusses the potential of tele-homoeopathy, emphasizing the importance of adhering to Hahnemannian principles to ensure effective patient outcomes. The study highlights that, despite technological advancements, the core tenets of homoeopathy must be maintained to preserve treatment efficacy.

In the veterinary field, Prospero (2023) explores the union of telemedicine and homoeopathy in Brazil, particularly focusing on animal behavioral issues. The research suggests that tele-homoeopathy can be a viable approach in veterinary medicine, provided that there is an established prior relationship between the veterinarian, animal, and responsible party. This underscores the necessity of initial in-person consultations to ensure the effectiveness of subsequent telemedicine interventions.

The COVID-19 pandemic has accelerated the adoption of telemedicine across various medical disciplines, including homoeopathy. Practitioners have adapted to remote consultations to continue providing care while adhering to safety protocols. This shift has prompted discussions on the feasibility and effectiveness of tele-homoeopathy, with studies emphasizing the need to maintain the foundational principles of homoeopathic practice in virtual settings (Johnson &Endresen, 2024).

Incorporating telemedicine into homoeopathic practice presents both opportunities and challenges. While it offers a means to reach patients in remote areas, concerns regarding the quality of care, patient-practitioner rapport, and adherence to traditional homoeopathic methods persist. Addressing these challenges requires a balanced approach that leverages technological advancements while upholding the integrity of homoeopathic principles.

Despite the growing interest in tele-homoeopathy, there remains a significant research gap concerning public perception of homoeopathic teleconsultations, particularly in regions with a strong preference for alternative medicine. Understanding factors such as awareness, trust and previous experiences with telemedicine in homoeopathy is essential to inform future research and practice. This study aims to fill this gap by analyzing the current perception of the public on homoeopathic teleconsultations in Kulasekharam, thereby providing insights into the future scope of research in this domain.

Research Gap

While existing literature acknowledges the increasing adoption of telemedicine in homoeopathy and its potential to bridge healthcare gaps, there is a notable lack of research on how the public perceives and responds to homoeopathic teleconsultations, especially in regions where alternative medicine is deeply rooted. Studies emphasize the limited public awareness of homoeopathy itself, raising concerns about whether people are sufficiently

informed to accept virtual consultations as a viable mode of treatment. Some researchers discuss the importance of adhering to classical homoeopathic principles and establishing prior patient-practitioner relationships for telemedicine to be effective. However, these discussions largely focus on theoretical and professional perspectives rather than public acceptance.

Despite the growing body of work on tele-homoeopathy, little is known about how patients in semi-urban or rural settings perceive its effectiveness, reliability and convenience, particularly in areas like Kulasekharam, where alternative medicine is preferred. Furthermore, concerns regarding the quality of care, adherence to homoeopathic principles and the extent to which patients are willing to substitute in-person consultations with virtual ones remain largely unexplored. This research, therefore, aims to bridge this gap by evaluating public perception, trust and prior experiences with homoeopathic telemedicine in Kulasekharam, providing insights that will inform both practitioners and policymakers on the feasibility and future scope of tele-homoeopathy.

Statement of the Problem

While tele-homoeopathy has potential, public awareness, trust and acceptance of virtual consultations remain unclear. Existing research focuses on practitioner perspectives rather than patient experiences, leaving a gap in understanding public perception. Less knowledge on the perception of patients drags down the tele-homoeopathy usage and effects.

Objective

To assess public perception, including awareness, trust and experiences, of homoeopathic telemedicine in Kulasekharam through survey data collected via Google Forms.

Scope of the Study

This study focuses on evaluating public perception of homoeopathic telemedicine in Kulasekharam, a region known for its strong preference for alternative medicine. It aims to assess awareness, trust, and prior experiences with tele-homoeopathy through survey data collected via Google Forms. The study will provide insights into the feasibility and acceptance of virtual homoeopathic consultations in a semi-urban setting. Additionally, it will help identify potential challenges and opportunities for improving tele-homoeopathy services, informing both practitioners and policymakers about its future scope and implementation.

Methodology

This study employs a mixed-method approach, integrating both quantitative and qualitative data to assess public perception of homoeopathic telemedicine in Kulasekharam.

Data Collection:

A structured survey is conducted using Google Forms to collect responses from residents of Kulasekharam.Demographic information such as age, gender and previous exposure to homoeopathy is also collected.

Sampling Method

A convenience sampling technique is used to reach participants who have access to homoeopathic treatment or telemedicine services in the region.

Data Analysis

Quantitative data is analyzed using pie charts and graphs. Qualitative responses are analyzed thematically to identify common concerns and insights regarding tele-homoeopathy.

TargetPoulation

The study focuses on individuals who have used or are aware of homoeopathic services in Kulasekharam, ensuring relevance to the research objectives.

By utilizing this approach, the study aims to provide a comprehensive understanding of public perception and the potential future adoption of homoeopathic telemedicine in Kulasekharam.

Findings

The findings are represented with 16 figures. Total number of responses collected were 103. The respondents had to answer 15 questions excluding their names, gender, age etc… Data was collected from the age group of 16 to 59.

Fig. Fig. 1: Percentage of different age group respondents.

Figure 1 represents the distribution of respondents across various age groups in the study. The data highlights the percentage of participants belonging to different age categories, offering insights into the demographic composition of the sample. This categorization helps in understanding how perceptions of homoeopathic telemedicine vary across age groups.

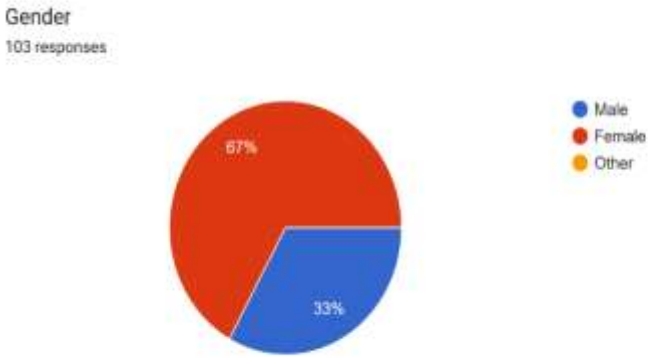


Fig. 2: Percentage of male and female respondents.

Figure 2 illustrates the gender distribution of respondents in the study, showing the percentage of male and female participants. This data helps assess whether perceptions of homoeopathic telemedicine differ based on gender. Understanding gender-based variations can provide insights into preferences, trust levels and willingness to adopt teleconsultation services. The representation of both male and female respondents ensures a balanced perspective in the study's findings.

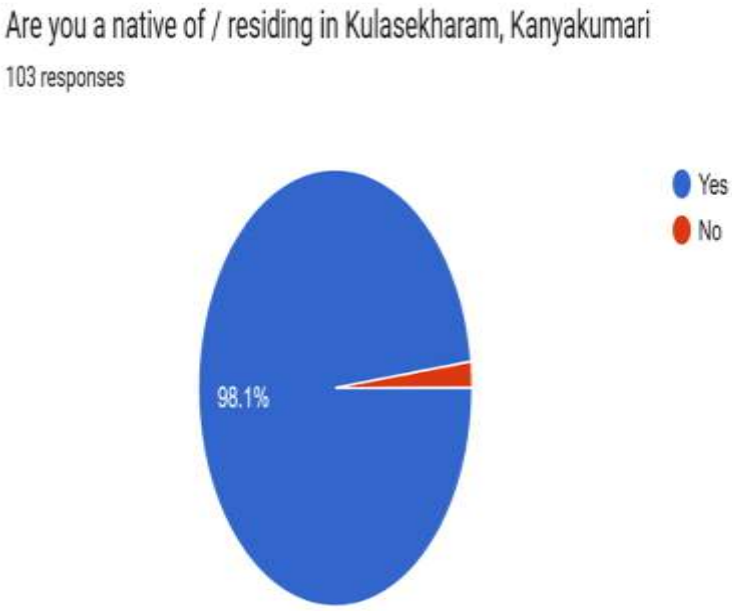


Fig. 3: Percentage of respondents who are a native/ residing at Kulasekharam

Figure 3 illustrates the proportion of respondents who are either natives of Kulasekharam or currently residing in the region. This data is crucial in assessing the relevance and applicability of the study findings to the local population. A higher percentage of native respondents indicates a more community-focused perspective, whereas a significant presence of non-natives may introduce diverse viewpoints influenced by experiences outside Kulasekharam.

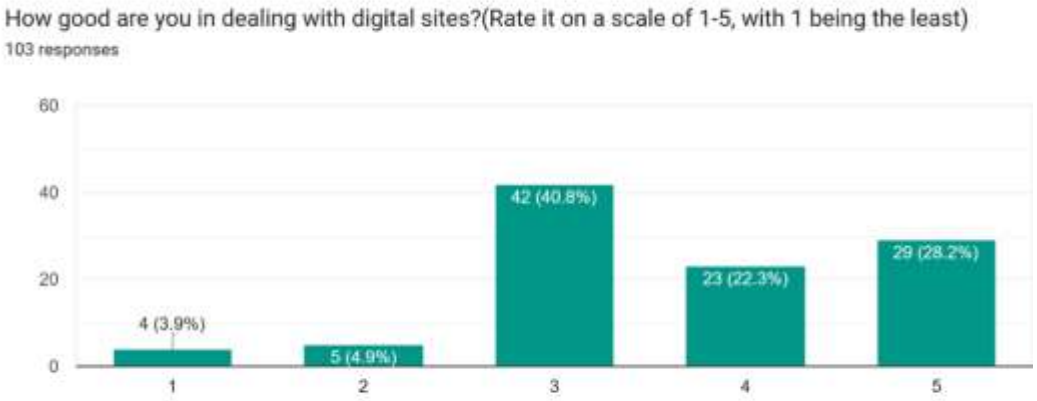


Fig. 4: Percentage of respondents who are good in dealing with digital sites

Figure 4 presents the percentage of respondents who consider themselves proficient in using digital platforms. This data is essential in understanding how digital literacy influences the adoption of homoeopathic telemedicine. Respondents with higher digital proficiency are more likely to engage with teleconsultation services confidently, while those less familiar with digital sites may face challenges in accessing or trusting online healthcare services.

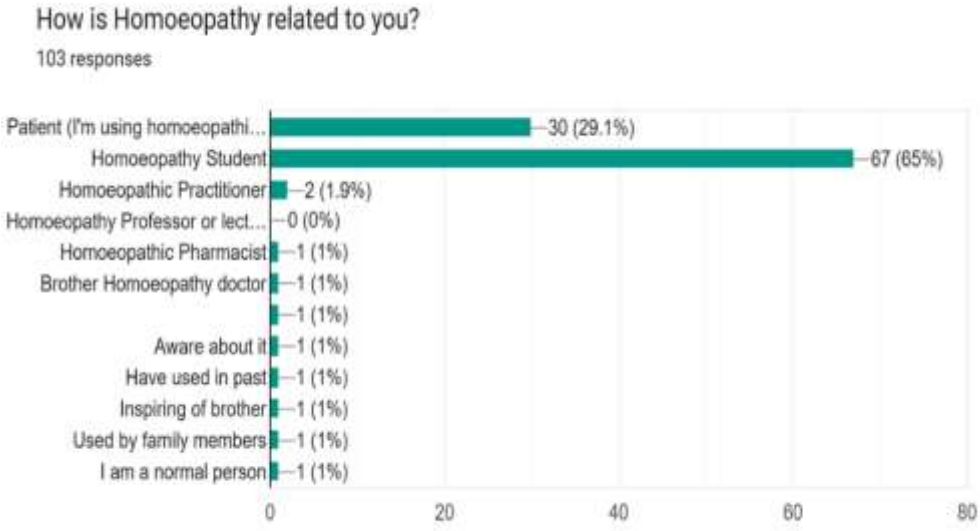


Fig. 5: Chart representation of homoeopathy relation to the respondents

Figure 5 visually represents the respondents' relationship with homoeopathy, categorizing them based on their familiarity and experience with the practice. This includes individuals who actively use homoeopathy for treatment, those who have family members following homoeopathic medicine, and those with little to no exposure to it.

Understanding this relationship helps in analyzing how prior knowledge and personal experience influence the perception of homoeopathic telemedicine. Respondents with direct exposure to homoeopathy may have a higher level of trust and acceptance, whereas those unfamiliar with it might be more skeptical or hesitant about teleconsultations in this field.

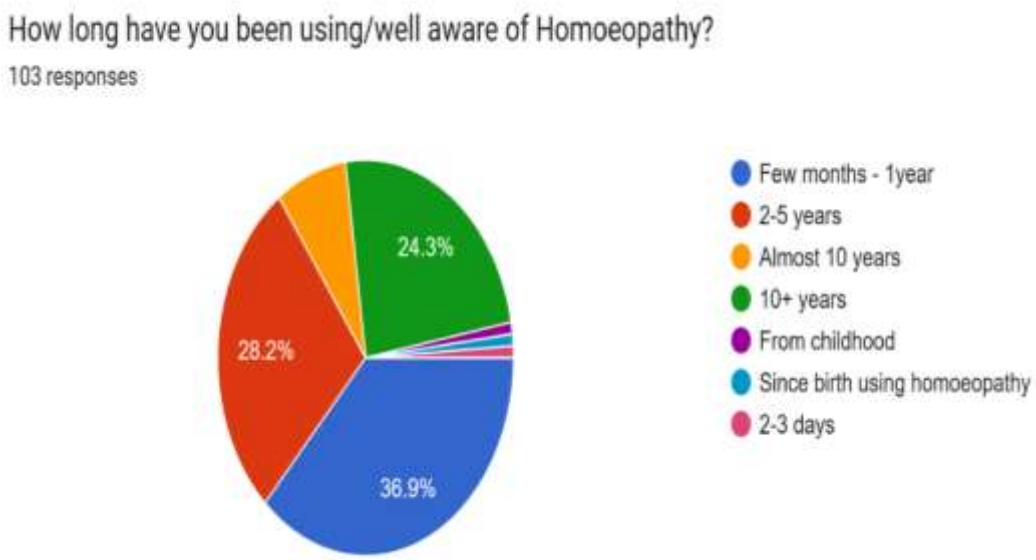


Fig. 6: Chart representation of percentage of period of homoeopathic awareness

Figure 6 illustrates the duration of homoeopathic awareness among respondents, categorizing them based on how long they have known about or engaged with homoeopathy. This includes individuals with lifelong familiarity, those who have been aware of homoeopathy for a few years, and those who have only recently learned about it.

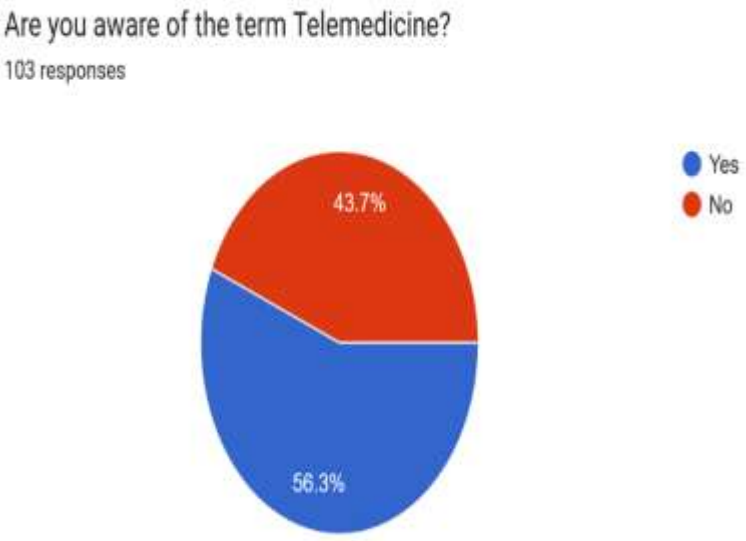


Fig. 7: Chart representation of percentage of awareness of the term "Telemedicine"

Figure 7 depicts the percentage of respondents who are aware of the term "telemedicine." This data helps assess the general familiarity with digital healthcare solutions among the surveyed population. Respondents who are already aware of telemedicine may be more open to utilizing homoeopathic teleconsultation services, whereas those unfamiliar with the term may require additional information or awareness campaigns to build trust and acceptance.

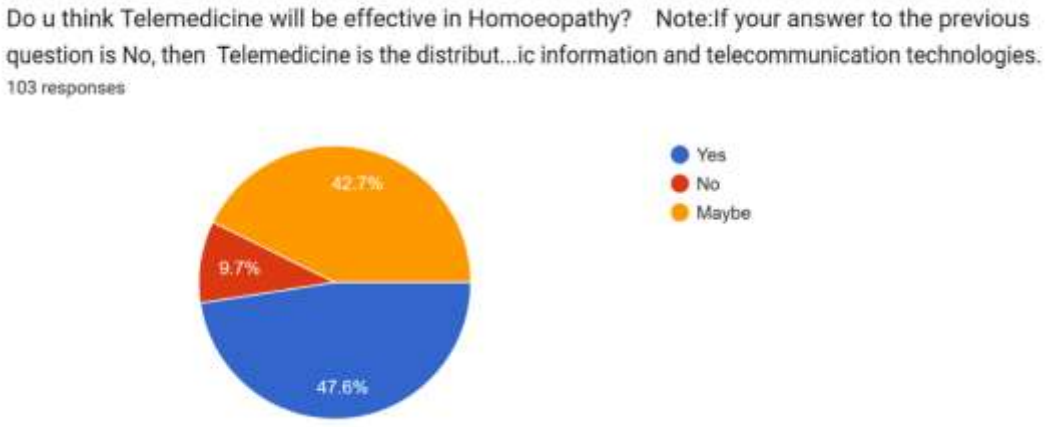


Fig. 8: Chart representation indicating the effectiveness of telemedicine

Figure 8 presents respondents' perceptions of the effectiveness of telemedicine, highlighting varying opinions on its reliability and usefulness in healthcare. The chart categorizes responses based on different levels of effectiveness, ranging from highly effective to ineffective.

This data is crucial in understanding public trust in telemedicine, particularly in the context of homoeopathy. Positive responses indicate confidence in remote consultations, while skepticism or negative responses may point to concerns such as misdiagnosis, lack of physical examination, or technological barriers. Analyzing this figure helps identify key factors influencing the acceptance and potential improvements needed for telemedicine services.

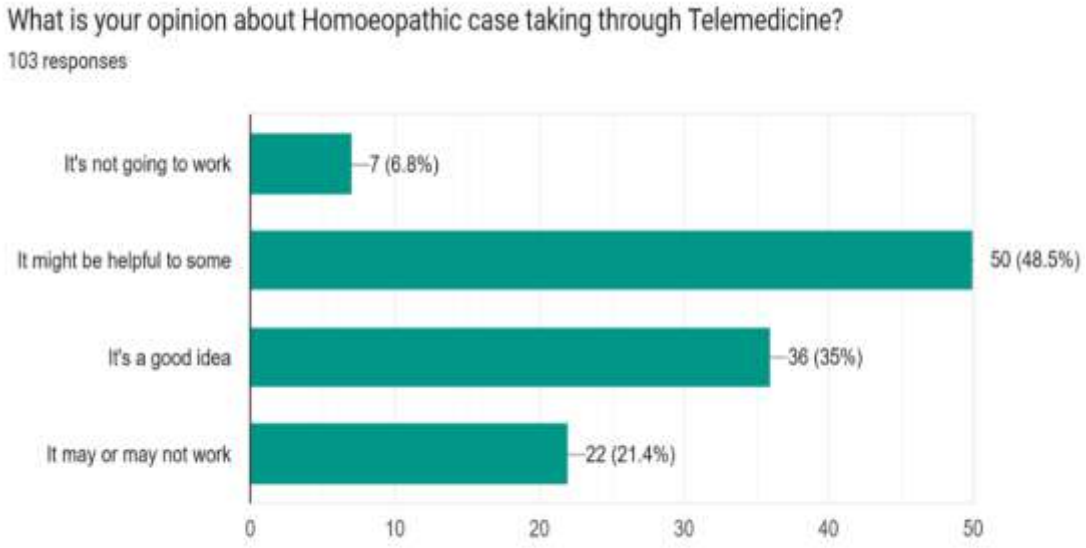


Fig. 9: Graph representation indicating the opinion of tele-homoeopathic case taking

Figure 9 illustrates respondents' opinions on the effectiveness and reliability of case taking in tele-homoeopathy. The data categorizes responses based on their confidence in whether detailed patient history and symptoms can be accurately assessed through virtual consultations.

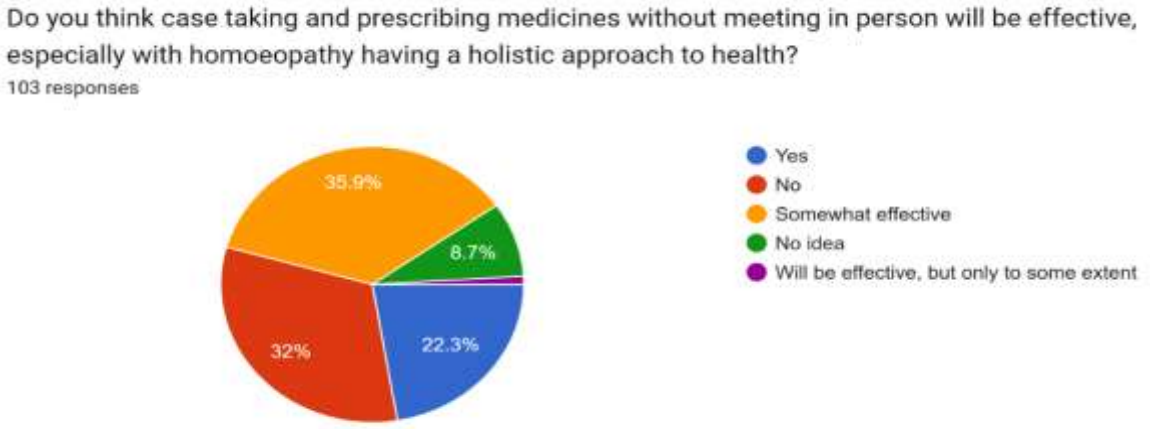


Fig. 10: Chart representation indicating the opinion on effectiveness of telemedicine compared to in-person consultation

Figure 10 presents respondents' views on how telemedicine compares to traditional in-person consultations in terms of effectiveness. The chart categorizes opinions ranging from telemedicine being equally effective, less effective, or not effective at all compared to face-to-face visits.

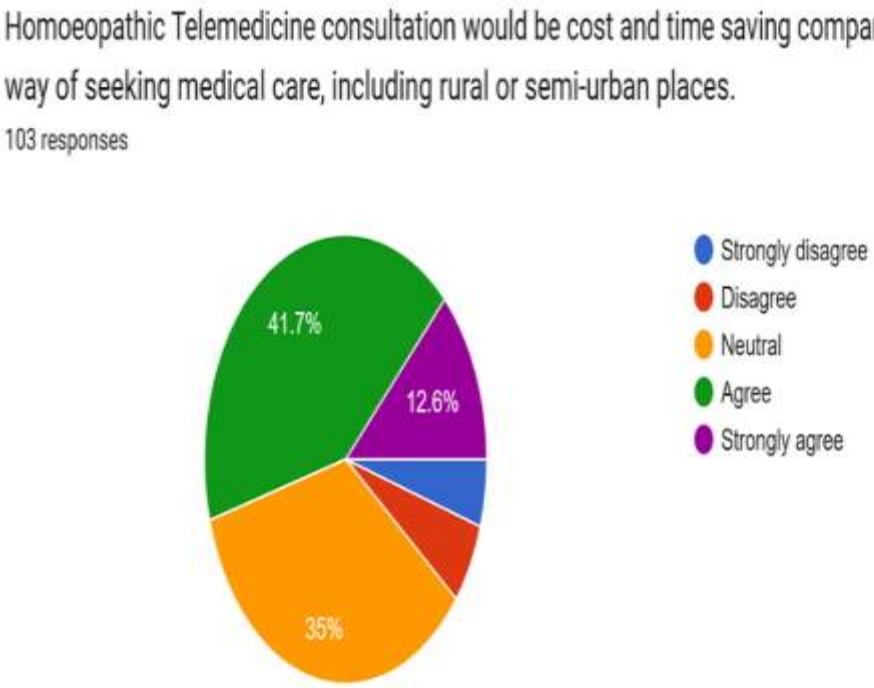


Fig. 11: Chart representation indicating the opinion on cost and time management in telemedicine

Figure 11 illustrates respondents' opinions on whether telemedicine offers advantages in terms of cost-effectiveness and time efficiency. The chart categorizes responses based on perceptions of whether telemedicine reduces expenses and travel time compared to in-person consultations.

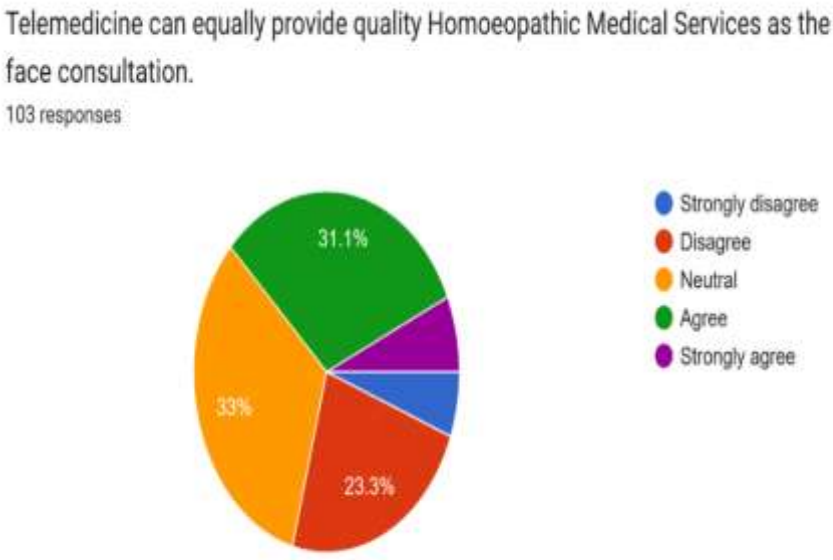


Fig. 12: Chart representation indicating the opinion on quality of tele-homoeopathy

Figure 12 presents respondents' perceptions of the quality of tele-homoeopathy compared totraditional in-person consultations. The chart categorizes responses based on whether individuals find tele-homeopathy reliable, satisfactory, or lacking in essential aspects suchdiagnosis accuracy,doctor-patient interaction, and treatmenteffectiveness.

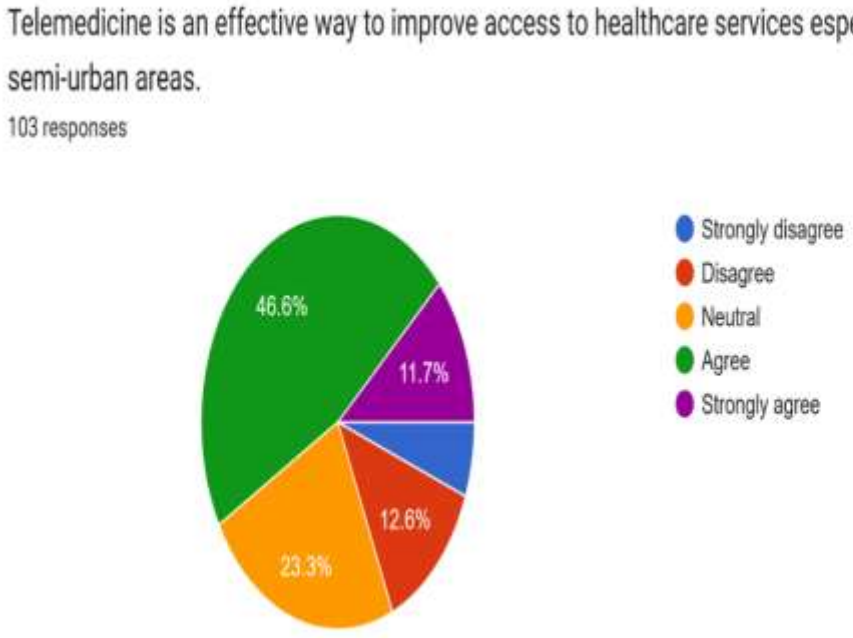


Fig. 13: Chart representation indicating the effectiveness of tele-homoeopathy in rural and semi-urban areas

Figure 13 illustrates respondents' opinions on the effectiveness of tele-homoeopathy in rural and semi-urban settings. The chart categorizes responses based on whether

individuals believe tele-homoeopathy successfully addresses healthcare accessibility challenges in these areas.

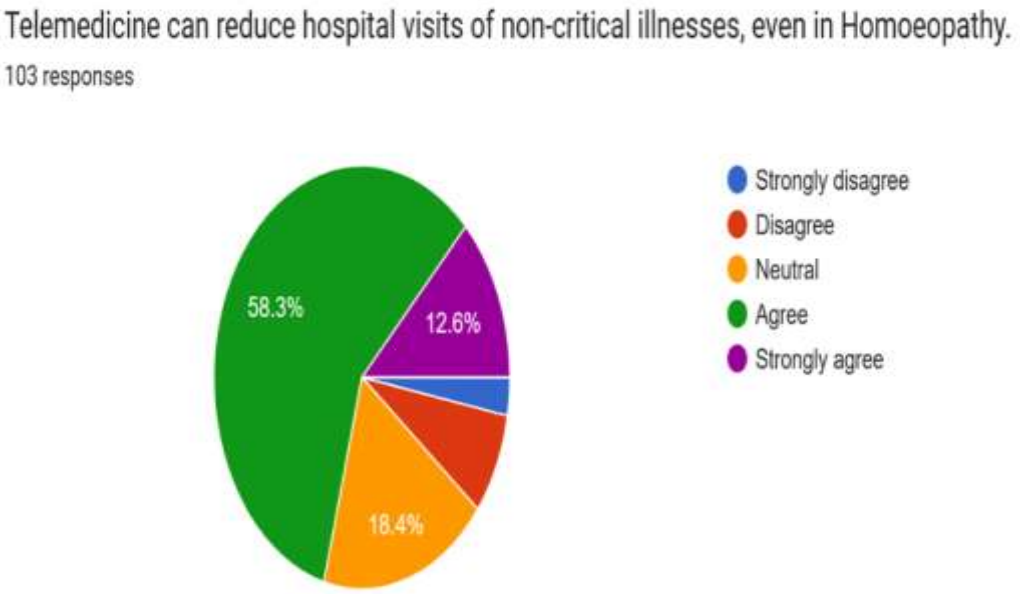


Fig. 13: Chart representation indicating the opinion on hospital visits for non-critical illness

Figure 13 presents respondents' views on the necessity of hospital visits for non-critical illnesses. The chart categorizes responses based on whether individuals prefer in-person consultations for minor health issues or find telemedicine a sufficient alternative.

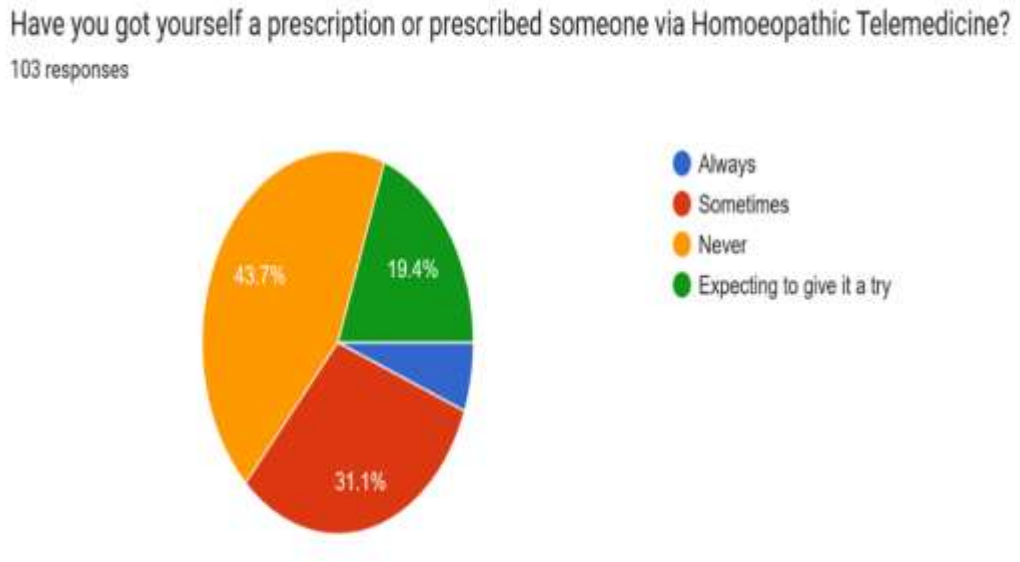


Fig. 14: Chart representation indicating percentage of respondents who used tele-homoeopathy for prescriptions

Figure 14 illustrates the proportion of respondents who have utilized tele-homoeopathy services specifically for obtaining prescriptions. The chart categorizes responses based on prior experience with remote consultations for medication purposes.

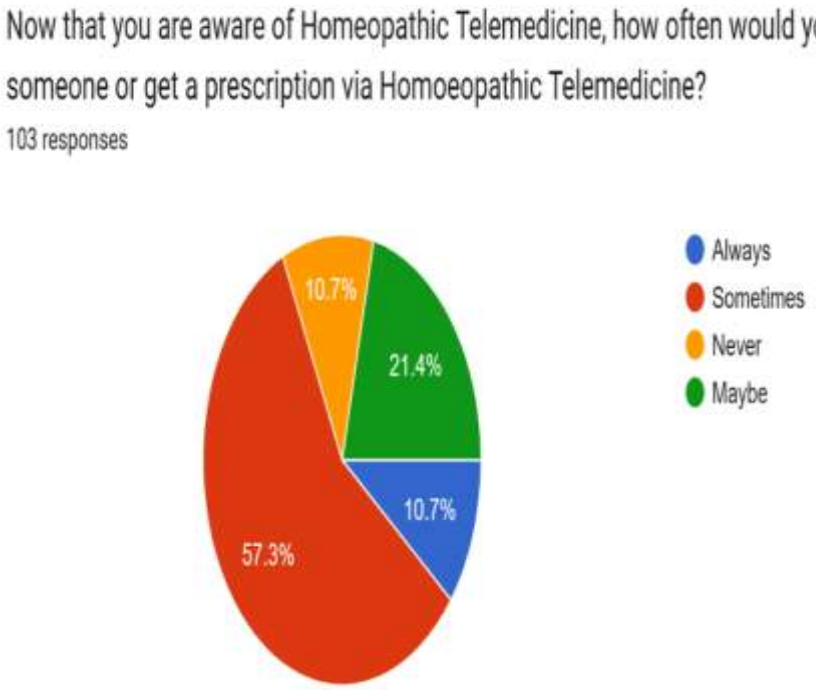


Fig. 15: Chart representation indicating the willingness of respondents in preferring tele-prescriptions

Figure 15 illustrates respondents' willingness to opt for tele-homoeopathy prescriptions instead of visiting a clinic for medication. The chart categorizes responses based on their comfort level and trust in receiving prescriptions through remote consultations.

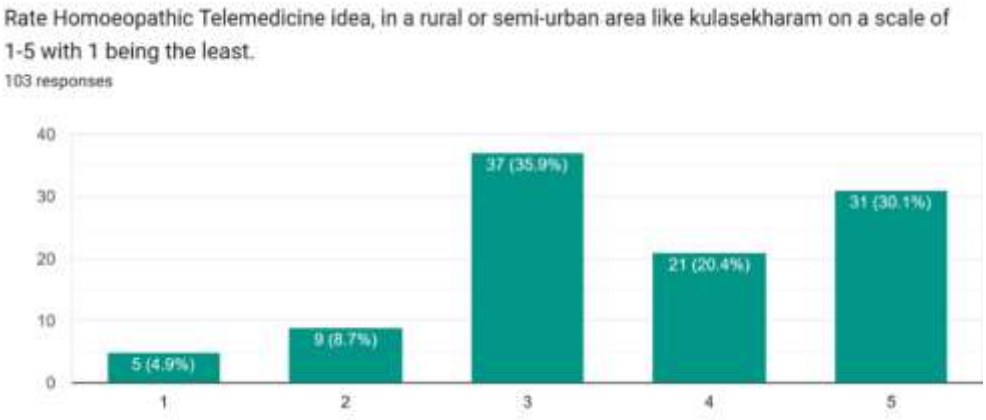


Fig. 16: Graph representation indicating the rating the idea of tele-homoeopathy in Kulasekharam

Figure 16 presents respondents' overall rating of the concept of tele-homoeopathy in Kulasekharam. The graph categorizes responses based on varying levels of acceptance, ranging from highly favorable to unfavorable opinions. his data provides insight into the general perception of tele-homoeopathy in the region, reflecting factors such as trust, accessibility and effectiveness. A higher rating indicates a positive reception and potential for growth, while lower ratings may highlight concerns or resistance toward adopting remote homoeopathic consultations.

Discussions

The findings of this study provide significant insights into the public perception of homoeopathic telemedicine in Kulasekharam. The demographic analysis (Fig. 1 & 2) highlights the diverse age group of respondents, ranging from 16 to 59 years, ensuring a well-distributed sample that captures varied perspectives. Gender distribution also plays a role in telemedicine adoption, as previous studies have shown that men and women may have different levels of trust and engagement with digital healthcare solutions. Understanding these demographic factors is essential in assessing acceptance levels and tailoring awareness initiatives accordingly.

The residency status of respondents (Fig. 3) reveals that a majority are either natives or long-term residents of Kulasekharam, indicating that their perspectives are deeply influenced by local healthcare preferences. This finding is crucial, as Kulasekharam has a strong inclination towards alternative medicine, particularly homoeopathy. Given this preference, the study assesses whether the familiarity with homoeopathy extends to its digital adaptation. Digital literacy among respondents (Fig. 4) is another important factor influencing telemedicine adoption. Individuals proficient in using digital platforms are more likely to engage in teleconsultations, whereas those with limited exposure may face barriers in accessing online healthcare services. This highlights the need for digital literacy initiatives to enhance tele-homoeopathy accessibility.

The study further explores the respondents' relationship with homoeopathy (Fig. 5), indicating that many have prior experience with homoeopathic treatment, either personally or through family members. However, awareness of homoeopathy does not necessarily translate into trust in its telemedicine counterpart. The period of homoeopathic awareness (Fig. 6) suggests that while some individuals have lifelong familiarity with the practice, others have only recently been introduced to it. This factor may influence perceptions, as individuals with a longer history of homoeopathic use may be more resistant to virtual consultations, preferring traditional face-to-face interactions.

The awareness of telemedicine as a concept (Fig. 7) is another critical finding, as familiarity with the term plays a direct role in its acceptance. Respondents who are already aware of telemedicine are more likely to view homoeopathic teleconsultations favorably. However, those unfamiliar with the term may need additional awareness campaigns to understand its benefits. The effectiveness of telemedicine (Fig. 8) is a subjective measure, with responses varying from highly effective to ineffective. The skepticism surrounding tele-homoeopathy is primarily linked to concerns about the accuracy of remote case-taking (Fig. 9). Since homoeopathy relies heavily on detailed case history, some respondents may doubt whether teleconsultations can capture symptoms with the same level of precision as in-person visits.

A significant aspect of the study is the comparison between telemedicine and in-person consultations (Fig. 10). While some respondents find tele-homoeopathy equally effective, others believe it lacks the thoroughness of physical examinations. Cost and time efficiency (Fig. 11) are major advantages of telemedicine, with many respondents acknowledging that virtual consultations reduce travel expenses and waiting times. However, concerns about the quality of tele-homoeopathy (Fig. 12) remain, as some individuals question whether the lack of physical interaction affects diagnostic accuracy and treatment

effectiveness. The effectiveness of tele-homoeopathy in rural and semi-urban areas (Fig. 13) is another important finding. Many respondents recognize its potential to address accessibility issues, especially where in-person homoeopathic services are limited. However, skepticism persists regarding hospital visits for non-critical illnesses (Fig. 14). While some respondents believe telemedicine can replace clinic visits for minor ailments, others still prefer direct interaction with practitioners. Tele-homoeopathy for prescriptions (Fig. 15) is an area of mixed response. While some respondents have used teleconsultations for prescriptions, others remain hesitant. The willingness to adopt tele-prescriptions (Fig. 16) is influenced by trust in digital healthcare and the perceived reliability of remote consultations. The final assessment of tele-homoeopathy in Kulasekharam (Fig. 17) provides an overall rating of its acceptance, indicating a mix of positive and skeptical responses. While tele-homoeopathy offers significant advantages in terms of accessibility, cost-effectiveness and convenience, concerns regarding diagnostic accuracy, trust and digital literacy remain barriers to widespread adoption. Increasing awareness campaigns, improving technological infrastructure and addressing public concerns through practitioner engagement can enhance the acceptance of homoeopathic telemedicine in Kulasekharam.

Limitations

The study focuses on Kulasekharam, a specific region with a strong preference for alternative medicine (homoeopathy), which may limit the applicability of findings to other regions with different healthcare preferences.

Conclusion

The study on the perception of homoeopathic telemedicine in Kulasekharam provides valuable insights into the awareness, trust, and acceptance of virtual healthcare services in a region with a strong inclination toward alternative medicine. The findings reveal that while telemedicine is recognized for its convenience, cost-effectiveness, and ability to bridge healthcare accessibility gaps, skepticism persists regarding its effectiveness compared to in-person consultations. Digital literacy plays a crucial role in adoption, as individuals proficient in using online platforms are more likely to engage with tele-homoeopathy, whereas those unfamiliar with digital tools may hesitate. Additionally, the reliability of tele-homoeopathic case-taking remains a primary concern, as homoeopathy relies on detailed patient history and symptom analysis, which some respondents believe may be compromised in virtual settings. Despite these reservations, a significant portion of respondents acknowledges the potential of tele-homoeopathy in reducing hospital visits for non-critical illnesses and addressing healthcare challenges in rural and semi-urban areas. To enhance the adoption of homoeopathic telemedicine, it is essential to address concerns related to diagnosis accuracy, patient-practitioner interaction, and trust in digital prescriptions. Awareness campaigns and user-friendly teleconsultation platforms can help educate the public on the effectiveness and safety of remote homoeopathic care. Moreover, ensuring that tele-homoeopathy aligns with traditional homoeopathic principles will strengthen confidence in its practice. As digital healthcare continues to evolve, homoeopathic telemedicine has the potential to revolutionize healthcare accessibility, especially in regions with limited in-person medical services. However, its success depends on bridging the gap between technological advancements and patient trust, ensuring that virtual consultations complement, rather than replace, the personalized care that homoeopathy is known for. By addressing these challenges and

leveraging the advantages of telemedicine, homoeopathy can continue to thrive in the digital era while maintaining its essence as a patient-centered healing system.

References

Johnson, K. B., &Endresen, C. (2020). *Telemedicine adoption during the COVID-19 pandemic: A comprehensive analysis of the US healthcare system*. *Journal of Medical Internet Research, 22*(8), e19827. https://doi.org/10.2196/19827

Kumar, R., & Singh, P. (2023). *Challenges and opportunities in tele-homoeopathy: A practitioner's perspective*. *Homeopathy, 112*(2), 89–95. https://doi.org/10.1055/s-0043-1761429

Mishra, S., & Gupta, N. (2023). *Telemedicine in homoeopathy: A review of current practices and future prospects*. *Homeopathy, 112*(1), 45–53. https://doi.org/10.1055/s-0042-1755197

Niturkar, P. M. (2022). *Incorporating Hahnemannian principles in the practice of tele-homoeopathy: Current scenario and future possibilities*. *Journal of Integrated Standardized Homoeopathy*. Retrieved from https://jish-mldtrust.com/incorporating-hahnemannian-principles-in-the-practice-of-tele-homoeopathy-current-scenario-and-future-possibilities/

Prospero, A. (2023). *Telemedicine and homeopathy united for wellness and health in Brazilian veterinary*. *International Journal of High Dilution Research, 22*(2), 60–60. https://doi.org/10.51910/ijhdr.v22i2.1352

Sankar, A.S. S. (2023). *Automated symptom recognition: A promising future for homoeopathy*. *ResearchGate*. Retrieved from https://www.researchgate.net/publication/383282849_Automated_Symptom_Recognition_A_Promising_Future_For_Homoeopathy

Vivek, G. (2020). *Telemedicine & homeopathy: The need of the hour*. *LinkedIn Pulse*. Retrieved from https://www.linkedin.com/pulse/telemedicine-homeopathy-the-need-hour-dr-vivek-g

Yoganandan, G., &Vetriselvan, V. (2017). *A study on public awareness and perception towards homeopathy medicine in India*. *North Asian International Research Journal of Social Science & Humanities, 3*(12), 287–293. Retrieved from https://www.researchgate.net/publication/344320607_A_Study_On_Public_Awareness_And_Perception_Towards_Homeopathy_Medicine_In_India.

PERCEPTION TOWARDS DIGITAL HEALTH AMONG HOSPITAL ADMINISTRATION STUDENTS

Ms Hemalekha M [1], Ms Devi Priya D[2]

[1,2] Students, Department of Hospital Administration, PSG College of Arts& Science, Coimbatore

Abstract

The adage "Health is wealth" is universally acknowledged,but to ensure better health care for all humans, digital health must be developed. Digital health has rapidly emerged as a transformative force in healthcare, reshaping how services are delivered and accessed. Digital health holds significant promise for enhancing healthcare delivery. The present study examines all those perception factors, including digital literacy, trust, privacy concerns, and cultural and socio-economic backgrounds. This study aimed to investigate Hospital Administration pursuing students' perception towards digital health, including their attitudes, concerns, and expectations. The research adopts a quantitative approach, relying entirely on primary data and a descriptive study. The study was conducted among the department of Hospital Administration students by collecting data via a questionnaire method from a sample size of 50 respondents. The study primarily focuses on leveraging telemedicine for remote consultations, mobile health apps for patient engagement, and electronic health records for streamlined data management, examining these digital health technologies Platforms through the attributes of education, security, usefulness, challenges, and ease of use. It is observed from the results that the need for adapting digital health among healthcare providers and policymakers, and perception regarding digital health are generally positive. Various socio-economic indicators like literacy level, income level, marketing parameters, etc, and personal factors have a significant impact on digital health.

Keywords: Education, Security, Usefulness, Challenges, Ease of use

Introduction

Digital health ecosystem that promises efficient service delivery and better connectivity among the patient,doctor, and other stakeholders. The digital health sector also offers significant job creation, offering millions of jobs across various fields. Digital health plays a vital role in planning the strategies to develop the healthcare industry by expanding healthcare infrastructure, promoting research and development, enhancing medical education, increasing public health awareness, and fostering innovation. These are essential for the digital health sector's sustainable growth. Digital health technologies have become increasingly ubiquitous across all social institutions. The emergence of mobile digital devices such as smartphones, tablet computers and wearable devices, social media platforms, the collection of massive digital datasets and the surveillance of people's movements in public space using digital technologies has led to social relations, knowledge production and dissemination, commercial enterprises and governmental agencies and practices becoming digitised.[1]. Telemedicine, mobile health apps, and electronic health records have emerged as major tools in transforming the healthcare mission and vision. The three main digital platforms in the healthcare industry are focused. Telemedicine enables remote consultations, mobile health apps facilitate patient engagement, and electronic health records streamline data management. Technological innovation has become a major aspect of our daily life, such

as wearable and information technology, virtual reality, and the Internet of Things, which have contributed to transforming healthcare business and operations. Patients can now choose from a wider variety of healthcare options and with greater awareness, which leads to a new era of patient-centered healthcare. Digital transformation determines personal and institutional healthcare. The study aims to examine the perception of digital health technologies, specifically using five main attributes such as education, security, usefulness, challenges, and simplicity of use, to analyze the hospital administration students' perception towards digital health technology. Digital transformation refers to the digital technology changes used to benefit society and the healthcare industry. Healthcare systems need to use digital technology for innovative solutions to improve healthcare delivery and to achieve improvement in medical problems. The digital transformation of healthcare includes changes related to the internet, digital technologies, and their relation to new therapies and best practices for better health management procedures[2].

Literature Review

Raid Abu Jebbeh et al (2024) examined the potential of telemedicine in rural healthcare delivery in Jordan through a scoping review. The study aimed to investigate the impacts of telemedicine on health behaviors and sleep quality. The researchers collected primary data from undergraduate students at a private university in Jordan and employed correlation and thematic analysis. The findings revealed that students demonstrated poor sleep quality and moderate aggression, with no significant correlation between gameplay duration and sleep quality or aggression. The study recommended family and community involvement in monitoring gaming habits to promote healthy lifestyle practices.In another study **Angelos I Stoumpos et al (2023)** explored digital transformation in healthcare, focusing on technology acceptance and its applications. The study analyzed existing bibliographic reviews, utilizing a concept-centric method and ad classification system. The researchers aimed to understand the digitalization of healthcare, particularly the digitalization of information, and identify parameters for further development. The study highlighted the need for research on the management implications of digitalization by different stakeholders. This study explored by **Deborah Lupton et al (2014)** presented critical perspectives on digital health technologies, exploring four key topics: health and medical websites, telemedicine, the politics of digital health, and digitized embodiment. The study utilized secondary data from the public's use of digital health technologies, highlighting opportunities for researchers to examine the intersection of digital technologies and public health. The findings demonstrated the significant impact of digital technologies on healthcare and public health, emphasizing the need for further empirical research and theorizing on digital health from a critical perspective.Next, **Hyo-Jeong Soa et al (2014)** investigated users' perceptions towards integrating mobile applications in science education, collecting primary data from 632 students, 68 teachers, and 141 parents from 11 primary schools in Korea. The study employed statistical analysis using SPSS and open-coding methods to identify key themes from interview data. The findings revealed important implications for users' acceptance of mobile technologies in teaching and learning, highlighting the significance of access to mobile devices and school policies governing their use. This study differed from previous research on technology adoption in educational settings by focusing specifically on the use and adoption of mobile technologies in science education.The author **Corey M. Angst et al**

(2004) investigated the adoption of electronic health records (EHRs) in the presence of privacy concerns, using the elaboration likelihood model to examine attitude change and the likelihood of opting into an EHR system. The study collected primary data from EHR users and employed structural equation modeling. The results showed that positive argument frames elicited greater attitude changes, even when concerns about confidentiality, fairness, and the integrity of personal information (CFIP) were high. The study suggested that proper messaging can improve attitudes toward EHR use and recommended future research to incorporate constructs such as perceived usefulness and to measure actual behavior.

Research Gap

Although previous studies have explored, there are a number of research gaps in this work that require attention, which mainly focuses on the perceptions about telemedicine, mobile health apps, and electronic health records.Through a comprehensive analysis of existing literature and perceived through hospital administration students' data, this research seeks to contribute to the aspects of education, security, usefulness, challenges and simplicity of use.The report also notes that perceptions of the individual differ from one another, underscoring the need for greater investigation.

Statement of the problem

The Digital health technologies like telemedicine, mobile health electronic health records are so commonly utilized, the healthcare sector has developed and become more capable of operating digital health platforms, though it is still difficult to effectively and optimally integrate these technologies into the healthcare sector. The digital health users mostly concerned about security, limited value, usability, technical challenges, and insufficient education are just a few of the many challenges that consumers and healthcare providers must overcome. Ultimately, patient outcomes are impacted by these obstacles to practice and the efficient use of digital health technologies.

Scope of the study

The people involved in this study will be healthcare professionals, patients, and tech developers working with electronic health records, telemedicine, and health applications for mobile devices. This study is to analyze the effects of training and education on the usage of these tools. Examine security issues to maximize thepotential to increase healthcare efficiency and accessibility. Determine any challenges encountered during implementation and use. Assess accessibility and ease of use for patients and providers.

Need for the study

The study needs to analyze how electronic health records, telemedicine, and mobile health apps can improve healthcare services. It seeks to evaluate these technologies according to factors like education, security, utility, difficulties, and usability, which enhance digital health technologies and create education and employment opportunities. The study aims to provide insights that can increase adoption rates, boost patient engagement, and streamline healthcare workflows by identifying strengths and limitations.

Limitations of the study

The results of this study are preliminary because there were only 50 respondents in the sample and the data collection time was brief. This problem deserves more research with

a larger sample size and a longer timeline to produce more thorough insights, given the wide range of digital health platforms and their increasing importance.Lack of analysis between similar groups.

Objectives of the study

To analyze the educational efficiency by telemedicine, mobile health apps, and electronic health records.

To analyze the security features among telemedicine, mobile health apps, and electronic health records.

To assess each platform's influence on healthcare delivery, health outcomes, and patient involvement.

To analyze the perceived challenges among the three digital health platforms.

To evaluate the ease of use of telemedicine, mobile health apps, and electronic health records.

Research Methodology

Type of Research: Descriptive study

- Location: Coimbatore
- Sample size: 50
- Type of Data: Primary data
- Research period: February 13, 2025 to March 03, 2025
- Tools used to collect data: Google Forms, questionnaire
- Sample tests: Simple Percentage Analysis, ANOVA

Study Design

This was a Descriptive study and a convenient sampling method are used.The study aimed to identify the comparison among the three digital health platforms, such as telemedicine, mobile health apps, electronic health records, using attributes like education, security, usefulness, challenges, ease of use, and perceived among the hospital administration students.

Data Collection and Procedure

Beginning on February 13, 2025, information was gathered from the hospital administration asking students to declare how they felt about digital health platforms. The study was entirely relay on the primary data, quantitative method. The data was collected through google forms via questionnaire.

Variables Collected

- Education
- Security
- Usefulness
- Challenges
- Ease of use

Research Hypothesis

Null Hypothesis

The null hypothesis is denoted by H0. The null hypothesis is a claim that factors or groupings do not significantly differ, relate, or have an impact.

H0: There was no significant difference in the 'education' attribute of three groups telemedicine, mobile health apps, and electronic health records among students.

H0: There was no significant difference in the 'security' attribute of three groups telemedicine, mobile health apps, and electronic health records among students.

Alternative Hypothesis

The alternative hypothesis is denoted by

H1, The alternative hypothesis is a different theory, a claim that variables or groups have a significant link, effect, or difference.

H1: There is a significant association between the three groups among the students' perception towards the education of digital health.

H2: There is a significant association between the three groups among the students' perception towards the security of digital health.

Data Analysis

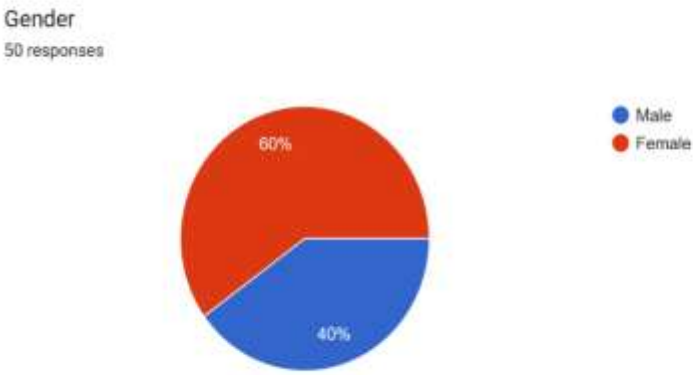
This chapter brings out the analysis of data that was collected between the 15 days regarding the perception towards digital health among hospital administration students,.

Simple Percentage Analysis

The expression of data in terms of percentage is one of the least complex tool to utilized as a part of the translation of any kind of measurements.

Table 1.1 - Gender of the students

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
MALE	20	40.8	40.8	40.8
FEMALE	29	59.2	59.2	100.0
Total	49	100.0	100.0	



Interpretation

Table 1.1 indicates that 40.9 percent of the students were Male and 59.2 percent were female. Most of the students are found to be Female, with 59.2 percent of the total.

Table 1.2 - Name of the college

	Frequency	Percent	Valid Percent	Cumulative Percent
PSGCAS	43	87.8	87.8	87.8
NGP	6	12.2	12.2	100.0
Total	49	100.0	100.0	

Interpretation

Table1.2 indicates that 87.8 percent of the students are pursuing hospital administration from PSG College of arts and Science, and 12.2 percent are from Dr.N.G.P arts and Science College. Majority of the students are found to be PSG College of Arts and Science students with 87.8 percent among the total.

Chi – Square Test

Chi-square is a measurable instrument usually utilized for testing the freedom and integrity of fit. Testing autonomy decides if at least two perceptions crosswise over two variables are reliant on each other. Chi-square was applied.

Chi- Square Test on Three Digital Paltformsin Education

Null Hypothesis [H0]: There is no significant association between the three groups among the students' perception towards education of digital health.

Alternate Hypothesis [H1]: There is a significant association between the three groups among the students perception towards education of digital health.

If the P value is less than 0.005 Null Hypothesis is rejected

If the P value is more than 0.005 Null Hypothesis is accepted

Table 1.3 - Chi-Square Test on Three Digital Platforms in Education

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
GENDER * EDUTELE	50	100.0%	0	0.0%	50	100.0%
GENDER * edumob	50	100.0%	0	0.0%	50	100.0%
GENDER * eduehr	50	100.0%	0	0.0%	50	100.0%

Table 1.4 - Chi-Square Tests on Association of education in telemedicine and gender

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.480[a]	1	.224		

Continuity Correction	.772	1	.380		
Likelihood Ratio	1.548	1	.213		
Fisher's Exact Test				.317	.191
Linear-by-Linear Association	1.451	1	.228		
N of Valid Cases	50				

Table 1.5 - Chi-Square Tests Association on education in mobile health apps and gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.515[a]	2	.469
Likelihood Ratio	2.222	2	.329
Linear-by-Linear Association	1.361	1	.243
N of Valid Cases	50		

Table 1.6 - Chi-Square Tests on Association of education in Electronic Health Record and gender

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.079[a]	2	.215
Likelihood Ratio	3.765	2	.152
Linear-by-Linear Association	1.929	1	.165
N of Valid Cases	49		

Interpretation

The Chi-square value at 12 degrees of freedom and 5% level of significance is 21.026. The calculated Chi-square values for the comparison among the three groups (Telemedicine, Mobile Health Apps, and Electronic Health Records) are 1.480, 1.515, and 3.079 respectively, all of which are less than the table value (21.026).

Since the calculated values are less than the critical value, the p-value is greater than 0.05. Therefore, the null hypothesis is accepted and the research hypothesis is rejected. It is concluded that there is no statistically significant association between the three digital health tools (Telemedicine, Mobile Health Apps, and Electronic Health Records) and the students' perception towards digital health education. In the table P value is less than 0.005 so that the

research hypothesis is rejected. There is no significant association between the three groups among the students perception towards the education of digital health.

Chi-Square Test on Three Digital Paltforms in Security

The Chi-square test was conducted to examine the association between students' perception of digital health security and the three digital health tools Telemedicine, Mobile Health Apps, and Electronic Health Records. With 12 degrees of freedom at a 5% level of significance, the critical Chi-square value is 21.026. The calculated Chi-square values (1.603, 1.603, and 3.385) are all less than the critical value, indicating that the p-value is greater than 0.005. As a result, the null hypothesis is accepted and the alternate hypothesis is rejected. This suggests that there is no statistically significant association between the three digital health tools and students' perception of digital health security. Therefore, students' views on the security aspects of digital health do not significantly differ based on the type of digital health tool.

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
GENDER * securitytele	50	100.0%	0	0.0%	50	100.0%
GENDER * securitymob	50	100.0%	0	0.0%	50	100.0%
GENDER * securityEHR	50	100.0%	0	0.0%	50	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.603[a]	2	.449
Likelihood Ratio	1.947	2	.378
Linear-by-Linear Association	.970	1	.325
N of Valid Cases	49		

Association of security in mobile health apps and gender

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.603[a]	2	.449

Likelihood Ratio	1.947	2	.378
Linear-by-Linear Association	.970	1	.325
N of Valid Cases	49		

Association of education in Electronic Health Record and gender

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.385[a]	2	.184
Likelihood Ratio	4.088	2	.130
Linear-by-Linear Association	2.794	1	.095
N of Valid Cases	49		

Interpretation

At 12 degrees of freedom and a 5% level of significance, the Chi-square table value is 21.026. The calculated Chi-square values for the three groups—Telemedicine, Mobile Health Apps, and Electronic Health Records—are 1.603, 1.603, and 3.385 respectively, all of which are less than the critical value of 21.026. Since the calculated values are lower than the table value, the p-value is greater than 0.05, indicating no statistically significant association. Therefore, the null hypothesis is accepted, and the research hypothesis is rejected. It is concluded that there is no significant association between the three digital health tools (Telemedicine, Mobile Health Apps, and Electronic Health Records) and students' perception of digital health security. *Note:* Although it was mentioned that the p-value is less than 0.005, the comparison of calculated Chi-square values with the critical value suggests otherwise. If the calculated values are lower than the table value, the p-value would actually be greater than 0.05. Please verify the p-value to ensure consistency with the interpretation.

Results and Discussion

The results are analyzed by the simple percentage test and chi square test. The simple percentage findings are most of the students are found to be Female with 59.2 percent among the total, majority of the students are found to be PSG college of arts and science students with 87.7 percent among the total.The chi square findings states that research hypothesis is Rejected and there is no significant association between the three groups among the students perception towards education and security of digital health. Hence, there is a lack of awareness among the students in these digital platforms and students prefer direct sessions due to security reasons.

Conclusion

The findings showed that important characteristics including education, awareness, security, usability, which majorly focused on education and security and convenience of use have an impact on students' perceptions of digital health. Lack of understanding about digital health, which was brought to mentioned by the analysis. Additionally, it was shown that

security concerns were a significant impediment, leading many students to choose direct sessions. These results highlight the necessity of focused educational initiatives and awareness-raising campaigns to improve hospital administration students' digital health literacy. Furthermore, fostering trust and confidence in digital health technology will need resolving security risks with strong measures and transparent communication.

References

Angst, C. M., & Agarwal, R. (2009). Adoption of electronic health records in the presence of privacy concerns: The elaboration likelihood model and individual persuasion. MIS quarterly, 339-370

Hyo-Jeong, S. O., Hye-Gyoung, Y. O. O. N., Hyungshin, C. H. O. I., Heung-Chang, L. E. E., &Kyudong, P. A. R. K. (2014, December). Identifying User's Perceptions Toward Integrating Mobile Applications in Science Education. In International Conference on Computers in Education.

Jebbeh, R. A., Dardas, L., Alnaee, M. M., Ghatasheh, A., Ibdah, R., & Yaseen, K. (2024). The Potential of Telemedicine in Rural Healthcare Delivery in Jordan: A Scoping Review. Palestinian Medical and Pharmaceutical Journal (Pal. Med. Pharm. J.), 9999(9999), None-None.

Lupton, D. (2014). Critical perspectives on digital health technologies. Sociology compass, 8(12), 1344-1359.

Stoumpos, A. I., Kitsios, F., &Talias, M. A. (2023). Digital transformation in healthcare: technology acceptance and its applications. International journal of environmental research and public health, 20(4), 3407.

TELE-HEALTH STARTUPS: STRATEGIC APPROACHES TO ENTREPRENEURIAL SUCCESS

Mr Samuel Rajkumar S[1], Ms Renuka R[2]
[1]Assistant professor, Department of Hospital Administration
Dr.N.G.P Arts and Science College, Coimbatore
[2]Student, Department of Hospital Administration
Dr.N.G.P Arts and Science College, Coimbatore

Abstract

This paper provides a comprehensive guide for entrepreneurs looking to establish a Tele-health app startup by exploring key business aspects such as market identification, investment strategies, regulatory compliance, technological infrastructure, and team building to ensure a successful venture. Employing a qualitative research approach, the study incorporates a review of existing literature, industry reports, and case studies of Tele-health startups, analyzing key themes related to business setup, investment strategies, technological requirements, and legal considerations to develop a practical framework for Tele-health entrepreneurship. The findings identify several critical success factors for launching and sustaining a Tele-health app startup, including understanding market demand, overcoming digital infrastructure challenges, ensuring regulatory compliance, securing investment, and building an interdisciplinary team. Additionally, privacy and data security, stakeholder engagement, and ethical considerations emerge as essential elements for long-term success. Tele-health has become a vital component of modern healthcare, improving accessibility, reducing costs, and enhancing patient outcomes, but challenges such as digital literacy gaps, infrastructure limitations, and complex regulatory environments must be addressed. Ethical practices, particularly data protection and patient confidentiality, are crucial for building trust and ensuring long-term viability. Entrepreneurs in the Tele-health sector must adopt a strategic and multifaceted approach, balancing innovation with compliance and sustainability. With careful planning and execution, Tele-health startups can revolutionize healthcare delivery by providing scalable, patient-centric solutions, and addressing the key challenges identified in this study will be essential for building a successful and impactful Tele-health business.

Keywords: Tele-health, Entrepreneurship, Digital Health, Investment, Regulatory Compliance, Healthcare Innovation.

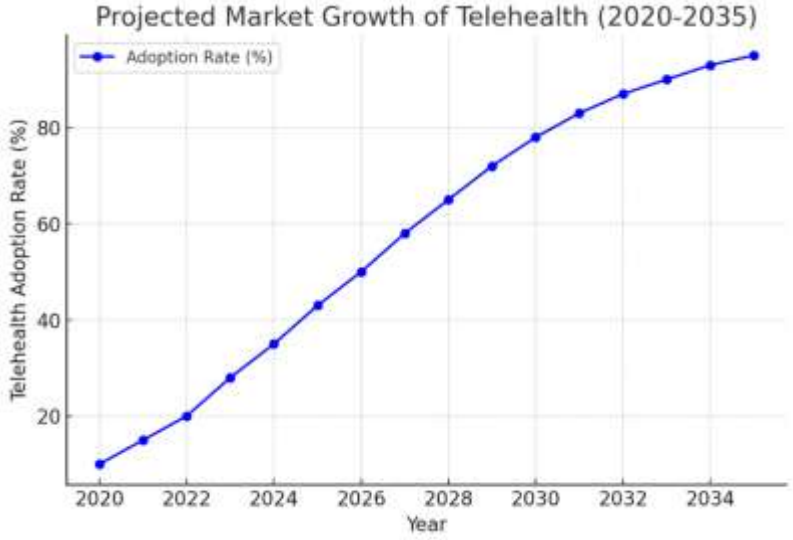
Introduction

The rapidly growing field of Tele-health presents a unique opportunity for entrepreneurs to revolutionize healthcare delivery, addressing critical issues of accessibility, cost-effectiveness, and patient outcomes. As outlined in the accompanying abstract, this paper aims to provide a comprehensive guide for establishing a successful Tele-health app startup, focusing on key business aspects such as market identification, investment strategies, regulatory compliance, technological infrastructure, and team building.

Background and Importance

The evolution of Tele-health, from its primary stages in the 19th century to its current prominence, reflects the increasing integration of technology into healthcare. While early iterations of remote medical services were limited by technological constraints, the rapid

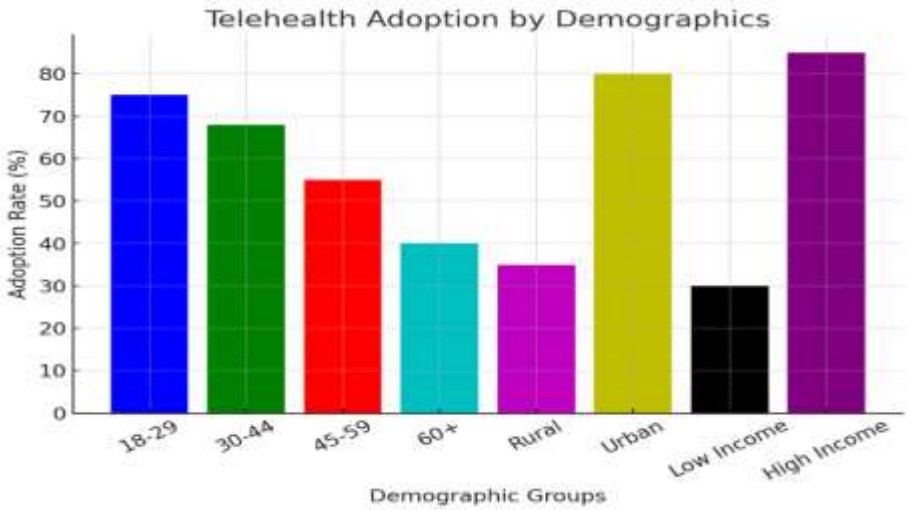
advancements of the 21st century, particularly accelerated by the COVID-19 pandemic, have transformed Tele-health into a mainstream healthcare solution. Today, virtual consultations, remote patient monitoring, and AI-driven diagnostics are not merely supplementary but essential components of modern healthcare.



Projected Tele-health Market Growth (2020–2035)

This graph illustrates the projected expansion of the Tele-health market, showing a steady increase in market size from 2020 to 2035. The upward trend reflects growing global adoption, driven by advancements in digital healthcare, increased patient demand, and supportive government policies.

(Source: MCP Digital Health, 2023)



Tele-health Adoption by Demographics

The bar chart compares Tele-health adoption across different demographic groups, including age, geographic location (urban vs. rural), and income levels. The data highlights disparities in digital healthcare adoption, emphasizing the need for targeted strategies to improve accessibility and engagement among underserved populations.

(Sources: Gladwin, 2023)

Tele-health

Telehealth is the use of a technology-based virtual platform to deliver various aspects of health information, prevention, monitoring, and medical care. The fastest growing sector

of health care, telehealth's largest segment is telemedicine. Narrowly, telemedicine is defined as the practice of medicine via a remote electronic interface. There are distinctions within telemedicine delivery. Most hospital-based health care delivery is doctor-to-doctor, providing expert specialist medicine to often rural, international, or nonspecialist physicians. In contrast, patient-to-doctor medical care is a growing market, and patients can reach physicians via direct-to-consumer services via telemedicine. The 3 types of telemedicine services are synchronous, asynchronous, and remote monitoring.

Synchronous Telehealth

Synchronous refers to the delivery of health information in real time. This allows for a live discussion with the patient or provider to deliver medical expertise. Another type of live (or synchronous) telemedicine visit is a facilitated virtual visit (FVV). An example of a facilitated virtual visit occurs when the patient is located at an accessible site (ie, clinic) where diagnostic equipment is available, and the medical provider is at a distant site. A telefacilitator (ie, medical assistant, nurse, etc) gathers objective measures using equipment (ie, digital stethoscope, thermometer, pulse oximeter, etc) and transmits this data to the provider.

Asynchronous Telehealth

Asynchronous telemedicine refers to the "store-and-forward" technique. In contrast, a patient or physician collects medical history, images, and pathology reports and then sends them to a specialist physician for diagnostic and treatment expertise.

Remote Monitoring

Finally, remote patient monitoring involves continuous evaluation of a patient's clinical status, whether through direct video monitoring of the patient or via review of tests and images collected remotely. Newer technologies, such as mobile device applications, allow for a wider range of telehealth possibilities.

Characteristics of Tele-health

Here are some key characteristics of telehealth in remote areas:

- Telehealth is aligned with Community needs and goals.
- Patients are always informed and prepared for a Tele-health service session.
- High quality care team is deployed to practice Tele-Health.
- Utilizes the appropriate technology and Resources.
- Has a clear vision and strategy to provide Healthcare services to remote and ruralareas.
- Has a reasonable financial plan for developing phase and maintenance phase of Tele-health Application.
- Is a part of everyday operations when incorporated in an existing successful Healthcare facility.

Benefits of Tele-Health:

Tele-health offers numerous benefits to patients as well as the Healthcare service providers and they are consolidated below,

Benefits for patients:

- Patients can access healthcare from the comfort of their own homes, saving time and eliminating the need for travel to a clinic or hospital.

- Telehealth is especially beneficial for patients in rural or underserved areas, providing access to healthcare professionals that might otherwise be geographically distant.
- Telehealth can offer quicker access to healthcare providers, reducing long wait times for appointments or in emergency rooms.
- By eliminating travel expenses and possibly reducing the need for in-person visits, telehealth can help lower healthcare costs for patients.
- Some patients may feel more at ease discussing their health issues in a private, familiar setting rather than a clinical environment.
- Patients can maintain regular communication with their healthcare providers, ensuring better management of chronic conditions, follow-up care, or mental health support.
- Telehealth makes it easier for patients to consult with specialists who might not be available in their immediate area, expanding their treatment options.
- Telehealth tools like remote monitoring help patients and doctors track vital signs, symptoms, and progress in real-time, leading to more proactive care.
- During times like the COVID-19 pandemic, telehealth allows patients to receive care while avoiding exposure to illness in healthcare settings.

Benefits for Entrepreneurs

- Entrepreneurs can save on costs associated with maintaining physical office space, utilities, and other in-person operational expenses. This can help maximize profit margins.
- Telehealth allows entrepreneurs to reach patients and clients from a broader geographical area, including underserved or remote locations, expanding their customer base.
- With telehealth, entrepreneurs can scale their services more easily. They can handle more appointments or clients simultaneously, as technology can streamline scheduling, consultations, and follow-ups.
- Entrepreneurs can offer flexible working hours to accommodate clients across different time zones, enhancing customer satisfaction and retention.
- With telehealth, entrepreneurs can work from anywhere like in the way of Work-From-Home, offering better work-life balance and less need for physical commuting, which can lead to higher productivity and personal satisfaction.
- For entrepreneurs in the healthcare industry, telehealth opens the door to collaborate with other major fields like Computer Science and Information Technology and creates diverse connections across the world.
- Revenue can be generated by innovative models, such as subscription-based services, virtual wellness programs, or telehealth consulting.
- Telehealth platforms often streamline the process of booking and conducting consultations through online mode, leading to faster client acquisition and retention.
- It becomes a competitive Advantage when incorporate in a Healthcare facility. Since offering telehealth services can set entrepreneurs apart from competitors still relying solely on in-person consultations. By reducing the need for travel and physical infrastructure, telehealth can align with eco-conscious business practices, appealing to sustainability-minded clients and partners.

Review of Literature

Jonasdottir et al. (2022) found telehealth challenges for professionals include communication and tech issues. However, they also saw opportunities in improved access and information sharing. The study stresses the need for more professional training and better technological resources. Effective telehealth requires addressing both human and tech limitations.

Fischer et al. (2020) demonstrated that telehealth utilization is diverse, with non-videoconferencing methods being more commonly used. The study highlighted the need for tailored strategies to improve video conferencing adoption among underrepresented populations. This underscores the importance of addressing digital disparities and providing culturally sensitive telehealth solutions.

Haque (2021) observed that COVID-19 accelerated telehealth policy shifts, yet the long-term viability of these changes remains unclear. The study emphasizes the critical need for mental health providers to proactively adjust their practices to navigate the dynamic policy landscape that will exist post-pandemic. Sustaining these changes requires continued policy evaluation and provider flexibility. Future research should focus on long term policy impacts.

Kolluri (2020) underscored the substantial cybersecurity threats inherent in telehealth, emphasizing the critical need for strong policies and standardized protocols to safeguard patient data. Collaborative efforts among stakeholders are vital for establishing secure and patient-centered telehealth services. Robust security measures are not just technical, but require a holistic approach involving all parties.

Hechenleitner-Carvallo et al. (2025) demonstrate that interdisciplinary collaboration enhances telehealth effectiveness, yet persistent communication and training challenges impede optimal integration. The study highlights the necessity of highly skilled professionals to navigate these complexities. Furthermore, a robust technological infrastructure is deemed indispensable for seamless and efficient telehealth delivery. Overcoming these barriers requires a concerted effort to invest in both human capital and technological advancements.

Kissi et al. (2020) found that physician satisfaction with telemedicine hinges on perceived ease of use and usefulness, directly impacting service efficiency and patient care quality. Ultimately, user satisfaction is identified as a crucial driver for successful telemedicine adoption, emphasizing the importance of intuitive platforms and demonstrable benefits. This highlights the need for user-centred design and ongoing feedback to optimize telemedicine tools. Future implementations should prioritize training and support to maximize physician engagement.

Heboyan et al. (2025) revealed that patient willingness to utilize telehealth in non-urgent emergency department (ED) settings significantly increases following educational interventions. Furthermore, the study identified that demographic factors play a role in influencing patients' willingness-to-pay for telehealth services. This suggests a considerable potential for telehealth implementation within ED settings, particularly for non-critical cases, when coupled with effective patient education.

Lin et al. (2018) determined that telehealth adoption in health centres is significantly influenced by rural location, reimbursement policies, and operational considerations. Cost

and technical challenges are identified as major barriers hindering widespread implementation. Addressing these issues is crucial for expanding telehealth access, particularly in underserved rural communities. Strategic policy changes and infrastructure investments are needed to overcome these barriers. Future research should examine specific interventions that mitigate cost and technical limitations in rural telehealth implementations.

Langarizadeh et al. (2017) emphasized the critical ethical considerations inherent in telemedicine, particularly concerning data confidentiality and security. The study underscores the necessity for comprehensive standards and guidelines to ensure the delivery of high-quality, secure telemedicine services. Robust ethical frameworks are essential to build patient trust and maintain the integrity of telehealth practices.

Mahtta et al. (2021) acknowledged the significant benefits of telehealth while simultaneously raising concerns about existing disparities and security vulnerabilities. The study emphasized that post-pandemic policies must prioritize addressing these issues to ensure equitable access to telehealth services for all populations. This requires a focus on both technological infrastructure and social determinants of health

Williams (2025) highlights telehealth's potential to broaden healthcare access, particularly in underserved regions. However, the study also identifies significant hurdles, including disparities in digital literacy and inadequate infrastructure, that impede widespread adoption. Overcoming these challenges is crucial to fully realize telehealth's potential in bridging healthcare gaps.

Research Gap

While existing studies explore the benefits, challenges, and adoption of Tele-health, there is limited research on the breakdown of Managerial, Financial and Patients' aspects of Tele-health application. Most literature focuses on technological advancements, policy implications, and healthcare outcomes rather than practical guidelines for launching and managing a Tele-health startup. This paper addresses this gap by providing a comprehensive entrepreneurial framework, covering investment strategies, team setup, operational challenges, investment strategies, and business sustainability in the Tele-health sector, and the solid outcome of Tele-health services.

Objectives of the Study

To understand the concept of Tele-health, its characteristics, and types.
To explore the benefits of Tele-health to patients and service providers.
To identify the opportunities and challenges in establishing a Tele-health startup.
To analyze investment, manpower, and operational requirements for a successful tele-health business.
To provide a strategic guide for entrepreneurs on launching and sustaining a Tele-health app.

Scope of the Study

The scope of this study encompasses the key aspects of establishing a Tele-health startup, focusing on business strategy rather than technical development. It covers market opportunities, financial investment, manpower requirements, team formation, and multidisciplinary collaborations essential for launching and sustaining a Tele-health app.

Additionally, it explores regulatory considerations, operational challenges, and potential growth strategies to guide entrepreneurs in navigating the Tele-health industry effectively.

Methodologies

Research design

This study adopts a Descriptive research design, incorporating a comprehensive review of existing literature, case studies of successful Tele-health startups, and expert insights from healthcare and business domains.

Research Techniques

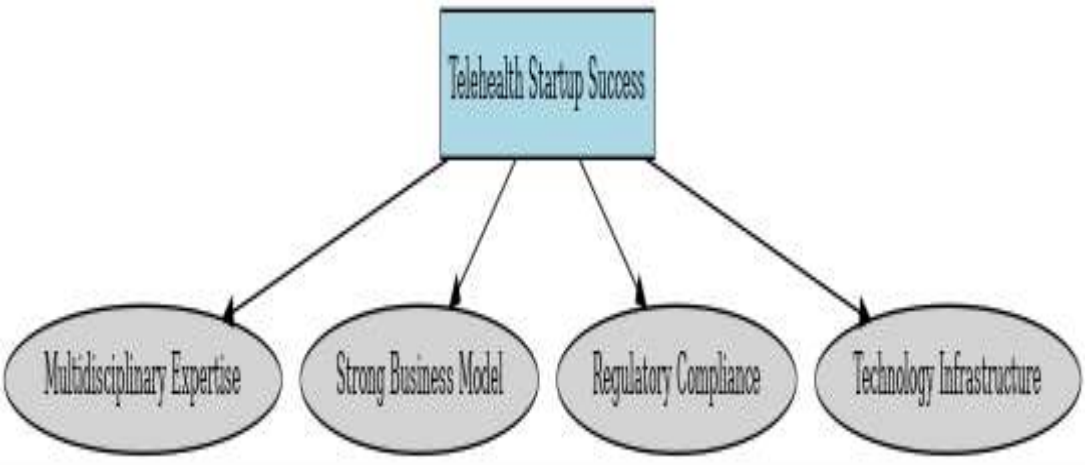
Since no primary data was collected this paper depends solely on Secondary data. Which is gathered from academic journals, industry reports, and market analyses to assess the feasibility, challenges, and opportunities in the Tele-health sector. Additionally, a comparative analysis of different Tele-health business models is conducted to identify best practices.

Discussions

Managerial and Human resource Aspects

Strategic Integration and Business Model Adaptation

Telehealth isn't a simple add-on; it requires a fundamental shift in service delivery. Managers must develop a clear strategic vision, integrating telehealth into the overall organizational mission. This includes defining target populations, service offerings, and revenue models.



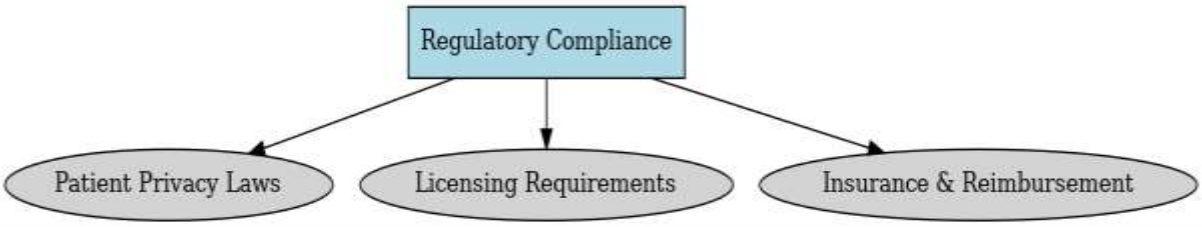
Key factors influencing the success of Tele-health startups, such as business model, regulatory compliance, and technological infrastructure.
(Sources: Smith & Johnson, 2021)

Regulatory Compliance Requirements in Tele-health

Telehealth businesses must navigate various legal considerations to ensure compliance and sustainability. They need to protect patient privacy by following laws like HIPAA in the U.S. or GDPR in Europe, as violating these can result in hefty fines. Additionally, healthcare providers must meet licensing requirements, which vary by region, to ensure they're operating legally. Lastly, understanding insurance reimbursement is crucial, as many insurers

and government programs have inconsistent policies on covering virtual consultations. Ensuring clear agreements with insurers is key to financial stability.

Overview of key regulatory compliance requirements for Tele-health startups, covering HIPAA regulations, licensing, and data security policies.
(Source: Digital Health, 2023)



Legal and Ethical compliance (NABH)

It is the role of Administrators to ensure the development of the Tele-Health service is complying with the NABH standards. To promote digital health in the health domain NABH launched the Digital Health Accreditation Programme on 17 September 2023. The Digital Health Accreditation Programme is a comprehensive process which focuses on the broad spectrum of innovations, including telemedicine, electronic health records (EHRs), mobile health apps, wearable devices, artificial intelligence, and all aspects of digitalization which may affect a patient or a family or an administrator. The Digital Health Standards have 8 chapters, 38 standards, and 181 objective elements which further combine to define the digital maturity of a hospital on levels such as Silver, Gold, and Platinum which have been defined below for the first accreditation cycle and the surveillance cycle.

Levels for First Accreditation Cycle

Table 1

At the time of first accreditation	Core	Commitment	Achievement	Excellence
Silver Level	100%	60%	NA	NA
Gold Level	100%	60%	60%	NA
Platinum Level	100%	60%	60%	60%

Levels for Surveillance Cycle

Table 2

Surveillance (After 24 months of first accreditation)	Core	Commitment	Achievement	Excellence
Silver Level	100%	80%	NA	NA
Gold Level	100%	80%	80%	NA
Platinum Level	100%	80%	80%	80%

Stakeholders of Tele-health start-ups

When considering the stakeholders involved in a telehealth startup, it's essential to recognize the diverse range of individuals and organizations that have a vested interest. Here's a breakdown of key stakeholders:

Core stakeholders

- Patients
- Healthcare providers like nurses, Doctors and other medical professionals
- Startup Founders and employees

- Investors

Supportive stakeholders

- Technology providers like software developers
- Business analysts
- Cyber security professionals
- Other Information Technology specialized staffs

Financial Aspects

Development cost (INR Estimates)

App Complexity	Estimated Cost Range (INR)	Key Features	Timeframe
Simple	□2,00,000- □ 4,00,000	Basicvideo consultations Appointment scheduling Secure messaging	2-3 Months
Medium Complexity	□4,00,000- □ 8,00,000	All simple app features EHR integration (limited) Payment gateway integration Basic remote monitoring	3-6 Months
Highly Complex	□8,00,000+	All medium app feature Advanced EHR integration AI diagnostics Advanced remote monitoring Full regulatory compliance	9+ Months

Maintenance cost

Category	Description	Estimated Annual Cost (% of Development)	Approximate Annual Cost Range (INR)
General Maintenance	Regular updates, bug fixes, and performance monitoring	15% - 20%	Varies greatly
Simple App Maintenance	Basic updates, bug fixes, and security patches	N/A	□30,000 - □ 80,000
Complex App Maintenance	Extensive updates, security, compliance, integrations, and AI management	N/A	□1,20,000- □ 5,00,000+

Revenue generated by 1000 users (approx.)

Revenue Stream	Assumption/Calculation	Monthly Revenue (□)
Virtual Consultations (Paid)	10% of users pay for a consultation monthly. Average consultation fee: □300.	1000 users * 0.01 * □ 300 = □30,000
Subscription Fees (Premium Features)	5% of users subscribe to premium features. Monthly subscription: □ 150.	1000 users * 0.05 * □ 150 = □7,500
Remote Patient Monitoring (RPM) Services	2% of users use RPM services. Monthly RPM fee: □ 400.	1000 users * 0.02 * □ 400 = □8,000
In-App Advertising (CPM)	Average CPM: □ 40. 2 ad impressions per session. 5 sessions per user monthly.	(1000 users * 5 sessions * 2 impressions / 1000) * □ 40 = □ 4,000
Sponsored Content/Partnerships	1 sponsored content partnership per month. Partnership fee: □ 80,000.	□8,000
Total Estimated Monthly Revenue	Sum of all revenue streams.	**□57,500 approx.**

Financial Breakdown

(For a Medium Complexity application)

Initial cost: 400,000
Maintenance cost: 30,000
Monthly revenue: 57,500

Monthly Profit:57,500 (revenue) - 30,000 (maintenance) = 27,500

Break-Even Period (in months):400,000 (initial cost) / 27,500 (monthly profit) = approximately 14.55 months.

That is 1 year 2 Months and 16 Days.

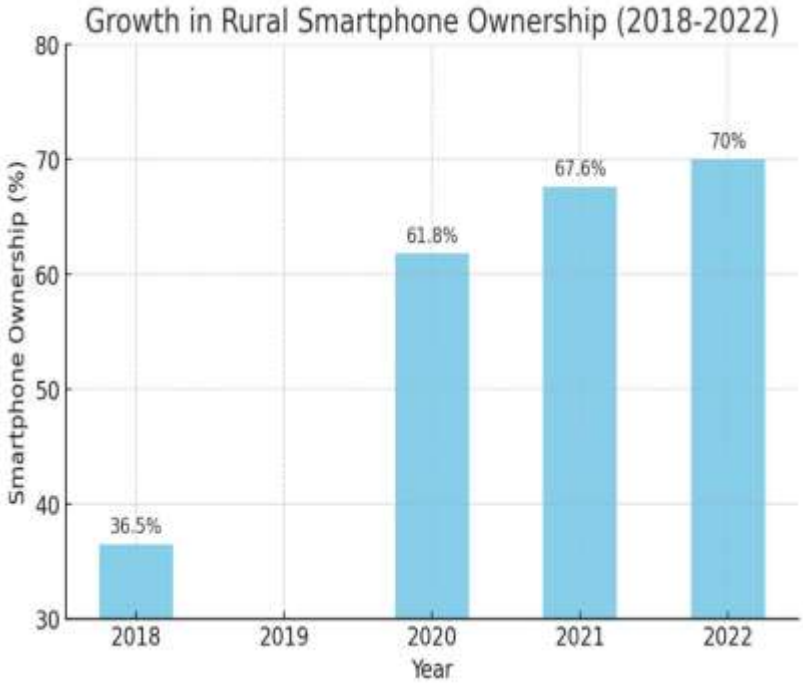
Patients aspects

Tele-Health has transformed the way patients access Healthcare, offering numerous benefits well also imposing some challenges. Here is the supportive breakdown of how Tele-health can save many lives.

Mobile phone usage in rural areas

Mobile phone usage has significantly increased in rural areas, driven by improvements in network connectivity and the affordability of smartphones. As access to mobile networks expands, rural populations are benefiting from enhanced communication, better access to information, and digital services that were previously unavailable. This growth in mobile phone usage has transformed daily life, offering new opportunities for

education, business, and social connectivity, ultimately bridging the gap between rural and urban communities.



The ASER 2022 Report shows rural smartphone ownership increased from 36% in 2018 to 75% in 2022. Articles from Hindustan Times and New Indian Express highlight the surge in adoption due to educational needs and state-specific growth, such as Jharkhand's rise from 17.6% to 61.7%.

Adoption of Tele-health

The adoption of telehealth reached its peak during 2019-2020, largely driven by the COVID-19 pandemic, which forced healthcare systems to rapidly shift to virtual care. As social distancing measures and lockdowns were implemented, telehealth provided a safe and efficient way for patients to access medical consultations without leaving their homes. This surge in adoption not only helped mitigate the spread of the virus but also accelerated the integration of digital health technologies into mainstream healthcare, establishing a lasting shift toward remote care services.

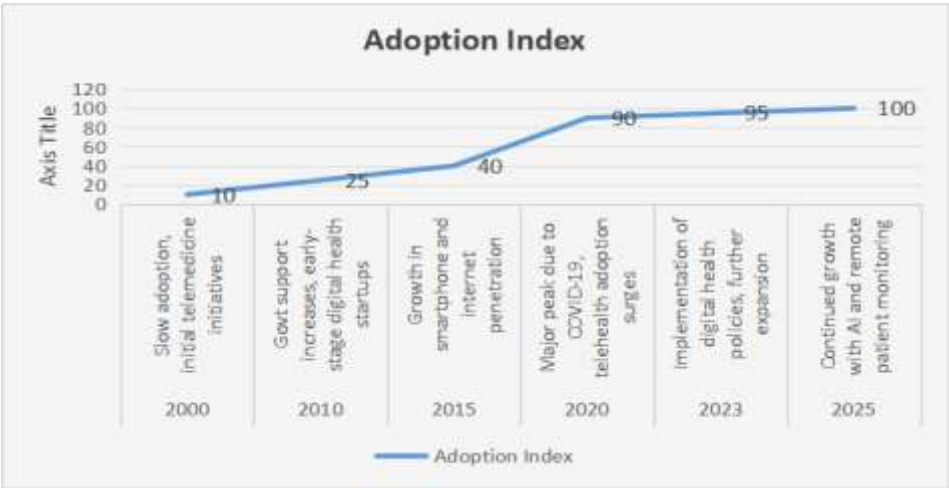


Figure depicting how Tele-Health has peaked during the pandemic by providing contact less Healthcare services simultaneously complying with the Quarantine protocols.

Impact of Tele-heath in minimizing deaths

Telehealth has played a crucial role in minimizing deaths by improving access to timely medical care, especially in underserved or remote areas. By enabling virtual consultations, it allows patients to receive prompt diagnoses, treatment advice, and ongoing monitoring without the risk of delays or exposure to infections in crowded healthcare settings. For chronic disease management, telehealth ensures continuous care, reducing complications and hospital readmissions. During emergencies or pandemics, it also helps alleviate the strain on healthcare systems, ensuring that critical resources and care are directed to those in urgent need, ultimately saving lives.

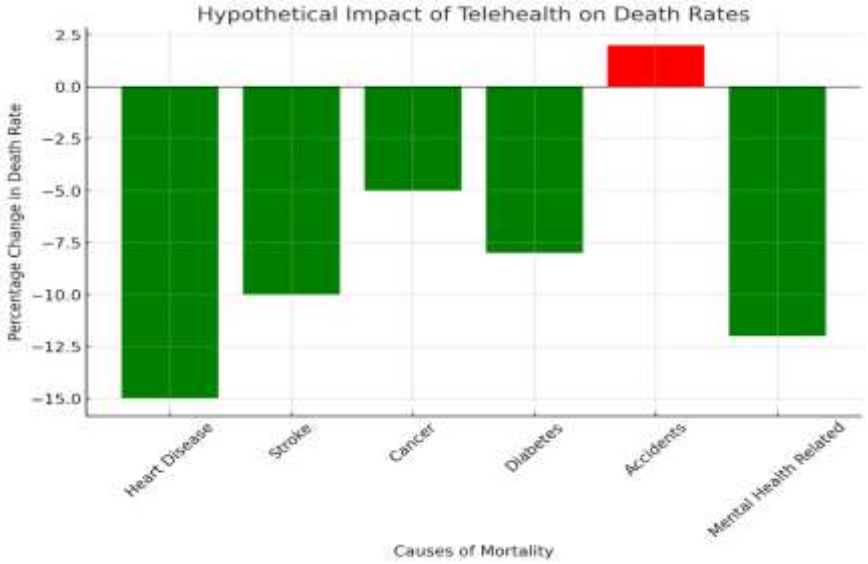


Figure depicting the deaths caused by people failed to adopt the Tele-health services and declared due to the emergency services in rural or remote areas.

Implications

Challenges

- Limited internet access, especially in rural or underserved areas, restricts the reach of telehealth services.
- Privacy and security concerns arise due to the risk of data breaches when transmitting sensitive health information online.
- Regulatory and licensing issues complicate cross-border telehealth services due to varying laws across regions.
- Some patients, particularly older adults or those unfamiliar with technology, face challenges in adopting telehealth.
- Technical issues, such as poor video or audio quality, can impact accurate diagnosis and effective communication during virtual consultations.

Suggestions

- Improve internet access in rural and underserved areas to expand telehealth services.
- Strengthen data security measures to protect patient information and build trust.

- Develop user-friendly telehealth platforms, especially for those unfamiliar with technology.
- Provide 24/7 technical support to ensure smooth virtual consultations.
- Educate both patients and healthcare providers on the benefits and effective use of telehealth.

Conclusion

By entrepreneurs adopting Tele-health startups there are many benefits that are directly related to the Corporate Social Responsibility of the Healthcare facility. As concluding this article, it provides the comprehensive understanding on Tele-heath and its benefits to the patients as well as the service providers. And breakdowns the Managerial, Human Resources, Financial and Patients aspects on Tele-health. The practice of adopting Tele-health services can uplift the Healthcare services via technology and innovation and significantly reduce the deaths by providing emergency consultancy services and guidance to patients who lack of facilities to reach out a Healthcare establishment.

References

Jonasdottir, S. K., Thordardottir, I., &Jonsdottir, T. (2022). Health professionals' perspective towards challenges and opportunities of Tele-health service provision: A scoping review. *International Journal of Medical Informatics, 167*, 104862.

Pollard, J. S., Karimi, K. A., &Ficcaglia, M. B. (2017). Ethical considerations in the design and implementation of a Tele-health service delivery model. *Behavior Analysis Research and Practice, 17*(4), 298–311.

Arif, M., Sajjad, M., Khan, R. A., & Ehsan, H. R. U. (2025). Development and validation of a tool to measure Tele-health educational environment (THEEM). *BMC Medical Education, 25*(1).

Kruse, C. S., Krowski, N., Rodriguez, B., Tran, L., Vela, J., & Brooks, M. (2017). Tele-health and patient satisfaction: a systematic review and narrative analysis. *BMJ Open*, *7*(8), e016242.

Fischer, S. H., Ray, K. N., Mehrotra, A., Bloom, E. L., &Uscher-Pines, L. (2020). Prevalence and characteristics of Tele-health utilization in the United States. *JAMA Network Open*, *3*(10), e2022302.

Haque, S. N. (2020). Tele-health beyond COVID-19. *Psychiatric Services, 72*(1), 100–103.

Kolluri, V. (2021). Cybersecurity And Data Privacy In Wearable Health Technologies: Examining the Security Measures And Privacy Concerns Associated with Wearable Health Devices. In International Journal of Creative Research Thoughts (IJCRT), *International Journal of Creative Research Thoughts (IJCRT)* (Vol. 9, Issue 8) [Journal-article].

Hechenleitner-Carvallo, M., & Ibarra-Peso, J. (2024). Interdisciplinarity in the Effectiveness of Tele-health: challenges, opportunities, and necessary competencies. *Data & Metadata*, *4*, 542.

Kissi, J., Dai, B., Dogbe, C. S., Banahene, J., & Ernest, O. (2019). Predictive factors of physicians' satisfaction with telemedicine services acceptance. *Health Informatics Journal, 26*(3), 1866–1880.

EXPLORING PUBLIC PERCEPTION AND ACCEPTANCE OF DIGITAL HEALTH TECHNOLOGIES IN RURAL AREAS: BARRIERS AND OPPORTUNITIES

Dr J Josephine Lalitha[1],Ms Raveena P[2], Ms Avantika J [3]
[1]Assistant Professor, PSG College of Arts & Science, Coimbatore
[2,3] Student, PSG College of Arts & Science, Coimbatore

Abstract

Digital health technologies have the potential to revolutionize healthcare delivery in rural areas, addressing long-standing disparities in access and quality of care. This study explores the impact of digital health capabilities on healthcare outcomes in rural settings, focusing on key dimensions such as governance, IT capability, skills, interoperability, strategy, data analytics, and consumer-centered care. The findings highlight the importance of a coordinated digital strategy to achieve better healthcare outcomes, emphasizing the need for user-friendly devices, effective training programs, and reliable internet connectivity. The study also identifies barriers to adoption, including digital literacy and trust in technology, and suggests strategies to overcome these challenges. Overall, the integration of digital health technologies in rural healthcare systems can significantly improve access to care, patient experience, and health outcomes.

Key Words: Digital health, Rural health care, Tele medicine, Healthcare Outcomes, Wearable Health Devices

Introduction

Digital health encompasses the use of advanced information and communication technologies to improve healthcare services, delivery, and outcomes. It represents the integration of digital innovations into the healthcare ecosystem to enhance the efficiency, accessibility, and quality of patient care. Key elements of digital health include: **Telemedicine, Mobile Health (mHealth),** Electronic Health Records (EHRs), Wearable Devices, Big Data and Analytics, Artificial Intelligence (AI), Remote Monitoring.

Digital health aims to create a more patient-centered and efficient healthcare system by leveraging technological advancements. It holds the potential to transform healthcare delivery, reduce costs, and enhance the overall quality of care. As the field continues to evolve, ongoing research and innovation in digital health will be pivotal in addressing emerging healthcare challenges and improving population health. The Indian government has launched several key initiatives to promote digital health and transform the healthcare landscape. Ayushman Bharat Digital Mission (ABDM), Digital India includes initiatives like the e-Hospitalande-Sanjeevani platforms, CoWIN App, AarogyaSetu, National Digital Health Mission (NDHM)**,** Digital Health Incentive Scheme (DHIS)**.** These initiatives are designed to enhance the accessibility, efficiency, and quality of healthcare services in India, making healthcare more inclusive and patient-centred. The digital healthcare market in India is projected to grow from $2.7 billion in 2022 to around $37 billion by 2030. As of August 2023, around 44.2 crore (442 million) unique health IDs have been created under the Ayushman Bharat Digital Mission (ABDM). The eSanjeevani platform facilitated over 1 crore (10 million) teleconsultations between 2022 and 2023. Health and Wellness Centers: There are 1.5 lakh (150,000) Health and Wellness Centers operating across India under the

ABDM. Healthtech Investments: The value of funding in health tech start-ups across India reached $2.3 billion in 2022.India has seen a significant increase in internet penetration, with over 800 million internet users as of 2023. The use of health and wellness apps among Indians has increased, with over50% of smartphone users utilizing such apps. Studying people's perceptions of digital health is essential for its successful adoption and implementation. Understanding public attitudes helps identify barriers to usage, build trust, and tailor user-centric solutions. It informs education and awareness campaigns, ensuring that users are well-informed about the benefits and security of digital health tools. Insights from perception studies guide policymakers in crafting responsive and inclusive regulations, promoting equitable access to healthcare technologies. Ultimately, understanding people's perceptions ensures that digital health initiatives are effective, trusted, and widely accepted, leading to improved healthcare outcomes and patient empowerment. This research topic focuses on understanding how people perceptions influence the adoption and utilization of digital health technologies in rural Coimbatore. The research will also propose strategies to enhance the acceptance and effectiveness of digital health solutions in diverse settings.

Literature Review

Jongebloed et al. (2024) evaluates the digital health literacy and engagement of people from rural and regional areas, identifying barriers such as product complexity, reliability, awareness, trust, and cost. It emphasizes the need to support individuals with lower levels of digital health literacy to effectively use digital health technologies.

Peck, Jackson, and Marshall (2023) examines the application of digital health technologies in rural areas across different countries. It discusses the potential of digital health to address spatial health inequalities and the barriers created by remoteness and low population density.

More (2021) explores the multifaceted effects of digitalization on rural India, focusing on areas such as agriculture, education, healthcare, and local economies. It highlights the benefits of digital technologies in enhancing the quality and accessibility of services, while also addressing challenges like the digital divide and limited digital literacy.

Woods et al. (2024) evaluate how digital health capabilities influence healthcare outcomes in rural settings. It identifies key dimensions such as governance, IT capability, skills, interoperability, strategy, data analytics, and consumer-centered care. The study highlights the importance of a coordinated digital strategy to achieve better healthcare outcomes.

Smith and Thompson (2022) investigate the barriers and facilitators to the adoption of telemedicine in rural communities. It finds that while telemedicine has the potential to improve access to healthcare, challenges such as internet connectivity, digital literacy, and trust in technology need to be addressed.

Patel and Kapoor (2023) examine the role of wearable health devices in managing chronic diseases in rural areas. It emphasizes the importance of user-friendly devices and effective training programs to ensure proper utilization and improved health outcomes.

Research Gap: While digital health holds great promise for rural areas, several key research gaps remain. There is a critical need to enhance digital literacy and ensure equitable access to technology among rural populations, as these barriers significantly hinder adoption. Poor infrastructure and limited internet connectivity further exacerbate the challenges, making it

difficult to implement digital health solutions effectively. Additionally, ensuring the interoperability of various digital health systems is crucial for seamless communication and data sharing. More research is needed to tailor digital health initiatives to the specific needs of rural communities, taking into account cultural and socio-economic factors. Lastly, comprehensive studies evaluating the impact of digital health on healthcare outcomes in rural settings, including patient experience, healthcare costs, and provider satisfaction, are necessary to inform future strategies.

Statement of the Problem

In the absence of digital health, several significant challenges and missed opportunities would arise, leading to less efficient healthcare delivery and poorer patient outcomes. Despite the potential of digital health technologies to improve healthcare outcomes in rural areas, their adoption and effective implementation face significant challenges. Rural communities often experience disparities in access to healthcare services due to geographical isolation, limited healthcare infrastructure, and workforce shortages. While digital health solutions, such as telemedicine and wearable health devices, offer promising ways to bridge these gaps, barriers such as internet connectivity, digital literacy, trust in technology, and lack of coordinated digital strategies hinder their widespread adoption and utilization. This research aims to explore these challenges and identify strategies to overcome them, enabling rural healthcare systems to fully leverage digital health capabilities for better patient outcomes.

Objectives

To Analyze the demographic profile and information sources of respondents, and evaluate their familiarity with and usage of digital health services in rural areas.

To identify the factors influencing the preference for digital health services.

To evaluate the perceived benefits of digital health apps in rural areas.

To Examine the perception and attitude towards the adoption of digital health technologies in rural areas.

To identify the barriers to the acceptance and adoption of digital health technologies and evaluate the demand for digital health solutions in rural communities

Scope of the Study

The scope of the Study on Digital Health in Rural Coimbatore focusses on Current Health Infrastructure, Digital Health Awareness, Usage and Adoption, Perceived Benefits, Barriers and Challenges and Government and Healthcare Provider Initiatives. This study aims to provide valuable insights into the potential of digital health technologies to improve healthcare access and outcomes in rural Coimbatore, and to identify areas for further development and investment.

Methodology

The study was conducted in five selected villages in rural Coimbatore namely Karamadai, Annur, Periyanaickenpalayam, Thondamuthur, Sulur. The sample size for the study was 500 respondents, distributed equally among the five villages, with 100 respondents from each village. A stratified random sampling technique was used to ensure representation from different demographic groups within each village. The strata were based on age, gender, and occupation. Structured questionnaires were administered to the respondents to gather

quantitative data on their awareness, usage, and perception of digital health services. FGDs was also organized with different demographic groups to explore their attitudes and experiences with digital health technologies.

Findings

Table-1: Demographic profile of the respondents

Demographic Category	Subcategory	No. of Respondents	Percentage
Age	Under 18	50	10
	18-30	125	25
	31-45	150	30
	46-60	100	20
	Over 60	75	15
Gender	Male	275	55
	Female	220	44
	Other	5	1
Education Level	No formal education	75	15
	Primary education	125	25
	Secondary education	150	30
	Higher secondary education	100	20
	Graduate or above	50	10
Occupation	Farmer	200	40
	Homemaker	100	20
	Student	50	10
	Employed	100	20
	Self-employed	40	8
	Other	10	2

Source: Field survey,2025

Table 1 showsmajority of respondents fall within the 31-45 age bracket (30%), followed by 18-30 (25%), 46-60 (20%), over 60 (15%), and under 18 (10%). A higher proportion of respondents are male (55%), with females comprising 44% and other genders 1%. Most respondents have secondary education (30%) or primary education (25%), with fewer having higher secondary education (20%), no formal education (15%), or graduate-level education (10%). The predominant occupation is farming (40%), followed by homemakers (20%), employed individuals (20%), students (10%), self-employed (8%), and others (2%).

Table -2: Sources of information

Source of Information	% of respondents
Healthcare provider	30
Family or friends	25
Social media	15
Television or radio	20
Community events	5
Other (please specify)	5

Source: Field survey,2025

Table 2 indicates that in remote rural areas, the primary sources of information about digital health technologies are healthcare providers (30%) and personal networks like family or friends (25%). Television or radio (20%) and social media (15%) also play a role, while community events and other sources are less common (5% each). This highlights the importance of leveraging trusted medical professionals and personal connections to promote awareness and education about health technologies in these regions

Table -3: Familiarity and usage of digital health services in rural areas

Features	**Very familiar**	**Somewhat familiar**	**Neutral**	**Not familiar**	**Not at all familiar**
Telemedicine (e.g., video consultations with doctors)	20%	25%	25%	20%	10%
Health monitoring apps (e.g., tracking blood pressure, glucose levels)	25%	25%	20%	20%	10%
Wearable health devices (e.g., fitness trackers, smartwatches)	25%	25%	20%	20%	10%
Health information platforms (e.g., health websites, online medical journals)	30%	30%	20%	15%	5%
Online appointment booking	30%	30%	20%	15%	5%
Usage					
Frequency of usage	**Always**	**Often**	**Some times**	**Rarely**	**Never**
Use telemedicine services for healthcare consultations	20%	22%	22%	18%	18%
Health monitoring apps to track your health metrics	20%	22%	22%	18%	18%
Wearable health devices to monitor your fitness and health	25%	25%	20%	16%	14%

Access online health information platforms to seek medical advice o	30%	28%	20%	15%	7%

Source: Field survey,2025

Familiarity with Health Technologies

Telemedicine:
Only 20% are very familiar, and 25% are somewhat familiar, indicating limited awareness.

Health Monitoring Apps:
Similar to telemedicine, only 25% are very familiar and 25% are somewhat familiar.

Wearable Health Devices:
Awareness is also limited with 25% very familiar and 25% somewhat familiar.

Health Information Platforms:
Awareness is higher, with 30% very familiar and 30% somewhat familiar.

Online Appointment Booking:
Similar to health information platforms, 30% are very familiar, and 30% are somewhat familiar.

Usage of Health Technologies

Telemedicine Services:
Only 20% always use them, while 22% use them often. The usage is distributed with 22% sometimes, 18% rarely, and 18% never using them.

Health Monitoring Apps:
The pattern is similar to telemedicine, with 20% always, 22% often, 22% sometimes, 18% rarely, and 18% never using them.

Wearable Health Devices:
25% always use them, 25% often, 20% sometimes, 16% rarely, and 14% never use them.

Online Health Information Platforms:
Higher usage with 30% always, 28% often, 20% sometimes, 15% rarely, and only 7% never use them.

Implications

The data indicates limited familiarity and moderate usage of health technologies in rural areas. While there is some awareness of health information platforms and online appointment booking, other technologies like telemedicine, health monitoring apps, and wearable devices have lower familiarity. Usage patterns show that while some residents regularly use these technologies, a significant portion still rarely or never use them. This underscores the need for increased education and access to boost the adoption of digital health technologies in rural regions.

Table-4: Different types of digital health apps used by the rural people

Category	No. of Users	%
Fitness and Exercise Apps (Nike Training Club /	75	15

MyFitnessPal)		
Nutrition and Diet Apps (Lose It! / MyPlate)	64	13
Mental Health and Well-being Apps (Calm /Headspace)	50	10
Telemedicine Apps (Teladoc / Practo)	100	20
Medication Management Apps (Medisafe / MyTherapy)	25	5
Chronic Disease Management Apps (Glucose Buddy / MySugr)	75	15
Women's Health Apps (Flo / women health diary)	38	7
Sleep Tracking Apps (Sleep Cycle / Pillow)	50	10
Health Monitoring Apps (Apple Health / Samsung Health)	63	12
Mental Health Therapy Apps (BetterHelp / Talkspace)	50	10

Source: Field survey,2025

Telemedicine Apps:
Most interest (20%), reflecting the need for virtual healthcare access due to limited facilities.
Fitness and Exercise Apps:
Lower interest (15%) due to fewer resources for physical fitness.
Chronic Disease Management Apps:
Significant interest (15%) due to the need for managing chronic conditions.
Nutrition and Diet Apps:
Moderate interest (12.5%), emphasizing the importance of dietary management.
Health Monitoring Apps:
Moderate interest (12.5%) for tracking vital health metrics.
Other Categories:
Lower interest but still relevant for mental health, women's health, medication management, and sleep tracking. This data highlights the importance of telemedicine and chronic disease management in rural areas, while also indicating a general interest in health and wellness apps.

Table-5: Factors influencing the preference for digital health services

Factors	**Average Garett score**	**Rank**
Convenience	60	1
Health Monitoring and Management	58	2
Better Access to Healthcare Services	55	3
Cost Savings	52	4
Recommendation by a Healthcare Provider	48	5
Other	42	6

Source: Field survey,2025

Based on the Garett scores in table 5, the primary reasons for preferring digital health in rural areas are as follows:

Convenience (Rank 1) with an average Garett score of 60, highlighting the ease of accessing healthcare services through digital means.

Health Monitoring and Management (Rank 2) with an average score of 58, indicating the importance of continuous health tracking and management.

Better Access to Healthcare Services (Rank 3) with a score of 55, emphasizing the improved reach and availability of healthcare services.

Cost Savings (Rank 4) with a score of 52, showing the financial benefits of using digital health.

Recommendation by a Healthcare Provider (Rank 5) with a score of 48, reflecting the influence of healthcare professionals' recommendations.

Other Reasons (Rank 6) with a score of 42, representing various additional factors.
These insights reveal that convenience and health monitoring are the top motivators for rural populations to adopt digital health technologies

Table-5: Respondent's opinion on Perceived benefits of digital health services

Perceived benefits	**Mean**	**Median**	**Standard Deviation**
Improved access to healthcare	4.20	4	0.84
Cost-effective healthcare	3.80	4	0.45
Enhanced health outcomes	4.60	5	0.55
Patient empowerment	3.40	3	0.55
Digital divide	2.40	2	0.49
Digital literacy	3.00	3	0.63
Trust and reliability	2.60	3	0.49
Infrastructure challenges	2.80	3	0.40

Source: Field survey,2025

Improved Access to Healthcare:

The mean response is 4.20, indicating a positive perception. The standard deviation of 0.84 shows moderate variability in responses.

Cost-Effective Healthcare:

The mean response is 3.80, suggesting a generally positive perception with a low standard deviation of 0.45.

Enhanced Health Outcomes:

The mean response is 4.60, indicating a strong positive perception with a moderate standard deviation of 0.55.

Patient Empowerment:

The mean response is 3.40, suggesting a slightly positive perception with a moderate standard deviation of 0.55.

Digital Divide:

The mean response is 2.40, indicating a perception of challenges related to the digital divide with a low standard deviation of 0.49.

Digital Literacy:

The mean response is 3.00, suggesting a neutral perception with moderate variability (standard deviation of 0.63).

Trust and Reliability:

The mean response is 2.60, indicating concerns about trust and reliability with low variability (standard deviation of 0.49).

Infrastructure Challenges:

The mean response is 2.80, suggesting moderate challenges with a low standard deviation of 0.40.

Table -6: Perception and attitude on digital health technologies enhances health care access in rural communities

Response	No of respondents	Percentage
Strongly agree	140	28
Agree	160	32
Neutral	100	20
Disagree	50	10
Strongly disagree	50	10

Source: Field survey,2025

Table 6 suggests that most people in remote rural areas believe digital health technologies can improve healthcare access, with 60% agreeing or strongly agreeing, while 20% are neutral and 20% disagree.

Table -7: Willingness to Learn About Digital Health Technologies with Training

Response	Number of Respondents	Percentage
Yes	400	80%
No	100	20%

Source: Field survey,2025

Table 7 shows a significant majority (80%) of respondents are willing to learn more about digital health technologies if proper training is provided. A smaller portion (20%) of respondents are not willing and are reluctant to engage in learning about these technologies, even with training opportunities.This data suggests a strong interest among the rural population in adopting digital health technologies, provided they receive adequate training. Addressing the concerns of the reluctant group through targeted awareness programs may further enhance adoption rates.

Table-8: Respondent's opinion on the kind of support type required

Support Type	**No of respondents**	**Percentage**
Training programs on digital literacy	150	30%
Subsidized internet services	125	25%
Access to affordable digital devices	100	20%
Community awareness programs	75	15%
Support in local language	40	8%
Other (please specify)	10	2%

Source: Field survey,2025

Training Programs on Digital Literacy (30%): The most critical support needed, as many residents lack basic digital skills.
Subsidized Internet Services (25%): Important for improving internet accessibility and affordability.
Access to Affordable Digital Devices (20%): Ensuring that residents can obtain the necessary technology.
Community Awareness Programs (15%): Essential for spreading knowledge and encouraging the adoption of digital health technologies.
Support in Local Language (8%): Helpful for making digital tools more accessible to non-English speakers. Other (2%): Includes various other support measures that might be needed.

Table-9: Barriers to Acceptance and Adoption of Digital Health Technologies

Barrier Category	**Specific Barriers**	**% of Respondents Affected**
Cultural	Lack of trust in technology	40%
	Preference for traditional healthcare methods	35%
Social	Low digital literacy	50%

	Limited awareness of digital health benefits	45%
Economic	High cost of digital devices	30%
	Limited financial resources	40%
Infrastructural	Poor internet connectivity	55%
	Lack of access to digital health services	50%

Source: Field survey,2025

Cultural Barriers:

A significant portion of the rural population (40%) lacks trust in digital health technologies, preferring traditional healthcare methods (35%). This indicates a need for culturally sensitive approaches to promote digital health adoption.

Social Barriers:

Low digital literacy (50%) and limited awareness of the benefits of digital health technologies (45%) are major social barriers. Educational initiatives and awareness campaigns can help bridge this gap.

Economic Barriers:

The high cost of digital devices (30%) and limited financial resources (40%) hinder the adoption of digital health technologies. Subsidies and financial assistance programs can alleviate these economic constraints.

Infrastructural Barriers:

Poor internet connectivity (55%) and lack of access to digital health services (50%) are critical infrastructural barriers. Improving internet infrastructure and expanding digital health services in rural areas are essential steps to overcome these challenges.

Table-10: Respondent's opinion on demand for digital health solutions in rural communities

Response	No of respondents	Percentage
Strongly agree	200	40%
Agree	275	35%
Neutral	75	15%
Disagree	35	7%
Strongly disagree	15	3%

Source: Field survey,2025

A significant majority (75%) of respondents strongly agree or agree that the government and healthcare providers should invest more in digital health solutions for rural communities. This indicates a strong demand for improved access to digital health technologies in these areas. A smaller portion (15%) remains neutral, while a very small group (10%) disagrees, reflecting the overall positive perception of the potential benefits of such investments.

Discussion

The study on digital health in rural Coimbatore provides valuable insights into the adoption, usage, and perceptions of digital health technologies among the rural population.

The findings reveal that while there is a notable level of awareness and interest in digital health services, actual usage remains moderate due to several barriers.

Awareness and Familiarity:

The study shows varying levels of familiarity with different digital health technologies. Health information platforms and online appointment booking are relatively more familiar to respondents, compared to telemedicine, health monitoring apps, and wearable health devices.

Usage Patterns:

Although some respondents regularly use digital health technologies, a significant portion still rarely or never use them. This indicates a gap between awareness and actual usage, highlighting the need for targeted interventions to bridge this gap.

Barriers to Adoption:

Infrastructure Challenges:

Limited internet connectivity and digital infrastructure in rural areas impede the effective adoption of digital health technologies.

Digital Literacy:

Lack of digital literacy is a significant barrier, as many respondents may not fully understand how to use these technologies or the benefits they offer.

Trust and Privacy Concerns:

Concerns about data privacy and trust in digital health solutions may also hinder their adoption.

Implications:

Educational Programs:

To increase familiarity and usage, there is a need for educational programs that focus on digital literacy and the practical benefits of digital health technologies.

Infrastructure Investment:

Improving internet connectivity and access to digital devices in rural areas is crucial for the effective adoption of these technologies.

Community Engagement:

Involving local community leaders and healthcare providers in promoting digital health can enhance trust and acceptance among the rural population.

Future Research:

The study's limitations, such as the sample size, response bias, and language barriers, should be addressed in future research. Expanding the sample size, employing longitudinal designs, and enhancing data collection methods can provide more robust and representative results. Additionally, continuous monitoring and evaluation of digital health initiatives are essential to measure their effectiveness and identify areas for improvement. Overall, the study underscores the potential of digital health technologies to improve healthcare access and outcomes in rural Coimbatore, while also highlighting the challenges that need to be addressed to achieve successful implementation

Limitations

Although a sample size of 500 provides valuable insights, a larger sample size could offer more robust and representative results. While interviews and focus group discussions provide qualitative insights, the depth of information may be constrained by the number of

participants and the duration of the sessions. Language barriers may have influenced the understanding and interpretation of survey questions and interview responses, potentially affecting the accuracy of the data. There may be response bias due to social desirability or reluctance to disclose certain information, which could affect the accuracy of the data collected.

Conclusion

The study on digital health in rural Coimbatore reveals several key insights. First, there is a significant potential for digital health technologies to improve healthcare access and outcomes in these rural areas. The community shows a considerable level of awareness and interest in digital health services, with telemedicine and chronic disease management apps being among the most favored. The perceived benefits include improved access to healthcare, cost-effectiveness, and enhanced health outcomes. However, the study also identifies several barriers to the adoption of digital health technologies, such as infrastructure challenges, lack of digital literacy, and trust issues. Addressing these barriers through targeted initiatives, such as training programs on digital literacy, subsidized internet services, and community awareness programs, is essential for successful implementation. Furthermore, there is a strong demand for government and healthcare provider investments in digital health solutions. By understanding the community's needs and preferences, stakeholders can develop effective strategies to enhance the adoption and usage of digital health technologies, ultimately improving healthcare services and quality of life in rural Coimbatore.

References

Awale, P. S., Kumar, A., Bankar, N. J., Makade, J., & Kale, Y. (2024). eHealth and telehealth adoption in rural and underserved communities in India: A review.

Chandrakar, M. (2024). Telehealth and digital tools enhancing healthcare access in rural systems. Discover Public Health.

Jongebloed, H., Anderson, K., Winter, N., Nguyen, L., Huggins, C. E., Savira, F., Cooper, P., Yuen, E., Peeters, A., Rasmussen, B., Reddy, S., Crowe, S., Bhoyroo, R., Muhammad, I., & Ugalde, A. (2024). The digital divide in rural and regional communities. BMC Research Notes. Available at: BMC Research Notes.

More, V. K. (2021). The impact of digitalisation on rural communities in India. International Journal of Advance and Applied Research.

HOSPITAL ANXIETY AND DEPRESSION DUE TO THE USAGE OF DIGITAL PLATFORM

Mr Monish Kumar R [1], MsSangamithra S[2]
[1,2] Student, Department of Hospital Administration
PSG College of Arts & Science, Coimbatore

Abstract

"Depression is the soul's way of telling you to change something in your life, not to cut your own bangs."

-John Fugelsang.

Hospital visits and medical treatments might cause people to feel uneasy or anxious and depressed. To find the finest management techniques, such as cognitive behavioural therapy or medication, people can consult a physician or a loved one. Digital platforms are business models that use online infrastructure to facilitate interactions between groups. The present research focuses on the hospital anxiety and depression due to the usage of digital platform. The method of analysis used in this study was simple random sampling which involves 108 participants from various places of Tamil Nadu. The participants were assessed using Hospital Anxiety and Depression Scale (HADS) by Zigmond and Snaith (1983). The data will be analysed using Statistical Package for Social Sciences (SPSS). The further results of this will be discussed with further lights of research.

Key words: Anxiety, Depression, Digital Platforms.

Introduction

Anxiety

These anxiety and panic attacks can be long-lasting, difficult to regulate, and out of proportion to the real threat. They often interfere with day-to-day activities. To avoid unpleasant emotions, you might steer clear of certain locations or circumstances. The symptoms may begin in childhood or adolescence and persist throughout adulthood .Among the most prevalent mental health issues are anxiety disorders:

- Up to 12% of Americans suffer from specific phobias.
- Approximately 7 percent of Americans suffer from social anxiety disorder.
- The prevalence of generalized anxiety disorder in the United States is approximately 3%.
- It is estimated that 1.7% of Americans suffer from agoraphobia.
- About 4% of children, 1.6% of adolescents, and up to 1.9% of adults suffer with separation anxiety disorder.
- The least prevalent type of anxiety illness is selective mutism. Between 0.47% and 0.76% of Americans are impacted.

Depression

Depression differs from normal mood swings and sentiments about day-to-day living. All facets of life, including those with friends, family, and the community, may be impacted. It may be the cause of or contribute to issues at work and school.Anyone can experience depression. Depression is more common in people who have experienced abuse, significant

losses, or other stressful situations. Compared to men, women are more prone to experience depression.

Hospital Anxiety and Depression

People may experience worry or discomfort when they go to the hospital or have medical procedures done. Individuals can consult a physician or a loved one to identify the most effective management techniques, such as cognitive behavioral therapy or prescription drugs.For a variety of reasons, including apprehension about an impending treatment or a challenging diagnosis, many people steer clear of hospitals. Anxiety in the hospital might hinder a person's recuperation or force them to postpone or prolong necessary medical procedures. Undiagnosed anxiety.Anxiety related to hospital visits or medical treatments is known as hospital anxiety. People who suffer from hospital anxiety also obsess over unpleasant or painful outcomes of going to the hospital, such as getting ready for a major surgery or invasive procedure.

Digital Platforms

Digital platforms refer to business concepts that leverage online infrastructure to enable group interactions. Among the examples are:

- Online markets
- social media platforms
- Crowdsourcing apps and websites

Numerous characteristics of digital platforms improve their usefulness and attractiveness. They can expand and handle transactions without incurring large cost increases, to start. Expanding market reach with less business infrastructure requires that scalability. A corporation can improve internal operations and customer satisfaction by standardizing business processes through more transparent and efficient workflows. Businesses can more effectively develop and market goods, provide customer service, and generate intelligence to enhance operations and guide company and product strategy by utilizing digital platforms. Employees, including customer service representatives, can use this enhanced intelligence to better engage customers and increase revenue by using the data, analytics, and insights it provides. To enhance patient care and engagement, a digital health platform uses state-of-the-art medical services and technologies. Healthcare businesses can enhance patient satisfaction and care quality by implementing these platforms. Numerous healthcare technologies and services are combined into a digital health platform. Patients can check test results, access health information, message their providers, pay bills, register symptoms in real time, request medication refills, and more in this online environment, whether they are using a laptop, a smartphone app, or a distant device.

Review of Literature

Choi, Kim, and Min(2023) studied social anxiety disorder using digital phenotype. They used unsupervised machine learning and the data collected from smartphones, called digital phenotype, to investigate the heterogeneity of social anxiety disorder. They identified three subgroups of social anxiety disorder using digital phenotype. Symptom severity scores as well as app usage, call usage, phone usage, movement pattern and ambient light differed significantly across subgroups. Their findings provided insights into the behavioral traits collected through smartphones of social anxiety disorder-related subgroups.

Prabakar, A. S. N, J. S and P. S(2024) the study presented is an anxiety evaluation technique designed specifically for kids with various illnesses. Utilizing sensors and user-friendly software to track vital indications such as heart rate, temperature, breathing rate, and galvanic skin response. With a few easy questions that the mobile application poses to caregivers, the method aims to precisely assess the mental and behavioral health of these kids; each response raises the caregiver's overall score. The collected data, including the score and physiological markers, is processed by an Arduino, which then assigns the child's anxiety level to an appropriate group. The well-being of children with numerous disorders is improved by this methodology, which offers an effective tool for prompt identification and customized care.

Singal, Gary, Pina, Stoll and Amresh(2024) reported that Applications for mobile health offer the potential to treat chronic illnesses, but adherence to the degree to which a patient follows a clinical protocol presents difficulties. Greater impacts of the intervention should result from high levels of adherence; the more faithfully one follows the procedure, the more benefits one should obtain from it. Additionally, just-in-time "micro" interventions—smaller but more frequent doses of skill practice are supported by this delivery method. The ability of patients to sustainably follow a protocol and to drive intervention effect sizes are two areas where mHealth is limited.This approach has been implemented within an mHealth app for middle school that was successfully pilot-tested in the Phoenix area.

Amin, Mishar, and Sathyanarayana(2024) study reported that Students frequently suffer from depression as a result of social and academic demands. This study investigates the relationships between personality factors and social interaction patterns and depression. We used the StudentLife dataset's smartphone sensing data to group students according to the Big Five personality traits. Results indicate that social interaction variability is higher among those with high neuroticism and depression, most likely as a result of emotional instability and low self-esteem. This emphasizes how crucial interpersonal aspects are in identifying kids who are at risk and creating focused interventions to promote mental health.

Rutowski, Shirberg, Harati, Lu, and Oliveria(2020) studied that Applications for digital screening and monitoring can help clinicians manage mental health issues. They investigated deep language models that use conversational speech as input to identify depression, anxiety, and their comorbidity. 16k spoken exchanges with labels for anxiety and depression make up the speech data. Depending on condition and comorbidity, they found that binary classification values vary from 0.86 to 0.79 AUC.

Jin and Huang(2025) study shows that Millions of people worldwide suffer from depression, yet standard monitoring depends on sporadic, subjective evaluations. A more complete picture is provided by wearable technology, which continuously records vital indications like heart rate, sleep, and activity. Over a six-month period, we monitored 302 hospitalized patients with depression and correlated physiological data with HAMA and HAMD ratings. Findings indicated that moderate and severe cases differed significantly, and a logistic regression model with an AUC of 0.84 demonstrated good classification accuracy. More accurate, individualized, and proactive mental health care is made possible by wearable technology, which improves depression monitoring.

Nguyen, Kolappan, Bhat and Krishnan(2021) studied on clustering and Feature Analysis of Smartphone Data for Depression Monitoring.Multimodal data gathering for mental health monitoring is made possible by technological advancements. The Dartmouth dataset comprises PHQ-9 depression scores and smartphone sensor data gathered from 60 participants during 10 weeks. Three data views—average, trend, and location—are used in this study's multi-view bi-clustering (MVBC) algorithm to divide participants into groups with low, medium, and high levels of depression. Key traits are prioritized by minimum redundancy maximum relevance (mRMR) to increase efficiency. With an accuracy of 94.7±1.62%, Decision Tree cross-validation shows promise for low-power, edge computing applications in long-term smartphone-based mental health monitoring.

Kitsing(2020) studied on scenarios for digital platform ecosystems. The future evolution of digital platforms is examined in this article. It presents the idea of digital platform ecosystems, focusing on institutions and governance in addition to technological and economic aspects. Instead of depending on trend extrapolation, it uses scenario planning to investigate different future pathways. Lastly, it talks about scenarios from national and international organizations that show possible futures for platform ecosystems.

Need for the Study

This study is made to create awareness of the individual's hospital anxiety and depression due to the usage of digital platforms. The individuals may acquire knowledge of their anxiety and depression in the area of hospital treatment and their present or upcoming illness.

Objectives of the Study

To assess the hospital anxiety and depression due to the usage of digital platforms.
To compare the relationship between hospital anxiety and depression due to the usage of digital platforms.
To find the relationship differences between demographic variables on hospital anxiety and depression due to the usage of digital platforms.

Alternate Hypothesis

There is a significant difference in the levels of hospital anxiety and depression.
There is a significant difference in the levels of usage of digital platforms.
There is a significant relationship between hospital anxiety and depression due to the usage of digital platforms.
There is a significant gender differences in hospital anxiety and depression due to the usage of digital platforms.

Sample

Individuals living in Tamilnadu were approached for the study. Simple random sampling method was used to collect the data. This method was used to collect the data as it was a much more convenient method to collect the data for the research study.

Inclusive Criteria

- Both male and female

Exclusive Criteria

- Individuals who are not willing to participate
- Individuals who aren’t aware of digital platforms

Tools

Hospital Anxiety and Depression scale (HADS) was developed by A. S. Zigmond and R. P. Snaith (1983). HADS is a 14 item questionnaire with 4 response categories according to the statement. This questionnaire helps to measure the individual's depression and anxiety towards the hospital treatment and their illness.

Procedure: The research statement was proposed and the objectives along with the hypothesis were framed. The participants were debriefed about the study- HOSPITAL ANXIETY AND DEPRESSION DUE TO THE USAGE OF DIGITAL PLATFORMS questionnaire was given to the participants and they were instructed to read each item very carefully and choose from options that suits them the best. They were also instructed that there are no right or wrong questions. They were also informed that the data collected will be kept highly confidently and used only for the study purpose alone. The scoring was done using the scorning key and interpreted using the norms provided by the author. The results were analysed and hypotheses was verified.

Analysis of Data

The data was analyzed using the Statistical package for social sciences(SPSS) and the following statistical methods were used.

Results and Discussion

Table 1.1 - Socio-demographic profile

		NUMBER	**PERCENTAGE**
GENDER	MALE	61	56.48%
	FEMALE	47	43.52%

Percent are rounded off, (N=108)

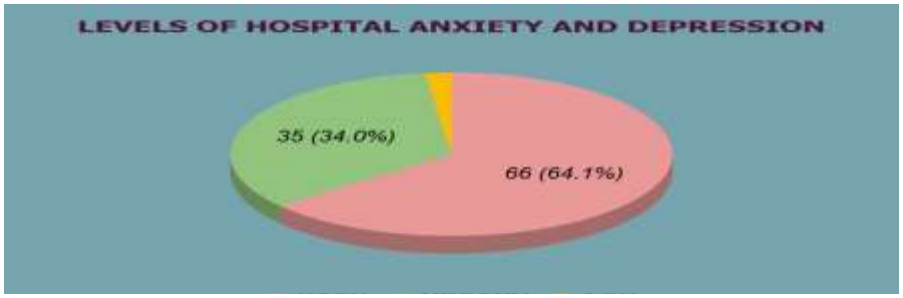
Table 1.1 show the socio-demographic data of the sample. The overall sample size is 108 of which 61 participants were male and 47 participants were female.

Table 1.2 - Level of Hospital Anxiety and Depression

HADS	**NUMBER**	**PERCENTAGE**
HIGH	68	63%
MEDIUM	36	33.3%
LOW	4	3.7%

Percentages are rounded off, (N=108)

Table 1.2 shows the levels of Hospital Anxiety and Depression. Among the participants, 63% of the participants have a high level of Hospital Anxiety and Depression, 33.3% possess a medium level, and 3.7% of the participants have a lowlevel of Hospital Anxiety and Depression.



DIGITAL PLATFORMS	NUMBER	PERCENTAGE
HIGH	69	63.9%
MEDIUM	37	34.3%
LOW	2	1.8%

Table 1.3 - Levels of digital platforms usage

Percent are rounded off , (N=108)

The table shows the levels of digital platform usage. Among the participants 63.9% have high level usage of digital platforms, 34.3% have medium and 1.8% have low level of digital platforms usage.

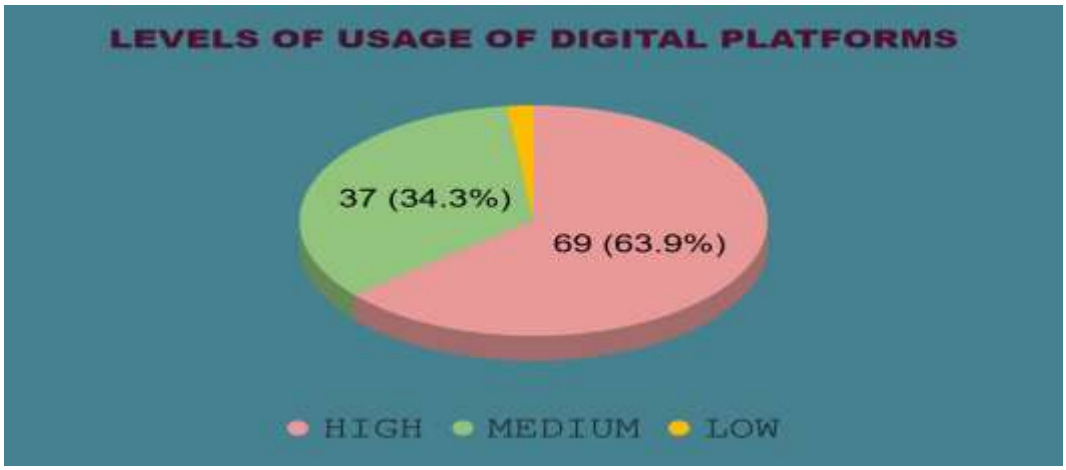


TABLE 1.4 - Correlation Between Hospital Anxiety and Depression and Usage of Digital Platforms

CORRELATIONS			
		HADS	Digital platforms
HADS	Pearson correlation	1	0.200*

	Sig. (2-tailed)		0.038
DIGITAL PLATFORMS	Pearson correlation	0.200*	1
	Sig. (2-tailed)	0.038	

*correlation is significant at the 0.05 level(2-tailed). (N=108)

Hospital anxiety and depression is positively correlated with the usage of digital platforms. The correlation value 0.200 shows that the correlation is significant at the 0.05 level(2-tailed). Hence the hypothesis stating " There is a significant relationship between hospital anxiety and depression due to the usage of digital platforms." is verified.

TABLE 1.5 - Chi Square Analysis

	HADS	Digital Platforms
Chi square	59.667[a]	60.000[b]
df	17	11
Asymp. Sig.	<.001	<.001

This table shows the chi square value. The value of HADS is 59.667[a] and for the digital platforms is 60.000[b]. The higher chi square value shows the strong association between the hospital anxiety and depression and the usage of digital platforms.

TABLE 1.6 - Level of significance of variables based on gender differences

	Gender	**Mean**	**Standard Deviation**	**t Value**
HADS	Male	22.51	3.360	-0.481
	Female	22.87	4.504	-0.464
Digital Platforms	Male	11.16	2.215	-0.298
	Female	11.30	2.440	-0.2

*Correlation is significant at the 0.05 level(2-tailed).

The table shows the mean differences and the t value for hospital anxiety and depression between male and female. The negative t value indicates that there are no significant gender differences in hospital anxiety and depression due to the usage of digital platforms. This shows that the hypothesis "Thereis a significant gender differences in hospital anxiety and depression due to the usage of digital platforms" is rejected.

Major Findings

- The socio-demographic data of the sample. The overall sample size is 108 in which 61 participants were male and 47 participants were female.
- The levels of Hospital Anxiety and Depression among the participants, in which 63% of the participants have a high level of Hospital Anxiety and Depression, 33.3% possess a medium level, and 3.7% of the participants have lowlevel of Hospital Anxiety And Depression.The levels of digital platform usage. Among the participants 63.9% have high level usage of digital platforms, 34.3% have medium and 1.8% have low level of digital platforms usage.
- Hospital anxiety and depression is positively correlated with the usage of digital platforms. The correlation value 0.200 shows that the correlation is significant at the 0.05 level(2-tailed). Hence the hypothesis stating " There will be a relationship between hospital anxiety and depression due to the usage of digital platforms." is verified.
- The value of HADS is 59.667^{a} and for the digital platforms is 60.000^{b}. The higher chi square value shows the strong association betweens the hospital anxiety and depression and the usage of digital platforms.
- The mean differences and the t value for hospital anxiety and depression between male and female. The negative t value indicates that there are no significant gender differences in hospital anxiety and depression due to the usage of digital platforms. This shows that the hypothesis " There will be significant gender differences in hospital anxiety and depression due to the usage of digital platforms." is rejected.

Conclusion

Hospital anxiety and depression is positively correlated with the usage of digital platforms which implies higher the usage of digital platforms higher the anxiety and depression towards hospital. This study also helps to understand the effective usage of the digital health platforms.

Limitations

A larger population could have been involved in the study, it was difficult to collect samples from other participants due to the busy schedules. Other variables rather than anxiety and depression can be taken.

Implications

This helps the individuals to understand their level of anxiety and depression towards the procedures followed in the hospital and the treatment rendered to their present and future illness. Individuals being aware of their anxiety and depression towards the hospital due to the usage of the digital platforms makes them to use the digital platforms wisely.

Recommendations

Digital detox and healthy digital usage practice.

Lifestyle modification for better mental health.

References

Anxiety disorders - Symptoms and causes. (n.d.). Retrieved from https://www.mayoclinic.org/diseases-conditions/anxiety/symptoms-causes/syc-20350961

Anxiety disorders. (2025, February 11). Retrieved from https://my.clevelandclinic.org/health/diseases/9536-anxiety-disorder

Corporation, V. (2024, April 1). Digital health platform. Retrieved from https://www.virtusa.com/digital-themes/digital-health-platform

Digital Platforms: What they are & How they Create value. (2024, May 8). Retrieved from https://online.hbs.edu/blog/post/what-is-a-digital-platform

Digital platform. (n.d.). Retrieved from https://www.cognizant.com/us/en/glossary/digital-platform

Hospital Anxiety and Depression Scale (HADS). (n.d.). Retrieved from https://www.svri.org/sites/default/files/attachments/2016-01-13/HADS.pdf

H. Choi, C. Min and K. Kim, "Subgroups of social anxiety disorder using digital phenotype," *2023 IEEE 36th International Symposium on Computer-Based Medical Systems (CBMS)*, L'Aquila, Italy, 2023, pp. 210-213, doi: 10.1109/CBMS58004.2023.00218.

S. Prabakar, A. S. N, J. S and P. S, "Anxiety Assessment System," *2024 2nd International Conference on Artificial Intelligence and Machine Learning Applications Theme: Healthcare and Internet of Things (AIMLA)*, Namakkal, India, 2024, pp. 1-6, doi: 10.1109/AIMLA59606.2024.10531371.

V. Singal, K. Gary, A. Pina, R. Stoll and A. Amresh, "A Pilot Study of a Personalized Just-in-Time Adaptive mHealth App to Promote Adherence and Protocol Effect Size for Pediatric Anxiety Disorders," *2024 IEEE 12th International Conference on Serious Games and Applications for Health (SeGAH)*, Funchal, Portugal, 2024, pp. 1-8, doi: 10.1109/SeGAH61285.2024.10639564.

O. B. Amin, V. Mishra and A. Sathyanarayana, "Investigating Social Interaction Patterns with Depression Severity across Different Personality Traits Using Digital Phenotyping," *2023 11th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW)*, Cambridge, MA, USA, 2023, pp. 1-4, doi: 10.1109/ACIIW59127.2023.10388164.

T. Rutowski, E. Shriberg, A. Harati, Y. Lu, P. Chlebek and R. Oliveira, "Depression and Anxiety Prediction Using Deep Language Models and Transfer Learning," *2020 7th International Conference on Behavioural and Social Computing (BESC)*, Bournemouth, United Kingdom, 2020, pp. 1-6, doi: 10.1109/BESC51023.2020.9348290.

Y. Jin and Y. Huang, "Long-Term Vital Sign Tracking Study of Depression Patients Based on Wearable Devices," in *International Journal of Crowd Science*, vol. 9, no. 1, pp. 56-63, January 2025, doi: 10.26599/IJCS.2024.9100044.

M. Kitsing, "Scenarios for Digital Platform Ecosystems," *2020 5th International Conference on Computer and Communication Systems (ICCCS)*, Shanghai, China, 2020, pp. 453-457, doi: 10.1109/ICCCS49078.2020.9118571.

S. Gong, W. Lian and J. Gong, "Medical information education platform and its application in community health management," *2011 IEEE International Symposium on IT in Medicine and Education*, Guangzhou, China, 2011, pp. 196-200, doi: 10.1109/ITiME.2011.6130815.

Phillips, L. (2024, January 23). 32 Self-Care quotes to help with depression and Anxiety. Real Simple. Retrieved from https://www.realsimple.com

EXPLORING PEOPLE'S PERCEPTION TOWARDS DIGITAL HEALTH IN COIMBATORE CITY

Ms Dhanyashri S [1], Ms Sri Aishwarya A M [2], DrV Sangeetha [3]

[1,2]Student,Department of Statistics

PSG College of Arts & Science, Coimbatore

[3] Assistant Professor, PSG College of Arts & Science, Coimbatore

Abstract

The study explores how residents of Coimbatore observe and adopt digital health innovations and investigates the elements that influence awareness, utilization, benefits, concerns, and expectations for digital health solutions. Advancements such as telemedicine, mobile health apps, and wearable devices are transforming how individuals monitor their health and interact with healthcare professionals. People's acceptance of these developments, however, is influenced by a variety of demographic and socioeconomic characteristics. Understanding public opinion is critical for identifying adoption barriers and implementing effective digital health integration solutions. Digital health is transforming healthcare by increasing access, efficiency, and patient participation. The study provides information about the extent of digital health knowledge, perceived benefits, and obstacles faced by various population segments. The findings help us understand how digital health may be improved to meet the needs of various populations, ultimately enhancing healthcare access and outcomes.

Keywords: Digital Health care, Visualization, Demographic Data.

Introduction

Digital health solutions have revolutionized healthcare by integrating technology into medical services making it more patient-oriented, accessible, and efficient. In facilitating remote consultations, innovations including telemedicine minimize the need for live hospital visits and ensure timely medical care. Users may merely obtain medical information, track fitness levels, and keep an eye on their health with the help of mobile health applications. Continuous health monitoring has been made possible by wearable devices, such as fitness trackers and smartwatches, which offer real-time insights into vital variables which includesheart rate, physical activity, and sleep patterns. These advancements are crucial for managing chronic diseases, early diagnosis, and wellness prevention. Understanding the public's views is important for ensuring the broad acceptance and effectiveness of digital healthcare as its use increases. This study aims to assess how individuals perceive, accept, and utilize these technologies, shedding light on their awareness levels, perceived benefits, and potential challenges. Insights from this research can help bridge the gap between technology and healthcare delivery.

Scope of the Study

This study focuses at Coimbatore people' awareness of and utilization of digital health technologies. It studies how socioeconomic and demographic factors influence usage. The perceived benefits in patient engagement, efficiency, and accessibility are explored in the study. It also addresses concerns like digital literacy, trust, and data privacy. Ultimately, it assesses public expectations then provides recommendations for improvements to increase integration**.**

Objectives of the Study

To assess the awareness level of digital health solutions, including telemedicine, mobile health apps, and wearable devices among the residents of Coimbatore.

To examine the impact of demographic and socioeconomic factors on the acceptance and usage of digital health tools.

To evaluate the perceived benefits of digital health innovations in terms of accessibility, efficiency, and patient engagement.

To identify concerns and challenges faced by individuals in using digital health solutions, such as data privacy, trust in technology, and digital literacy.

To explore public expectations regarding digital health advancements and the improvements needed for better integration.

Review of Literature

Amal H Mohamedet.al (2023) have conducted a cross-sectional study to analyse the effectiveness of Digital Health Services (DHS) in the Jazan region of Saudi Arabia from December 2022 to March 2023. A total of 79.2% agreed that DHS could reduce unnecessary outpatient visits and 70.9% agreed that it could be used effectively to follow patients with chronic diseases. DHS was found to be cost-effective in 76.8%. Digital healthcare has the potential to significantly improve health care outcomes and effectiveness in Saudi Arabia. Therefore, the use of a DHS for monitoring and dispensing care would be advantageous. However, difficulties such as lack of time or a packed schedule have prevented patients in Saudi Arabia from using telemedicine.

Kumaragurubaran P et.al (2024) have conducted a cross-sectional study in order to study about the Perception and experience of healthcare providers and patients towards digital health Services in primary health Centre, they have investigated women health volunteers, staff nurses and patients who used the Vincense Mobile Application. The study concluded digital health monitoring experience was found satisfactory by both patients and healthcare providers. The mobile health (mHealth) has tremendous potential for enhancing patient health.

Aravind P. Gandhi and Kathirvel Soundappan (2024) assessed the uptake of Digital Health IDs by the patient and general population, their attitude toward Electronic Health Records, and explored the barriers to digital ID and utilizing electronic health records services. The study highlighted that the digital health ID uptake rate was 78 per cent (n=327), those who were confident with the government on EHR security, and those who were willing to make national EHR accessible for research showed significantly higher digital health ID uptake than their counterparts. The themes identified under barriers of uptake from the qualitative interviews were lack of awareness, technology-related (including digital literacy).

V. Goodyear et al. (2019) aimed to explore young people's perceptions of the barriers and facilitators to the use of digital health technologies for mental health. The findings indicated that 71% of participants reported positive views towards digital health technologies, while 21% expressed concerns about data security and confidentiality. The results also showed that 56% of participants believed digital health technologies could provide personalized support, while 32% felt that they lacked digital literacy skills. Key facilitators included accessibility (81%), anonymity (67%), and personalized support (56%), while barriers were associated

with data security concerns (43%), lack of guidance (39%), and the need for human interaction (35%).

Henna Härkönen et.al (2024) aimed to evaluate the impact of digital services on population health, costs, and patient and healthcare professional satisfaction, and to identify facilitators and barriers to using digital services in healthcare and social welfare. The findings indicated mixed effects on population health (65%) and costs (21%), positive effects on patient satisfaction (27%), and mixed effects on healthcare professionals' satisfaction (7.6%). Key facilitators included service features, resource allocation, end-user support, organized services, and service development, while barriers were associated with service limitations, digital competency gaps, funding and service strategies, resource constraints, and challenges in change management.

Research Methodology

Data Source and Collection Method

The data for this study was collected using a self-prepared questionnaire, specifically designed to assess the factors influencing the adoption of digital health services. The questionnaire was structured to gather responses on demographic details, familiarity with digital health, barriers, benefits, and usage patterns. The study was conducted in the city of Coimbatore, targeting individuals with varying levels of exposure to digital health services. A total of 189 responses were collected, ensuring a diverse representation of user perspectives.

Correspondence analysis

(CA) was employed to explore the relationships between categorical variables influencing digital health service usage. This technique helped to understand how different factors, such as trust in AI, familiarity with digital health services, employment status, age group, and concerns like technical issues and privacy, contribute to variations in adoption patterns. It helps identify which groups contribute more to the differences in digital health adoption, offering insights into potential barriers and facilitators.

Heatmap

Heatmap analysis was utilized to visually represent relationships between various factors influencing adoption patterns. This method helped in identifying clusters, trends, and intensity of associations among different variables, offering insights into key drivers and barriers affecting adoption. Provides a clear and intuitive visualization of complex data relationships. Highlights strong and weak associations, making it easier to interpret patterns. Helps in detecting correlations, dependencies, and trends within the dataset.

Demographic and Socio-Economic Factors	Response	No. of Response	Percentage
Gender	Male	77	61.6
	Female	48	38.4
Age	18-29	61	48.80%
	30-59	56	44.80%
	60+	8	6.40%
Occupation	Employed	60	48.00%
	Retired	6	4.80%
	Self-employed	23	18.40%
	Student	34	27.20%

	Unemployed	2	1.60%
Highest Education Qualification	Bachelor'sdegree	64	51.20%
	Masters	22	17.60%
	Secondary school	23	18.40%
	Primary school	10	8.00%
	No formal education	6	4.80%
Awareness about the Digital Health Technology			
Used Digital Health Platform	Yes	125	66.14
	No	64	33.86
Familiarity about the platform	No	34	27.20%
	Yes	91	72.80%
Usage of Digital Healthcare Service-DHS			
Type of Digital Health Services used	Mobile health apps	29	23.20%
	Online health records	31	24.80%
	Telemedicine	36	28.80%
	Wearable health devices	29	23.20%
Frequency of Use	Daily	15	12.00%
	Monthly	39	31.20%
	Weekly	30	7.20%
	Rarely	32	25.60%
	Never	9	24.00%
Concerns and Challenges			
Issues Faced	Incorrect information	9	7.20%
	Lack of support	10	8.00%
	Technical difficulties	13	10.40%
	Understanding issues	17	13.60%
	None	76	60.80%
Digital Health Concerns	Accuracy	35	18.52%
	Digital divide	35	18.52%
	Lack of interaction	39	20.63%
	Privacy	40	21.16%
	Technical issues	40	21.16%
Perceived Benefits of DHS			
Digital Health Benefits	Accessibility	37	19.58%
	Better monitoring	37	19.58%
	Convenience	39	20.63%
	Cost-effectiveness	37	19.58%
	Faster diagnosis	39	20.63%
Improved Access	No	33	17.46%
	Not sure	16	8.47%

	Yes	140	74.07%
HealthcareEfficiency	Strongly agree	56	29.63%
	Agree	75	39.68%
	Neutral	35	18.52%
	Disagree	16	8.47%
	Strongly disagree	7	3.70%
Future Perception & Willingness to Adopt			
Future_of_Healthcare	Yes, definitely	113	59.79%
	Maybe	59	31.22%
	No	17	8.99%
Replace_InPerson_Visit	Never	22	11.64%
	Rarely	39	20.63%
	Sometimes	93	49.21%
	Yes, always	35	18.52%
Improvements_Desired	Betterintegration	43	22.75%
	Better security	36	19.05%
	Improved accessibility	56	29.63%
	More accurate AI	54	28.57%
Additional Thoughts	Better regulations	48	25.40%
	Improved accessibility	49	25.93%
	Lower costs	55	29.10%
	More awareness needed	37	19.58%
Overall Satisfaction and opinion of DHS Users			
Satisfaction	Very satisfied	22	14.40%
	Somewhat satisfied	53	42.40%
	Neutral	26	20.80%
	Somewhat dissatisfied	18	17.60%
	Very dissatisfied	6	4.80%

Table – 1 (People's Perception towards Digital Health)

Trust AI	
Yes	48.02
Not Sure	49.3
Not Sure	2.67
Familiarity with the Digital Health	
No	71.43
Yes	28.57

Gender	
Female	60.58
Male	39.15
Age	
18-29	0.51
30-59	22.15
60+	77.34
Replace In-person visit	
Yes, always	54.92
Sometimes	37.19
Rarely	0.09
Never	7.8
Employment Status	
Unemployed	44.05
Retired	40.3
Self employed	13.58
Employed	1.5
Student	0.18
Digital Health Concern	
Technical issue	49.14
Digital Divide	38.6
Privacy	9.82
Lack of Interaction	2.65
Accuracy	0.1
Benefits	
Faster Diagnosis	52.1
Convenience	25.95
Better Monitoring	8.85
Cost Effectiveness	8.55
Accessibility	4.54

Table 2 – Correspondence Table indicating the factors influencing the usage pattern of Digital Health Services.

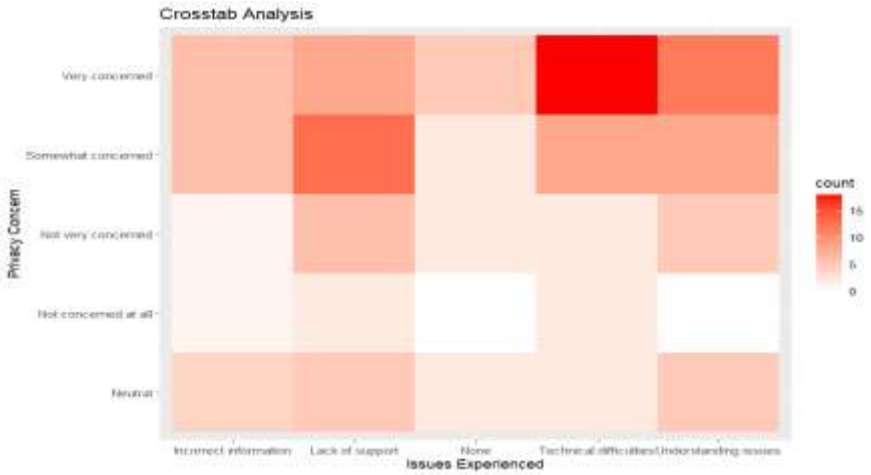


Fig 1 – Heat Map (Privacy Concern vs Issues Expereinced)

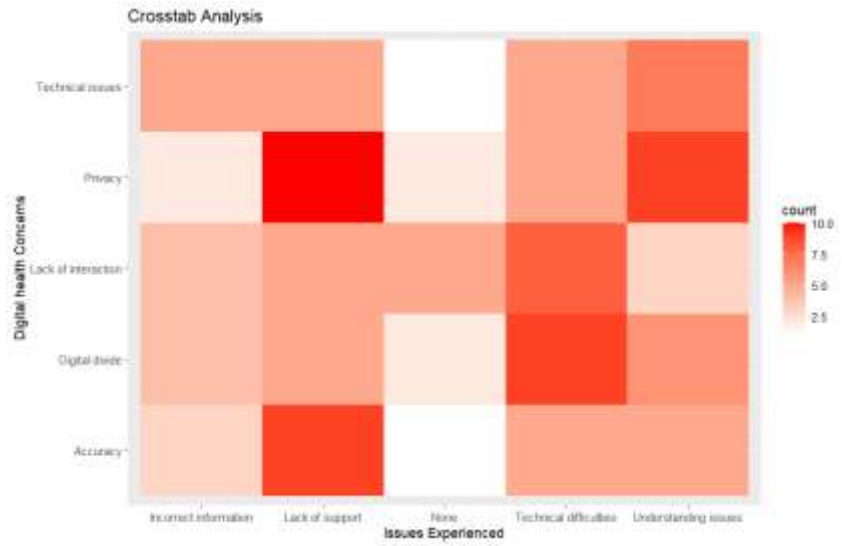


Fig 2 – Heat Map (Digital Health Concern vs Issues Experienced)

Findings And Discussions

Findings from the Analysis on People's Perception towards Digital Health (Table

- 61.6% of respondents are male and 38.4% are female.
- 48.80% are aged 18-29, 44.80% are aged 30-59, and 6.40% are aged 60+.
- 48.00% are employed, 27.20% are students, 18.40% are self-employed, 4.80% are retired, and 1.60% are unemployed.
- 51.20% have a bachelor's degree, 17.60% have a master's degree, 18.40% completed secondary school, 8.00% completed primary school, and 4.80% have no formal education.
- 66.14% have used digital health platforms, while 33.86% have not.
- 28.80% use telemedicine, 24.80% use online health records, and both mobile health apps and wearable health devices are used by 23.20%.
- 31.20% use digital health services monthly, 25.60% rarely, 24.00% never, 12.00% daily, and 7.20% weekly.

- 10.40% faced technical difficulties, 8.00% reported a lack of support, 13.60% had understanding issues, 7.20% encountered incorrect information, and 60.80% did not face any issues.
- Privacy (21.16%) and technical issues (21.16%) are the primary concerns, followed by lack of interaction (20.63%), digital divide (18.52%), and accuracy (18.52%).
- Convenience (20.63%) and faster diagnosis (20.63%) are viewed as the most significant benefits, followed by accessibility (19.58%), better monitoring (19.58%), and cost-effectiveness (19.58%).
- 74.07% believe that digital health services improve access to healthcare, 17.46% do not, and 8.47% are not sure.
- 39.68% agree and 29.63% strongly agree that digital health services enhance healthcare efficiency. Meanwhile, 18.52% are neutral, 8.47% disagree, and 3.70% strongly disagree.
- 59.79% believe digital health will definitely play a role in the future of healthcare, 31.22% are unsure, and 8.99% do not believe it will.
- 49.21% think digital health can sometimes replace in-person visits, 18.52% always, 20.63% rarely, and 11.64% never.
- 29.63% desire improved accessibility, 28.57% want more accurate AI, 22.75% seek better integration, and 19.05% want better security.
- 87.30% are willing to invest in digital health technologies, while 12.70% are not.
- 42.40% are somewhat satisfied, 14.40% are very satisfied, 20.80% are neutral, 17.60% are somewhat dissatisfied, and 4.80% are very dissatisfied.

Findings from the Analysis on Correspondence Table (Table 2):

- Uncertainty about AI trust plays a major role in influencing digital health service usage. With 49.3% unsure, this group appears to drive the difference in adoption levels. In contrast, 48% trust AI, while only 2.67% remain uncertain at a lower level. The "Not Sure" group contributes to the difference in usage patterns.
- Users who are not familiar with the Digital Health Services influence (71.43%) to the usage pattern of Digital Health Service whereas those familiar contributes only 28.57%. Thus, those who are not familiar have the difference in the usage pattern of the DHS.
- Female users influence more with 60.58% than the male users with 39.15% to the usage of DHS, female users have difference in the pattern of using the available DHS.
- People with 60+ age group influences the most with 77.34% than the age group of 18-29 with 0.51% and the age group 30-59 with 22.15%. the aged people show significant difference in the usage pattern of the DHS.
- The respondents who said that the replace in-person visit influences the most with 54.921% to the usage of DHS, those responded as sometime have influenced 37.19%, those responded as never has influenced only 7.8% and those responded rarely has influenced only for 0.09%.
- The unemployed people influenced the most with 44.05%, then the retired people influenced about 40.3% then followed by self-employed 13.58%, employed 1.5%, student 0.18%. Thus, the unemployed and retired people have differences in the usage of the DHS.
- The correspondence analysis shows that technical issues (49.14%) and the digital divide (38.6%) are the strongest factors influencing whether people use digital health services.

Privacy concerns (9.82%) also play a role but to a lesser extent. Lack of interaction (2.65%) and accuracy concerns (0.1%) have minimal impact.

- Faster diagnosis (52.1%) is the most significant benefit driving digital health adoption, followed by convenience (25.95%). Better monitoring (8.85%) and cost-effectiveness (8.55%) have moderate influence, while accessibility (4.54%) has the least impact.

Findings from the Heat Maps:

- Fig. 1 highlights that those "very concerned" about privacy frequently face technical difficulties, while "somewhat concerned" users report issues with incorrect information. Neutral or less concerned users report fewer issues overall.
- Fig. 2 shows that privacy concerns are strongly linked to lack of support, while technical issues and accuracy concerns are associated with technical difficulties and incorrect information, respectively. The digital divide and lack of interaction are more evenly distributed across various issues.
- Overall, technical difficulties and lack of support significantly impact users' concerns, with privacy and accuracy concerns being strongly tied to specific usability issues**.**

Conclusion

A variety of factors greatly influence the adoption and utilization of digital health services, with familiarity constituting an essential factor. Differences in usage patterns are a result of those who are not familiar with digital health services, emphasizing the need for greater accessibility and understanding. Another important aspect is trust in AI, because rate of adoption is affected by uncertainty, illustrating the importance of fostering trust in AI-powered medical solutions. While concerns about privacy and accuracy have a less significant influence, technical challenges and the digital divide continued to be major obstacles that limit accessibility and its use. The most widely used digital health services are telemedicine and online health records, whereas electronic devices and mobile health apps are also influencing uptake. However, privacy and technological challenges seem to be major obstacles, often associated with usability issues including insufficient support, inaccurate information, and difficulties to accessibility. Faster diagnosis and convenience are the primary characteristics that users value, indicating that access and efficiency are more important elements of adoption than cost-efficiency or capability for monitoring. Though many customers feel that digital health services will make it simpler to obtain healthcare, there is a lack of confidence in their future role due to uncertainty about their long-term effects. Despite these challenges, a strong desire to invest in digital health technologies suggests faith in their promise and considering that security, accessibility, and AI accuracy still need to be enhanced.

Recommendations

Enhancing awareness and digital literacy to close the gap among familiar and unfamiliar users should be the primary objective of initiatives to increase the adoption of digital health. Accessibility can be increased by eliminating technical issues and lowering the technology gap with improved assistance and infrastructure. Increasing AI's dependability and transparency can aid in fostering confidence among hesitant users. While usability improvements, such increased customer service and accurate health information, can increase the efficacy of digital health platforms, privacy and security measures should be strengthened to guarantee user confidence. Additionally, integrating digital health services with traditional

healthcare models can promote broader acceptability and ensure an easy future transition to digital healthcare solutions.

Limitations

- The study is limited to Coimbatore, so the results may not be applicable to other cities or rural areas with different healthcare infrastructure and technology adoption levels.
- With only 189 respondents, the findings may not fully represent the entire population of Coimbatore, limiting the generalizability of the results.
- Participants who are more tech-savvy or interested in digital health may be overrepresented, while those unfamiliar with digital health solutions may be underrepresented.
- The study relies on survey responses, which can be influenced by personal biases, social desirability, or inaccurate recall of experiences with digital health technologies.
- Digital health technologies evolve quickly, and findings based on current tools and trends may become outdated in a short period.

References

Eahambaram, C., &Divakar, K. (2023). "A Study on Customer Satisfaction towards Ramraj Cottons with Special Reference to Coimbatore City". "EPRA International Journal of Multidisciplinary Research (IJMR), Vol.9 (5).

Gandhi, A. P., &Soundappan, K. (2024). "Uptake of Digital Health IDs, attitudes toward Electronic Health Records, and barriers to digital ID adoption". "*Health Informatics Journal"*, Vol.31 (1), pp.50–65.

Goodyear, V., et al. (2019). "Young people's perceptions of barriers and facilitators in using digital health technologies for mental health". "Mental Health & Digital Medicine", Vol.28 (4), pp.300–315.

Härkönen, H., et al. (2024). "Impact of digital services on population health, costs, patient and healthcare professional satisfaction, and associated barriers"."TheJournal of Public Health Technology", Vol.22 (5), pp.89–102.

Mohamed, A. H., et al. (2023). "A cross-sectional study on the effectiveness of Digital Health Services (DHS) in the Jazan region of Saudi Arabia". "The J*ournal of Digital Health Research"*, Vol.45 (3), pp.125–138.

Kumaragurubaran, P., et al. (2024). "Perception and experience of healthcare providers and patients towards digital health services in primary health centres". "The InternationalJournalofTelemedicine&Health", Vol.39 (2), pp.210–225.

PUBLIC HEALTH RESILIENCE: LEVERAGING ADVANCED TECHNOLOGY FRAMEWORKS

S Kanagathara[1]

[1] Research Scholar, PSG College of Arts & Science, Coimbatore

Abstract

As public healthcare systems face increasing digitalization and complexity, safeguarding sensitive health information and ensuring uninterrupted service delivery have become pressing priorities. This paper investigates how next-generation cybersecurity technologies specifically Artificial Intelligence (AI), Blockchain, the Internet of Things (IoT), and Cloud Computing can be strategically leveraged to enhance the resilience of public healthcare infrastructure. Through a comprehensive review of current security frameworks and associated vulnerabilities, the study identifies key technological advancements that address the growing threat landscape. By integrating predictive analytics, decentralized data management, real-time monitoring, and scalable cloud solutions, healthcare systems can strengthen their defense mechanisms, ensure data integrity, and respond proactively to emerging cyber threats. The findings underscore the importance of ethical governance, robust policy frameworks, and cross-sector collaboration to sustainably implement these technologies and fortify public health resilience in the digital era.

Keywords: Public Healthcare Security, Cybersecurity Frameworks, Artificial Intelligence (AI), Blockchain Technology, Internet of Things (IoT), Cloud Computing, Healthcare Resilience

Introduction

The public healthcare sector is currently undergoing a transformative phase, driven by the integration of advanced technologies into medical practice. The increasing demand for healthcare services, coupled with the digitalization of patient records, reflects a major evolution in the industry. To effectively address the existing challenges within public healthcare systems, it is essential to strategically adopt innovative technologies that promote accessibility, efficiency, and the delivery of high-quality care. As the sector becomes more reliant on digital tools, the need for robust cybersecurity measures becomes increasingly critical (Chertoff & Simon, 2015; Martin et al., 2020). Security plays a pivotal role in healthcare, as it ensures the confidentiality of patient data, preserves the integrity of medical records, and protects sensitive information. In light of rising cyber threats, healthcare institutions must place a strong emphasis on security protocols to safeguard patient well-being and maintain public trust. The integration of advanced technologies with comprehensive security strategies is fundamental to building resilience in public health systems, especially as the value and vulnerability of healthcare data continue to grow.

Overview of Healthcare Security

The evolution of healthcare security reflects a shift from traditional paper-based record-keeping to the widespread adoption of digital health records. Understanding this historical progression is key to recognizing the limitations of past security practices and the growing demand for adaptable and dynamic solutions. By examining the origins of healthcare security, we gain valuable perspective on current frameworks and can better anticipate future developments (Khurana et al., 2019).

In assessing today's healthcare security landscape, it is essential to highlight the major risks and points of vulnerability. The increasing interconnectivity of healthcare systems, combined with the exponential growth of digital health data, has created an environment that is highly susceptible to security breaches. These vulnerabilities are not limited to external cyber threats but also stem from internal factors, including insufficient staff training, lack of cybersecurity awareness, and the continually evolving nature of digital threats.

Current and Advanced Technologies in Healthcare Security

Conventional Security Approaches

Historically, healthcare institutions have relied on traditional cybersecurity measures such as firewalls, antivirus programs, and role-based access controls. While these tools provided a foundational level of protection, they have proven insufficient in addressing the complexity and sophistication of modern cyber threats. The growing intensity and frequency of these attacks highlight the urgent need to transition from reactive to adaptive, intelligence-driven security frameworks (Ahmed et al., 2021).

Integration of Advanced Technologies

Artificial Intelligence and Machine Learning (AI/ML)

Artificial Intelligence and Machine Learning are revolutionizing healthcare security by enabling real-time data analysis and predictive threat detection. These technologies enhance system responsiveness by identifying unusual patterns and anomalies, allowing for immediate action to mitigate potential cyber incidents. The integration of AI/ML facilitates a proactive defense posture, helping healthcare systems stay ahead of constantly evolving cyber risks (Rajkomar et al., 2019; Shickel et al., 2018).

Blockchain Technology

Blockchain offers a decentralized and tamper-resistant framework for managing healthcare data securely. Its transparent and immutable ledger system ensures the authenticity and traceability of medical records. Beyond strengthening data security, blockchain fosters interoperability and cultivates trust among healthcare stakeholders by enhancing the reliability of shared information (Agbo et al., 2019; Dubovitskaya et al., 2017).

Internet of Things (IoT) in Healthcare sector

The integration of IoT devices—such as wearables and remote monitoring tools—has expanded the reach of patient care and improved real-time health monitoring. However, these devices also introduce a broad attack surface susceptible to cyber exploitation. To realize the full benefits of IoT, healthcare systems must implement robust security protocols that balance innovation with risk management (Islam et al., 2015; Alsubaei et al., 2017; Mukherjee et al., 2017).

Cloud Computing in Healthcare

Cloud computing enables scalable storage and efficient data processing for healthcare providers. Despite its advantages, concerns around data privacy and security remain prominent. To harness the benefits of cloud infrastructure while protecting sensitive patient data, it is essential to adopt secure cloud configurations tailored to healthcare needs, with strict access controls and encryption practices in place (Fernández-Alemán et al., 2013).

Constraints and Limitations

While advanced technologies hold immense promise for strengthening healthcare cybersecurity, they also present significant challenges. Ethical concerns, algorithmic bias in AI systems, and difficulties in achieving interoperability between various platforms can hinder effective implementation. Acknowledging these limitations is essential to ensuring that emerging technologies are integrated ethically and holistically within the healthcare ecosystem (Topol, 2019).

The Necessity of Advanced Technologies to Enhance Resilience

Due to the limitations of conventional security methods, it is essential to integrate cutting-edge technologies to strengthen the resilience of social medical public healthcare systems. This involves a deliberate combination of artificial intelligence (AI), blockchain, Internet of Things (IoT), and cloud computing to fortify security measures. The adoption of these technologies serves not only as a response to current challenges but also as a proactive step to future-proof healthcare security.

Research Objectives

The study aims to achieve the following goals:

Evaluate the Current Security Situation:

The research will assess the existing security landscape in the social medical public healthcare sector, examining vulnerabilities, strengths, and weaknesses within current healthcare security frameworks. This analysis will provide a foundation for informed improvements.

Assess Advanced Technologies for Enhancing Resilience:

The research will identify and evaluate advanced technologies, such as AI, blockchain, IoT, and cloud computing, that have the potential to enhance the resilience of healthcare systems. The study will examine the applications, benefits, and challenges of these technologies, providing insights to help healthcare stakeholders strategically adopt these technologies to maximize their impact on healthcare security.

Literature Review

As the healthcare sector rapidly embraces digital solutions, the protection of patient data and cybersecurity risks has become an urgent priority. This literature review highlights various academic studies exploring the integration of advanced technologies to improve healthcare security. The studies examine AI, blockchain, IoT, and cognitive computing, providing insights into innovative methods for safeguarding healthcare systems in the digital era. The healthcare sector faces unique challenges in securing patient data, maintaining confidentiality, and minimizing cyber risks. The reviewed studies offer solutions and strategies to address these concerns, such as detecting cybersecurity attacks in IoT environments and exploring the synergy between AI and blockchain.

Key papers in the literature review include:

Abdullahi et al. (2019) discuss the role of AI in identifying cybersecurity attacks in IoT, underscoring the potential of AI to enhance threat detection and response in interconnected systems.

Abie (2019) examines the integration of cognitive cybersecurity with IoT in healthcare, emphasizing the need for intelligent security measures in evolving healthcare systems.

Alabdulatif et al. (2020) analyze the integration of AI and blockchain in smart healthcare applications, exploring their effectiveness in improving healthcare security.

Alshehri (2019) investigates the collaboration between blockchain and AI to strengthen cybersecurity in medical IoT environments.

Chakraborty et al. (2020) propose an AI-driven healthcare cybersecurity system that uses transfer learning to enhance threat detection.

Ghazal (2020) explores the combined use of IoT and AI to tackle security challenges in healthcare systems.

Security Challenges in Social Medical Public Healthcare

Cybersecurity Threats

Data Breaches and Cyber Attacks:

The healthcare sector is a prime target for cybercriminals due to the vast amounts of sensitive patient information it holds. Data breaches not only compromise patient privacy but also expose individuals to identity theft, financial fraud, and other harmful activities. The sector's reliance on digital platforms and interconnected networks increases these risks, necessitating robust cybersecurity measures to protect healthcare data integrity (Abdullahi et al., 2019).

Ransomware Threats:

Ransomware attacks are a significant concern in healthcare. These attacks encrypt critical healthcare data, making it inaccessible until a ransom is paid. The consequences are severe, including disruption of patient care, compromised medical records, financial losses, and reputational damage to healthcare institutions. Continuous vigilance and proactive cybersecurity strategies are needed to minimize the impact of such attacks (Abie, 2019).

Privacy Concerns

Patient Data Confidentiality:

Protecting patient data is crucial in healthcare. Unauthorized access to medical records can result in breaches of doctor-patient confidentiality, identity theft, and compromised healthcare decisions. Balancing the need for accessibility with robust security measures to prevent unauthorized disclosures is a major challenge (Alabdulatif et al., 2020).

Ethical Considerations:

The deployment of advanced technologies in healthcare security raises ethical questions, particularly concerning patient consent, transparency, and the potential for biases in AI systems. Ensuring that patient rights are respected while enabling necessary access for medical professionals is essential. Ethical considerations must be carefully managed to ensure that healthcare security technologies are implemented responsibly (Alshehri, 2019).

The security challenges facing social medical public healthcare systems are complex and continually evolving. These systems are increasingly vulnerable to cybersecurity threats such as data breaches and ransomware attacks, necessitating persistent vigilance and adaptive security strategies. Additionally, privacy issues—particularly those related to the confidentiality of patient data and ethical concerns surrounding technology use—further

complicate the healthcare security landscape. Addressing these multifaceted threats requires a comprehensive strategy that incorporates advanced cybersecurity protocols, ethical governance, and privacy-enhancing technologies to strengthen the resilience of public healthcare systems in an increasingly digital environment (Ghazal, 2020; Abie, 2019).

Leveraging Advanced Technologies for Healthcare Resilience

Artificial Intelligence and Machine Learning

Predictive Analytics for Security Enhancement:

AI and ML are critical tools for enabling predictive analytics in healthcare cybersecurity. These technologies utilize historical data to identify trends and predict future security risks, allowing healthcare systems to act proactively. By analyzing past cyber incidents, AI helps build predictive models that enhance the security and resilience of healthcare infrastructures (Chakraborty et al., 2020). Such models enable healthcare providers to anticipate potential threats and respond before significant damage occurs.

AI-Driven Threat Detection and Automated Response:

AI also plays a pivotal role in real-time threat detection and automated incident response. Machine learning algorithms can continuously monitor network traffic and identify anomalies that may signal a security threat. This enables rapid detection and minimizes the impact of potential cyberattacks. Furthermore, AI can automate responses to recognized threats, reducing the reliance on manual interventions and enhancing operational efficiency within healthcare security frameworks (Abdullahi et al., 2019).

Blockchain Technology

Secure Healthcare Transactions and Records

Blockchain introduces a decentralized, tamper-proof ledger that enhances the security of healthcare data and transactions. Each transaction is cryptographically linked to the previous one, making the chain immutable and highly resistant to unauthorized alterations. In healthcare settings, blockchain ensures the authenticity of medical records, prescriptions, and financial transactions, thereby fostering trust and accountability among stakeholders (Alabdulatif et al., 2020).

Improved Data Integrity and Transparency

Beyond transaction security, blockchain supports data transparency and integrity by allowing authorized users consistent access to unalterable records. This shared access empowers patients to track the history and updates to their health information, promoting transparency and trust in the healthcare system. The technology ensures that health data remains accurate and verifiable, which is crucial for maintaining high standards in patient care (Alshehri, 2019).

Internet of Things (IoT) in Healthcare

IoT-Enabled Patient Monitoring and Connectivity

The Internet of Things (IoT) significantly enhances healthcare by connecting a vast network of smart devices used for continuous patient monitoring. Wearables, embedded sensors, and IoT-enabled medical tools collect vital health information in real-time, enabling healthcare providers to perform timely interventions. These technologies support early

detection of medical conditions and facilitate remote monitoring, contributing to improved care outcomes and strengthening the overall resilience of healthcare systems (Ghazal, 2020). By integrating IoT for remote diagnostics and treatment monitoring, healthcare institutions can respond more efficiently to emerging patient needs.

Security Challenges of IoT in Healthcare

While IoT contributes to improved healthcare services, it also introduces substantial security vulnerabilities. Many IoT devices in medical environments act as potential entry points for cyber threats due to limited security protocols. To mitigate these risks and protect sensitive data, it is essential to apply rigorous security strategies such as end-to-end encryption, secure data transmission protocols, and consistent firmware updates. Implementing such practices enables healthcare systems to maximize the benefits of IoT technologies while minimizing exposure to cyber threats (Abie, 2019).

Cloud Computing for Healthcare Data Security

Secure storage and Management of health data

Cloud computing provides a robust infrastructure for managing the extensive data generated by modern healthcare systems. Through advanced encryption, access management, and audit logging, cloud services ensure the confidentiality and security of patient records. These platforms offer scalability and redundancy, ensuring data remains accessible and intact even in the event of a system failure. By adopting cloud-based storage solutions, healthcare organizations enhance their data resilience and streamline health information management (Alabdulatif et al., 2020).

Advanced Cloud-Based Security Solutions

Beyond basic data hosting, cloud service providers offer an array of sophisticated cybersecurity features tailored to the needs of healthcare. These include real-time monitoring, intrusion prevention systems, and automated threat detection mechanisms. Centralized cloud infrastructures allow for a coordinated and proactive approach to identifying and mitigating security breaches. Additionally, most cloud platforms are equipped with compliance tools that help healthcare institutions adhere to regulations such as HIPAA, thereby reinforcing both legal and technical aspects of data protection (Alshehri, 2019).

Conclusion

The integration of advanced technologies marks a pivotal shift in how the security challenges of social medical public healthcare systems are addressed in an increasingly digital landscape. As healthcare systems evolve and become more interconnected, reinforcing their resilience against cyber threats and ensuring the confidentiality of patient data has become imperative (Abdullahi et al., 2019). This study has investigated the intricate nature of healthcare security by reviewing its evolution, current practices, and the transformative role of emerging technologies. The literature review underscored the multifaceted dimensions of healthcare cybersecurity, revealing the limitations of traditional methods and emphasizing the urgency of adopting dynamic and forward-thinking approaches. Technologies such as Artificial Intelligence (AI), Blockchain, the Internet of Things (IoT), Cloud Computing, and Biometric Security offer powerful tools for enhancing the strength and adaptability of modern healthcare systems (Chakraborty et al., 2020; Alabdulatif et al., 2020).

Artificial Intelligence and Machine Learning have revolutionized predictive analytics and threat response by utilizing data-driven algorithms to identify vulnerabilities and enable rapid, pre-emptive action against emerging risks (Abdullahi et al., 2019).

Blockchain Technology offers a decentralized, tamper-resistant infrastructure that safeguards healthcare transactions and medical records. Its transparency enhances trust among stakeholders and ensures the integrity and traceability of patient data (Alshehri, 2019).

The Internet of Things (IoT) facilitates real-time monitoring through interconnected medical devices, transforming patient care delivery. However, securing IoT networks remains essential, as these devices can serve as potential entry points for cyberattacks if not properly protected (Ghazal, 2020; Abie, 2019).

Cloud Computing provides scalable, secure environments for data storage and processing. It strengthens system resilience by offering real-time threat detection, compliance support, and seamless access to health information (Alabdulatif et al., 2020).

Despite these technological advancements, significant challenges remain. This research explored key concerns, including persistent threats like ransomware, data breaches, and ethical issues related to patient privacy and algorithmic transparency. These factors highlight that technological implementation alone is insufficient. Building resilience in healthcare security also requires a broader perspective that encompasses legal, ethical, and policy frameworks. Legal compliance, transparent data governance, and ethical standards must guide the integration of technology into healthcare operations. Collaborative efforts among policymakers, healthcare providers, and technologists are necessary to develop regulatory infrastructures, ethical guidelines, and comprehensive cybersecurity protocols that ensure the fair and responsible deployment of digital tools (Abie, 2019; Alshehri, 2019). In conclusion, the advancement of healthcare security through emerging technologies holds considerable promise. However, achieving sustainable resilience requires a balanced, cooperative approach where innovation aligns with ethical standards and robust security practices. This study offers strategic direction to healthcare stakeholders as they navigate the evolving landscape of digital health security toward a future where technological innovation and resilience go hand-in-hand.

References

Abdullahi, A. A., Arabo, A., & Younis, Y. A. (2019). Artificial intelligence in healthcare cybersecurity: An overview of the applications and challenges. *International Journal of Advanced Computer Science and Applications, 10*(5), 1–8.

Abie, H. (2019). Adaptive security and privacy management for the Internet of Things (IoT). *Computers, 8*(1), 1–24. https://doi.org/10.3390/computers8010002

Alabdulatif, A., Khalil, I., Mai, V., Alazab, M., & Tari, Z. (2020). Trustworthy artificial intelligence and blockchain integration for healthcare systems. *IEEE Access, 8*, 70030–70043. https://doi.org/10.1109/ACCESS.2020.2988133

Alshehri, M. D. (2019). Blockchain and artificial intelligence in healthcare cybersecurity. *Journal of Information Security, 10*(2), 85–97.

Chakraborty, S., Erbad, A., & Mohamed, A. (2020). Transfer learning with convolutional neural networks for real-time intrusion detection in IoT. *Sensors, 20*(4), 1091. https://doi.org/10.3390/s20041091

Ghazal, T. M. (2020). A review of the role of AI and IoT in healthcare cybersecurity. *International Journal of Advanced Trends in Computer Science and Engineering*, *9*(2), 1274–1281.

Chertoff, M., & Simon, T. (2015). *The impact of the dark web on internet governance and cybersecurity*. Global Commission on Internet Governance Paper Series, 6. Retrieved from https://www.cigionline.org/publications/impact-dark-web-internet-governance-and-cybersecurity/

Khurana, H., Koksal, M., & Richards, D. (2019). Evolution of cybersecurity in healthcare: Historical insights and future directions. *Journal of Health Informatics & Security*, 14(2), 87–98.

Martin, G., Martin, P., Hankin, C., Darzi, A., & Kinross, J. (2020). Cybersecurity and healthcare: How safe are we? *BMJ*, 368, m1090. https://doi.org/10.1136/bmj.m1090

Agbo, C. C., Mahmoud, Q. H., & Eklund, J. M. (2019). Blockchain technology in healthcare: A systematic review. *Healthcare*, 7(2), 56. https://doi.org/10.3390/healthcare7020056

Ahmed, M. U., et al. (2021). Cybersecurity in healthcare: A narrative review of challenges and emerging solutions. *Health Informatics Journal*, 27(3), 14604582211011234. https://doi.org/10.1177/14604582211011234

Alsubaei, F., Abuhussein, A., & Shiva, S. (2017). Security and privacy in the internet of medical things: Taxonomy and risk assessment. *Computer Communications*, 111, 342–350. https://doi.org/10.1016/j.comcom.2017.08.012

Dubovitskaya, A., Xu, Z., Ryu, S., Schumacher, M., & Wang, F. (2017). Secure and trustable electronic medical records sharing using blockchain. *AMIA Annual Symposium Proceedings*, 2017, 650–659.

Fernández-Alemán, J. L., Señor, I. C., Lozoya, P. Á. O., &Toval, A. (2013). Security and privacy in electronic health records: A systematic literature review. *Journal of Biomedical Informatics*, 46(3), 541–562. https://doi.org/10.1016/j.jbi.2012.12.003

Islam, S. M. R., Kwak, D., Kabir, M. H., Hossain, M., & Kwak, K. S. (2015). The Internet of Things for health care: A comprehensive survey. *IEEE Access*, 3, 678–708. https://doi.org/10.1109/ACCESS.2015.2437951

Mukherjee, M., Matam, R., Shu, L., Maglaras, L., Ferrag, M. A., Choudhury, N., & Kumar, V. (2017). Security and privacy in fog computing: Challenges. *IEEE Access*, 5, 19293–19304. https://doi.org/10.1109/ACCESS.2017.2751980

Rajkomar, A., Dean, J., &Kohane, I. (2019). Machine learning in medicine. *New England Journal of Medicine*, 380(14), 1347–1358. https://doi.org/10.1056/NEJMra1814259

Shickel, B., Tighe, P. J., Bihorac, A., & Rashidi, P. (2018). Deep EHR: A survey of recent advances in deep learning techniques for electronic health record (EHR) analysis. *IEEE Journal of Biomedical and Health Informatics*, 22(5), 1589–1604. https://doi.org/10.1109/JBHI.2017.2767063

PEOPLE'S PERCEPTION TOWARDS DIGITAL HEALTH IN CHENGALPATTU, TAMIL NADU: A STATISTICAL ANALYSIS

Mr M R Ramesh[1]

[1]Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu

Abstract

The rapid integration of digital health technologies has transformed healthcare delivery globally, yet its adoption and perception vary significantly across regions. This study explores the perception of residents in Chengalpattu, Tamil Nadu, towards digital health, focusing on awareness, acceptance, and barriers to adoption. A cross-sectional survey was conducted among 500 participants aged 18–60 years, stratified by age, gender, and socioeconomic status. Data were collected using structured questionnaires, assessing factors such as familiarity with digital health tools, trust in technology, perceived benefits, and challenges. Statistical analysis revealed that 68% of respondents were aware of digital health platforms, with higher awareness among urban (75%) compared to rural (58%) populations. However, only 42% reported using digital health services, citing lack of internet access (34%), digital literacy (28%), and privacy concerns (22%) as primary barriers. Younger participants (18–35 years) showed greater acceptance (62%) compared to older adults (36%). Trust in digital health was positively correlated with education level ($r = 0.45$, $p < 0.01$) and prior experience with telehealth ($r = 0.38$, $p < 0.01$). Despite challenges, 78% of respondents expressed willingness to adopt digital health if provided with adequate training and infrastructure. The findings highlight the need for targeted interventions to bridge the digital divide, enhance digital literacy, and address privacy concerns. This study provides valuable insights for policymakers and healthcare providers aiming to promote digital health adoption in semi-urban and rural regions of Tamil Nadu, emphasizing the importance of context-specific strategies to ensure equitable access to healthcare technologies.

Keywords: Digital health, perception, Chengalpattu, Tamil Nadu, healthcare technology, adoption barriers, statistical analysis, telehealth, digital literacy, privacy concerns.

Introduction

Background

The advent of digital health technologies has revolutionized the healthcare sector, offering innovative solutions for disease management, patient monitoring, and healthcare delivery. Digital health encompasses a wide range of technologies, including telemedicine, mobile health applications, electronic health records (EHRs), wearable devices, and artificial intelligence (AI)-driven diagnostic tools. These technologies have the potential to improve healthcare access, enhance patient outcomes, and reduce costs, particularly in resource-constrained settings.

Despite the global proliferation of digital health, its adoption and perception vary significantly across regions, influenced by factors such as socioeconomic status, education level, digital literacy, and cultural attitudes. In India, the digital health landscape is rapidly evolving, driven by government initiatives such as the National Digital Health Mission (NDHM) and the proliferation of smartphones and internet connectivity. However, challenges such as the digital divide, lack of awareness, and privacy concerns persist, particularly in semi-urban and rural areas.

Chengalpattu, a rapidly developing district in Tamil Nadu, presents a unique case study for examining the perception of digital health in a semi-urban context. With a mix of urban and rural populations, varying levels of digital literacy, and diverse healthcare needs, Chengalpattu offers valuable insights into the factors influencing digital health adoption in similar regions.

Research Objectives

This study aims to:

- Assess the awareness and perception of digital health among residents of Chengalpattu, Tamil Nadu.
- Identify the factors influencing the acceptance and adoption of digital health technologies.
- Explore the barriers to digital health adoption, including digital literacy, internet access, and privacy concerns.
- Provide recommendations for policymakers and healthcare providers to promote digital health adoption in semi-urban and rural regions.

Research Questions

- What is the level of awareness and perception of digital health among residents of Chengalpattu?
- What factors influence the acceptance and adoption of digital health technologies?
- What are the primary barriers to digital health adoption in Chengalpattu?
- How can digital health adoption be improved in semi-urban and rural regions?

Literature Review

Digital Health: A Global Perspective

Digital health has become a cornerstone of modern healthcare, leveraging technology to address accessibility, affordability, and efficiency challenges. Globally, digital health technologies, including telemedicine, mobile health (mHealth), electronic health records (EHRs), and artificial intelligence (AI)-driven diagnostics, have revolutionized patient care. These innovations enhance healthcare delivery by enabling remote consultations, personalized medicine, and real-time health monitoring. In developed nations, digital health adoption is facilitated by advanced infrastructure, widespread internet access, and favourable policies. Countries such as the United States and the United Kingdom have integrated digital health within national healthcare systems, leading to improved patient outcomes and cost efficiencies. However, developing nations face barriers such as limited infrastructure, digital illiteracy, and regulatory hurdles, hindering the full potential of digital health interventions.

Digital Health in India: Opportunities and Challenges

India has seen rapid growth in digital health adoption, driven by government initiatives like the National Digital Health Mission (NDHM), Ayushman Bharat Digital Mission (ABDM), and the expansion of telemedicine services. The widespread availability of smartphones and affordable internet has further propelled the adoption of digital health, particularly in urban areas. These advancements have improved healthcare access, enabled early disease detection, and fostered patient engagement. Despite these opportunities, challenges persist. The digital divide remains a major hurdle, with rural populations facing inadequate internet access and low digital literacy. Privacy concerns and data security issues

further complicate digital health adoption. Additionally, cultural resistance and skepticism towards digital healthcare solutions, particularly among older populations, pose significant barriers.

Perception and Adoption of Digital Health

Public perception is a crucial determinant of digital health adoption. Trust in technology, perceived benefits, and ease of use significantly influence individuals' willingness to adopt digital health solutions. Studies indicate that younger populations, who are more tech-savvy, demonstrate higher acceptance rates compared to older generations.

In India, socioeconomic factors such as education level, income, and regional disparities also play a role in shaping digital health adoption. Addressing these concerns through targeted awareness campaigns, digital literacy programs, and robust regulatory frameworks can foster greater acceptance and integration of digital health technologies.

Methodology

Study Design

This study employed a cross-sectional survey design to assess the perception of digital health among residents of Chengalpattu, Tamil Nadu. The survey was conducted among 500 participants aged 18–60 years, ensuring a diverse representation across different age groups, gender identities, and socioeconomic backgrounds. The study aimed to capture current attitudes, awareness, and barriers to digital health adoption within the region.

Sampling and Data Collection

A stratified random sampling method was used to ensure equitable representation of urban and rural populations. Participants were selected from households, healthcare centers, and community hubs to ensure inclusivity. Data were collected using structured questionnaires administered face-to-face by trained enumerators. The questionnaire covered aspects such as familiarity with digital health tools, trust in technology, perceived benefits, and barriers. Ethical approval was obtained, and informed consent was secured before data collection.

Data Analysis

The collected data were processed and analyzed using SPSS version 25. Descriptive statistics, including frequencies and percentages, were used to summarize demographic characteristics and levels of digital health awareness. Inferential statistics, including chi-square tests and correlation analysis, were conducted to explore associations between demographic factors and digital health adoption, along with key barriers influencing usage patterns.

Results

Demographic Characteristics

The study sample consisted of 500 participants, ensuring a balanced representation of gender, age, education, and residential background. The gender distribution was nearly equal, with males constituting 52% and females 48% of the sample. In terms of age, the majority of respondents (58%) belonged to the 18–35-year age group, indicating a predominance of younger participants. The 36–50-year age group accounted for 30%, while 12% were aged between 51 and 60 years. Educational background varied across participants, with 45% having completed secondary education, 30% holding a bachelor's degree, and 25% possessing a postgraduate qualification. This distribution suggests a diverse range of

educational attainment among respondents, which may influence their awareness and adoption of digital health platforms. The sample also included a mix of urban (60%) and rural (40%) residents, ensuring representation from different geographical backgrounds.

Awareness and Perception of Digital Health

The findings indicate that 68% of participants were aware of digital health platforms, highlighting a relatively high level of awareness in the general population. However, awareness levels differed significantly between urban and rural respondents, with 75% of urban participants indicating familiarity with digital health services compared to only 58% of rural participants. This disparity suggests a digital divide, likely driven by infrastructural and socio-economic factors. Despite a reasonable level of awareness, only 42% of respondents reported using digital health services. The primary barriers preventing utilization included limited internet access (34%), digital literacy challenges (28%), and privacy concerns (22%). These factors suggest that while knowledge of digital health exists, multiple challenges hinder its adoption, particularly among rural and less-educated populations.

Factors Influencing Digital Health Adoption

Age, education, and prior experience with telehealth services emerged as key determinants influencing digital health adoption. Younger participants (18–35 years) demonstrated a higher acceptance rate (62%) compared to older adults (36%). The correlation analysis revealed that trust in digital health was significantly associated with education level ($r = 0.45$, $p < 0.01$), indicating that individuals with higher education were more likely to adopt and trust digital health services. Similarly, previous exposure to telehealth positively correlated with digital health adoption ($r = 0.38$, $p < 0.01$), suggesting that familiarity with virtual healthcare services fosters confidence in digital platforms. Another crucial factor was the willingness to adopt digital health if provided with adequate training and infrastructure. Notably, 78% of respondents expressed a willingness to use digital health services under such conditions, indicating that targeted interventions, such as digital literacy programs and infrastructure improvements, could significantly enhance adoption rates.

Barriers to Digital Health Adoption

Several barriers to digital health adoption were identified, with the most prominent ones being:

Lack of Internet Access:

- Approximately 34% of respondents cited limited internet access as a significant barrier.
- Rural participants were disproportionately affected, with many reporting unreliable network coverage and high data costs as limiting factors.
- The digital infrastructure gap between urban and rural regions further exacerbates the challenge, limiting equitable access to digital health services.

Digital Literacy Challenges:

- Digital literacy emerged as a significant barrier for 28% of respondents.
- Older adults and individuals with lower educational attainment were more likely to struggle with navigating digital health platforms.
- The lack of user-friendly interfaces and technical support contributes to difficulties in engaging with digital health services.

Privacy and Security Concerns:

- About 22% of participants expressed concerns regarding the security and confidentiality of their health data.
- Fear of data breaches, unauthorized access, and misuse of personal health information were major deterrents.
- Transparency in data handling and robust security measures are necessary to address these concerns and build trust in digital health platforms.

Summary of Key Findings

The study highlights significant disparities in digital health awareness and adoption based on demographic factors such as age, education, and geographical location. While awareness levels are relatively high (68%), actual utilization remains low (42%) due to various barriers, including internet accessibility, digital literacy challenges, and privacy concerns. Younger, more educated individuals demonstrate a higher propensity for adopting digital health, while older adults and rural residents face greater challenges. Importantly, the study reveals a strong willingness (78%) among participants to adopt digital health services if appropriate training and infrastructure support are provided. These findings underscore the need for targeted policy interventions, including digital literacy initiatives, improved internet infrastructure, and enhanced data security measures, to bridge the digital health divide and promote equitable healthcare access.

Implications for Policy and Practice

The results indicate several key implications for policymakers, healthcare providers, and technology developers:

Improving Digital Infrastructure:

Expansion of internet services, especially in rural areas, is essential to ensuring widespread digital health access.

Enhancing Digital Literacy:

Educational campaigns and training programs should be implemented to equip individuals with the necessary skills to use digital health platforms effectively.

Addressing Privacy Concerns:

Strengthening data protection policies and implementing transparent security measures can help alleviate privacy-related apprehensions.

Targeted Outreach Programs:

Special initiatives should focus on engaging older adults and less educated populations to facilitate their integration into digital health ecosystems.

By addressing these challenges, digital health services can become more inclusive, improving healthcare accessibility and efficiency for diverse populations.

Discussion

Awareness and Perception of Digital Health

The study reveals a disparity in awareness and perception of digital health among residents of Chengalpattu. While a considerable proportion of respondents have heard of digital health platforms, the actual utilization remains low, particularly in rural areas. This gap is largely influenced by factors such as internet accessibility, digital literacy levels, and

concerns over data security. Many individuals, especially in less urbanized regions, lack adequate knowledge about digital health services, leading to hesitation in adopting these technologies. The findings suggest a need for more targeted awareness campaigns to improve digital health literacy.

Factors Influencing Digital Health Adoption

The research highlights that younger individuals and those with higher education levels demonstrate a greater inclination toward adopting digital health solutions. This trend aligns with existing literature that links digital literacy with higher adoption rates. Furthermore, prior exposure to telehealth services fosters a sense of trust, which significantly impacts user acceptance. This suggests that gradual integration of digital health into existing healthcare practices can enhance familiarity and encourage broader adoption. Healthcare providers can play a crucial role by introducing digital health options to patients and offering guidance on their usage.

Barriers to Digital Health Adoption

Key barriers to digital health adoption in Chengalpattu include poor internet connectivity, especially in rural areas, limited digital literacy, and privacy concerns. Many respondents expressed skepticism about the security of their personal health information, reflecting a need for improved data protection policies. Additionally, inadequate technological infrastructure continues to hinder access, reinforcing the urban-rural divide. Addressing these challenges through targeted policy interventions is critical.

Implications for Policy and Practice

To promote digital health adoption, investments in digital infrastructure must be prioritized, particularly in rural areas. Community-driven digital literacy programs can bridge knowledge gaps, while stringent data security policies can alleviate privacy concerns. Policymakers must collaborate with healthcare providers to create an inclusive digital health ecosystem that ensures accessibility and trust.

Conclusion

This study provides valuable insights into the perception of digital health among residents of Chengalpattu, Tamil Nadu, highlighting key challenges and opportunities in the adoption of digital health technologies. The findings emphasize the need for targeted interventions to bridge the digital divide, enhance digital literacy, and address privacy concerns. Limited awareness, infrastructural constraints, and concerns about data security have emerged as significant barriers to digital health adoption. By addressing these challenges, policymakers and healthcare providers can create more inclusive digital health frameworks. Initiatives such as community-driven digital literacy programs, affordable access to digital health platforms, and robust cybersecurity measures can enhance public confidence in digital healthcare. Additionally, collaborative efforts between the government, healthcare institutions, and technology providers can facilitate the seamless integration of digital health solutions, ensuring equitable healthcare access for semi-urban and rural populations. Furthermore, future research should explore the long-term impact of digital health interventions and the effectiveness of policy measures in improving health outcomes. By fostering digital inclusivity and strengthening healthcare infrastructure, digital health can serve as a transformative tool in achieving sustainable and accessible healthcare for all.

References

World Health Organization. (2020). Digital health. Retrieved from https://www.who.int/health-topics/digital-health

National Digital Health Mission. (2021). Government of India. Retrieved from https://ndhm.gov.in

Kumar, S., & Preetha, G. S. (2012). Health promotion: An effective tool for global health. Indian Journal of Community Medicine, 37(1), 5–12.

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. MIS Quarterly, 36(1), 157–178.

Anderson, R. M., & Funnell, M. M. (2010). Patient empowerment: Myths and misconceptions. Patient Education and Counselling, 79(3), 277–282.

MEDICAL MISINFORMATION & INFODEMIC: A COVID SPECIFIC STUDY

Mr Ajjay Marshal R [1], Ms Shakthi Roshini G [2], Ms Amritha Shree S [3]

[1] Data Analyst, Coimbatore

[2] Teaching Assistant, Department of Hospital Administration
PSG College of Arts & Science, Coimbatore

[3]Student, Department of Hospital Administration
PSG College of Arts & Science, Coimbatore

Abstract

Introduction

The COVID-19 pandemic unleashed an unprecedented wave of misinformation, creating what the World Health organization termed an "infodemic". This paper explores the ramifications of this infodemic, focusing on its impact on patient behaviour, the dynamics of echo chambers, and the development of a vicious cycle of medical misinformation.

Objectives

To critically analyse the public and behaviour post infodemic, to assess the impacts of echo chambers and to develop a model to explain medical misinformation cycle.

Methodology

A censorious content analysis was done for the study and a framework was developed to explain the criticality of infodemic and medical misinformation.

Findings

Through the analysis, patterns and trends were identified with respect to the source, mode of spread, and impacts of medical misinformation and infodemic.

Discussion

The findings of the study suggest the need for strict laws and regulations to curb the rapid spread of medical misinformation. Other findings also call for the establishment of fact checking websites which can be used by the public to check if an information is fake or true. Application of alternative medications have also been addressed in the study.

Conclusion

The study highlights all major aspects of infodemic and provides clear suggestions to manage the infodemic and medical misinformation situation.

Keywords: Infodemic, Misinformation, COVID-19, Echo Chambers, Medical Misinformation, Public Behaviour

Introduction

Medical misinformation during the pandemic which is also referred to as an infodemic was a critical problem which triggered a major public health crisis. The year 2020 was the year when the novel corona virus caused an epidemic worldwide and made people stay in their homes. Panic struck all over the world as the globe wasn't prepared for a pandemic. There was no sort of emergency preparedness to tackle the serious situation. Healthcare systems in many areas were strained due to the surge in COVID-19 cases. Hospital faced challenges in managing patient loads, and healthcare workers experienced unprecedented pressures. The coronavirus disease (COVID-19) is caused by the severe acute

respiratory syndrome, first reported in December 2019 in Wuhan, China. Believed to have originated from a seafood market selling live wild animals, the virus was identified by Chinese authorities as a novel coronavirus genetically similar to the 2002-2003 SARS virus. It spreads primarily through respiratory droplets from infected individuals. As COVID-19 spread rapidly in late 2020, chaos and confusion gripped the world. The devastating loss of lives, lack of effective treatments, and widespread misinformation about the virus's origin, transmission, and cure intensified the crisis. The rapid circulation of false information through online platforms outpaced accurate reporting, influencing public behavior, inciting fear, and obstructing effective health responses. The COVID-19 pandemic, a global crisis of unparalleled proportions underscored the critical importance of accurate and reliable health information. Misinformation was so rampant that the World health organization (WHO) coined a new term to address the overflow of information. "Infodemic" is the term coined by WHO to address the situation. An infodemic is referred to as too much information including false or misleading information in digital and physical environments during a disease outbreak. It can intensify or lengthen outbreaks when people are unsure about what they need to do to protect their health and the health of the people around them. With the growing technology and expanded social media information spreads very rapidly in an amplified way.

The public's voracious appetite for information, combined with the ease of sharing on social media, created an environment where accurate medical guidelines had to compete with a flood of misinformation that often directly contradicted factual information. False claims and unverified treatments circulated widely, shaping public perceptions, influencing behavior, and even affecting policy decisions. The interconnected nature of the globalized world enabled both accurate and misleading information to spread rapidly, complicating public understanding and posing significant threats to public health efforts. As people critically observed various aspects of the virus, differing viewpoints emerged, triggering curiosity and further fueling the chaos. The influx of misleading information, often backed by so-called "evidence," made it difficult for the public to distinguish between truth and falsehood, influencing behavior and inducing fear.

Objectives

The objectives of this study are:

- To critically analyse the public and behaviour post infodemic
- To assess the impacts of echo chambers
- To develop a model to explain medical misinformation cycle

Review of Literature

Several studies have explored the impact of misinformation and infodemic during the COVID-19 pandemic. **Rathore and Farooq (2020)** reviewed the challenges posed by information overload and the infodemic, suggesting general measures to mitigate their effects in the digital age. **Germani and Biller Andorno (2021**) conducted a behavioural analysis of anti-vaccination supporters on Twitter, comparing them with pro-vaccination supporters. Their study emphasized the need for policies to curb the circulation of vaccine-related misinformation. **Chowdhury et al. (2023)** analysed misinformation surrounding COVID-19 through a rapid review, drawing insights from previous disease outbreaks. The study identified that a lack of scientific knowledge and distrust in the government heightened the spread of misinformation, particularly through unregulated social media. Similarly, **Cinelli et**

al. (2020) performed a large-scale data analysis across platforms like Twitter, Instagram, YouTube, Reddit, and Gab, assessing the evolution of COVID-19 discourse and estimating the platform-dependent amplification of rumours.

Banerjee and Meena (2021) examined the role of social media in shaping the COVID-19 infodemic and its influence on public health. They proposed integrating social media into public health frameworks for digital balance and pandemic preparedness. **Roozenbeek and Schneider (2020)** investigated susceptibility to COVID-19 misinformation across different countries and found that trust in scientists and higher numeracy skills correlated with lower susceptibility. **Naeem and Kamel Boulos (2021)** provided an overview of the impact of COVID-19 misinformation on social media and its link to digital health literacy. They advocated for a mixed approach to tackling misinformation and mitigating its negative effects.

Evanega et al. (2020) quantified sources and themes of COVID-19 misinformation in traditional media, concluding that then-U.S. President Donald Trump was a significant driver of misinformation. **Caceres et al. (2022)** reviewed the role of media and information outlets in shaping pandemic responses, emphasizing the need to prevent the spread of misinformation.

Lastly, **Lee et al. (2022)** found that exposure to vaccine misinformation increased hesitancy and reduced willingness to vaccinate. **Zimmerman et al. (2023)** highlighted that different types of misinformation correspond to specific vaccine-hesitancy attitudes and argued that scientific approaches alone may not be enough to counter misinformation rooted in religion, media, or politics. These studies collectively underscore the urgent need for regulatory measures, fact-checking mechanisms, and public awareness campaigns to combat medical misinformation and mitigate its societal impact.

Conspiracy Theories

Virus

Bioweapon

This is one of the most widely believed conspiracy theories across the globe. This conspiracy theory stated that China had deliberately created the novel coronavirus and spread it across the globe as a part of their bio warfare. The theory suggest that the coronavirus was designed in the Wuhan laboratory as a bioweapon. The claims were supported with the fact that China had downplayed and misrepresented the impacts and the other aspects about the virus which led to detrimental impacts all over the world. A Wuhan researcher reported that their superior provided them with four strands of the virus to assess their severity and noted that several colleagues went missing during the 2019 Military World Games. One missing researcher revealed they were sent to hotels housing athletes to inspect health conditions, but Chao Shao from the Wuhan Institute of Virology suspected the true goal was to spread the virus, as virologists were unnecessary for such inspections (Chaturvedi, 2023). These claims support the theory that China engineered COVID-19 as a bioweapon. However, this information could also be a misleading narrative from anti-China groups. This situation reflects the delusions people faced during the infodemic, which significantly influenced public perceptions and decisions. Conspiracy theories about the origins of COVID-19 emerged, many with political implications. One theory claimed the U.S. deliberately released the virus in China, while another suggested it was a tool used by the U.S. and Israel against

China and Iran. China's censorship fueled speculation that COVID-19 was part of a bioweapon program, supported by past U.S. concerns about the Wuhan laboratory. Additionally, some believed the virus was engineered to reduce the global population and establish a New World Order. These narratives increased public distrust and hostility toward China. However, all these theories were discredited due to a lack of evidence. The bioweaponhypothesis was particularly debunked. The *Financial Times* reported that Trevor Bedford, a global virus expert, confirmed there was *"no evidence whatsoever of genetic engineering"* and that the virus's mutations were *"completely consistent with natural evolution."* While these theories failed to prove China's responsibility, they kept the public engaged and fueled global controversy.

5G Network

Conspiracy theories related to the 5G network began to soar high during the pandemic. This preposterous claim was rather sub missed with clear evidence that it is biologically impossible for viruses to spread using the electromagnetic spectrum, yet the rumours found its way worldwide. In Bolivia, a video showing telecommunications equipment and falsely claiming that 5G caused the coronavirus spread widely on social media. This misinformation led to attacks on transmission masts in two towns, despite the absence of 5G technology at the time. - A Nigerian senator's video alleging that 5G causes harm and that COVID-19 was a cover-up for its introduction was shared over 25,000 times on Facebook. - A Tanzanian evangelical pastor claimed that the push for mobile-related 5G technology was the source of the virus in a widely circulated video. - A former grand mufti in Egypt discussed how 5G's electromagnetic disturbances facilitated the spread of COVID-19 on live television, reaching millions. - In Serbia, 5G conspiracy theories gained popularity through television and tabloids, primarily influenced by UK and Russian media. Many celebrities played a significant role in amplifying conspiracy theories, further complicating efforts by governments to control misinformation.

Tennis star Novak Djokovic openly opposed COVID vaccines, while his wife shared videos promoting the 5G conspiracy theory linked to the virus. Rapper Wiz Khalifa fueled speculation with his tweet: *"Corona? 5G? Or both?"* Actor Woody Harrelson shared similar content on Instagram with his 2 million followers before later deleting the post. Other well-known figures, including British rapper M.I.A.**,** boxer Amir Khan, actor **J**ohnCusack, music producer Teddy Riley, and TV personality Amanda Holden, also contributed to spreading these theories. The mainstreaming of the COVID-5G conspiracy theory was largely driven by celebrity endorsements. A central claim of the theory was: *"Did the 5G rollout in Wuhan damage the innate cellular defence cells of the population, putting the people at risk of complications and death from coronavirus?"* This statement, among others, fuelled widespread scepticism and misinformation about the pandemic.

Nonetheless there were no credible and scientifically reasonable evidences to blame 5G technology for the spread of COVID-19 but it did create havoc which included burning of cell phone towers in major cities.

A plot by Big Pharma

Another persistent conspiracy theory about the pandemic claims that the pharmaceutical industry orchestrated it for profit, suggesting that major companies supported the spread of COVID-19 to sell vaccines. This theory gained traction among anti-vaccine

groups, especially when vaccines were developed at unprecedented speeds, raising suspicion. The perception of big pharma as profiteers, often blamed for rising medication costs, has fueled this belief. However, the rapid vaccine development stemmed from extensive global collaboration, not a conspiracy. While some continue to allege that government officials were bribed to hide the truth, it is crucial to understand that this does not imply that pharmaceutical companies engineered the virus. The key takeaway is that the remarkable collaboration allowed for the swift rollout of vaccines, which would have been far more challenging without such unity. Despite the crisis, steps were taken to ensure vaccines were developed and produced quickly.

COVID doesn't exist

Believers of this conspiracy theory led anti-lockdown protests, viewing restrictions as an infringement on their freedoms. Many refused to follow safety measures like social distancing, directly contributing to the virus's spread. Statements like former U.S. President Donald Trump's claim that COVID-19 was no more dangerous than seasonal flu further fueled these conspiracies, with some theorists insisting that the death toll was exaggerated. Ironically, some who initially dismissed COVID-19 as a hoax later contracted the virus and shared their suffering in online confessions. During protests, signs like "FAKE NEWS IS THE REAL VIRUS" reflected the deep mistrust in official narratives. The theory, though it drew a lot of attention there wasn't enough evidence to support it. The exaggerated death toll was a major part of the claims which was widely believed by people across the world. The refusal to follow social distancing believing the theories and not abide by the guidelines made people get affected with the virus and in the worst of cases die due to it.

Vaccine

Misinformation about COVID-19 vaccines created significant challenges for governments and communities. One major consequence was vaccine hesitancy inconsistent and inaccurate media coverage of vaccine development fueled conspiracies, while claims of unusually rapid development further deepened public suspicion.

Anti vax organisations

During the pandemic, 147 major anti-vaccination social media accounts amassed over 7.8 million followers, using COVID-19 as a platform to expand their reach. These groups oppose not only COVID vaccines but all vaccines, claiming they are unsafe and violate human rights, despite a lack of scientific evidence. The anti-vaxxer movement dates back to the 18th century in the U.S., where religious leaders condemned vaccines as the "devil's work," later evolving into a human rights issue in the 19th and 20th centuries. Their widespread misinformation about vaccine safety and efficacy significantly contributed to vaccine hesitancy, posing a major obstacle from development to rollout. Their actions also hindered efforts to achieve herd immunity, a concept explored later in this research.

Surveillance

One of the most prominent misinformation or conspiracy theory about COVID vaccine was that microchips were injected in the human body in the name of COVID vaccination. Theorists and people who believed this were of the thought that the government or the deep state for that matter wanted to establish a surveillance and monitoring system to

monitor each and every person's individual behaviour. The monitoring aspect through microchips was seen as a hindrance to the freedom of the people, so the individuals who supported and believed this theory refused to take up vaccines leading to impacts in providing herd immunity.

Major misinformation on COVID vaccine

COVID-19 vaccine causes heart problems: This was a prominent misinformation. During the pandemic when Tamil actor/comedian Vivek passed away due to a cardiac arrest, a fellow actor accused the COVID vaccine for his sad demise. He stated that the vaccine was the reason for actor Vivek to suffer a cardiac arrest.

COVID-19 vaccine causes cancer? People believed that the vaccine caused mutations in the human genes and induced cancer.

COVID-19 vaccine was only tested on eight mice? The claim that COVID-19 vaccines were only tested on eight mice fueled public suspicion about their safety. Concerns over rapid development further deepened doubts. However, in reality, the vaccines underwent extensive clinical trials before reaching the market.

Top leaders of the world did not get injected with the COVID vaccine? This misinformation supported a slew of other misinformation and conspiracy theories such as "COVID was created by the deep state" and "the vaccine was created for injecting microchips" and etc.,

The vaccine impacts fertility in women? An important statement which was popular in the Indian subcontinent. Many people believed that the COVID vaccine would make women infertile or impact their fertility. Though COVID vaccine is known to alter the menstrual cycle of women it doesn't impact the fertility rate or any other aspect related to it.

Role of Governments

The pandemic period was the most critical timeline for Governments across the globe. A never seen before situation had hit the new age governments with a plethora of problems which resulted in grievous impacts.

Emergency preparedness

The pandemic brought to light the serious problems associated with emergency preparedness during the outbreak of COVID-19. People began to brew conspiracy theories of various kinds and spread misleading information due to experiencing and watching the inefficiency of the governments to handle and control the situation. This aspect of lacking emergency preparedness made people doubt their governments which resulted in triggering another major issue which is known as public health crisis. The loss of trust in the government to handle the situation had to be compensated and the trust had to be won back. The governments across the globe formulated various methods to tackle the imminent public health crisis and the major issue associated with it which is the spread of misleading information.

Increasing access to accurate information

To counter misinformation, governments implemented various strategies to control its rapid spread. Social media and literacy campaigns were launched to provide accurate information, often in collaboration with external organizations. Taiwan held daily press conferences, partnered with media and tech companies, and developed apps and maps for

public resources. The Taiwan Fact Check Centre verified online information within 60 minutes, ensuring swift public clarification.

Ethiopia integrated COVID-19 awareness messages into phone calls, providing prevention tips in Amharic. The UK launched a media literacy campaign, urging the public to verify sources, read beyond headlines, and fact-check with legitimate sources before sharing information. South Africa and Nigeria collaborated with WhatsApp to disseminate essential COVID-19 safety guidelines.

Restricting access to accurate information

Some governments restricted access to accurate information by suppressing journalism, limiting communication from health officials, or silencing whistleblowers. A notable case was in Wuhan, China, where Dr. Li Wenliang was silenced after warning about a potential new coronavirus strain, leading to serious consequences.

- Belarus was accused of withholding COVID-19 data and ignoring formal information requests.
- Aruba and Peru fined or detained journalists for violating curfews while reporting on the pandemic.
- Kuwait banned newspaper distribution under the pretext of preventing virus transmission, despite safety measures.
- Bosnia charged a doctor for revealing hospital equipment shortages on social media.
- Brazil dismissed its health minister for advocating public health measures.
- The U.S. removed two high-ranking federal health officials after they highlighted testing delays and medical supply shortages.

  Many governments lacked transparency, concealing critical information and restricting press freedom during the crisis.

Governments Releasing False Information

This event of connection is where the Governments themselves released false information to the public. Leaders of US, China, Russia, and Iran accused each other of engaging in disinformation propaganda in the global fight to frame the native surrounding COVID-19.

- Iran’s top Government leader referred to the virus as a biological attack.
- Government officials also disseminated misinformation about the virus and unproven or untested treatments or preventions. For example,
- The governor of Nairobi, Kenya distributed bottles of cognac as part of relief efforts, stating that research conducted by WHO and other health organizations found that alcohol killed the virus.
- The president of Madagascar broadcast his support for an herbal tea, COVID Organics, that he said cures the virus in days; the government required the tea to be consumed by public school children, distributed it throughout Madagascar, and donated it to several African countries.
- The U.S. president suggested that ingesting hydroxychloroquine and injecting disinfectant, light, or heat might prevent or cure COVID-19. Such disinformation campaigns reach large populations, distort public discourse, and politicize health and science.

- Disinformation spread by government officials is particularly problematic, as people generally trust official statements. When misleading information is legally released, it gains credibility, making it more difficult to counteract. Despite the fact that such statements can undermine national security, public order, and public health, government officials' speech is often protected under international law. This protection limits the ability to hold leaders accountable for spreading false information, complicating efforts to combat misinformation at an institutional level.

Actions Taken

The major actions taken by governments to combat misinformation across the globe include:

- Philippines arrested people for allegedly spreading false rumors about COVID-19 in their local neighborhoods.
- March 2020, the interim president of Bolivia signed an emergency decree criminalizing acts that "misinform or generate uncertainty to the population."
- Botswana's April 2020 Emergency Powers (COVID-19) Regulations criminalized relaying "any information to the public about COVID-19 from a source other than the Director of Health Services" or the World Health Organization.
- Hungary's parliament passed an emergency law that gave the Prime Minister powers to rule by decree and penalize people who spread "fake news" about the virus or measures against it.
- The Philippines "Bayanihan to Heal as One Act" penalized "creating, perpetrating, or spreading false information regarding the COVID-19 crisis."
- And Zimbabwe enacted a regulation clarifying that the government could prosecute "any person who publishes or communicates false news" about officials enforcing the national lockdown. People prosecuted under these countries' new laws could be fined and imprisoned for up to 20 years.

Article 19

Article 19, which safeguards freedom of speech and expression, presented a major challenge for governments during the COVID-19 infodemic. Efforts to curb misinformation risked being perceived as attacks on fundamental rights, raising the question: "Don't people have the right to express their opinions regardless of the situation?" Governments imposing restrictions had to demonstrate a direct and immediate link between speech and the threat while ensuring the least intrusive measures were used. While international human rights frameworks emphasize transparency, press freedom, and whistleblower protection, it remains uncertain whether governments fully upheld these principles while combating misinformation during the pandemic. Article 19 of the ICCPR does not protect commercial fraud, defamation, hate speech intended to incite violent behavior, incitement of war, or threats to national security. During a state of emergency "that threatens the life of a nation," Article 4 of the ICCPR permits states to "derogate" or deviate from their obligations "to the extent strictly required by the exigencies of the situation." However, derogation of Article 19(2) is not considered necessary to address COVID-19 misinformation. The United Nations Special Rapporteur on the protection and promotion of the right to freedom of opinion and expression emphasized that even in times of crisis like COVID-19, states must adhere to the limitations set forth in Article 19, rather than invoking Article 4 to derogate from their obligations to

protect free expression. Article 19(3) permits restrictions on freedom of expression only when they are:

Provided by law:

The limitations must be clearly defined in terms of scope, meaning, and effect, ensuring individuals understand how to regulate their actions to avoid violations. Vague or overly broad provisions granting excessive discretion to authorities do not meet this requirement.

Necessary and proportionate:

Any restriction must be strictly required to address national security, public order, public health, or morals, without endangering the fundamental right itself. In essence, any limitation on freedom of expression for public health purposes must serve a legitimate objective, be necessary and proportionate, and not erode the right to free speech itself.

Echo Chambers

Echo chambers were the major source of misinformation during the pandemic and a major cause for the infodemic. An echo chamber is an environment where a person only encounters information or opinions that reflect and reinforce their own. Echo chambers can create misinformation and distort a person's perspective so they have difficulty considering opposing viewpoints and discussing complicated topics. They're fuelled in part by confirmation bias, which is the tendency to favour and feed info that reinforces existing beliefs. Echo chambers can happen anywhere information is exchanged, whether it's online or in real life. But on the Internet, almost anyone can quickly find like-minded people and perspectives via social media and countless news sources. This has made echo chambers far more numerous and easier to fall into. The Internet also has a unique type of echo chamber called a filter bubble. Filter bubbles are created by algorithms that keep track of what you click on. Websites will then use those algorithms to primarily show you content that's similar to what you've already expressed interest in. This can prevent you from finding new ideas and perspectives online. These echo chambers were a major and the most critical source of misinformation during the pandemic, The fact that people were confined to their homes and spend most of their time online during the pandemic provided a proper environment to fall into these echo chambers and function in it. The people find connect with other people based on their ideology, political views, social views and various other criteria's. The lockdown was one of the reasons for such echo chambers to flourish.

Findings

Significant findings of the study are as follows:

- The infodemic triggered a major anti vaccination movement across the globe including India.
- People started to avoid vaccines due to the misinformation spread about vaccines. This activity led to difficulties in achieving herd immunity.
- During the infodemic there was a growing popularity for alternative medications (Ayurveda, Siddha, Homeopathy, and etc).
- Echo chambers and online communities played a critical role in the creation and spread of medical misinformation. Their growing popularity is a crucial concern.
- Lack of emergency preparedness in Hospitals and healthcare institutions during the pandemic made people loose trust in the healthcare systems.

- Social media is still being used as a vital tool to propagate medical misinformation and negatively influence the general public.
- Absence of proper laws to curb and contain the spread of medical misinformation furthers the spread of medical misinformation and cause grievous impacts.
- Internet has always been a significant source for health-related information without any checks and balances. This can impose as an influential factor on patient behaviour.

Discussion

Vaccine hesitancy

Vaccine hesitancy, fuelled by misinformation and conspiracy theories, significantly hindered efforts to achieve herd immunity during the COVID-19 pandemic. Skepticismtoward vaccines led to widespread refusal, preventing communities from reaching necessary immunity levels and prolonging the crisis. Herd immunity occurs when a large portion of the population becomes immune, reducing disease spread. However, vaccine refusal increased the required coverage, leading to outbreaks, overwhelmed healthcare systems, and resource shortages. While skepticism toward vaccines isn't new, COVID-19 misinformation amplified public fear, making widespread vaccination crucial for returning to normalcy and controlling future outbreaks.

Patient behaviour post infodemic

Misinformation posed a major challenge to public health and government policies, particularly affecting vulnerable populations like the elderly. Since older adults make up a significant portion of patients, their susceptibility to false information heightened risks for the healthcare system. Misinformation spread rapidly, often shared without scrutiny due to sensational headlines. Studies showed younger, less-educated, and economically disadvantaged individuals were also highly influenced, often feeling victimized by society, which reinforced their belief in misleading narratives.

End of the day, patients did loose trust in the healthcare system and hospitals due to the infodemic. There are quite a lot of reasons for it which include

- Lack of emergency preparedness
- Lack of accurate information
- Lack of infrastructure to curb misinformation
- Slow paced vaccine development
- Absence of information on the source of the virus
- Failure of healthcare systems
- Non-availability off hospital beds, ventilators, oxygen tanks and etc.

The COVID-19 infodemic fuelled trust issues among patients, though vaccine acceptance improved as fact-based information gained traction. However, lingering mistrust continues to shape patient behaviour. In the digital era, people often rely on the internet for medical advice, but the pandemic exposed the dangers of misinformation, which fosters doubt and fear. Its seemingly credible "evidence" makes false claims appear legitimate, further eroding trust. Despite these challenges, a positive outcome has been increased patient awareness, leading to greater health consciousness—an essential step toward societal progress.

Methods and Suggestions to Curb Medical Misinformation

Psychological inoculation:

It closely follows the biomedical analogy: just as how a weakened dose of virus helps the body immunologically resist future infection, same way preemptively exposing people to a weakened dose of info would help people psychologically resist the misinformation.

Regulatory policies:

The infodemic has shown the importance for the needs of strong regulatory and monitoring policies to regulate the information available online. The access to such information should also be looked upon.

Refutational pre-emption:

It comes under the inoculation theory. It refers to the content that helps bolster positive and credible attitude towards a subject to refute the incoming attack.

Freedom of speech:

It's a major aspect related to the control of misinformation. All over the world irrespective of anything people are entitled to have their own opinions. The contradictory aspect here is that when a person posts some conspiracy theories or misinformation, the governmental authorities wouldn't be able to restrict them form posting as they have the freedom of speech and expression.

THE VICIOUS CYCLE OF MEDICAL MISINFORMATION

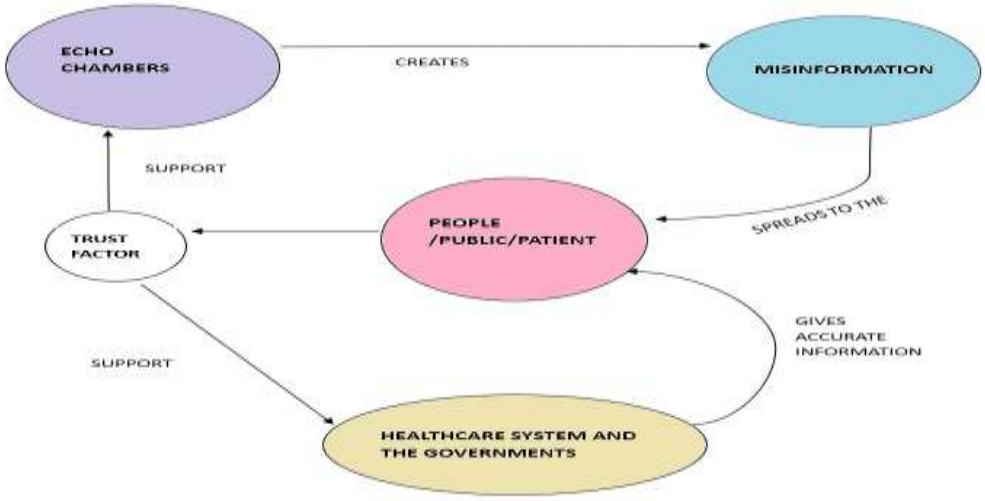


Fig 1. Vicious Cycle of Medical Misinformation. *Created by authors*

The cycle of misinformation begins with echo chambers generating false narratives, which then spread to the public. Governments attempt to counteract this by providing accurate information and debunking false claims.

At the centre of this cycle are the people. If individuals align with misinformation due to personal beliefs or ideology, they reinforce echo chambers, perpetuating the cycle. However, if they trust verified information, they strengthen public health systems and government efforts.

Conclusion

The study underscores the critical impact of misinformation on public understanding during COVID-19 pandemic, contributing to an infodemic. It highlights the urgent need for targeted strategies to combat false information and promote accurate sources, fostering a

more informed and resilient society in the face of health crises. Furthermore, the findings emphasize the role of governments and the necessity for collaborative efforts between authorities, media, and technology companies to curb the spread of misinformation. The study on infodemic reveals a concerning landscape where inaccurate information can profoundly impact public perception. Recognizing the pervasive nature of misinformation underscores the importance of proactive measures in communication, education, and regulatory framework to mitigate its influence. The alarming misuse of technology has also been adversely covered in the study. The rapid spread of false information through various digital platforms highlights the need for enhanced technological safeguards and responsible practices. Only through concreted efforts can we fortify our defences against misinformation, ensuring a more resilient and well-informed global community, particularly in the face of health challenges such as the COVID-19 pandemic. In the case of a future pandemic or any other case of events where an infodemic is bound to occur, the study can be referred understand the intricacies and modes of spread and suggestions to avoid and minimize the impacts of an infodemic. It is not restricted to global events. Even small scenarios where there is a rapid spread of misinformation is on the purge, this study can be referred to understand the details.

References

Chaturvedi, A. (2023, June 28). *China Deliberately Engineered Coronavirus As " Bioweapon" Wuhan Researcher*. www.ndtv.com. https://www.ndtv.com/world-news/china-deliberately-engineered-coronavirus-as-bioweapon-wuhan-researcher-4159339

Lee, Sun Kyong, et al. "Misinformation of COVID-19 vaccines and vaccine hesitancy." *Scientific reports* 12.1 (2022): 13681.

Zimmerman, Tara, Kristina Shiroma, Kenneth R. Fleischmann, Bo Xie, Chenyan Jia, Nitin Verma, and Min Kyung Lee. "Misinformation and COVID-19 vaccine hesitancy." *Vaccine* 41, no. 1 (2023): 136-144.

Loomba, S., de Figueiredo, A., Piatek, S.J., de Graaf, K. and Larson, H.J., 2021. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature human behaviour*, *5*(3), pp.337-348.

Roozenbeek, J., Schneider, C.R., Dryhurst, S., Kerr, J., Freeman, A.L., Recchia, G., Van Der Bles, A.M. and Van Der Linden, S., 2020. Susceptibility to misinformation about COVID-19 around the world. *Royal Society open science*, *7*(10), p.201199

Zhao, S., Hu, S., Zhou, X., Song, S., Wang, Q., Zheng, H., Zhang, Y. and Hou, Z., 2023. The prevalence, features, influencing factors, and solutions for COVID-19 vaccine misinformation: systematic review. *JMIR Public Health and Surveillance*, *9*(1), p.e40201.

Kricorian, K., Civen, R. and Equils, O., 2022. COVID-19 vaccine hesitancy: misinformation and perceptions of vaccine safety. *Human Vaccines &Immunotherapeutics*, *18*(1), p.1950504.

Van der Linden, S., Dixon, G., Clarke, C. and Cook, J., 2021. Inoculating against COVID-19 vaccine misinformation. *E Clinical Medicine*, *33*.

Pomeranz, J.L. and Schwid, A.R., 2021. Governmental actions to address COVID-19 misinformation. *Journal of public health policy*, *42*, pp.201-210.

Romer, D. and Jamieson, K.H., 2020. Conspiracy theories as barriers to controlling the spread of COVID-19 in the US. *Social science & medicine*, *263*, p.113356.

Pummerer, L., Böhm, R., Lilleholt, L., Winter, K., Zettler, I. and Sassenberg, K., 2022. Conspiracy theories and their societal effects during the COVID-19 pandemic. *Social Psychological and Personality Science*, *13*(1), pp.49-59.

Uscinski, J.E., Enders, A.M., Klofstad, C., Seelig, M., Funchion, J., Everett, C., Wuchty, S., Premaratne, K. and Murthi, M., 2020. Why do people believe COVID-19 conspiracy theories?. *Harvard Kennedy School Misinformation Review*, *1*(3).

Loomba, S., de Figueiredo, A., Piatek, S.J., de Graaf, K. and Larson, H.J., 2021. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nature human behaviour*, *5*(3), pp.337-348.

Roozenbeek, J., Schneider, C.R., Dryhurst, S., Kerr, J., Freeman, A.L., Recchia, G., Van Der Bles, A.M. and Van Der Linden, S., 2020. Susceptibility to misinformation about COVID-19 around the world. *Royal Society open science*, *7*(10), p.201199.

Bin Naeem, S. and Kamel Boulos, M.N., 2021. COVID-19 misinformation online and health literacy: a brief overview. *International journal of environmental research and public health*, *18*(15), p.8091.

Evanega, S., Lynas, M., Adams, J., Smolenyak, K. and Insights, C.G., 2020. Coronavirus misinformation: quantifying sources and themes in the COVID-19 'infodemic'. *JMIR Preprints*, *19*(10), p.2020.

Cinelli, M., Quattrociocchi, W., Galeazzi, A., Valensise, C.M., Brugnoli, E., Schmidt, A.L., Zola, P., Zollo, F. and Scala, A., 2020. The COVID-19 social media infodemic. *Scientific reports*, *10*(1), pp.1-10.

Banerjee, D. and Meena, K.S., 2021. COVID-19 as an "infodemic" in public health: critical role of the social media. *Frontiers in Public Health*, *9*.

Germani, F. and Biller-Andorno, N., 2021. The anti-vaccination infodemic on social media: A behavioral analysis. *PloS one*, *16*(3), p.e0247642.

Chowdhury, N., Khalid, A. and Turin, T.C., 2023. Understanding misinformation infodemic during public health emergencies due to large-scale disease outbreaks: a rapid review. *Journal of Public Health*, *31*(4), pp.553-573.

Gisondi, M.A., Barber, R., Faust, J.S., Raja, A., Strehlow, M.C., Westafer, L.M. and Gottlieb, M., 2022. A deadly infodemic: social media and the power of COVID-19 misinformation. *Journal of medical Internet research*, *24*(2), p.e35552.

Solomon, D.H., Bucala, R., Kaplan, M.J. and Nigrovic, P.A., 2020. The "infodemic" of COVID-19. *Arthritis & Rheumatology*, *72*(11), pp.1806-1808.

DIGITAL TOOLS FOR MENTAL HEALTH AND WELLBEING

Dr V Uma[1],Ms P Yagavi[2], Ms M Sunmathi[3]

[1] Professor & Head, Department of Hospital Administration
Dr.N.G.P Arts and Science College, Coimbatore

[2,3] Student, Department of Hospital Administration
Dr.N.G.P Arts and Science College, Coimbatore

Abstract

Digital tools for mental health and well-being have emerged as transformative resources in addressing the growing demand for accessible and effective mental health support. These tools, which include mobile applications, online platforms, and wearable technologies, offer a variety of interventions ranging from mindfulness exercises and cognitive behavioral therapy (CBT) to mood tracking and social support communities. By leveraging advanced algorithms and usercentered design, these digital solutions provide users with personalized experiences, enabling them to manage stress, anxiety, depression, and other mental health concerns in a convenient and confidential manner. This paper explores the development and implementation of digital tools for mental health, highlighting their benefits and colour psychology. Through an analysis of current trends, user engagement, and outcomes, the paper discusses how these tools can enhance mental well-being, reduce barriers to care, and complement existing mental health services, ultimately fostering a more inclusive and supportive environment for mental health care globally

Key Words: Digital Tools , Mental Health , Colour psychology

Introduction

Mobile mental health applications (apps) are digital platforms delivered through smartphones that offer self-guided or remotely assisted mental health services, including communication, self-monitoring, diagnosis, and treatment. These apps aims to address barriers often associated with traditional mental health treatments, such as limited availability, accessibility, and acceptability, by providing users with timely, cost-effective, and discreet ways to manage their mental health. Specifically, these apps help users avoid issues common in conventional clinical settings, such as long wait times, limited clinic hours, and living in areas with inadequate mental health care. Instead of waiting an average of 14.5 days for a clinician consultation, users can access relevant information and interventions promptly, and use apps for on-demand emotional expression . The rapid development and adoption of mental health apps reflect the increasing demand for mental healthcare. Between 2016 and 2018, the number of these apps tripled, providing users with over 10,000 mental health apps to choose from. In a survey of 320 outpatient help-seekers from four U.S. clinics, 70% expressed interest in using apps to support self-monitoring and management of mental health issues. Given their growing popularity, it is important to explore how these apps might complement traditional treatments**.** Digital tools for mental health and wellbeing offers several advantages like personalized support ,cost effective, anonymity and reduced stigma.

Although research on integrating mobile mental health apps with traditional treatments is emerging, the findings have been limited and somewhat divided. For example, Torous et al. [14] focused on challenges posed by mental health apps, while Eisenstadt et al. [15] explored their potential benefits. Some studies have shown that these apps can be

valuable in enhancing traditional interventions, such as providing educational content before treatment, helping with symptom tracking during treatment, and offering ongoing access to resources after treatment. However, other studies have raised concerns about risks, including privacy issues and the use of non-evidence-based approaches. Given these mixed findings, there is a need for a more thorough analysis of the mobile mental health app landscape to offer researchers a more complete understanding of how these apps might complement the existing applications. While numerous reviews have examined the current state of mobile mental health apps, we aim to conduct an umbrella review to provide a comprehensive summary of the evidence, highlighting effectiveness of mental health apps and bringing all criteria in the same platform along with a study of colour psychology.

Objectives

Our aim was to identify the types of apps currently available for mental health and wellbeing in Google playstore and iOS stores and to assess their features and the quality of their content.

To bring all psychological solutions in a single platform

To develop an application which is user friendly on the basis of colour psychology.

Methodology

A systematic review approach was used to search, screen, and evaluate apps. We searched Google Play and iOS stores for English-language apps designed for individuals with Mental health and wellbeing . The completeness and quality of information were assessed based on core psychoeducation principles and current mental health and wellbeing treatment guidelines. Management tools were evaluated according to best-practice standards for the specific area. Additionally, general app features, along with privacy and security, were also reviewed.

Using snowballing method data were extracted from these sites:

- Insights10
- Google scholar
- PubMed
- JSTOR
- Research Gate
- IEEE Xplore
- Academia.edu

Review of Literature

Mental health apps can amplify treatment outcomes by complementing different stages of traditional interventions in line with their specific purpose. For example, in Hwang et al.'s scoping review, certain mental health apps (e.g., MoodPrism, mHealth)—which track and monitor users' emotional state and psychological stress—were found to reduce symptoms of depression, anxiety, and stress. Hence, by providing on-the-go documentation of users' psychological well-being, these apps can tailor relevant goals for each user in real-time and supplement traditional treatment. In addition, Oyebode et al.'s thematic analysis of user reviews of 104 mental health apps revealed positive themes such as "reminder and notification", "in-app support", "logging", "analytics and visualization", "assessment", and "data export"; which indicate the unique features of mental health apps that are valued by help-seekers. Together, this suggests that users could utilize mental health apps in conjunction

with traditional treatment to enjoy higher therapeutic success as compared to only receiving the traditional face-to-face intervention alone.

Colour psychology

Blue and green are often considered calming and soothing colours. These hues can evoke feelings of tranquility, peace, and serenity, making them ideal for spaces where patients may feel anxious or stressed. In healthcare environments such as waiting rooms or patient rooms, this makes it an excellent choice for patient rooms and waiting areas where relaxation is key.

- Blue: Associated with stability and calmness, blue is a popular choice for healthcare design. Lighter shades of blue can create a sense of openness and cleanliness, while darker blues can evoke a more formal and professional atmosphere.
- Green: Symbolizing nature and growth, green is inherently calming. It can reduce anxiety and promote a sense of harmony. It's known to reduce stress and create a sense of harmony. In healthcare spaces, incorporating greens can create a restful environment, particularly in areas where patients need to unwind or recover. Soft greens are often used in healthcare settings to create a connection to the outdoors and promote healing.

Data

The India Mental Health Apps Market was valued at $112.75 Mn in 2023 and is predicted to grow at a CAGR of 18.2% from 2023 to 2030, to $363.46 Mn by 2030. The key drivers of this industry include government initiatives, reduced stigma, and increasing smartphone penetration.

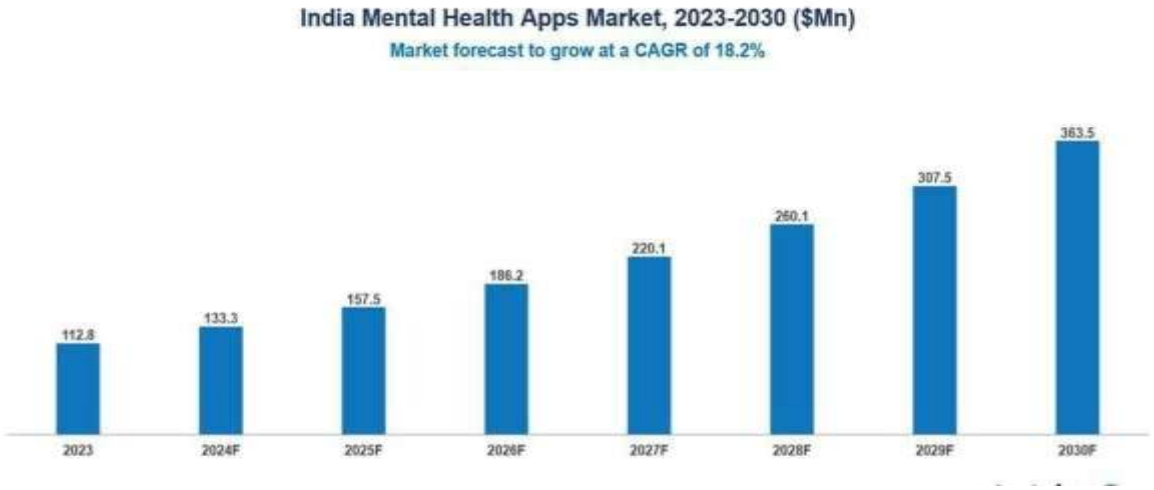


Fig.1. insights10

WHO Data Insight

India contributes to 18% of the global population. WHO estimates that the burden of mental health problems in India is 2443 disability-adjusted life years (DALYs) per 10000 population; the age-adjusted suicide rate per 100000 population is 21.1. The economic loss due to mental health conditions, between 2012-2030, is estimated at USD 1.03 trillion.

Prevalence

The National Mental Health Survey (NMHS) 2015-16 by NIMHANS found that 10.6% of adults in India suffer from mental disorders.

The lifetime prevalence of mental disorders in India is 13.7%.

National studies reveal that 15% of India's adult population experiences mental health issues requiring intervention.

Urban areas have a higher prevalence (13.5%) compared to rural (6.9%).

Treatment Gap

70% to 92% of people with mental disorders do not receive proper treatment due to lack of awareness, stigma, and shortage of professionals.

According to the Indian Journal of Psychiatry India has 0.75 psychiatrists per 100,000 people, whereas WHO recommends at least 3 per 100,000.

Colour psychology

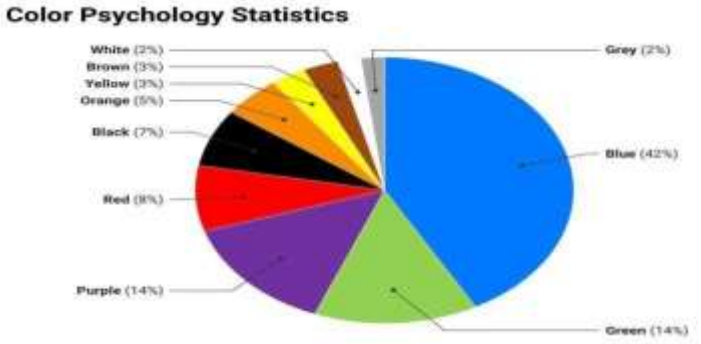


Fig.2. – Color Psychology

- Blue is linked to trust and safety, with 34% choosing it as the most trustworthy colour.
- Around 28% of people said they think of Blue when asked about a secure feeling.

Discussion

Mental health applications are diverse and cater to various needs, from therapy and crisis support to meditation and mental health monitoring. They are designed to make mental health resources more accessible, especially in a country like India where access to traditional inperson counselling can be limited in certain areas.

The total number of mental health applications listed is **29**.

- Teletherapy and Online Counselling: 5 apps
- These apps focus on providing virtual therapy and online counseling services to individuals. With teletherapy gaining popularity, especially post-pandemic, these apps serve as a bridge for users who cannot access in-person therapy sessions.
- Mental Health Monitoring and Self-help: 7 apps
- Apps in this category focus on tracking mental health metrics (e.g., mood, sleep, stress levels) and offering self-help tools such as journaling, cognitive-behavioral therapy (CBT) exercises, and relaxation techniques.
- Support Communities and Peer Support: 5 apps
- These apps provide platforms for users to connect with others who share similar experiences, offering peer support through discussion forums, group chats, or virtual communities.
- Mental Health Education and Awareness: 5 apps

- These apps focus on educating users about mental health, offering information, resources, and training to raise awareness and improve understanding of mental health issues.
- Crisis Management and Suicide Prevention: 5 apps
- These apps provide immediate support during a mental health crisis, including suicide prevention hotlines, crisis intervention services, and emergency contact options.
- Corporate Wellness and Employee Assistance Programs (EAPs): 4 apps
- Apps in this category are aimed at improving the mental well-being of employees in organizations, offering services like stress management, mental health workshops, and counselling services.
- Other Notable Apps: 3 apps
- The high heterogeneity and use of custom criteria to assess mental health apps in terms of usability, user satisfaction, acceptability or feasibility present a challenge for understanding real world low uptake of these apps. This discrepancy between every study claiming high user engagement indicators suggests a need for the field to focus on engagement through the creation of reporting standards and more careful consideration of claims.

Conclusion

By bringing all mental health services under the same app, users can easily access various tools and resources without the need to juggle multiple platforms. This can include therapy sessions, mood tracking, meditation guides, cognitive-behavioral tools, community support, and educational resources. By integrating these calming colors into your app design, you're creating an environment that feels welcoming and supportive. It encourages users to engage with the content while also helping reduce any potential anxiety they may experience when using mental health services. Centralizing services allows for better personalization, where users can be guided to the tools that best fit their needs. This might include recommendations based on their emotional state, progress in therapy, or engagement with certain types of content. By giving users personalized suggestions or reminders, you're encouraging continued engagement and long-term use. Offering all services in one place also creates a sense of reliability. Users know they can come to the app for all their mental health needs, which builds trust and encourages ongoing usage. If the app provides consistent, high-quality support, it will be seen as a valuable resource, increasing user loyalty.

References

Bakker, D., Kazantzis, N., Rickwood, D., & Rickard, a. N. (2016, March 1).
Mental Health Smartphone Apps: Review and Evidence-Based Recommendations for Future Developments. (G. Eysenbach, Ed.) Journal of International Medical Research – Mental Health, 3 (1)(7). doi:10.2196/mental.4984

Garritty C, El Emam K: Who's using PDAs? Estimates of PDA use by health care providers: a systematic review of surveys. Journal of medical Internet research 2006, 8:e7.

rtphone adoption rate to reach 81% in 2012. 2012 [http:// manhattanresearch.com/News-and-Events/Press-Releases/physician-smartphones-2012].

Arpentier G, Benhamou P-Y, Dardari D, Clergeot A, Franc S, Schaepelynck-Belicar P, Catargi B, Melki V, Chaillous L, Farret A, Bosson J-L, Penfornis A:
The Diabeo Software Enabling Individualized Insulin Dose Adjustments

Combined With Telemedicine Support Improves HbA1c in Poorly
Controlled Type 1 Diabetic Patients: A 6-month, randomized, open-label, parallel-group, multicenter trial (TeleDiab 1 Study). Diabetes Care 2011,
34:533–539

Wang K, Varma DS, Prosperi M. A systematic review of the effectiveness of mobile apps for monitoring and management of mental health symptoms or disorders. J Psychiatr Res. 2018 Dec;107:73–8.

Liu Y, Weiss B, Karr C, et al. Potential and Pitfalls of Mobile Mental Health Apps in Traditional Healthcare Settings: A Systematic Review. J Med Internet Res. 2022 Jan 10;24(1):e274.

Cole-Lewis H: Text messaging as a tool for behavior change in disease prevention and management. Epidemiologic reviews 2010, 32:56–69.

Moher D, Liberati A, Tetzlaff J, Altman DG: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ
(Clinical research ed.) 2009, 339:b253

Lindquist AM, Johansson PE, Petersson GI, Saveman BI, Nilsson GC: The use of the Personal Digital Assistant (PDA) among personnel and students in health care: a review. Journal of medical Internet research 2008, 10:e31.

Phua J, Lim TK: How residents and interns utilise and perceive the personal digital assistant and UpToDate. BMC medical education 2008, 8:39

The role of color psychology in mobile app design" by MoldStud (2024): This piece discusses how color choices in mobile apps can affect user behavior, highlighting the emotional and perceptual impacts of various colors

AI-DRIVEN INNOVATIONS IN HEALTHCARE FINANCING: A CONCEPTUAL EXPLORATION

Mrs R M Nandhini [1]

[1] Research Scholar, PSG College of Arts & Science, Coimbatore

Abstract

Healthcare financing plays a critical role in ensuring the availability, accessibility, and affordability of health services. In many developing nations, traditional financing mechanisms such as taxation, insurance, and donor funding are often constrained by inefficiencies, fragmented systems, and rising healthcare demands. The emergence of Artificial Intelligence (AI) provides a transformative opportunity to modernize financing structures. The study also aims to develop a conceptual model that outlines the dynamic interaction between stakeholders (governments, insurers, providers, patients) and AI-enabled systems. Using a qualitative methodology based on secondary data and literature review, the study provides insights into the benefits and challenges of AI in health financing. Findings suggest that while AI offers great potential for improving financial sustainability and access, issues like data quality, bias, and regulatory gaps must be addressed. The paper offers suggestions for ethical AI use and policy support, contributing to the evolving discourse on digital health innovation.

Key Words: Healthcare financing, Artificial Intelligence, Digital health, Innovation

Introduction

Healthcare financing involves mobilizing, accumulating, and allocating financial resources to ensure that individuals and populations can access healthcare services. It is a crucial component of any healthcare system, as it ensures that healthcare providers receive payment for their services, essential medicines and technologies are available, and people can receive care without experiencing financial hardship.

Healthcare financing is the process of raising and allocating funds to cover healthcare needs. It's a key part of health systems and can help achieve universal health coverage.

Definitions of health care financing

According to the National Health Systems Resource Centre (NHSRC), India

Health Care Financing deals with the generation, allocation and use of financial resources in the health system. Globally, it has become increasingly recognized as an area of major policy relevance to achieve Universal Health Coverage (UHC).

Understanding the country's healthcare financing system allows us to recognize current finances available for health and ways to raise more funds, allocating them in a way to ensure equity and quality healthcare for everyone. It also helps to understand mechanisms to efficiently and equitably allocate, purchase, and spend finances to improve access to health services and reduce out-of-pocket expenditures that lead to catastrophe and impoverishment.

An Overview of Healthcare Financing Systems

Healthcare financing refers to the mechanisms through which financial resources are generated, allocated, and utilized to provide healthcare services to the population. The primary objective of healthcare financing is to ensure that adequate funds are available to support equitable access to quality health services, protect individuals from financial hardship, and promote efficient utilization of resources.

Globally, healthcare financing systems can be broadly classified into public financing, private financing, and external donor funding. Public financing is typically mobilized through taxation or social health insurance contributions and is managed by government agencies. Private financing includes out-of-pocket expenditures, private health insurance, and employer-based contributions. Although less prevalent in high-income countries, external donor funding remains critical in low- and middle-income nations.

Each country adopts a unique mix of these financing models depending on its socio-economic structure, political priorities, and health needs. Effective healthcare financing systems are characterized by risk pooling, strategic purchasing, equitable access, and sustainability.

How Healthcare Financing Systems Operate

Healthcare financing systems operate through a structured process that involves three key functions: resource generation, pooling of funds, and purchasing or allocation of resources.

Resource Generation:

This is the first step in financing, where funds are collected through various means such as taxes, insurance premiums, or donor contributions. Governments may levy specific health-related taxes or general taxes to fund national health programs.

Pooling of Funds:

Collected resources are then pooled to spread financial risks across the population. Pooling enables healthcare systems to offer financial protection and equity in access. Larger and more inclusive pools are generally more efficient and sustainable.

Purchasing of Services:

The pooled funds are then used to procure or reimburse health services. Strategic purchasing ensures that resources are allocated to the most cost-effective interventions and to providers who deliver high-quality care.

The operation of healthcare financing also involves regulatory frameworks, pricing mechanisms, incentive structures, and performance monitoring. Innovations such as Artificial Intelligence (AI) are now being integrated into financing systems to enhance decision-making, detect fraud, forecast expenditures, and optimize resource allocation.This study explores these dynamics through a conceptual model that illustrates how AI acts as an enabler across the core components of healthcare financing, offering new avenues for policy innovation and digital transformation.

The Current Landscape of Health Care Financing

The financing of health care is a pivotal concern for governments, organizations, and individuals alike. With escalating costs and varying access to services, there exists an urgent need to explore innovative strategies that enhance efficiency and efficacy within health care systems. One of the most promising advancements in this realm is the integration of artificial intelligence (AI) into health care financing. To understand the potential of AI in health care financing, it is essential to first grasp the existing challenges within the system. Traditional health care financing often involves complex processes, including billing, reimbursement, and claims management, which can be both time-consuming and prone to errors. These complexities contribute to increased administrative costs and inefficiencies that ultimately affect patient care. Furthermore, disparities in health care access often emerge due to

variances in funding structures, leading to unequal health outcomes across different demographics.

The Role of Artificial Intelligence in Healthcare Financing

AI encompasses a range of technologies that enable machines to perform tasks that typically require human intelligence, including problem-solving, pattern recognition, and data analysis. In the context of healthcare financing, AI can be utilized to optimize resource allocation, predict funding needs, and reduce administrative burdens.

Literature Review

In healthcare, AI has already made significant contributions to diagnostics, personalized medicine, and public health surveillance **(Topol, 2019; Rajkomar et al., 2019).**AI algorithms can predict the cost of care based on patient demographics and clinical history, enabling more accurate premium pricing and budgeting **(Obermeyer & Emanuel, 2016).**AI supports real-time fund allocation based on population health trends, utilization rates, and risk profiles **(He et al., 2021)**. AI can personalize payment plans, send financial alerts, and promote early intervention to reduce long-term costs **(Jiang et al., 2017).**Provides evidence-based recommendations for establishing and improving health financing systems based on AI applications to ensure that vulnerable groups face minimum challenges and benefit from improved health financing.**(Ramezani, M., *et al.*,2023).** The strategic importance of investing in AI technologies, not only for improving operational efficiency but also for aligning with global imperatives such as Sustainable Development Goal 3 (SDG 3), which focuses on ensuring healthy lives and promoting well-being for all at all ages. **(Bhatnagar, M., &Sehajpal, S. 2024).**

Research Objective

To identify the role of Artificial Intelligence in strengthening healthcare financing mechanisms.

To analyze the transformative potential of Artificial Intelligence (AI) in redefining traditional healthcare financing systems toward greater efficiency, responsiveness, and patient-centeredness.

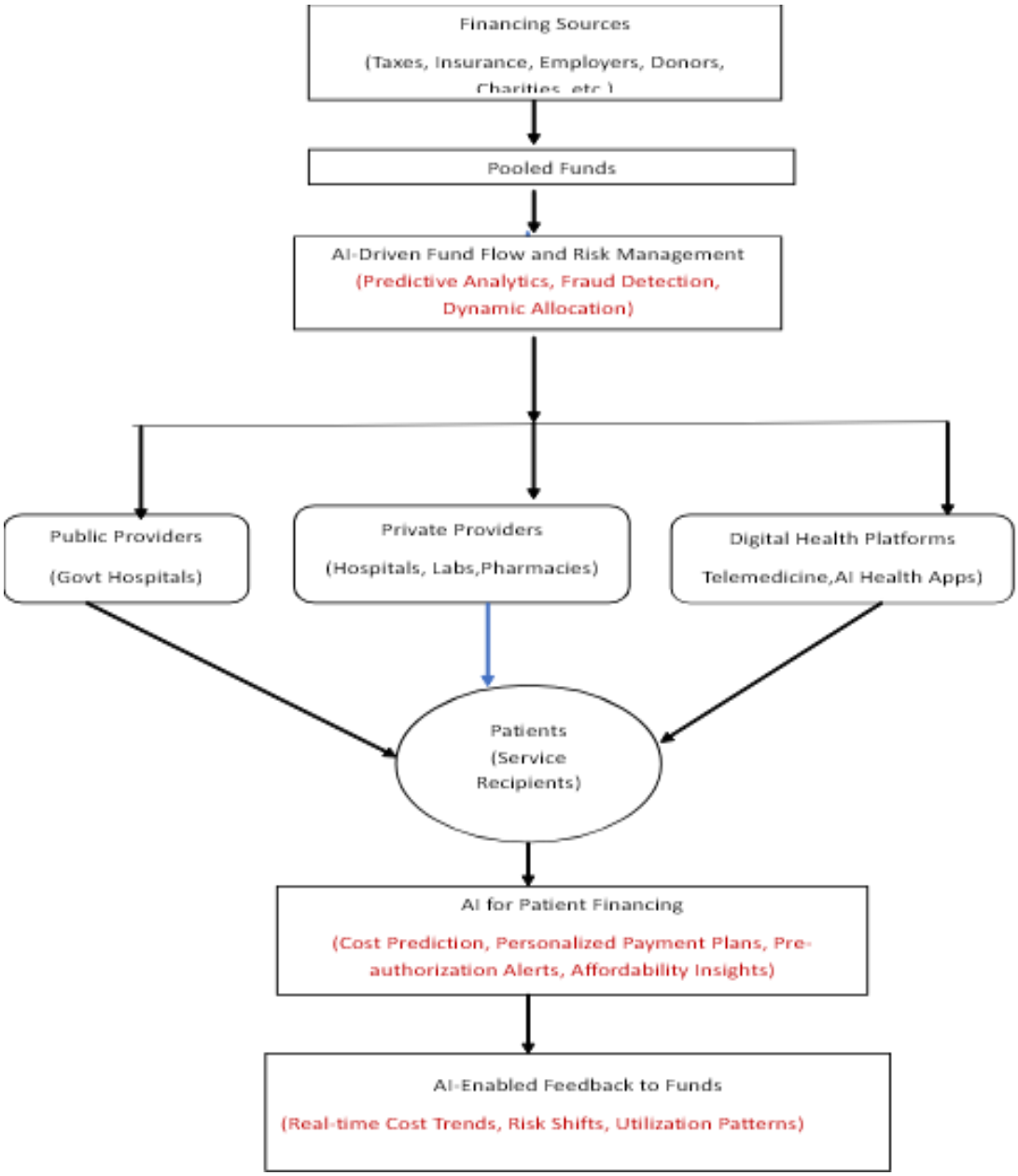
Methodology

This study adopts a conceptual and qualitative research design to explore the structure and evolution of healthcare financing systems, with a particular focus on the integration of Artificial Intelligence (AI) in financing mechanisms. The methodology encompasses a literature-based approach, supported by thematic analysis and the development of a conceptual model.

Conceptual Model

The conceptual model developed in this study provides a comprehensive framework for understanding the integration of Artificial Intelligence (AI) into healthcare financing systems. It illustrates how AI can influence each stage of the financial flow—from the initial collection of funds to the final delivery of healthcare services. By mapping out the key stakeholders, such as government bodies, insurance providers, health service institutions, and patients, the model demonstrates the interconnected nature of modern healthcare financing and how AI can enhance decision-making, efficiency, and equity throughout the process. It is based on insights from contemporary literature on artificial intelligence in healthcare financing (Obermeyer & Emanuel, 2016; He et al., 2021; Jiang et al., 2017). The model aims

to bridge conventional public health financing mechanisms with emerging AI technologies for predictive analytics, fraud detection, and personalized financial planning



Source : opol, 2019; Rajkomar et al., 2019; He et al., 2021

Components of the Model

The model highlights six key components or stakeholders, each playing a distinct and vital role:

Government Taxes (Public Funding):

Governments collect taxes from citizens and businesses. A portion of these tax revenues is earmarked for health care financing. In many countries, public funding constitutes the backbone of health systems, especially for primary and preventive care.

Insurance Premiums (Private and Social Insurance Contributions):

Individuals and employers contribute to health insurance schemes, either voluntary (private insurance) or mandatory (social health insurance). These premiums create another stream of health care financing, particularly for specialized services, hospitalization, and

expensive treatments. Insurance companies act as intermediaries, collecting these premiums and channelling them into health care services.

Pooled Health Funds:

All collected funds, whether from government taxes or insurance premiums, are pooled into a common fund. Pooling serves the purpose of risk-sharing, ensuring that resources are available when needed, regardless of an individual's ability to pay at the time of illness. This fund forms the financial base from which providers are paid and services are financed.

Purchasing and Payor System:

This component represents the mechanisms that allocate pooled funds to health care providers. In public systems, government agencies act as the primary purchasers, paying public hospitals directly. In mixed systems, insurance companies or health maintenance organizations (HMOs) function as purchasers, reimbursing both public and private providers based on contracts or service delivery.

Health Service Providers (Public and Private):

Providers include public hospitals, primary health centers, private clinics, diagnostic labs, pharmacies, and specialists. Providers deliver health services to patients and receive payment through various mechanisms such as capitation, fee-for-service, or bundled payments.The quality, accessibility, and efficiency of these providers directly influence health outcomes.

Patients:

Patients are at the center of the model. They receive health care services either directly financed by government/public funds or through insurance mechanisms. In some cases, patients still bear some level of out-of-pocket expenses, especially for services not covered by public or insurance schemes.

Explanation of the model and the role of AI

Financing Sources:

This is the **origin of health financing**. Funds are collected from diverse sources, including:

Taxes (Government health budgets)

Health Insurance Premiums (Paid by individuals and employers)

Employer Contributions (Employer-sponsored health insurance)

Donor Aid (International agencies, NGOs)

Charitable Contributions (Foundations, philanthropists)

AI can forecast expected revenue flows by analyzing historical contribution patterns, economic conditions, employment data, and population health trends, providing more accurate predictions of future financial needs in healthcare systems. Additionally, AI can simulate various financing scenarios, such as economic downturns or pandemics, to help policymakers and insurers develop contingency plans. By considering potential risks and changes in external factors, AI enables proactive financial management, ensuring that healthcare systems can adapt to unforeseen challenges and maintain financial stability.

Pooled Health Funds:

All collected funds from the sources above are pooled into a central fund. This pool is used to pay for healthcare services when needed by patients. AI plays a crucial role in

optimizing fund allocation across various healthcare service providers, including public, private, and digital platforms. By analyzing data on provider performance, patient demand, and treatment outcomes, AI ensures that funds are distributed efficiently, prioritizing areas of greatest need. Additionally, AI monitors real-time fund depletion rates and detects potential fraudulent claims through pattern recognition. It also recommends optimal reserves management strategies to maintain financial sustainability, ensuring that funds are available for future healthcare needs while minimizing waste and inefficiencies.

AI-Driven Fund Flow & Risk Management:

This is the core intelligence layer, where AI actively manages the movement of funds to healthcare providers and monitors financial risks. AI enhances healthcare financing by leveraging predictive analytics, fraud detection, and dynamic fund allocation. Predictive analytics forecasts future healthcare costs by analyzing patient demographics, disease burden, and healthcare inflation, enabling better financial planning. Fraud detection uses pattern recognition and anomaly detection to identify suspicious claims or unusual billing practices, ensuring the integrity of the system. Dynamic allocation allows for real-time adjustments in fund disbursement, based on factors such as disease outbreaks, seasonal illness trends, or emerging health crises, ensuring resources are efficiently distributed where they are most needed.

Service Providers (Public, Private, Digital):

Healthcare services are delivered through three primary channels:

Public Providers: Government hospitals, public health clinics.

Private Providers: Private hospitals, diagnostic labs, pharmacies, specialized clinics.

Digital Health Platforms: Telemedicine apps, AI-powered health assistants, wearable device integration.

AI plays a crucial role in optimizing healthcare financing and service delivery. It analyzes provider performance by assessing factors such as cost efficiency, patient satisfaction, and treatment outcomes, which influences future fund allocation. Additionally, AI enhances digital health platforms by integrating patient data, aiding in remote diagnostics, and optimizing teleconsultation triage. Furthermore, AI can match patients with the most suitable providers based on criteria such as cost-effectiveness, proximity, and clinical specialization, ensuring that patients receive the best possible care while minimizing costs**.**

Patients (Service Recipients):

Patients are the ultimate recipients of healthcare services. They access services from the public, private, and digital health ecosystem. AI plays a pivotal role in empowering patients with clear insights into healthcare financing. It helps individuals understand their financing options, estimate out-of-pocket expenses, and compare providers based on cost-effectiveness and service quality. AI-powered chatbots and virtual financial counselors provide personalized guidance on insurance coverage, eligibility for subsidies or financial aid, and suggest affordable care providers. Furthermore, AI can forecast the long-term costs of managing chronic diseases, enabling both patients and insurers to make informed, proactive financial plans for sustainable care management.

AI for Patient Financing:

This layer focuses on how AI helps patients finance their care in a personalized way. It focuses on leveraging artificial intelligence to help patients manage healthcare expenses in a personalized and efficient manner. AI tools predict total treatment costs by analyzing diagnoses, provider pricing, and local trends. They also generate customized payment plans based on individual financial profiles, including income and credit history. AI systems provide timely pre-authorization alerts for procedures requiring insurer approval and suggest alternative treatments that might bypass such requirements. Additionally, AI offers affordability insights by recommending cost-effective options such as generic medicines and budget-friendly diagnostics, ultimately enhancing access and financial transparency for patients.

AI-Enabled Feedback to Funds:

The feedback loop ensures that the financing system continuously learns and adapts. AI-Enabled Feedback to Funds serves as a critical feedback loop that allows healthcare financing systems to continuously learn and adapt. Through real-time tracking of treatment costs, AI helps adjust reimbursement rates to reflect actual expenditures. It also analyzes disease patterns, social trends, and environmental changes to predict emerging health risks. Additionally, AI monitors utilization patterns to identify overuse of certain procedures or underuse of essential services like preventive care. This dynamic feedback enables smarter, data-driven decision-making for fund allocation and policy adjustments.

Challenges of Using AI in Health Care Financing

Data Quality and Integration Issues:

AI relies heavily on accurate, comprehensive, and real-time data to generate meaningful insights. In health care financing, data is fragmented across public insurance systems, private insurers, hospital billing systems, and government databases. Inconsistent data formats, missing data points, and outdated records can compromise AI predictions and decisions.

Bias and Fairness Concerns:

AI models trained on historical health financing data may inherit systemic biases, such as discrimination based on socioeconomic status, gender, or ethnicity. This can lead to inequitable allocation of funds, biased risk assessments, and unfair premium calculations, reinforcing existing health disparities.

Privacy and Data Security Risks:

Health financing involves sensitive financial and medical data, which must be protected under regulations like HIPAA (in the US) or GDPR (in Europe). AI systems processing vast volumes of this data are attractive targets for cyberattacks, and breaches can erode public trust. Ensuring compliance with strict data protection laws while enabling effective AI training is a complex balancing act.

Transparency and Explainability:

Many AI models, especially those using deep learning, operate as "black boxes," making it difficult for stakeholders to understand how decisions are made.

In health care financing, this lack of explainability raises ethical and legal questions, especially if a patient's claim is denied or if premiums are adjusted based on opaque AI predictions.

Regulatory and Legal Uncertainty:

The regulatory landscape for AI in health care financing is still evolving. Existing health finance regulations were designed for human decision-making processes and may not account for AI-driven automation and decision-making. This regulatory gap creates uncertainty for insurers, providers, and policymakers, slowing AI adoption.

High Implementation Costs:

Deploying AI systems for health financing requires significant investments in infrastructure, talent, and continuous model training. For low- and middle-income countries, these upfront costs may be prohibitive, limiting equitable access to AI-driven financing improvements.

Resistance to Change:

Health financing organizations (insurers, public health agencies, etc.) often have established workflows and legacy IT systems. Integrating AI into these systems requires not only technical upgrades but also cultural change, convincing stakeholders to trust and adopt AI-generated insights.

Ethical Dilemmas:

AI-driven cost predictions may recommend denying expensive treatments to high-risk patients, raising ethical questions about balancing financial sustainability with patient rights and access to care. Decisions purely driven by cost optimization may conflict with core healthcare principles like equity and compassion.

Discussion

This study sheds light on the evolving role of Artificial Intelligence (AI) in healthcare financing, with a particular focus on how AI can optimize resource allocation. It supports real-time decision-making on fund distribution based on patient demand, AI tools predict total treatment costs, create custom payment plans based on a patient's income and credit score, and suggest more affordable alternatives for medications or treatments (Jiang et al., 2017). seasonal health trends, and emerging health crises (He et al., 2021). Enhance cost prediction and ensure equitable distribution of funds. The integration of AI into healthcare financing offers a transformative opportunity for both public and private sectors to streamline operations and improve financial sustainability. The findings of this study demonstrate that AI has the potential to revolutionize healthcare financing by improving efficiency, cost-effectiveness, and equity. However, successful integration of AI into these systems will require careful attention to data quality, ethical concerns. This creates uncertainty for policymakers, insurers, and providers regarding the legal and ethical implications of AI adoption (Topol, 2019) and regulatory frameworks. As AI continues to evolve, its role in healthcare financing is likely to expand, offering more personalized, efficient, and equitable solutions for patients and healthcare systems alike.

Conclusion

This study provides a conceptual exploration of how Artificial Intelligence (AI) is reshaping healthcare financing systems, enhancing efficiency, equity, and sustainability. Traditional healthcare financing mechanisms have long been challenged by issues such as administrative inefficiencies, cost escalation, and unequal access. With the integration of AI, a transformative shift is taking place, introducing data-driven decision-making, predictive modeling, real-time fund allocation, and personalized patient financial guidance. The

conceptual model developed in this study demonstrates how AI operates at multiple levels of the healthcare financing ecosystem. It influences revenue forecasting, optimizes risk pooling and fund allocation, enhances fraud detection, and empowers both providers and patients through smart tools and insights. The incorporation of AI in strategic purchasing and real-time system feedback loops ensures dynamic adaptability, especially in times of crisis such as pandemics or economic downturns. This study highlights the transformative potential of Artificial Intelligence in healthcare financing. AI improves efficiency, transparency, and equity by enabling predictive cost analysis, dynamic fund allocation, fraud detection, and personalized financial guidance. It supports data-driven decisions that enhance both patient experience and system sustainability. However, challenges such as data privacy, algorithmic bias, and implementation costs must be addressed. Overall, AI is emerging as a strategic tool to modernize healthcare financing and support the move toward Universal Health Coverage.In conclusion, AI is not merely a technological tool but a strategic enabler of sustainable and inclusive health financing. It holds the promise to close existing gaps, anticipate future needs, and create resilient healthcare systems responsive to the complexities of both patient care and fiscal management.

References

Bhatnagar, M., &Sehajpal, S. (2024). Leveraging AI for Financial Sustainability in Healthcare. *Advances in E-Business Research Series*, 411–426. https://doi.org/10.4018/979-8-3693-9699-5.ch017

He, L., et al. (2021). AI and healthcare financing: Improving the efficiency and equity of resource allocation. *Journal of Health Economics*, 75, 103-112.

Jiang, M., et al. (2017). AI in healthcare financing: Personalized payment plans and cost prediction. *Healthcare Management Review*, 42(3), 245-258.

Jiang, F., Jiang, Y., Zhi, H., et al. (2017). Artificial intelligence in healthcare: past, present and future. *Stroke and Vascular Neurology*, 2(4), 230–243.

Joudaki, H., Rashidian, A., Minaei-Bidgoli, B., Mahmoodi, M., Geraili, B., Nasiri, M., & Arab, M. (2015). Using data mining to detect health care fraud and abuse: A review of literature. *Global Journal of Health Science*, 7(1), 194.

Khan, N., Rehman, A., Jabeen, R., Siraj, M., Ahmed, I., & Iftikhar, A. (2024). The Intersection of AI in Finance and Healthcare. *Advances in Healthcare Information Systems and Administration Book Series*, 301–312. https://doi.org/10.4018/979-8-3693-6577-9.ch016

CHANGING LEADERSHIP IN THE DIGITAL AGE OF HEALTHCARE

Ms N Tejashwini[1] , Ms P Sindhu[2]

[1,2] Student, Department of Commerce PA,KG College of Arts and Science, Coimbatore

Abstract

Changing in Leadership in the Digital Age in the Healthcare industry evolving due to the rapid advancement of Digital Technologies. Leadership in Digital health service to offer high quality patience care. The Digital Age requires leader to be tech-savvy, flexible and innovative in the technology changes and human aspect of healthcare. WHO has implemented in digital system to health care service in order to achieve sustainable development goals. The Healthcare leader in order to perform in the Digital Healthcare service in the Digital World. Ensuring the Digital health practices comply with privacy laws like HIPPA in the U.S. In the present challenges, it opens many opportunities for improving fostering innovation, operational efficiency and patience care. The Challenges includes the integration of tools like Electronic Health Records (EHR), telemedicine, Artificial Intelligence, Big Data Analytics. The main aim to change the environment digitally. The Transformational Leadership theory was identified as the starting point for 'NEW-GENRE LEADERSHIP' models. To a clear vision for integrating digital technologies in leadership in the healthcare. The Leadership in the Digital age of Healthcare is not just about adopting new technology but also about reshaping system, patience and professionals.

Key words: Leadership, Technology Integration, Healthcare Efficiency, Change Management, Data Analytics, Cybersecurity, Telemedicine.

Introduction

The digital age has transformed nearly every sector, with healthcare being no exception. As technology continues to advance rapidly, healthcare leaders face the complex challenge of integrating new digital tools, systems, and strategies while maintaining high standards of patient care. The main aim of challenging leadership in the digital age of healthcare is to navigate and drive successful digital transformation within healthcare organizations while maintaining or improving patient care quality, operational efficiency, and staff engagement. Leaders must guide their teams through the integration of emerging technologies, such as AI, telemedicine, and electronic health records, while ensuring these innovations align with the organization's mission, values, and the needs of patients. The transition to these technologies is not without its obstacles. Healthcare leaders must navigate issues such as data security and privacy concerns, the training and adaptation of staff to new technologies, and the balancing act between technology-driven efficiency and human-centered care. The vision of challenging leadership in the digital age of healthcare is to create a healthcare environment where innovative digital technologies and compassionate, patient-centered care work seamlessly together to improve health outcomes, enhance the patient experience, and optimize operational efficiency.

Technological Innovation and Healthcare Transformation:

Technological innovation is central to the transformation of healthcare, and leadership plays a critical role in driving successful adoption and integration of these technologies. Effective leadership will determine how well healthcare organizations adapt to the digital age,

ultimately shaping the future of patient care, operational efficiency, and the healthcare experience.

Technological Innovation	Description	Impact on Healthcare	Key Leadership Actions
Electronic Health Records (EHR)	Digital version of patients' paper charts; centralizes health data.	- Improves patient care coordination. - Reduces medical errors. - Enhances accessibility and data sharing among providers.	-Lead the adoption and implementation of EHR systems. -Ensure staff training and system integration. -Monitor data security and compliance.
Telemedicine and Telehealth	Remote diagnosis, treatment, and consultation via video or phone.	- - Increases access to healthcare for rural and underserved populations. - Reduces in-person visits, lowering costs. - Supports continuity of care during emergencies (e.g., COVID-19).	-Establish telemedicine infrastructure. - Overcome regulatory and reimbursement barriers. - Ensure privacy and security compliance.

Technological Innovation	Description	Impact on Healthcare	Key Leadership Actions
Artificial Intelligence (AI) & Machine Learning (ML)	AI systems that analyse data to assist in diagnostics and decision-making.	- Enhances diagnostic accuracy and treatment planning. -Improves clinical decision support. -Reduces human error.	- Implement AI-driven tools for diagnostics and operations. - Train staff to use AI tools effectively. - Ensure ethical use and transparency in decision-making.
Blockchain in Healthcare	Distributed ledger technology for secure and transparent data sharing.	- Ensures secure and transparent sharing of patient data. - Reduces fraud and improves data accuracy. -Enhances interoperability between different systems.	- Implement blockchain solutions for secure health data exchange. - Address legal and regulatory considerations. - Foster collaboration among stakeholders for blockchain adoption.

Methodology

The methodology for exploring challenging leadership in the digital age of healthcare will involve a combination of qualitative and quantitative research approaches to gain a comprehensive understanding of the challenges faced by healthcare leaders, how they manage digital transformation, and the impact of technological innovations on healthcare systems. Below is a detailed outline of the research methodology.

I Qualitative Method

In-Depth Interviews:

Target participants: Healthcare leaders such as hospital administrators, medical directors, IT specialists, and department heads who have been involved in leading digital healthcare initiatives.

Interview focus: Understanding the specific challenges these leaders face when integrating digital technologies, strategies employed, leadership styles, and their experiences in managing digital transformation in healthcare.

Data analysis: Thematic analysis to identify recurring themes and insights related to leadership, technology adoption, and challenges in the digital healthcare landscape.

Case Studies:

Investigate real-world examples of healthcare organizations that have successfully or unsuccessfully implemented digital technologies.

Case study focus: Examining leadership strategies, organizational changes, and the outcomes of technological integration.

Data analysis: Comparative analysis of successful and unsuccessful cases to derive insights on best practices in leadership.

II Quantitative Methods

Surveys:

Target participants: Healthcare professionals, including physicians, nurses, and administrative staff, who are affected by digital transformation in healthcare.

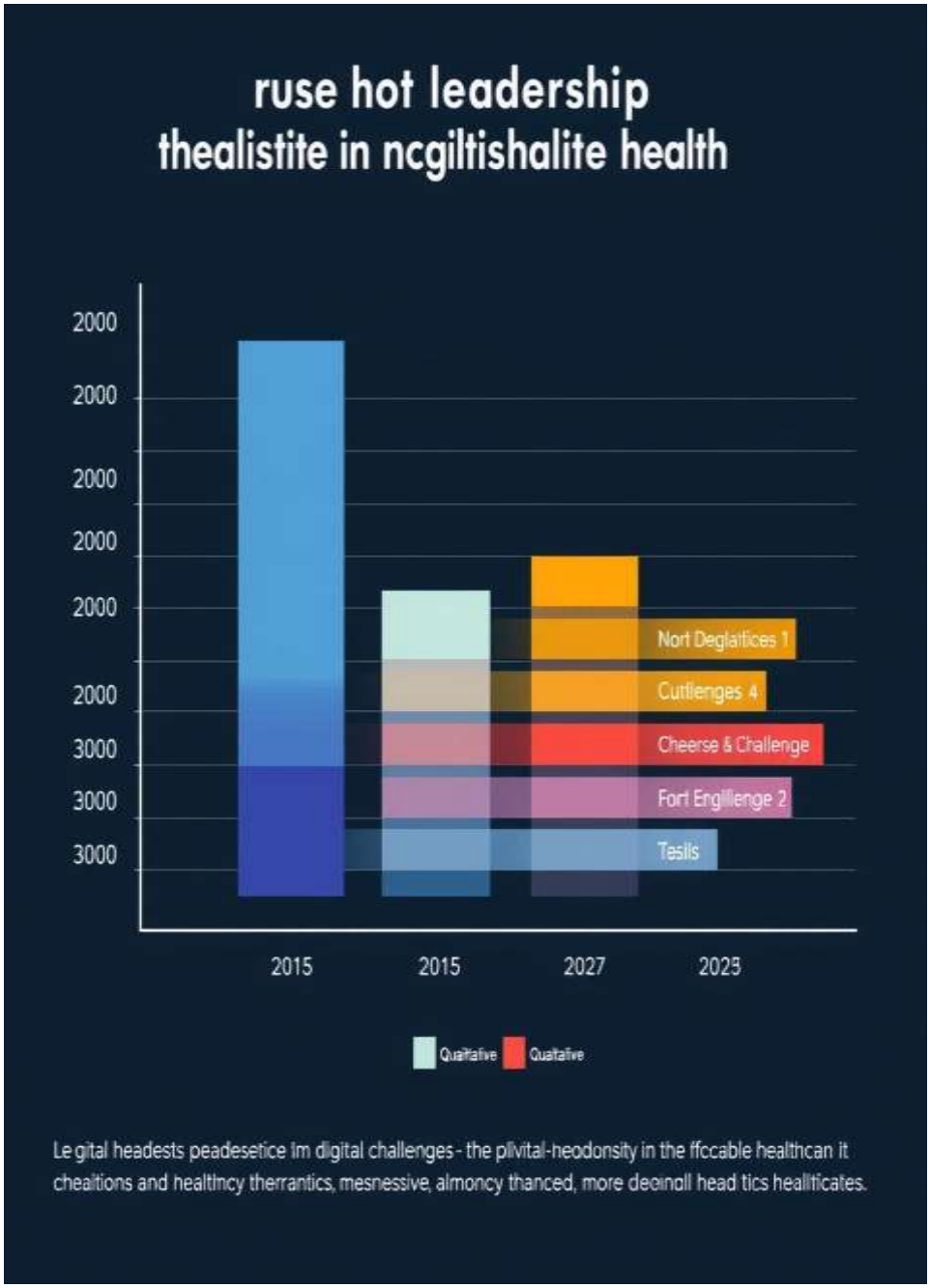
Survey focus: Attitudes towards digital tools, perceived leadership effectiveness in managing change, and the impact of digital technologies on patient care and operational efficiency.

Data analysis: Statistical techniques (e.g., regression analysis, factor analysis) to quantify relationships between leadership practices, digital adoption, and organizational outcomes.

Questionnaires:

Distributed to healthcare leaders to assess their leadership competencies and readiness to manage digital change.

Data analysis: Statistical analysis of responses to identify trends and patterns in leadership practices.



Research Focusing Areas

Leadership Competencies and Digital Fluency

- Identifying the specific competencies that healthcare leaders need to navigate the digital landscape effectively.
- Investigating how leaders can integrate digital literacy with traditional leadership skills in healthcare environments.
- Exploring the development of digital leadership training programs for healthcare environment.

Impact of Digital Technologies on Leadership Styles

- Examining how the adoption of digital tools (like AI, Electronic Health Records (EHRs), telemedicine) alters traditional leadership styles.
- Understanding the shift from top-down management to collaborative leadership in digital healthcare settings.
- Exploring the role of data-driven decision-making and how it reshapes leadership behaviour and management practices.

Digital Transformation and Organizational Culture

- Investigating how digital transformation influences the organizational culture of healthcare systems.
- Exploring how leadership can foster a culture of innovation and adaptability in a digital healthcare environment.
- Understanding the challenges of changing healthcare organizations' culture to embrace digital technologies.

Ethical Challenges and Leadership in Digital Healthcare

- Exploring the ethical dilemmas healthcare leaders face when implementing and managing digital technologies (e.g., AI, predictive analytics, patient data security).
- Investigating how leaders ensure patient privacy and data security in the age of digital healthcare.
- Analysing the ethical implications of using digital tools for decision-making, including AI-driven diagnostics and machine learning.

Managing Resistance to Change in Digital Healthcare

- Studying the psychological and organizational factors that contribute to resistance to digital change among healthcare professionals.
- Investigating how leadership can effectively manage resistance to new technologies and systems.
- Exploring strategies for fostering buy-in from staff and engaging stakeholders in the digital transformation process.

Digital Leadership in Remote Healthcare (Telemedicine and Virtual Care)

- Investigating the leadership challenges and strategies in telemedicine and virtual care environments.
- Exploring how leaders manage remote healthcare teams and ensure high-quality patient care through digital platforms.
- Analysing the effectiveness of leadership in delivering care remotely and managing virtual healthcare settings.

Financial and Resource Management for Digital Health Initiatives

Focus:

- Investigating the financial challenges healthcare leaders face when implementing digital health solutions, such as EHRs, telemedicine, or AI systems.
- Exploring strategies for resource allocation and funding to support digital transformation in healthcare organization.
- Studying the long-term effects of digital leadership on healthcare outcomes such as patient care quality, efficiency, and cost-effectiveness.
- Investigating how leadership in the digital healthcare context contributes to the sustainability of digital health initiatives and innovations.

Challenges and Solutions in Leadership of Healthcare

Resistance to Change and Adoption of New Technologies:

Healthcare organizations often face resistance from both staff and patients when implementing new digital tools and technologies. Many healthcare professionals may be resistant due to a lack of familiarity with digital systems, fear of job displacement, or concerns over technology replacing human interaction.

Impact: Resistance can slow down the digital transformation process and hinder the full integration of digital tools, which can affect patient care and organizational efficiency.

Solution: Leaders must foster a culture of openness, offer adequate training, and clearly communicate the benefits of technology to gain staff and patient buy-in.

Data Security and Privacy Concern:

As healthcare moves towards digital platforms, the risk of cybersecurity breaches and the loss of sensitive patient data becomes a significant concern. Digital health tools like EHRs (Electronic Health Records) and telemedicine generate and store massive amounts of sensitive information, making them prime targets for cyberattacks.

Impact:A data breach can lead to patient privacy violations, loss of trust, and potential legal and financial consequences.

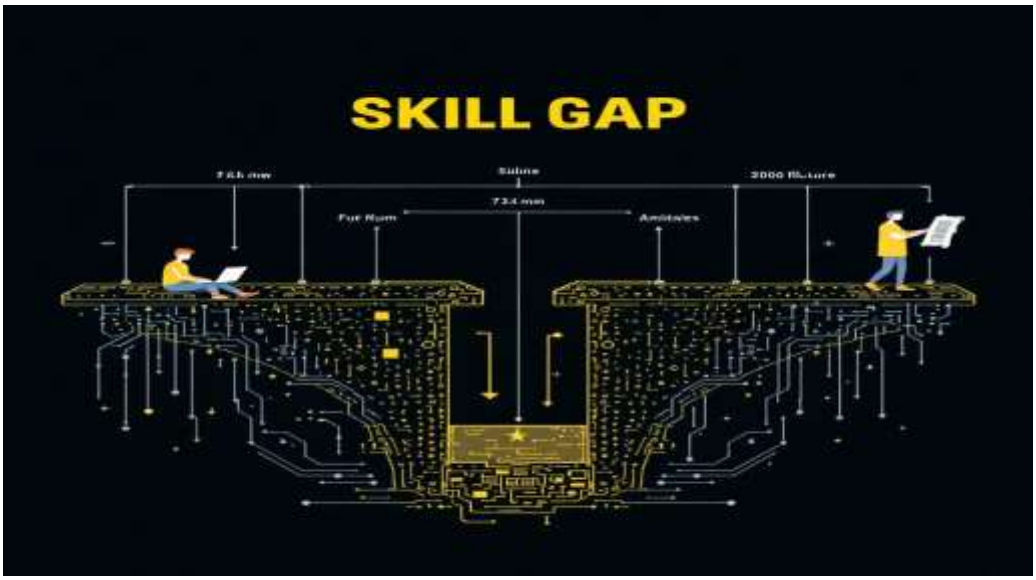
Solution: Leaders must prioritize data security measures, invest in cybersecurity infrastructure, and ensure compliance with regulatory frameworks like HIPAA (Health Insurance Portability and Accountability Act).

Skill Gaps and Digital Fluency:

There is often a significant digital skills gap among healthcare leaders and their teams, particularly in managing new technologies such as AI, machine learning, and big data analytics. Healthcare leaders may lack the necessary technical expertise to fully comprehend and guide the integration of these technologies.

Impact: This gap can lead to ineffective implementation and underutilization of digital health tools, as well as decreased performance in both leadership and clinical decision-making.

Solution: Leaders should invest in digital literacy and training programs for themselves and their staff, to ensure the team is equipped with the skills needed to leverage new technologies effectively.



Financial Constraints and Resource Allocation:

Digital health technologies often require substantial financial investment, including costs for hardware, software, and training. Healthcare organizations, particularly those with limited resources, may struggle to justify these expenditures especially in systems with tight budgets.

Impact: Limited financial resources can slow down or even halt the adoption of essential digital health technologies, affecting the overall transformation of the healthcare system.

Solution: Leaders must develop clear, data-driven business cases to demonstrate the return on investment (ROI) of digital health technologies, and prioritize spending on initiatives that promise the highest value in terms of patient outcomes and organizational efficienc

Ethical and Legal Issues:

The adoption of digital technologies like AI, big data, and genomic medicine raises significant ethical and legal concerns, including data privacy, consent, and the potential for algorithmic bias. Healthcare leaders must ensure that digital health tools are used in an ethical and legal manner, balancing innovation with patient rights.

Impact: Improper use of AI or big data could result in unfair treatment, lack of transparency, or violation of patient consent, which could damage an organization's reputation and lead to legal consequences.

Solution: Leaders must work closely with legal, ethical, and clinical experts to create guidelines and policies that ensure digital health tools are used responsibly and in accordance with the law.

Maintaining Patient-Centered Care Amid Technological Change:

As healthcare becomes increasingly digital, it's critical to ensure that patient-centered care remains at the core of the healthcare delivery model. There's a risk that the introduction of automated systems, AI, and telemedicine could depersonalize patient interactions.

Impact:Patients may feel less connected to their care providers or may struggle with navigating digital systems, leading to frustration and potentially worse health outcomes.

Solution: Leaders must ensure that digital health tools complement, rather than replace, the human element of care. This includes integrating digital tools in ways that enhance communication, ensure accessibility, and prioritize the patient experience.

Ensuring Long-Term Sustainability of Digital Health Initiative:

Many digital health initiatives face challenges related to sustainability, particularly regarding the long-term funding, maintenance, and adaptation of technologies as the needs of the healthcare environment evolve.

Impact: Without a clear strategy for long-term sustainability, digital health tools may become obsolete, unsupported, or underutilized, reducing their effectiveness and value.

Solution: Healthcare leaders must focus on scalability, maintenance plans, and upgrades to ensure that digital health innovations can be sustained over time. This includes establishing partnerships, securing long-term funding, and planning for future technological advancements.

Future of Digital Healthcare

Widespread Adoption of Telemedicine and Remote Care:

The demand for telemedicine and remote patient monitoring will continue to grow, offering more convenient ways for patients to access healthcare. Remote consultations, follow-ups, and diagnostic services are becoming standard, especially in rural or under-served areas where healthcare access is limited. AI-driven telemedicine platforms will evolve to offer personalized and more accurate consultations. Virtual health assistants will become commonplace, using natural language processing and AI to assist patients and healthcare providers. Enhanced remote monitoring will allow continuous health tracking, including chronic condition management, improving both preventive care and patient outcomes.

AI and Machine Learning in Healthcare:

Artificial Intelligence (AI) and Machine Learning (ML) will play an increasingly pivotal role in enhancing diagnostics, treatment planning, and operational efficiency in healthcare.AI will analyse medical images (e.g., X-rays, MRIs) more efficiently than ever before, aiding in quicker and more accurate diagnoses.Predictive analytics will be used to anticipate disease outbreaks, predict patient outcomes, and identify at-risk individuals for diseases like cancer, diabetes, and cardiovascular issues.Natural language processing (NLP) will help in interpreting patient records, speeding up clinical documentation and enabling more effective decision-making.

Expansion of Personalized and Precision Medicine:

The shift toward personalized medicine, where treatments are tailored to the genetic makeup and lifestyle of individuals, is gaining momentum. The integration of big data, genomics, and biotechnology will make personalized care more accessible.

Advanced genomic sequencing will allow for more targeted therapies and preventive strategies. Biometrics and wearable health tech (like fitness trackers) will continuously provide data for personalized health recommendations.AI-based analysis of genetic and medical data will help create tailored treatment plans for conditions such as cancer, heart disease, and rare genetic disorders.

The Rise of Digital Health Apps and Wearables:

Health and wellness apps, along with wearable devices (e.g., smartwatches, fitnesstrackers), are increasingly empowering individuals to monitor their health, track fitness goals, and manage chronic conditions.

Wearables will monitor an expanding range of vital signs, such as heart rate, oxygen levels, glucose levels, and sleep patterns, allowing patients to manage their conditions in real-time. Mobile health apps will continue to evolve, with enhanced AI-powered features to provide tailored advice, medication reminders, and even direct communication with healthcare professionals. Integration of wearable data with electronic health records (EHRs) will enable healthcare providers to receive real-time updates on their patients' health and make timely interventions.

Blockchain for Healthcare Data Security:

Blockchain technology will become more prominent in ensuring the security, privacy, and integrity of healthcare data. Blockchain’s decentralized nature provides an opportunity to securely store and share patient records without the risk of data breaches.

Blockchain-based systems will allow patients to control their health data, providing access only to approved medical personnel.It will enable secure sharing of medical records across different providers and institutions, improving the continuity of care and reducing administrative inefficiencies.Smart contracts powered by blockchain could automate various processes, such as insurance claims and billing, increasing efficiency and reducing errors.

Virtual Reality (VR) and Augmented Reality (AR) in Healthcare:

Virtual Reality (VR) and Augmented Reality (AR) will revolutionize medical training, patient education, and surgical planning.VR simulations will be used for medical training, allowing healthcare professionals to practice surgeries and procedures in a risk-free environment.AR-assisted surgeries will enhance precision by overlaying critical patient information (e.g., imaging data) directly onto the surgeon's view during procedures. VR will be used to help patients with pain management, particularly in areas like physical rehabilitation and mental health treatment.

Interoperability Across Healthcare Systems:

Interoperability will become a priority, allowing different healthcare systems and digital platforms to seamlessly exchange patient information, improving care coordination and efficiency. Cloud-based systems will enable healthcare providers to access patient records from multiple sources, ensuring a comprehensive and up-to-date view of patient health. Standardized health data formats and protocols will allow global healthcare systems to communicate, sharing critical health information during emergencies like pandemics or natural disasters.AI and machine learning tools will be used to bridge data silos, helping to create a unified health information ecosystem.

Conclusion

In the digital age of healthcare, effective leadership will also require a commitment to ethical principles and regulatory compliance to mitigate risks associated with new technologies, ensuring that they are used responsibly and equitably. The future of leadership in digital healthcare will be defined by the ability to embrace change, maintain resilience, and drive innovation. The challenges of leadership in the digital age of healthcare are significant, but they also offer the opportunity for transformative change. By harnessing the power of technology while staying grounded in human-centered values, leaders can pave the way for a

future where healthcare is more efficient, accessible, and personalized, ultimately improving the quality of life for patients worldwide.

References

Ginter, P. M., Duncan, W. J., & Swayne, L. E. (2018)
Braun, M. T., & Johnson, R. W. (2018).
Koch, S., &Stoeckigt, G. (2020).
World Health Organization (WHO). (2016).
McKinsey & Company. (2020). "Digital Health and Healthtech"
Healthcare Information and Management Systems Society (HIMSS). (2020).

LEVERAGING TECHNOLOGY FOR BETTER SLEEP AND MENTAL WELLBEING: A QUANTITATIVE APPROACH

Mr Prawinraj R S [1], Nivedita Subramaniam[2]
[1,2] Student, Department of Hospital Administration
PSG College of Arts and Science, Coimbatore

Abstract

Good mental well-being depends on getting enough decent quality sleep, but bad sleep may aggravate mental well-being concerns, and mental well-being difficulties can cause poor sleep. There is a significant correlation between sleep and health; getting too little sleep can raise your chance of being sick, and being sick might make it more difficult to fall asleep. Common mental well-being issues like despair and anxiety can frequently be the root cause of sleep issues. This is a quantitative study and the data was collected using convenient sampling method of 130 participants between the age group of 18 to 25 years. The participants were assessed using the Pittsburgh Sleep Quality Index by Chol Shin and Psychological Wellbeing Scale by Carol Ryff. The data will be analyzed using the Statistical Package for Social Sciences (SPSS). The additional findings of this study will be presented later in this paper.

Keywords: Sleep quality, digital tools, mental well-being

Introduction

Sleep Quality

Defining Sleep Quality:

Sleep is defined behaviourally as an unconscious state with characteristic supine sleep posture, lack of mobility, closed eyes and increased arousal threshold. (Singh & Jain, 2019) The distinct cycle of sleep phases, accompanied by certain EEG patterns and physiological alterations, sets sleep apart from unconsciousness and pain. (Schupp &Hanning, 2003) Getting enough sleep is essential for preserving mental health. It significantly affects our thoughts, feelings, and ability to handle stress. Lack of good sleep can have an impact on our mood, ability to think clearly, and general mental health.

The term sleep quality is commonly used in sleep medicine and can refer to a collection of sleep measures including Total Sleep Time (TST), Sleep Onset Latency (SOL), sleep maintenance, Total Wake Time (TWT), Sleep Efficiency (SE), and sometimes sleep disruptive events such as spontaneous arousal or apnea. (Fabbri et al., 2021) The phenomenon of sleep quality is complex as it has many aspects, no consensus definition, and can be measured subjectively and objectively. Total Sleep Time (TST), Sleep Onset Latency (SOL), Degree of Fragmentation (DoF), Total Wake Time (TWT), Sleep Efficiency (SE), and other quantitative sleep measures are sometimes referred to by this term. Other times, it refers to questions concerning overall sleep quality over a given time period in subjective/self-reported diaries or questionnaires.

Quality sleep is just as important for good health as proper nutrition and physical activity. It considers several elements that influence how rejuvenating and peaceful your sleep is. When you get good sleep, you wake up feeling awake and rejuvenated, but when you don't, you may feel sleepy, exhausted, or mentally hazy during the day. Mental health and sleep quality are intimately related and have a big impact on one another. While inadequate

sleep can have detrimental effects on emotional stability, cognitive performance, and mental health, adequate sleep promotes mental well-being. (Riadi et al., 2023)

Theories

Numerous theories of sleep make an effort to clarify the biological processes involved in sleep, as well as why we sleep and what transpires during it. Many of these theories provide insight into various aspects of why sleep is crucial for our health and well-being, even though no single explanation can adequately describe the intricacies of sleep. Some of the theories of sleep include:

Restorative Theory:

According to the restorative notion, sleep facilitates tissue healing and repair. Numerous biological activities take place while we are awake, and the body uses up all of its reserves. Sleep plays a major role in the body's attempts to repair itself through protein synthesis, muscle and tissue regeneration, and the release of growth-promoting hormones.

Adaptive Theory:

One of the earliest hypotheses to propose sleep as an adaptive behaviour to defend against predators and environmental hazards was the evolutionary or adaptive theory of sleep. Natural selection is believed to have shaped this habit into what we now refer to as sleep.

Brain Plasticity Theory of Sleep:

According to the hypothesis of brain plasticity, sleep is essential for neuronal remodelling and the development of the structure and function of the brain. It is obvious that sleep affects how the brain develops in both infants and children, which explains why newborns need to sleep for up to 14 hours per day.

Energy Conservation Theory:

The primary function of sleep, according to the energy conservation theory, is to reduce an individual's energy needs and expenditures during specific periods of the day or night, especially when food searching is ineffective.(Rappoport,2019)

Research Trends and Classification

Quantitative Research:

The impact of sleep patterns, sleep disruptions, and sleep quality on mental health outcomes is examined in quantitative research on the connection between mental health and sleep quality. To determine the type and degree of the link, these investigations employ statistical analysis and numerical data.

Qualitative Research:

Investigating people's individual experiences, perceptions, and emotions regarding the effects of sleep on their mental health is usually the main goal of qualitative research on the relationship between sleep quality and mental health. Qualitative research offers deep insights into the subjective and contextual components of sleep and mental health, in contrast to quantitative studies that collect numerical data. To learn about people's lived experiences, these studies frequently include techniques like focus groups, interviews, and content analysis.

Mixed-Methods Research:

A more thorough understanding of complicated phenomena, including the connection between mental health and sleep quality, can be obtained through mixed- methods research, which blends quantitative and qualitative techniques. Both quantitative data (such as surveys and questionnaires) and in-depth, individual insights (such as focus groups and interviews) can be gathered using this kind of research.

Importance of Sleep Quality in Mental Wellbeing

Sleep quality significantly impacts mental health perceptions. Quality of sleep is important for how we feel mentally. When we sleep well, we might see things more positively during the day. People often notice that when they get enough good sleep, they feel happier and able to handle challenges. So, it's crucial to prioritize sleep to support our mental well-being. (Javaid et al., 2024) Research on the relationship between sleep quality and mental health is well-established, with a substantial body of evidence demonstrating the critical role sleep plays in preserving emotional and psychological well-being. While high-quality sleep tends to promote mental and emotional resilience, poor sleep can have a significant negative influence on mental health and result in a variety of emotional, cognitive, and behavioral problems.

Factors of Sleep Quality

To find possible disruptors and open the door to better sleep hygiene, it is essential to comprehend the nuances of the elements that influence sleep. Sleep quality can be affected by a number of factors, including biological, environmental, and psychological ones. It is essential to comprehend these elements in order to enhance sleep quality and preserve general health. (Colpaert, 2015)

Sleep Environment:

Lighting, noise, temperature, comfort of bedding, etc. are some of the sleep environment factors that affect the quality of sleep. The body's ability to fall asleep is severely hampered by bright light, particularly blue light from device screens, which lowers the generation of the hormone melatonin. For optimal sleep quality, the temperature must be pleasant. Environments that are overly hot or chilly can interfere with sleep. Your body type should be supported and comfortable by the mattress and pillows. Poor sleep might result from discomfort caused by an uncomfortable bed.

Physical Health:

Back discomfort, arthritis, and other chronic pain disorders can all affect how well you sleep. Sleep patterns can be disturbed by hormonal changes, especially during pregnancy, menopause, or adolescence (hot flashes, or night sweats). As people age, their sleep habits change. Overall sleep quality may be impacted by older persons' increased fragmentation of sleep or decreased duration of deep sleep periods.

Lifestyle Choices:

Dietary habits like eating too much right before bed might cause pain or indigestion, which makes it hard to fall asleep. On the other hand, having a modest, light snack can help you unwind. Sleep can be adversely affected by the use of recreational drugs, alcohol, or nicotine. Alcohol alters the sleep cycle even though it may make you feel drowsy at first.

Genetics:

A person's genetic makeup influences whether they are an early riser or a late sleeper, which might impact the quality of their sleep if their schedule conflicts with their circadian rhythm. A person's ability to sleep deeply and wake up easily might also be influenced by genetic variations. To feel rested, some people inherently require more sleep than others.

Mental Wellbeing

Defining Mental Wellbeing:

Mental wellbeing refers to a positive state of psychological and emotional health; it indicates that a person is able to function cognitively and emotionally in a manner that is productive and fulfilling. (Chengti, 2018) Wellbeing is a multi-dimensional construct; a "meaningful" life, healthy development, and the fulfillment of fundamental human needs for autonomy, competence, and relatedness are all factors that contribute to wellbeing.

Self-esteem, positive effects, contentment, wellness, efficiency, social support, physical symptoms, personal control, and similar elements are all components of psychological well-being, also known as well-being. Well-being is a component of quality of life, which is defined as a combination of an individual's physical, psychological, and social well-being as judged by both the individual and the group. It includes one's thoughts, feelings, and actions and is frequently defined by one's capacity to manage life's challenges, uphold wholesome relationships, and make decisions that lead to a happy and purposeful existence. (Chengti, 2018).The concept of mental well-being is broad and encompasses an individual's emotional, psychological, and social state, which influences their thoughts, feelings, and actions in day-to- day living. It includes a number of elements that support a person in overcoming obstacles in life, being resilient, forming satisfying relationships, and living a purposeful existence. In addition to the absence of mental illness, pleasant mental emotions like happiness, satisfaction, and fulfillment are also indicators of good mental health. (Murphy et al., 2022)

Theories of Mental Wellbeing:

The goal of theories of mental well-being is to elucidate the social, psychological, and emotional elements that influence a person's general sense of fulfillment, enjoyment, and health. Numerous academic fields, including psychology, philosophy, and sociology, are covered by these theories. Some of the theories of mental wellbeing include:

The Hedonic Theory:

According to the hedonic approach to mental health, pursuing pleasure and avoiding suffering are the main ways to achieve happiness and mental health. This hypothesis states that the ratio of good to negative emotions serves as a gauge of mental health. The hedonic theory focuses primarily on short-term pleasure and doesn't fully account for deeper, more long-lasting aspects of well-being, such as meaning and purpose. The main elements of this theory are pleasure-seeking, positive affect, and life satisfaction.

The Eudaimonic Theory:

Based on the Greek word "eudaimonia," the eudaimonic idea stresses living in line with one's true self and attaining self-actualization, personal progress, and a sense of purpose. It implies that achieving one's potential and leading a meaningful life are more

important for mental health than just finding pleasure. Although the eudaimonic approach stresses greater fulfillment, it can be challenging to describe generically because meaning and purpose are personal and might differ from person to person.

The PERMA Theory of Wellbeing:

The PERMA model, a popular framework in positive psychology, was created by psychologist Martin Seligman and uses five essential elements to characterize mental well-being. These elements include positive emotions (P), engagement (E), relationship (R), meaning (M) and accomplishment (A). It suggests that by fostering these qualities, well-being can be attained. Although the PERMA model is thorough, it could be difficult to apply uniformly because everyone has different personal objectives and sources of fulfillment.

The Flourishing Model:

The flourishing model of mental health was created by Corey Keyes and makes a distinction between "flourishing" and "languishing." When people experience pleasant feelings, personal development, and meaningful interactions, they are said to be flourishing. The distinction between languishing and flourishing may not always be obvious or generally applicable, because flourishing is a subjective metric.(Ryff& Keyes, 1995)

Research Trends and Classification

Quantitative Research:

In order to comprehend and quantify elements of mental health, such as emotional wellbeing, psychological resilience, and social functioning, quantitative research on mental wellness collects and analyzes numerical data. By quantifying mental wellbeing and its affecting aspects using surveys, standardized scales, and statistical techniques, this kind of research seeks to offer objective insights.

Quantitative Research:

Investigating people's subjective experiences, perceptions, and meanings related to their mental health and wellbeing is the main goal of qualitative research on mental wellbeing. Through rich, in-depth descriptions and insights, qualitative research tries to comprehend the deeper, more intimate facets of mental wellbeing, in contrast to quantitative research, which measures and quantifies mental health outcomes.

Mixed-Methods Research:

To provide a more thorough understanding of mental health and wellness, mixed-methods research in this area integrates both quantitative and qualitative techniques. Mixed-methods research captures the breadth and depth of mental wellbeing by combining numerical data with rich, descriptive insights. This allows for the simultaneous exploration of patterns, correlations, and individual experiences.

Importance of Mental Wellbeing in Sleep Quality

There is a strong correlation between sleep quality and mental health, with each having a major impact on the other. Emotional, psychological, and social health are all components of mental well-being, which influences our thoughts, feelings, and actions. Poor sleep quality is one of the many physical and cognitive disturbances that can occur when our mental health is affected.

On the other hand, adequate sleep is essential for our general health and is facilitated by mental well-being. (Scott et al., 2021) Mental health affects our thoughts, feelings, and behaviors as well as how we manage stress, interact with people, and make decisions. decent mental health depends on getting enough decent sleep, but bad sleep can exacerbate mental health concerns, and mental health difficulties can cause poor sleep. To learn more about the reciprocal relationship betweensleep and mental health, research is still being conducted. Despite the fact that both are complicated problems influenced by numerous variables, there is compelling evidence that enhancing sleep can improve mental health and be a part of the treatment of numerous psychiatric conditions.

Factors of Mental Wellbeing

Numerous factors that fall within the human, social, environmental, and biological domains all have an impact on mental health. These elements can influence how people perceive and experience their emotional, psychological, and social states, influencing mental health in both direct and indirect ways. (Naisi et al., 2009) The following are some important variables that affect mental health:

Psychological Factors:

Emotionally stable people are more likely to be resilient and have good mental health. Better mental health is frequently associated with high self-esteem. Self-satisfied people are better equipped to manage stress and conquer obstacles. People's mental health is greatly impacted by how they handle stress and hardship. While bad coping mechanisms can be detrimental to mental health, healthy ones promote wellbeing.

Social Factors:

Mental health relies on strong relationships with friends, family, and the community, which improve resilience, a sense of belonging, and stress reduction. Frequent social interaction fosters these qualities. However, cultural background and societal expectations can influence mental health perceptions, and stigma associated with mental illness can discourage treatment, negatively impacting mental health. Therefore, maintaining strong connections is crucial for overall well-being.

Biological Factors:

Mental health is influenced by genetic predisposition. A person's genetic composition may make them more vulnerable to specific mental health issues. Hormonal (cortisol, thyroid hormones) and neurotransmitter (serotonin, dopamine) imbalances can have a major effect on mental health. A person's mental and physical health are intimately related. While physical health can enhance mental wellbeing, chronic ailments, discomfort, or exhaustion can have a detrimental impact on mental health.

Environmental Factors:

Living environments that are safe, secure, and supportive are crucial for mental health. Instability can harm mental health, while a calm home environment reduces stress. Work-life balance, job happiness, and workplace stress also impact mental health. Supportive, adaptable environments foster good mental wellbeing. Mental wellbeing is significantly influenced by social services, mental health resources, and community support initiatives. Access to self-help programs, counseling, and therapy can improve mental health. Basic necessities like food, shelter, and medical care are essential, as economic stressors can exacerbate mental health conditions.

Leveraging Digital Tools for Betterment of Sleep Qualityand Mental Wellbeing

Digital Tools for Better Sleep:

Many digital tools are now accessible to assist monitor, enhance, and optimize sleep quality thanks to technological improvements. These products, which range from wearable technology to smart home integrations, provide data-driven insights and interventions to encourage better sleeping practices. (Lee, n.d.) By providing individualized, data-driven solutions, digital technologies have completely changed the way people enhance their sleep. These technologies assist users in developing better sleep patterns, whether through wearable trackers, smart home integrations, or mental wellness applications. (Baria et al., 2023) Some of the digital tools used for better sleep include:

Sleep Tracking and Monitoring Devices:

These include wearable sleep trackers which help in monitoring sleep patterns, heart rate, movement, and breathing that help to assess sleep quality. Smartphone based sleep tracking apps use sensors, microphones and motion detection to analyze individual's sleep patterns. On-bed and non-wearable sleep monitors are tools for those who do not prefer to wear a tracker, and assess sleep patterns passively through under-the-mattress or bedside sensor monitors.

Smart Home Technology for Better Sleep:

Smart light and circadian rhythm management which mimic daylight cycles to support melatonin production and regulate circadianrhythms. White noise and sleep sound machines are tools that create ambient soundscapes to block distractions and promote relaxation. Smart thermostats and climate control devices help in controlling and maintaining optimal conditions.

Digital mental wellness tools for sleep:

Meditation and relaxation apps in guide meditation, breathing exercises and sleep stories that help in calming the mind before sleep. CBT apps for insomnia help users restructure negative sleep thoughts and develop better sleep.

AI and Data-driven Sleep Optimization:

AI powered sleep coaching apps are tools analyze sleep data and provide personalized recommendations.

Digital Tools for Better Mental Wellbeing

Digital tools for mental health use technology to improve mindfulness, lower stress, and promote emotional wellness. These resources include wearable technology, smartphone apps, and AI-powered treatment platforms. Digital tools for mental health are changing how people deal with worry, stress, and sleep. Even if they offer easily available and reasonably priced treatments, it is crucial to confirm their efficacy via scientific research. Future developments in wearables, VR, and AI will strengthen their use in mental health treatment. (Victoria University of Wellington, 2018) A thorough analysis of the many kinds of digital tools, their efficacy, and their significance for mental health may be found below:

- Meditation & Mindfulness Apps: These apps focus on guided meditation, breathing exercises, and relaxation techniques to help reduce stress and anxiety.
- Mood Tracking & Journaling Apps: These apps allow users to record their emotions, thoughts, and triggers, providing insights into their mental health patterns.

- Therapy &Counseling Platforms: Online therapy platforms connect users with licensed professionals through video calls, messaging, or AI-driven chatbots.
- Stress & Anxiety Management Tools: These tools use cognitive behavioral therapy (CBT), gamification, and biofeedback to help users manage stress.
- Sleep & Relaxation Tools: Sleep plays a critical role in mental well-being. These tools focus on tracking sleep patterns and improving sleep quality.
- Habit & Self-Care Apps: These apps encourage users to develop healthy habits related to mental well-being, such as exercise, gratitude, and self-care.(Type & Date, n.d.)

Review of Literature

Sleep Quality:

MarilisaBerti de Azevedo Barros, MargarethGuimarães Lima, Maria Filomena Ceolim, EdilsonZancanella, Tânia Aparecida Marchiori de Oliveira Cardoso (2019), studied the effect of quality of sleep on health and wellbeing through a cross-sectional study using samples of 1998 individuals. The association of sleep quality with different complaints and characteristics of sleep was analyzed. The prevalence of poor self-rated sleep was 29.1%, and it was considerably greater among women and people between the ages of 40 and 50. Reports of having trouble falling asleep were closely linked to poor sleep. The findings highlight the population segments that require more attention due to their poor sleep quality. It also emphasizes how important it is to take into account mental health and well-being in addition to comorbidities when caring for patients who have sleep issues and when designing therapies to encourage sound sleep. (Berti& Barros, 2019)

Allison G. Harvey, Kathleen Stinson, Katriina L. Whitaker, Damian Moskovitz, and Harvinder Vik (2008), attempted to study the subjective meaning of sleep quality using comparison of individuals with insomnia. This was a cross-sectional study between two groups of total 58 participants and analysis was conducted across three variables. Both the insomnia and normal sleeper groups defined sleep quality by tiredness on waking and throughout the day, feeling rested and restored on waking, and the number of awakenings they experienced in the night. The insomnia group had more requirements for judging sleep to be of good quality. The meaning of sleep quality among individuals with insomnia and normal sleepers was broadly similar. A comprehensive assessment of a patient's appraisal of their sleep quality may require an assessment of waking and daytime variables. (Harvey et al., 2008)

GirumNakie*et al*(2024), studied 35 articles from 11 African countries and were assessed and included in a systematic review. Total of 16,275 study participants from 35 studies were included in this meta-analysis and systematic review. Theoverall pooled prevalence of poor sleep quality among university students in Africa was 63.31%, The subgroup analysis shows that the combined prevalence of poor sleep quality in East, North, West, and South Africa were 61.31. This study shows that there is a high prevalence of poor sleep quality among university students in Africa. (Nakie et al., 2024)

Natalie Guadiana and Taylor L. Okashima (1998), studied the effects of sleep deprivation on college students selecting convenience samples of 100 university students who were recruited through emails and social media. The demographic data was evaluated using descriptive statistics, and any associations between sleep deprivation and the students' physical, mental, and cognitive health were examined. According to the data, getting enough

sleep is essential for both individual functioning in the medical workplace and for undergraduate college students to do well. According to the literature study, sleep deprivation can lead to issues like a rise in drug and procedural errors, as well as detrimental effects on clinical and academic performance. Lack of sleep can significantly affect mental health, psychomotor abilities, and brain function. (Calverley, 1998)

Sutapa Mukherjee*et al* (2015), aimed to study and provide a review of the current scientific literature to assist healthcare providers in making recommendations to patients and general public. Good quality and quantity of sleep are essential for good health and overall quality of life; therefore a strong recommendation was made for the implementation of public education programs on the importance of sleep health. (Mukherjee et al., 2015)

Mental Wellbeing:

Bilal Ahmad Bhat (2018), studied a sample of 519 senior secondary school pupils from various Kulgam and Anantnag district senior secondary schools about the psychological wellbeing of adolescents in relation to school environment. A multi-stage stratified sampling procedure was used to draw the sample. The study examines how senior secondary school students' psychological health is impacted by their educational environment, housing situation, and school type. It also offers some recommendations to improve the psychological health of our developing human resource while bearing in mind the study's conclusions.

Shubhangi Moghe and Dr. Shaili Misra (2024) conducted a Study on Psychological Well-being among University Students collecting primary data from 120 participants. The data was acquired using the Psychological Well-being Scale created by Carol Ryff. The findings show that men and women have the same level of psychological well-being. Furthermore, there were no statistically significant differences between male and female students in the parameters influencing psychological well-being. Additionally, there are no appreciable disparities in the psychological health of day students and dormitory residents. Lastly, there were no discernible differences between day students and dormitory residents in the psychological well-being categories.

Peter J. O. Aloka*et al* (2023), studied the wellbeing and mental health initiatives for students in universities. This chapter examined mental health and well-being programs for college students by using a conceptual review of the literature. This chapter's literature review led to the following conclusions: mentorship at various academic departments, building social networks, providing opportunities for student engagement, mental health in universal health coverage, supportive work environments, and, lastly, the use of individual coping strategies to improve the mental health and general well-being of university academic staff. It is advised that academic institutions create comprehensive mentorship programs for students to address all facets of their lives.

Ren Vanderlind (2014), studied the effects of mental health on students' learning using random sampling method across 132 institutions in Texas State. This study concluded that although literature has explored link between mental health and college performance, college students mental health will likely remain part of the conversation about the challenges faced by students.

Dr Priya and Mr. Sudhanshu Singh (2023), conducted a study on "Evaluation Of Psychological Well-Being Of College Students During Pandemic Covid 19". The study's main goal was to determine whether college students may benefit from Ryff's six-factor

model of psychological well-being in the event of a pandemic. The study also attempted to ascertain how the demographics of the students affected their mental health. A total of 160 graduate and post- graduate survey respondents were selected from different universities to participate in an online survey. The results of the study showed that six characteristics significantly influenced SPWB,with college students giving personal progress a high score. The data and the suggested model agree. For better psychological well-being, it is advised to remember good things, show gratitude and empathy, maintain a strong social network, and get help from parents and teachers.

Sleep Quality and Mental Wellbeing:

N. A. Hamilton*et al* (2007), studied the relationship between sleep and dimensions of psychological wellbeing with 502 participants who were surveyed about sleep habits, symptoms of anxiety and depression using the Ryff's 6 dimensions of wellbeing. The participants were categorized into various types of sleepers based on the average hours of sleep they get. The analysis showed that optimal sleepers reported fewer symptoms of depression, anxiety, and reported higher levels of self acceptance, purpose in life, and personal growth. Even after removing those with mild to severe depressive symptoms from the data set, there were still notable differences between ideal and non-optimal sleepers in terms of depressive symptoms, positive relationships with others, life purpose, and self-acceptance. These findings align with a theoretical framework that characterizes sleep as a tool associated with self-regulation and stress management. (Hamilton et al., 2007)

Shay-Ruby Wickham*et al* (2020), conducted a cross-sectional study to find the relationship between sleep quality and mental wellbeing among young adults. 1111 participants were chosen for the study between the age of 18 to 25 years and were asked to answer an online survey measuring typical sleep quality and quantity, physical activity and consumption of nutritious food. Controlling for covariates, sleep quality was the strongest predictor of depressive symptoms and well-being, followed by sleep quantity and physical activity. There were some higher-order interactions among health behaviors in predicting the outcomes, but these did not survive cross-validation. (Wickham et al., 2020)

Keyu Zhai*et al*(2021), conducted a study to better understand the role of sleep quality in psychological well-being, by examining the association between different sleep quality and mental health. It was a cross-sectional survey of 2465 participants of final year students in China. They employed multivariable logistic regression to assess betweendifferent sleep quality and psychological wellbeing. Having normal sleep quality is associated with lower level of psychological well-being problems. By contrast, poor sleep quality is associated with high level of negative psychological well-being. Poor sleep quality has higher potency than normal sleep quality due to negative bias. Among covariates, age, gender and education have significant effects on psychological well-being. (Scott et al., 2021)

P. Gothe*et al*(2020), studied the role of physical activity, sleep and quality of life in older adults. The purpose of this study was to longitudinally test a model examining how changes in physical activity and sleep quality, predict physical, mental and social well-being and global QoL across a 6-month exercise trial in a sample of healthy older adults. At both time-points, physical activity and sleep quality were significantly correlated. Sleep quality

indirectly influenced QOL via physical, mental and social well-being. (Activity & Well-being, 2021)

Need for the Study

Addressing sleep quality and mental wellbeing of individuals is crucial for several reasons. Examining these variables aids in comprehending how people's sleep quality is impacted for a variety of causes and how it significantly impacts their mental wellbeing. Understanding the relationship between these variables can assist in enhancing better sleep quality and mental wellbeing through various digital tools.

METHODOLOGY

Aim

To investigate the bidirectional relationship between sleep quality and mental well-being, and using digital tools as interventions for improvement.

Hypothesis

H_0: There is no relationship between sleep quality and mental well-being.

H_1: There is a positive relationship between sleep quality and mental well-being.

Objectives

The objectives of the study are as follows:

- To study the relationship between sleep quality and mental well-being.
- To assess the quality of sleep and mental wellbeing of college students.
- To employ digital tools for the betterment of sleep quality and mental wellbeing.

Methodology

Sample for Study:

Participants are selected using convenience sampling. Convenience sampling is a nonprobability sampling technique often employed in research when practicality and ease of access to participants are prioritized over random selection methods (Babbie, 2016). The target population comprises of individuals who are more likely to be susceptible to irregular sleep schedules. This study includes 130 college students between the age group of 18 to 25 years.

Sample Characteristics:

The study focuses on a specific demographic group, namely college students between the ages of 18 and 25. This targeted sample aims to explore the research questions within the context of this particular population.

Operational Definitions: Sleep Quality: The term sleep quality is commonly used in sleep medicine and can refer to a collection of sleep measures including Total Sleep Time (TST), Sleep Onset Latency (SOL), sleep maintenance, Total Wake Time (TWT), Sleep Efficiency (SE), and sometimes sleep disruptive events such as spontaneous arousal or apnea. (Fabbri et al., 2021)

Mental Wellbeing:

Mental wellbeing refers to a positive state of psychological and emotional health; it indicates that a person is able to function cognitively and emotionally in a manner that is productive and fulfilling. Wellbeing is a multi-dimensional construct; a "meaningful" life, healthy development, and the fulfillment of fundamental human needs for autonomy, competence, and relatedness are all factors that contribute to wellbeing. (Chengti, 2018)

Inclusion and Exclusion Criteria

- Individuals from age group 18 to 25 years are included.
- Participants must be between the ages of 18 and 25 to ensure they fall within the specified demographics.
- Participants must be currently enrolled in a college or university.
- Individuals below the age of 18 and above 25 years of age are excluded.

Research Design

This study is a cross-sectional study and will employ a quantitative research design to investigate the relationship between sleep quality and mental well-being among college students and the use of digital tools for the betterment.

Tool Description

The following scales were used:

Sleep Quality Scale: The Sleep Quality Scale (SQS) developed by Chol Shin (2006) measures sleep quality in people who live in the general population. It is a self- report scale designed to measure six domains of sleep quality consisting of 28 items which works for adults aged 18 – 59 years old. It evaluates 6 domains of sleep quality: daytime symptoms, restoration after sleep, problems initiating and maintaining sleep, difficulty waking, and sleep satisfaction. (Shahid et al., 2012)

The Ryff 42-Item Psychological Well-Being (PWB) Scale is a widely used measure for assessing psychological well-being, based on Carol Ryff's model. It evaluates six key dimensions of well-being: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance. It is used in psychological research to study well-being across different populations and applied in clinical psychology, counseling, and positive psychology.(Ryff et al., 2010)

Procedure

Participants will be selected through convenience sampling from various college students. They will receive information about the study's purpose, and consent will be obtained from those willing to participate. Participants were administered with self-report questionnaires after, which guarantees their voluntary involvement and anonymity. Participants' basic demographic information (initial, age, gender, and educational level) was collected using online questionnaires,and they were asked to fill in the questionnaire. Their responses were later scored, interpreted and analyzed using Statistical Package for Social Sciences.

Ethical Consideration

Ethical considerations for this study include obtaining informed consent from participants, ensuring participant confidentiality and anonymity, and addressing any potential risks or discomfort associated with the study. These ethical concerns will be carefully managed throughout the research process.

Results And Discussion

TABLE 4.1 - *Descriptive statistics of the participants for their demographic characteristics*

Variables	Sub Variable	N	%	Mean	SD
Gender	Male	81	37.7%	63.79	0.486
	Female	49	62.3%		

Educational Level	Undergraduation	36	27.7%	66.54	0.510
	Postgraduation	89	68.5%		
	Research Scholars	5	3.8%		
Sleep Quality		130		34.49	12.044
Mental Wellbeing		130		201.300	63.753

The above table shows the socio demographic characteristics of the study participants. A total of 130 participants filled out the questionnaires. The study comprised of 37.7% of male and 62.3% of female participants among which 27.7% are undergraduation students, 68.5% are postgraduation students and 3.8% are research scholars. The mean value of sleep quality of 130 participants is 34.39, and the mean value of mental wellbeing is 201.300.

TABLE 4.2 - *Results for Mann – Whitney U test for Sleep Quality and Mental Wellbeing*

Variables	Gender	Mean Rank	Z-Value	U Statistics
Sleep Quality	Male	53.13	-2.596	1374.00
	Female	70.61		
Mental Wellbeing	Male	67.57	-0.853	1724.50
	Female	61.83		

Based on the Mann-Whitney U test results for the variables of Sleep Quality and Mental Wellbeing, the following findings can be observed. In Sleep Quality, there is a statistically significant difference between males and females (Z = -2.596, U = 1374.00), and both males and females have difference in the mean values. In Mental Wellbeing there is a slight statistically significant difference between males and females (Z = -0.853, U = 1724.50), and both males and females have slight differences in the mean value. Overall, the results suggest that there is significant difference in sleep quality and slight significant difference in mental wellbeing of the participants. The Mann Whitney U tests revealed significant differences between the males and females only in mental wellbeing variable and not in sleep quality variable.

TABLE 4.3*Results of correlation between Sleep Quality and Mental Wellbeing*

Variables	Sleep Quality	Mental Wellbeing
Sleep Quality	1.000	0.999**
Mental Wellbeing	0.999**	1.000

*Note **p < 0.01*

Spearman rank order correlation is taken to analyze the relationship between Sleep Quality and Mental Wellbeing. The test results reveal Sleep Quality has Positive Strong Correlation

with Mental Wellbeing ($r = 0.999$, $p < 0.01$). This suggests that individuals who have bad quality of sleep have high effect on the mental wellbeing of individuals, and vice versa. Good sleep quality can help in improvement of mental wellbeing to a great extent. Overall, these correlation analysis results provide insights into the relationships between the variables of interest. There is a bidirectional relationship between sleep quality and mental wellbeing: mental health problems can exacerbate sleep quality, and bad sleep can cause mental health problems. It is essential to comprehend this reciprocal relationship in order to enhance sleep quality and mental health in general.

Summary and Conclusion

Summary

The study aimed to explore the socio-demographic characteristics of participants and their associations with sleep quality and mental wellbeing. The analysis included descriptive statistics, Mann-Whitney U tests, and Spearman rank order correlation. The descriptive statistics provided insights into the demographic characteristics and variables of interest among the 130 study participants. The study comprised of 37.7% of male and 62.3% of female participants among which 27.7% are undergraduation students, 68.5% are postgraduation students and 3.8% are research scholars. Additionally, mean scores were calculated for sleep quality (34.39) and mental wellbeing (201.300). The Mann Whitney U tests revealed significant differences between the males and females only in mental wellbeing variable and not in sleep quality variable. Both males and females have slight differences in the mean value. The Spearman rank order correlation analysis indicated significant relationship between the two variables. Sleep quality positively correlated with mental wellbeing ($r = 0.999$, $p < 0.01$), indicating very bad sleep quality report to disturbances in mental wellbeing and the vice versa.

Conclusion

The study aimed to explore the socio-demographic characteristics of participants and their associations with sleep quality and mental wellbeing. The analysis included descriptive statistics, Mann-Whitney U tests, and Spearman rank order correlation. The descriptive statistics provided insights into the demographic characteristics and variables of interest among the 130 study participants. The Mann-Whitney U tests revealed no significant differences between genders for sleep quality and significant differences in mental wellbeing. Both male and female participants showed slight differences in mean ranks for these variables, indicating gender-based disparities. The Spearman rank order correlation analysis indicated a significant relationship between the twovariables. While gender did not significantly influence these variables, correlations revealed associations between sleep quality and mental wellbeing. Several digital tools such as sleep tracking devices and apps, white noise and sleep sound apps, meditation and mindfulness apps, CBT for insomnia apps, blue light blocking tools, etc. can be used to help with better sleep quality and mental wellbeing.

Limitations and Implications

Limitations

In this quantitative study, focusing on the two variables among 130 college students, limitations may arise from factors like sampling bias, as the sample representativeness can be restricted by various factors or aspects like age, educational level, etc. Cross-sectional design

limits the ability to capture changes over time. There is limited generalization to diverse cultural groups, age groups, and other factors like mental health status post-challenges. These constraints highlight the necessity for methodological improvements to be carefully considered in future research projects, as well as for cautious interpretations.

Quantitative studies on these variables face limitations such as sampling bias, response bias, and cross-sectional nature, as populations with restricted internet access are frequently omitted. Sampling bias may distort the results, and challenges also arise from ethical issues about consent, and data privacy, the rapid evolution of social media platforms necessitates advancements and cautious interpretation to fully understand its impact on people and society.

Implications

The findings from the present study offer valuable insights into the complex interplay between sleep quality and mental wellbeing. These insights have significant implications for various fields, particularly in counseling and intervention practices. Research on the connection between mental health and sleep quality has important ramifications for public health, education, healthcare, workplace regulations, and individual lifestyle decisions. Gaining insight into these relationships can enhance productivity, general well-being, and mental health care. There are broad implications for healthcare, businesses, education, public health, and individual behaviors from research on sleep quality and mental health. Making sleep a priority is a crucial tactic for enhancing mental well-being, cognitive performance, and general lifehappiness. People and society may promote greater emotional resilience, productivity, and long- term well-being by incorporating these insights into everyday routines and policy. With the popularity of applications and gadgets that encourage healthy lives, using digital tools to improve mental health and sleep quality has grown in popularity. These apps can help you manage stress, enhance mental health, and improve sleep patterns by providing data-driven insights, tailored suggestions, and interactive features.

References

Aloka, P. J. O., Omare, J. M., Owuor, E. A., Okongo, C., & Owino, J. (2023). Well-being and mental health initiatives for students in universities. *Mental Health Crisis in Higher Education, December 2023*, 1–13. https://doi.org/10.4018/979-8-3693-2833-0.ch001

Bhat, B. A. (2018). A Study of Psychological Well-Being of Adolescents in Relation to School Environment and Place of Living. *Online Submission*, *7*(October 2018), 605–613.

Chengti, S. (2018). Understanding Mental Health and Well-being. *The International Journal of Indian Psychology*, *6*(2), 126–135. https://doi.org/10.25215/0602.219

Colpaert, F. C. (2015). State Dependence of Memory. In *Encyclopedia of Psychopharmacology* (pp. 1640–1647). https://doi.org/10.1007/978-3-642-36172-2_184 Dv, L. Q. G., Ri, I., &Rq, H. (n.d.). *Mental Health and Student Learning*.

Hamilton, N. A., Nelson, C. A., Stevens, N., &Kitzman, H. (2007). Sleep and psychological well-being. *Social Indicators Research*, *82*(1), 147–163. https://doi.org/10.1007/s11205- 006-9030-1

Harvey, A. G., Stinson, K., Whitaker, K. L., Moskovitz, D., & Virk, H. (2008). The subjective meaning of sleep quality: A comparison of individuals with and without insomnia. *Sleep*, *31*(3), 383–393. https://doi.org/10.1093/sleep/31.3.383

A STUDY OF THE TELEMEDICINE LANDSCAPE IN CHINA: IDENTIFYING CHALLENGES AND EXPLORING STRATEGIES THAT INDIA CAN ADOPT

Ms Ruby Elizabeth P R [1], Ms Harshitha Vandana B [2], Ms Varuniga S D [3]

[1,3] II MSc student, Department of Hospital Administration

PSG College of Arts & Science, Coimbatore

[2] IV MBBS student, Rangaraya Medical College, *Kakinada, Andhra Pradesh*

Abstract

Introduction

The concept of telemedicine was first introduced in the 1960s by NASA to provide healthcare support for astronauts in space. Since then, it has gained significant traction, and has further accelerated its adoption after the spread of COVID-19 pandemic. This paper looks into the unique aspects of the telemedicine landscape in China, while also examining the challenges faced during its implementation, and identifying strategies that can enhance the adoption of telemedicine in India.

Objectives

To analyse the proliferation of telemedicine applications in China, to identify barriers to telemedicine utilization, and to examine China's telemedicine strategies that could enhance India's healthcare system.

Methodology

A thematic content analysis was conducted using secondary data resources to extract key findings on telemedicine adoption, challenges, and strategic implementations.

Findings

Telemedicine has led to a significant shift in healthcare service delivery. China's introduction of internet hospitals and sub-centres has facilitated easier access to telemedicine services; however, despite these advancements, several challenges persist alongside its adoption and implementation.

Discussion

Several key factors that contributed to the successful adoption of telemedicine in China were identified, and plausible strategies to overcome barriers have been suggested. Insights from China's telemedicine adoption model can be used to help navigate India's efforts in expanding telemedicine and improving digital healthcare accessibility.

Conclusion

While telemedicine presents both opportunities and challenges, analysing global examples can help optimize its implementation as a vital tool in healthcare delivery.

Keywords: telemedicine, telehealth, remote specialty, telemedicine barriers, virtual care.

Introduction

The World Health Organization (WHO) defines telemedicine as: "The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities." Telemedicine involves providing support healthcare services from a distance using audiovisual communication technologies. This allows the

patient to consult the physicians and speak to them while eliminating the necessity of in-person visits. The word "tele" originating from Greek means "distance" and the word "mederi" of Latin origin means "to heal". Time magazine referred to telemedicine as "healing by wire".

Telemedicine, although seemingly a new concept, had begun during the 1960s. NASA played a major role in contributing to the field. The Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC), conceived by NASA to provide healthcare for astronauts in space and general medical care to the Papago Reservation, was one of the initial telemedicine projects. Telemedicine encompasses two vastly different spectrums. On one side is the use of telecommunication technologies for consultations and on the other end there are innovative and advanced outcomes such as tele-surgery and AI-driven diagnostics. Telemedicine, therefore, is convergence of technology, healthcare specialties, research, and innovation. Telemedicine has become an integral part of the healthcare system following the COVID-19 pandemic, accelerating its adoption. In Brazil, various levels of care were made available during COVID-19 to screen symptomatic patients and prevent overcrowding. Initially, a platform aimed to clarify doubts and identify symptoms was developed. The next level included telephone tele-monitoring and screening of symptomatic patients, followed by a follow-up and tele-education. When aggregated, it led to reduced burden and overload on healthcare organizations, enabling improved patient management. In China, with the advent of internet hospitals, telemedicine started to gain traction. It is a digital platform using which patients and doctors can exchange images, prescriptions and reports. Patients now had the opportunity to connect with doctors from top-level hospitals by visiting the medical consultation facilities near their homes. Machine operated devices on site provided the body temperature, blood glucose concentrations, blood pressure and uploaded in the diagnostic systems. Platforms like Ping An's Good Doctor (Ping An Health) and WeDoctor, among the many telemedicine platforms, have grown significantly since their launch in China. They have transformed the traditional healthcare model, enabling patients to receive medical advice, consultation, and even prescriptions remotely. Despite the significant results obtained from the introduction of internet hospitals, its adoption presented several challenges in implementation and other aspects. This paper explores the various challenges in its adoption and also looks into what made them so unique and popular. This also makes one wonder that despite the dominance of technology in this digital era, telemedicine continues to face significant challenges in adoption. For instance, in India telemedicine also gained traction during the pandemic. Ministry of Health and Family Welfare launched eSanjeevani in 2019. It provides doctor to doctor consultation as well as doctor to patient consultation free of cost. Despite its impact, there is not much widespread awareness. People prefer in-person consultations to online. Resistance stems from various factors such as lack of awareness, regulatory hurdles, data security concerns, limitation in existing technological infrastructure, language barriers, and skepticism about virtual consultations. Identifying the challenges and barriers in adoption and addressing them is essential for its continued success and impact.

Literature Review

The Incorporation and Usage of Telemedicine:

Multiple researches have looked into the factors that have been known to impact the incorporation and use of telemedicine. **Phorah and Motsi (2025)** studied the factors

influencing telemedicine usage in South Africa's public healthcare facilities. Their research found that both attitude and perceived usefulness toward telemedicine were important, while perceived ease of use was not. Nonetheless, user resistance, inadequate technical support, and insufficient training are significant obstacles to adoption. **Haleem *et al.*, (2021)** put more emphasis on the adoption barriers in their review-capability based study but also addressed privacy issues along with infrastructural and regulatory barriers as the most prominent ones.

Gobburi*et al.*,, (2025) examined telemedicine's impact on the accessibility of healthcare in remote regions of the UK. Their research identified that mobility restrictions were compensated by higher usage of telehealth services, especially in utilization of mental health care. However, barriers such as digital literacy and internet connectivity posed a considerable risk. **Khan (2025)** also reported similar findings in a rural part of Pakistan in which telemedicine improved utilization of specialist services and decreased maternal health complications by 30%. Ultimately, more low infrastructure regions continue to struggle alongside the technological advancements.

Telemedicine and Healthcare Outcomes:

Telemedicine's cost-effectiveness concerning the well-being of a patient is well established. **Vudathaneni*et al.*, Teladoc Health, Inc. (2024)** performed an extensive review of healthcare system delivery and telehealth. Their results underscored that the telemedicine is linked to better health outcomes, greater patient satisfaction and lower costs. In contrast, **Anawade*et al.*, (2024)** reported that the role of telemedicine was increasing in the alleviation of cost and distance of health care delivery.

Telemedicine Obstacles Due To Policies And Regulations:

There are numerous telemedicine studies that cite policies and regulations as barriers. **Bali (2018)** looked into telemedicine in developing countries and cites a relative lack of policies, legal barriers, and high investments into infrastructure as some of the most significant problems. **Mathur *et al.*, (2017)** studied the use of telemedicine in India and remarked on government initiatives like ISRO's satellite based telemedicine network as well as the role of the private sector. They stressed, however, the need for cohesive regulation and reimbursement policies to enable the provision of such services in other States. In the same manner, **Adeghe*et al.*, (2024)** studied the legal and ethical issues of providing AI-driven telemedicine services and suggested that issues of terrorism and privacy policy need to be resolved.

Research Gap

Telemedicine has experienced remarkable growth in recent years further accentuated by the COVID-19 pandemic. In China, various telemedicine platforms have emerged as leading performers in the telemedicine space. They enable patients to receive consultations, advice and e-prescriptions remotely. One significant gap is the lack in identifying what are the unique factors are that has made such platforms popular in China. While India has adopted digital health technologies, their implementation and usage varies significantly due to governance, social attitude, digital literacy, and healthcare infrastructure.

Statement of the Problem

Telemedicine remains underutilized and has not achieved widespread proliferation or public awareness despite the advancements in technology. A substantial portion of the population is unaware of the telemedicine services. Analyzing the underlying factors that are

contributing to the slow adoption is crucial for developing strategies and enhance the reach of telemedicine.

Objectives

The study aims to provide a comprehensive understanding of China's telemedicine landscape and to understand it's unique features behind its widespread adoption in China while identifying the reason for its success.

The main objectives of the study are as follows:

- To analyse the proliferation of telemedicine applications in China and understand factors contributing to their success.
- To identify barriers to telemedicine utilization and analyze factors hindering the adoption of telemedicine services in China.
- To conduct a comparative study between China and India and identifying telemedicine strategies that could be adapted to enhance telemedicine utilization in India.

Scope of the Study

The study seeks to understand the adoption and effectiveness on the use of telemedicine in China. The study identifies the challenges to adopting telemedicine. A comparative approach has been undertaken to identify the best practices and recommendations aimed at increasing telemedicine use in India.

Methodology

This study uses secondary data approach to understand the challenges of telemedicine concerning its adoption and implementation. Data has been collected from various articles, case studies, journals and published reports of telemedicine platforms in China. A comparative research design has been used to analyse differences between China's and India's telemedicine landscapes. Thematic content analysis has been employed to get key findings from multiple resources. By relying on existing literature this methodology ensures a comprehensive evaluation of telemedicine impact.

Findings

The Telemedicine Landscape in China and its Evolution:

The evolution of telemedicine has led to a significant shift in healthcare service delivery. By mid-2024, around 365 million people in China had utilised online medical services confirming its widespread adoption. It has offered a feasible solution to bridge the gap between rural and urban healthcare services while addressing inequities in the healthcare resource distribution. Telemedicine can overcome the geographical limitations enabling physicians to reach patients across locations.

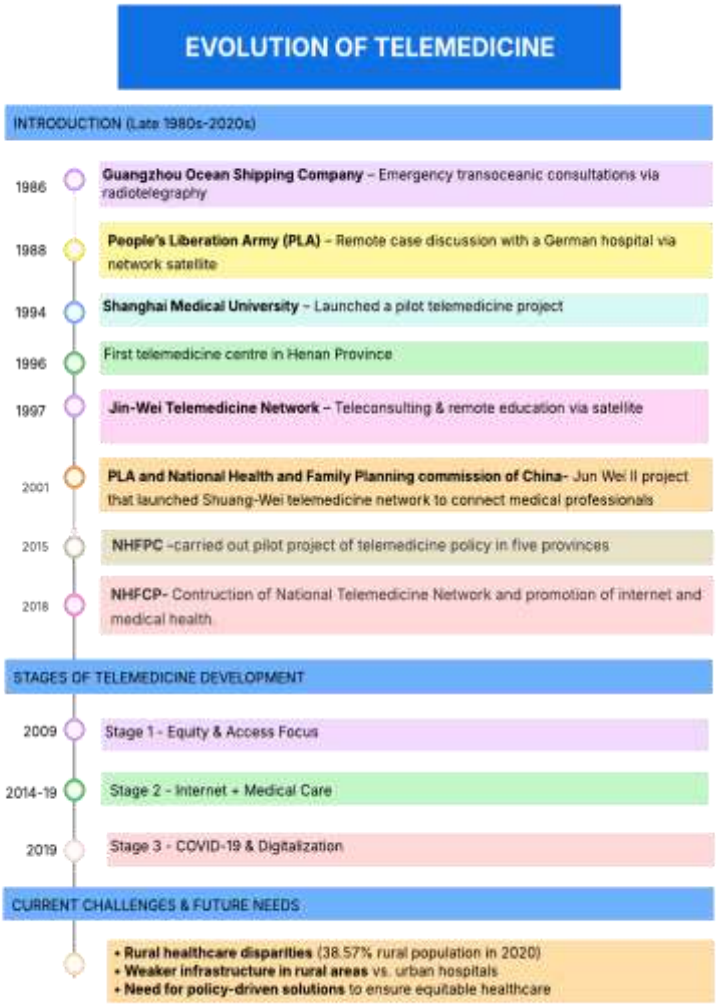
History of Telemedicine In China:

The late 1980s saw the introduction of various telemedicine services. In 1986, Guangzhou Ocean Shipping Company provided emergency transoceanic consultations for the ships' crew via radiotelegraphy. In 1988, the People's Liberation Army conducted a remote discussion with the German hospital via network satellite. China's telemedicine sector experienced rapid development in the late 1990s. In 1995, Shanghai Medical University launched a pilot telemedicine project. In 1997, the Chinese Jin-Wei telemedicine network

was established, which offered teleconsulting and remote education services through satellite communications. Since then, with the support of the central and local government, numerous telemedicine programs have been launched across various provinces of China.

Telemedicine in China can be understood by dividing it into three stages:

In 2009, the first stage was to address the income and resource gap between urban and rural areas. Remote medical consultation was implemented with a focus on addressing equity issues. The second stage (2014-2019) was marked by the promotion of Internet + Medical Care hospitals. Telemedicine services were limited to consultation, prohibiting conducting medical diagnoses of patients through teleconsultation. It was legalised only to respond to inquiries and give advices. The third stage began in 2019 after the spread of COVID-19. To provide medical support, online hospital platforms and consultation channels were created. To minimize the risk of cross-infection, the government encouraged telemedicine application by strengthening information technology. During the COVID-19 pandemic, remote consultation and diagnosis using telemedicine platforms increased more than 20 times, while e-prescription increased nearly 10 times. As of 2020, China's rural population was 38.57% of the total population, where the healthcare infrastructure was significantly weak compared to urban areas. The rural-urban disparity in healthcare resource distribution continues to widen and requires the implementation of actionable goals.



Design and Implementation of Telemedicine in China:

In China, the telemedicine consultation system begins when patients approach a local sub-center of the telemedicine network and apply to the top-tier urban hospitals for healthcare services. The local institution or sub-center will upload the patient's electronic medical record (EMR). Following this, thorough verification is performed by top-tier hospitals, and teleconsultation services are arranged by setting up the platform and connecting the patient and provider. Diagnostic conclusions and treatment plans are developed based on the EMR data, ensuring evidence based decision making. A regular follow-up system is enabled to update the treatment plan and provide better care. Mobile applications like Wedoctor and Ping An's Good Doctor are among the consultation applications that give access to a large network of doctors. They operate by partnering with hospitals, clinics, pharmacies thereby providing a comprehensive healthcare service delivery as well as insurance coverage. Telemedicine has offered a cost-effective solution while increasing accessibility to healthcare services for the rural population. It is a time-saving way to obtain healthcare services without indirect costs like travelling expenses and the added discomfort of the long journeys, which may be hard for the elderly.

Key Factors Contributing In Successful Implementation Of Telemedicine:

Since the pandemic, various practices have been implemented to enhance its uptake. A combination of government policies, technological advancements and educational initiatives has led to a significant increase in the adoption of telemedicine.

China has a government-led healthcare system. This enables prioritisation and formulation of telemedicine strategies to implement it at the national level. In countries like India, where digital healthcare is dominated by the private sector, telehealth implementation at the national level can be through strategic partnership. Collaboration with leading telehealth platforms can increase the awareness of the services. The hospitals in China received financial support and quick approvals of the hospitals joining the telemedicine platform, and a similar strategy can be adopted to promote telemedicine in India.

Advanced real-time treatment requires sophisticated infrastructure. China has advanced telecommunication services and technology. Commercial apps and software such as WeChat, which is a widely used social media application, provided low-barrier communication and increased accessibility. Chinas' strategy to integrate telemedicine services with WeChat to disseminate knowledge and health information has enabled telemedicine to reach diverse population. Such apps are increasingly well-known to the public and have low barriers with high accessibility. This has provided sufficient exposure to telemedicine.

A well-trained team of healthcare professionals and IT personnel is required. Using their expertise can lead to better outcomes. Collaborating with companies or government-funded infirmary centres helps to facilitate the implementation and maintenance of the telehealth system. China prioritised the training of health IT professionals leading to productive outcomes while not overburdening the healthcare providers. The cooperation between healthcare organisations, government agencies, non-profit agencies and technological companies has led to the success of telemedicine. Digital literacy among patients is also required to ensure ease of use and increased accessibility.

Challenges In Telemedicine's Adoption In China:

Privacy concerns:

China lacks a stringent regulatory body dedicated to consistently monitoring and enforcing ethical standards in healthcare and medical innovation. In 2021, the Personal Information and Protection Law was implemented to strengthen regulatory frameworks and securely expand telemedicine services. With its implementation the regulatory environment and security had strengthened.

Lack of digital literacy:

Despite the growing awareness of telemedicine's effectiveness, studies indicate that many individuals lack the knowledge and understanding to navigate telemedicine platforms. China currently has a rapidly growing elderly population, which may lead to challenges in using technology, making them depend on others to use telemedicine platforms.

Lack of trust:

The general population tends to have a negative perception about the reliability and privacy of data. The worries about internet scammers persist among them. But at the same time, people perceived the doctors with certification from reputed institutions, hospitals and those following government laws and regulations to be more trustworthy. With the increase in fake video and audio recordings, the trust that people have in online platforms is gradually decreasing.

Quality of care issues:

There are concerns about the quality of care being delivered via telemedicine. In-person care varies significantly from virtual care in terms of patient's interaction and diagnosis. Studies show that misdiagnosis and recurring follow-up visits were noticed through telemedicine. 35% of telemedicine consultations result in follow-ups due to unresolved issues**.**

Lack of coverage by insurance:

Telemedicine services are not covered by public health insurance in China, leading to technical and payment challenges. Only a few private health insurance companies offer comprehensive coverage. There are no structured payment frameworks, which results in different reimbursement ratios. It poses a challenge in calculating specific reimbursements.

Social acceptance:

Since 2000, the government of China has been promoting telemedicine, but the public acceptance towards the new technology has not met expectations. The aging population is expected to increase gradually, and due to factors such as age, facility, and disability, the elderly will require long-term, high-frequency and multidisciplinary disease management, thereby making telemedicine one of the main services. Nevertheless, the promotion and usage are facing difficulties. The elderly may face challenges to adopt modern technology and may require operational assistance. They are less likely to use such services.

Discussion & Suggestions

Despite the switch to modern technology, rural communities in India still face challenges in adopting telemedicine. This section discusses the possible approaches to overcoming these challenges and key takeaways from China's telemedicine implementation.

Technological Barriers

To increase digital literacy, bridge technological barriers and enable people to use telemedicine, educational initiatives targeted at training individuals to effectively utilise telemedicine for their healthcare needs are necessary. Using the local governing bodies and healthcare volunteers, educational awareness drives can be conducted to help people use these platforms. Common platforms that are already familiar to the population must be used to reduce the resistance to telemedicine.

Infrastructure and Accessibility Limitations

A major hurdle is the lack of a dependable internet connection, which can hinder the effectiveness of telemedicine services. Initiatives must be taken by the government to reach wider and diverse populations. In recent times, with the availability of inexpensive data and the wide use of smartphones in India, connectivity will not be as much of a challenge soon. BharatNet is one such government initiative to provide broadband connectivity to all gram panchayats in India under the 2025 budget. Many rural residents rely on government healthcare facilities due to financial constraints. Moreover, the elderly population—who are among the most frequent users of healthcare services—may not have the financial means to afford smartphones. Efforts to set up remote service centres can be a plausible solution as seen from the example of China. Telemedicine reduces the wait time and also alleviates overcrowding in hospitals and is a major advantage by eliminating travel and staying expenses. Additionally, eSanjeevani telemedicine services are free of cost and can be availed by the people by approaching the local healthcare community centre. Telepharmacy services can be integrated with local service centres.

Cultural Barriers

A significant challenge in implementing telemedicine in rural areas is resistance to change. Due to traditional beliefs, lack of awareness, and a preference for in-person consultations, individuals remain hesitant to adopt telemedicine services. To overcome this, targeted educational campaigns should be conducted to inform the community about the advantages of telemedicine while addressing misconceptions and fears.

Privacy and Security Concerns

Privacy concerns in telemedicine extend to both cultural and cybersecurity aspects. Female patients may prefer female doctors, and similarly, male patients may also feel more comfortable consulting male doctors for certain health issues. Telemedicine should be inclusive of such privacy concerns. Before storing personal and medical data, patients' consent must be obtained. Additionally, concerns regarding data breaches and hacking deter some individuals from utilising telehealth services, therefore, stringent laws must be enforced to assure the patients.

Differences in Virtual and In-Person Care

A common concern is that in-person care differs greatly from virtual consultation by offering a greater level of interaction and assurance from the doctors. Adopting hybrid models and sticking to performing only early screening and diagnosis through telemedicine is an effective strategy. Physical examinations can be performed for getting accurate diagnosis

and treatment. Routine screening programmes through online consultations can enhance disease prevention and also improve public health.

Lack of Training in Telemedicine Practices

Physicians often hesitate to use technology. Medical professionals who have the ability to understand and learn the intricacies while also facing the challenges associated with telemedicine must take up this field. Including subjects related to the field of digital healthcare service delivery in their curriculum can help them to better adapt. Training programs should focus on equipping medical professionals with adequate skills to navigate the telemedicine landscape.

Limitations

The study has limitations that may affect the comprehensiveness of the research. It uses secondary data to analyse the challenges faced by healthcare professionals. It limits the ability to get an in-depth understanding of the issues faced by various stakeholders and individual perspectives. A detailed region-specific breakdown was not possible due to time constraints. Despite these limitations, the study provides a valuable overview of the telemedicine landscape in China and identifies the key challenges and opportunities in enhancing delivery of patient-centered care.

Conclusion

Resolving hurdles related to implementation, digital literacy, infrastructure, privacy, cultural significance, and accessibility is crucial for the acceptance of telemedicine and can make it an essential tool for enhancing healthcare delivery while also improving public health outcomes. It is a cost-effective alternative that can be used to manage non-critical conditions in the hospital without overburdening the staff. Telemedicine presents both opportunities and challenges. It offers an effective solution in reaching underserved communities, but its usability remains a challenge for many, especially for the elderly. A context-specific approach is necessary to analyse challenges and learn from the best practices implemented around the globe while formulating tailored strategies that will help in maximizing the potential of telemedicine. A one-size-fits-all approach is not an effective solution as every country is unique. India, being a diverse nation requires cooperation and collaboration between public and private sectors in reaching new heights in service delivery using telemedicine and bridging the accessibility gaps. A well-balanced approach, leveraging the current technology, government support through initiatives like the National Telemedicine System, aimed at developing the digital health infrastructure and strategic collaborations can help expand the telemedicine services. Overcoming barriers is the way forward to analyse ways in which each problem can be resolved and thereby make the adoption of telemedicine in India a success.

Data Availability

All data are incorporated into the article and its online supplementary material. Data sharing is applicable on this article.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Alkmim, M. B. M., Marcolino, M. S., De Oliveira, C. R. A., Borges, I. N., Cardoso, C. S., Rocha, G. M., Ribeiro, L. B., De Sousa, L. a. P., Mendes, M. S., Da Paixão, M. C., Figueira,

R. M., & Ribeiro, A. L. P. (2021). TeleCOVID-19: A Multifaceted Strategy from a Public Brazilian Telehealth Service During the COVID-19 Pandemic. In Studies in health technology and informatics. https://doi.org/10.3233/shti210022

Alkmim, M. B. M., Marcolino, M. S., De Oliveira, C. R. A., Borges, I. N., Cardoso, C. S., Rocha, G. M., Ribeiro, L. B., De Sousa, L. a. P., Mendes, M. S., Da Paixão, M. C., Figueira, R. M., & Ribeiro, A. L. P. (2021). TeleCOVID-19: A Multifaceted Strategy from a Public Brazilian Telehealth Service During the COVID-19 Pandemic. In *Studies in health technology and informatics*. https://doi.org/10.3233/shti210022

Anawade Sr, P. A., Sharma, D., &Gahane, S. (2024). A comprehensive review on exploring the impact of telemedicine on healthcare accessibility. *Cureus*, *16*(3).

Bali, S. (2018). Barriers to development of telemedicine in developing countries. In *Telehealth*. IntechOpen.

Dasgupta, A., & Deb, S. (2007). Telemedicine: A New Horizon in Public Health in India. *Indian Journal of Community Medicine : Official Publication of Indian Association of Preventive & Social Medicine*, *33*(1), 3. https://doi.org/10.4103/0970-0218.39234

Du, Y., Zhou, Q., Cheng, W., Zhang, Z., Hoelzer, S., Liang, Y., Xue, H., Ma, X., Sylvia, S., Tian, J., & Tang, W. (2022). Factors Influencing Adoption and Use of Telemedicine Services in Rural Areas of China: Mixed Methods Study. JMIR Public Health and Surveillance, 8(12), e40771. https://doi.org/10.2196/40771

Gao, J., Fan, C., Chen, B., Fan, Z., Li, L., Wang, L., Ma, Q., He, X., Zhai, Y., & Zhao, J. (2022). Telemedicine Is Becoming an Increasingly Popular Way to Resolve the Unequal Distribution of Healthcare Resources: Evidence From China. Frontiers in public health, 0, 916303. https://doi.org/10.3389/fpubh.2022.916303

Haleem, A., Javaid, M., Singh, R. P., & Suman, R. (2021). Telemedicine for healthcare: Capabilities, features, barriers, and applications. Sensors international, 2, 100117. https://doi.org/10.1016/j.sintl.2021.100117

Haleem, A., Javaid, M., Singh, R. P., & Suman, R. (2021). Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sensors international*, *2*, 100117.

Institute of Medicine (US) Committee on Evaluating Clinical Applications of Telemedicine, & Field, M. J. (Eds.). (1996). *Telemedicine: A Guide to Assessing Telecommunications in Health Care*. National Academies Press (US).

Kavita Bajeli-Datt, & Kavita Bajeli-Datt. (2023b, August 7). Centre's flagship telemedicine programme "eSanjeevani" has few takers: Study. The New Indian Express.

Khan, A. (2025). The Role of Telemedicine in Enhancing Healthcare Accessibility in Rural Areas. *International Journal of Medical Sciences*, *10*(10).

Mathur, P., Srivastava, S., Lalchandani, A., & Mehta, J. L. (2017). Evolving role of telemedicine in health care delivery in India. *Prim Health Care*, *7*(260), 2167-1079.

OCCUPATIONAL HEALTH HAZARDS FACED BY CONSERVANCY WORKERS IN PALAKKAD

Dr Sripriya[1], Ms Sneka S[2]

[1]Associate Professor & Head of BBA IS, PSG College of Arts & Science, Coimbatore

[2]Third year BBA IS, PSG College of Arts & Science, Coimbatore

Abstract

Occupational health is a part of public health that deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards especially from unhygienic environment. The study examines working atmosphere, problems faced and safety awareness of the conservancy workers in Palakkad as they play important role in solid waste management system. The design is descriptive and using purposive sampling interview of 46 conservancy workers was conducted using a Questionnaire. This study seeks to explore the extent to which welfare schemes of the Kerala Government have been successful in improving the lives of conservancy workers.

Keywords:*conservancy workers, occupational health, health hazards*

Introduction

Conservancy workers both men and women, who work at any part of the long sanitation chain: that begins with flush of the toilet or waste disposal. It is the most important job in the society, who start their work very early in the morning and skip their breakfast, lunch and do all the cleaning activities. In all other countries they are treated with huge respect, whereas in India they are still not recognised, without proper appreciation and also with unfair salary. Conservancy workers are unaware of the use of protective devices in most of the areas and Unhygienic environment exposes them to acute health risk like respiratory and eye diseases, accidents, injuries, skin infections, and animal bites.

Occupational health is one of the major areas of community medicine and public health. Conservancy workers are the main working force to enhance traffic safety by removing harmful pollutant. They are working in an environment full of microbes, pollutants, organic and nonorganic wastes. Manual system of sweeping and scavenging expose them under high level of risk for developing infections and other morbidities through dust, harmful gases and infective garbage materials. Since 2014, Swachh Bharat mission across India initiated by the Narendra Modi government to eliminate open defecation and improve solid waste management. This mission gave people access to toilets but the cleanup of toilet by workers often significant issue. During covid-19 pandemic had only agitated the plight of sanitation workers apart from the economic crisis they had to clean the cities exposing them full risk of infection. In the context of conservancy workers, who play an indispensable role in maintaining the hygiene and sanitation of our cities and towns, the impact of such welfare initiatives cannot be overstated. These workers often operate under harsh and hazardous conditions, facing numerous health risks, social stigma, and limited access to essential services. Despite the critical nature of their work, conservancy workers frequently remain on the fringes of social and economic policies, leading to a cycle of poverty, exclusion, and poor living standards. Governments and local bodies have implemented various welfare schemes over the years, aimed at improving the living conditions, health, and financial stability of these workers. These schemes typically encompass provisions for healthcare, education,

insurance, housing, and pensions. However, the actual reach, effectiveness, and sustainability of these programs often remain questionable. Studying the impact of welfare schemes on conversancy workers is multifaced. This includes the accessibility of healthcare services for conservancy workers in different regions of Palakkad. Examining the education opportunities and initiatives aimed at improving literacy and skills among conservancy workers, assess the adequacy and quality of housing provided to these workers through welfare schemes. The study examines the lifestyle of conservancy workers in Palakkad and focuses on their work atmosphere, health, safety and salary.

Literature Review

Occupational health concerns exist at every stage, from the collection point at residences to transportation, recycling, or disposal sites (Marahatta, Katuwl, Adhikari, &Rijal, 2017). Domestic waste collection is also an occupation that requires a lot of continuous, heavy physical strain and repetitive activities requiring effort-encompassing actions such as lifting, carrying, pulling, and pushing. Waste collectors may be exposed to several health risks and diseases during regular handling (Aminuddin& Rahman, 2015). Waste collectors in low-income countries frequently lift big loads to higher-loading locations, as the overpopulation in Kathmandu produces a large amount of waste (Pandey, 2004). Municipal solid waste is collected and sorted manually in low-income nations (Melaku&Tiruneh, 2020). Occupational health issues may occur at every stage of the solid waste management process for waste collectors and other staff (Jerie, 2016). According to several studies, garbage workers had lower lung capacity than non-waste workers (Wankhede &Wanjari, 2021). Musculoskeletal disorders (MSD) are a common complaint among waste collectors. MSD affects the waste collector's body, such as tendons, muscles, ligaments, nerves, and joints (Aminuddin& Rahman, 2015; Jayakrishnan, Jeeja, & Bhaskar, 2013). Policymakers and researchers should pay extra attention to occupational hazards and detrimental health outcomes in the waste collector occupation due to these negative outcomes (Zolnikov, da Silva, Tuesta, Marques, &Cruvinel, 2018).

Methodology

The main purpose of the study is to explore the status of conservancy workers of Palakkad with regard to occupational health. The study adopts descriptive design and the data was collected through an interview method using a questionnaire. 46 respondents were identified by purposive sampling and data complied using percentage sampling. The respondents were street sweepers, waste collectors and sanitation workers.

Findings

- Equal representation of men and women in the sample
- 82.6% of the respondents monthly earned less than Rs. 15000/-
- 54% of the respondents had completed vocational or primary education
- 45.7% of the respondents were married with three or four family members
- 69.6% of the respondents had less than 5 years of experience
- 70.5% of the workers agree that salary offered is not sufficient to take care of their families
- 54.3% of the workers opine that welfare schemes offered are not sufficient
- 58.9% of the workers are not fully aware of the schemes
- 86.9% are not satisfied with health check-ups, insurance and other facilities provided

- 83.5% of the workers face work stress
- 75.8% of the workers are not happy the quality of Personal Protective Equipment (PPE) like mask, gloves, apron, cap, rain-coat and boots
- 7.6% of the workers do not use PPE at work
- Only 12.3% of the workers were not vaccinated as they recently joined
- 61.1% of the workers had injuries at work, 54.9% of them had skin allergies, 86.4% of them were affected by back pain and 79.3% of them suffered from abdominal issues like vomiting and dysentery
- 51.4% of the workers went to Government hospitals for treatment
- 82.3% of the respondents are aware of personal hygiene practices like washing hands, bathing and having separate clothes for work.

Conclusion

Based on the findings, majority of the workers are experiencing health hazards and they are satisfied with PPE provided by the Government. These workers, often from marginalized communities, perform essential duties but face harsh working conditions, low wages, health hazards and lack of social security. Welfare programs aimed at improving their living standards, such as health insurance, housing support, and education benefits may provide some relief. For these schemes to be more effective, they need better outreach, simplified procedures, and focus on education and skill development of conservancy workers and their families to overcome their economic and health issues. Overall, while the welfare schemes have provided some improvements, much more needs to be done to ensure that these workers lead safer, healthier, and more dignified lives.

References

Alam, R., Chowdhury, M., Hasan, G., Karanjit, B., & Shrestha, L. (2008). Generation, storage, collection and transportation of municipal solid waste–A case study in the city of Kathmandu, capital of Nepal. Waste management, 28(6), 1088-1097. doi:https://doi.org/10.1016/j.wasman.2006.12.024

Aminuddin, M. S. H., & Rahman, H. A. (2015). Health risk survey for domestic waste management agency workers: Case study on Kota Bharu Municipal Council (MPKB), Kelantan, Malaysia. International Journal of Environmental Science and Development, 6(8), 629.
doi:https://doi.org/10.7763/IJESD.2015.V6.671

Dangi, M. B., Urynowicz, M. A., &Belbase, S. (2013). Characterization, generation, and management of household solid waste in Tulsipur, Nepal. Habitat international, 40, 65-72. doi:https://doi.org/10.1016/j.habitatint.2013.02.005

Gutberlet, J., & Uddin, S. M. N. (2017). Household waste and health risks affecting waste pickers and the environment in low-and middle-income countries. International Journal of Occupational and Environmental Health, 23(4), 299-310. doi:https://doi.org/10.1080/10773525.2018.1484996

Jayakrishnan, T., Jeeja, M. C., & Bhaskar, R. (2013). Occupational health problems of municipal solid waste management workers in India. International Journal of Environmental Health Engineering, 2(1), 42.

Marahatta, S. B., Katuwl, D., Adhikari, S., &Rijal, K. (2017). Knowledge on occupational health hazard and safety practices among the municipal solid waste handler. Journal of

Manmohan Memorial Institute of Health Sciences, 3(1), 56-72. doi:https://doi.org/10.3126/jmmihs.v3i1.19179

Pandey, R. (2004b). Sweepers and scavengers in third world cities: a study on occupational health problems of sweepers and scavengers of Kathmandu, Nepal. University of Oslo, Norway.
https://www.duo.uio.no/bitstream/handle/10852/15970/2/Sweepers_and_Scavengers.pdf

Patil, P. V., &Kamble, R. (2017). Occupational health hazards in municipal solid waste collecting workers of Chandrapur city, Central India. International Journal of Environment, 6(1), 46-57. doi:https://doi.org/10.3126/ije.v6i1.16867

Thakur, P., Ganguly, R., & Dhulia, A. (2018). Occupational health hazard exposure among municipal solid waste workers in Himachal Pradesh, India. Waste management, 78, 483-489. https://doi.org/10.1016/j.wasman.2018.06.020

Wankhede, P., &Wanjari, M. (2021). Health Issues and Impact of Waste on Municipal Waste Handlers: A Review. Journal of Pharmaceutical Research International, 33(46B), 577-581. doi:https://10.9734/jpri/2021/v33i46B32979

Zolnikov, T. R., da Silva, R. C., Tuesta, A. A., Marques, C. P., &Cruvinel, V. R. N. (2018). Ineffective waste site closures in Brazil: A systematic review on continuing health conditions and occupational hazards of waste collectors. Waste management, 80, 26-39.

CYBER SECURITY IN HEALTHCARE: SAFEGUARDING DIGITAL HEALTH IN THE AGE OF INNOVATION

Prostuti Bharddwwaj, Dr.PL.Sridevi Sivakami
M.sc student*, Associate Professor*
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and Higher Education for Women,
Coimbatore, Tamil Nadu 641-043

Abstract

In an era of increasing numbers of chronic diseases where emphasizing person-centric care has become a necessity, digital health has emerged as a global solution to enhance quality healthcare delivery. While digital health technologies improve patient care, they also introduce significant cyber security risks, particularly in low and middle income countries. Despite making an effort, the healthcare sector has failed to maintain data security effectively. This review highlights critical cyber security threats to the healthcare system, including endpoint vulnerabilities, inadequate user authentication and excessive user permissions, which make healthcare a prime target for cybercriminals. According to an FBI report in 2021, ransomware is the most common cyber-attack in the healthcare sector. Additionally, concerns have been raised about the security of genomic data, with pathogen databases at risk of cyber-attacks that could compromise integrity or enable unethical manipulation. This emphasizes the need for emerging technologies like blockchain and encryption, alongside cyber security awareness, to enhance security and reduce human error. In conclusion, as digital health continues to evolve, the development of the regulatory framework and implementation of robust cyber security strategies is crucial to ensuring patient safety and maintaining the trust necessary for the successful adoption of healthcare innovations.

Keywords: *digital health , cyber security risk , data security , encryption , emerging technologies.*

Introduction

Digital technology has revolutionized a number of fields and industries, including research, industry, education and most recently, healthcare. The term "digital health" implies a wide range of tools and methods used to enhance medical results**(Pawar et al., 2024)**. In 2000, Seth Frank initially proposed the idea of "digital health," which primarily refers to Internet-based media and apps that improve medical content, connectivity and commerce. As technology has advanced, digital health has broadened to include a much greater range of scientific ideas and tools, such as wearables, mobile applications, big data technology, genomics, artificial intelligence methods, telemedicine and the Internet of things. The idea of digital health is a dynamic one that has become extremely significant during the pandemic, when social distance and lockdowns forced widespread adoption of digital health and health technologies worldwide **(Kostkova, 2015)**.The Food and Drug Association**(FDA)** says digital technology has been accelerating a revolution in healthcare, from artificial intelligence and machine learning to mobile medical apps and software that assist physicians in their daily clinical decisions. Digital health tools offer enormous promise to improve individual health care delivery and our capacity to accurately detect and treat disease.**(FDA 2020).**Digital technologies in healthcare have a significant impact on how health services are provided and

how the health service as a whole functions. Data management became the primary emphasis of digital healthcare in order to achieve this. By 2025, the digital health market is projected to reach 38 billion. Global financing for digital health was 13.9 billion as of 2020, demonstrating the healthcare industry's ambition to integrate digital technologies into clinical procedures **(Digital health- statistics and facts, 2021)**

Fig 1:- Digital Health Application Worldwide

India's digital health ecosystem is growing rapidly, using cutting-edge tools and approaches to solve healthcare issues. Enhancing access, delivery and results is the goal of integrating data, technology and electronic communication in healthcare, especially in rural regions.**(Makal, 2023).** Telemedicine, electronic health records, mHealth and health information exchanges are important elements. In light of the increasing global need for digital health and advancement of literacy rate in the country, the Government of India prioritised the digitization of healthcare through the National Digital Health Mission (NDHM)**(Gudi et al., 2021)**.The government further introduces Ayushman Bharat Digital Mission and integration of biometric identification to enhance healthcare delivery**(Narayan et al., 2024)**

Table I : Digital Health Technologies in India (created by author)

Technology	**Used for**	**Benefit**
ICDS-CAS (integrated child development services) common application software	AWW (Anganwadi Worker)	This technology aids in enhancing both the real-time monitoring (RTM) system for nutritional outcomes in the Anganwadi and the service delivery system.
ANMOL app (ANM online)	ANM (Auxiliary Nurse Midwife)	Helps to track pregnant women for ANC and children for immunization
e-Health record card	Any individual	Store patient records, enabling quick access to medical history and reducing paperwork. They enhance coordination between healthcare providers, leading to better diagnosis and treatment.
Kilkari app	Pregnant women and Lactating women	Provides free, timely audio messages to pregnant women and new mothers in India, offering crucial health information to improve maternal and child care.

Telemedicine/national tele consultation service: (e-Sanjeevani)	Doctor-patient consultation	Provides healthcare services to patients in their homes.
RCH portal (Reproductive and Child Health)	Women	Monitor the health condition of both newborn babies and pregnant women.
eVIN (electronic Vaccine Intelligence Network)	Immunization	Helps in real-time monitoring of stock and storage temperature of the vaccines
CoWIN app	Immunization	Widely used during the pandemic for the beneficiaries to register themselves for vaccination
Arogya setu app	Surveillance	Contact-tracing app that helps users assess risk, stay informed and access health services.
IHIP (Integrated Health Information Platform)	Surveillance	Enables real-time disease surveillance, data integration and efficient public health response in India.
Tuberculosis-NIKSHAY, DOTS-99 (Directly Observed Treatment Short Course), MERM (Medication Event Reminder Monitor) box	Doctor-patient	Real-time monitoring, notification and case management purposes
HIV-SOCH (Strengthening Overall Care of HIV beneficiaries)		
Leprosy-NIKUSHTH		

Artificial Intelligence	Individual	Helps in screening, diagnosis and management of health-related events through the use of machine learning, the Internet of Things and other artificial intelligence techniques

Although digital health has potential advantages, like ongoing data collecting, risk assessment and better diagnosis and treatment, there are also disadvantages. These include the requirement for clinical validation, issues with regulations, transparency and the confidentiality of medical data. Moreover, these technologies also introduce significant cybersecurity risks, particularly in low- and middle-income countries. Major loopholes including endpoint vulnerabilities, inadequate user authentication and excessive user permissions, make healthcare a prime target for cybercriminals **(Uzzaman, 2018).**Despite of making efforts, the health care sector has failed to maintain data security and protect privacy effectively. Medical data leaks and breaches are so common that when compared to other industries they are found to be three times more. As per an **Federal Bureau of Investigation** report, 148 organizations from the healthcare sector have complained about data breaches and cyber-attacks. This highlights the severity of cybercrimes in and around healthcare.

Cyber-Attacks Prevailing in the Healthcare Sector

The **United States National Institute of Standards and Technology (NIST)** defines cyber attacks as "any kind of malicious activity that attempts to collect, disrupt, deny, degrade, or destroy information system resources or the information itself. The rise in Internet of Things (IoT) gadgets and connected medical devices has raised concerns about cyber security in the healthcare industry. Protecting their networks against ransomware attacks, data breaches and even medical device tampering are just a few of the issues that healthcare organizations are dealing with. Weak defences a large number of data access points and time-sensitive nature of healthcare services are the main causes of the vulnerabilities. Cyber attacks can cause major financial losses, disruptions in the provision of treatment and the leakage of patient data.

Table II: Common Cyber Attacks in Healthcare Sector(created by author)

S.no	Type	Description
1	Injection attack	The cyber attacker may inject any web application with malicious data. The most common injection attacks are malware. Malware is a computer code that is used to gain unauthorized access.
	SamSam	SamSam is an expert in exploiting Java-based web server vulnerabilities, RDP and FTP to get access to the victims' computers. It is a kind of malware that first surfaced in late 2015.
	Locky	It works by looking for specific file types on the victim's

		storage, including network drives and then encrypting them using RSA and AES. It was introduced in 2016 and used a hybrid cryptosystem.
	Netwalker	In a netwalker attack, the attacker encrypts every Windows-based device on the victim's network. The attacker can execute his attack using executable files that transit across networks or phishing emails.
2	Social engineering	It is a technique where an attacker takes advantage of the victim's psychological weaknesses through social interactions to get them to reveal important information.
	Phising	Phishing is a technique of social engineering used by hackers to deceive their victims into disclosing private information such as bank account details, usernames and passwords. Specifics, etc. To do this, a malicious program is downloaded or a link to a fraudulent website is clicked, deceiving the victim.
3	Denial of Service (DoS)	Is a kind of cyber attack is mostly concerned with using up resources, such as memory or processing power. This attack can be carried out via cable or wireless connections. Distributed denial of service attacks are a specific type of DoS attack that targets websites. An attacker utilizes malicious software that has been installed on multiple other computers to attack a single victim. The website is meant to stop functioning.

RDP: Remote Desktop Protocol; FTP:File Transfer Protocol; RSA:Rivest–Shamir–Adleman; AES: Advanced Encryption Standard

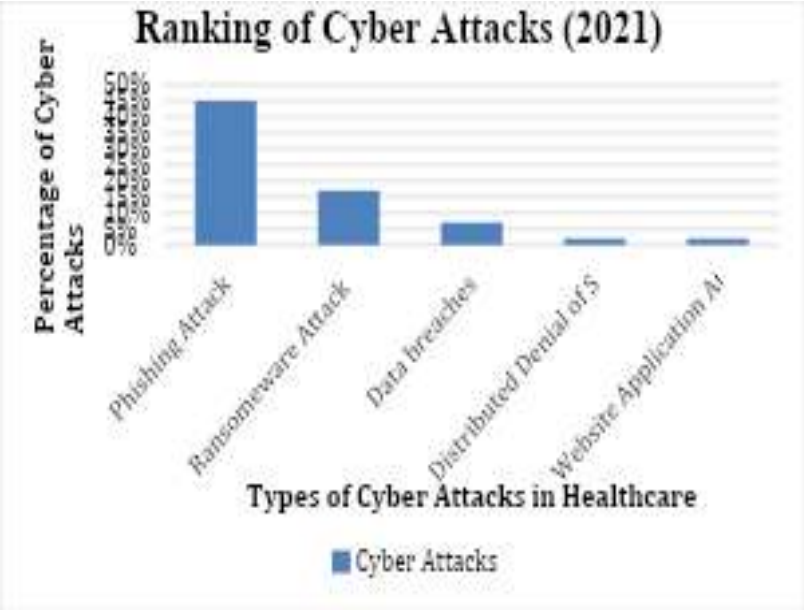


Fig 2: A compilation of 2021's top attacks
(HIMSS Healthcare Cyber security Survey Report 2021)

In recent years, a number of significant cyberattacks have targeted healthcare organizations. Ninety-four percent of health institutions worldwide reported patient and hospital data breaches. In March 2020, the World Health Organization was the target of a phishing attack. By building an illegal website that mimicked the organization's internal email system, cybercriminals aimed to obtain credentials from WHO employees. Despite failing, the attempt demonstrated the sophistication of phishing attempts directed at healthcare institutions**(She et al.,2020)**.The healthcare sector has suffered severe reputational harm and financial losses as a result of recent cyber security events like the WannaCry ransomware attack and the 2016 Hollywood Presbyterian Medical Centre ransomware attack**(Ehlam,2023)**Similarly, the 2017 WannaCry ransomware attack affected more than 150 countries, forcing the UK's National Health Service (NHS) to reschedule treatments and cancel appointments**(Collier R. 2017).**The Irish Health Service Executive (HSE) experienced a ransomware attack in 2021 that seriously interrupted healthcare services**(Balaji et al.,2023)**.Cyber threats have also increased in Low- and Middle-Income Countries' health systems. In 2020, a ransomware attack on Thailand's East Asia Saraburi Hospital was followed by a hack on the Public Health Ministry. When combined, this might have led to the theft of 16 million medical records. Similar to this, a 2020 attack on Life Healthcare, a private provider in South Africa, affected with email servers, business processing systems and admissions systems **(Hasegawa et al.,2024).**

After the United States and China, India has the third-highest number of internet users worldwide. Between 2012 and 2017, the number of users increased sixfold at a compound annual growth rate of 44 percent. India joins the United States as one of the top 10 countries in the world for sending spam. In a survey released on October 22, the online security company "Symantec Corp." listed India as one of the top five nations impacted by cybercrime.Recent cyberattacks on Indian healthcare institutions have highlighted the vulnerability of the sector's digital infrastructure**(NITI AAYOG, 2019)**.In 2020, a massive data leak occurred when sensitive information regarding COVID-19 test results of Indian citizens was made publicly accessible due to a security lapse in the systems of private testing labs. The leak exposed millions of individuals' personal and medical details, including their COVID-19 test results, phone numbers and other personal health data**(Dar and Wani , 2023)**.The All India Institute of Medical Sciences (AIIMS) in Delhi suffered a major ransomware attack in 2022, disrupting critical services and compromising patient data. The cyberattack crippled the hospital's IT systems, causing delays in patient services, including access to medical records and diagnostic systems. Attackers reportedly demanded a ransom, though it wasn't paid. **(Gandhi and Pahwa, 2024).** This incident is part of a broader trend, with India ranking second globally in healthcare-related cyber attacks in 2022**(Talwar and Mehra, 2024).** A similar attack occurred at the Safdarjung Hospital in New Delhi in November 2022, but the hospital was able to promptly restore its system and there was no sign that any data had been compromised. In 2022, the Indian Council of Medical Research (ICMR) suffered a cyberattack that led to the breach of sensitive data, including research documents and personal information of health professionals. The breach exposed vulnerabilities in India's public health data management systems, raising concerns over data security in critical government institutions **(ET World Health ,2023)**

International College for Security Studies (ICSS,2023)highlights that 5,898 cyberattacks targeting healthcare and medical institutions occurred in India in 2020, a 37 percent increase from 2019.In 2020, 16.3percentof all cyberattacks in India targeted the healthcare industry, making it the second most targeted sector. At 44.8percentof all attacks, phishing attacks were the most prevalent kind against healthcare institutions. With ransomware attacks making up 21.5percentof all attacks, they were the second most prevalent kind. In 2020, India saw 20 ransomware assaults on average every day.

According to a study by **Vinatzer et al., (2019)** another potential target for the cyber criminals could be the genomic database. Public genome databases are becoming more and more significant for current biological research. Designing and carrying out biological studies in many animals depends heavily on the information provided by genome databases, which include genomic sequences, gene annotations, protein sequences, protein interactions and metabolic networks. Research indicates outbreaks of foodborne pathogens that could potentially impact thousands of people can now be tracked using metagenomic sequencing. Additionally, a recent study demonstrated that metagenomic sequencing can even disclose an individual's identify. Although online genome databases are crucial for biological and pathogenic research, there is little debate that concentrates on biosecurity and threats related to cyber security. Gaining access to private data is a primary driving force for cyber attacks. The majority of public genome databases don't include private, sensitive data such as social security numbers or credit card numbers, for example, but they do contain a person's genetic information, which is arguably the most "personal" of all. The attacker attempts to correlate certain individuals or user groups to biological data. Attackers can take advantage of an unconfirmed data transfer procedure in a number of ways. The provision of inaccurate data, intended to direct future research toward particular results. Another kind of attack involves gradually inserting false records into a bigger collection of valid data. The attacker could, for instance, download already-existing data from the database, remove a portion of the data and add false data. Probabilistic analysis-based detection methods may not be able to identify the faulty records in this situation. Even though the information that is currently available shows that genome databases have not been identified as the main targets of cyber security threats as the population of users of genome databases are mainly research scientists and accounts for a small percentage of the entire population. Also advanced and expensive technologies are required to exploit the data. But genome databases are susceptible to numerous basic cyber security risks. Genome database disruptions may result in lost private information, lost research funding and decreased productivity.As knowledge and training spreads and with technological advances, it becomes less expensive and easier to exploit data and hence cyber security is important in protecting sensitive, private and health-related genomic data.

CYBER SECURITY

Cyber security is a means of protecting the confidentiality, integrity and availability of information while preventing illegal access to networks, devices and data. Information security has gained more attention in the last decade. There have been numerous previous cyber attacks in the consumer and business sectors and the most recent ones in the healthcare sector are concerning. The above mention facts and data have highlighted the need of cyber security very well. Recent research have highlighted few of the measure that can be beneficial to prevent cyber crimes within the health care industry.

Table III. Proposed Cybersecurity Solutions for Healthcare Industry

Solution	Description	Reference
Mutual authentication solution	The researchers develops a protocol that employs biometrics to preserve user anonymity and integrates key negotiation and authentication to ensure privacy and access control.	Chenet al., (2022)
Authentication and key agreement solution	The study suggested a security plan to guarantee data integrity, transparency, decentralization and efficient physical security. It can ensure "mutual authentication," "untraceability" and "anonymity" while thwarting a number of security threats, such as "impersonation," "session key disclosure," and "forgery" attacks.	Yuet al.,(2022)
Lightweight authentication solution	To improve the security and privacy of CHI (Connected Health Infrastructure) in IoMT (Internet of Medical Things) applications, the researcher introduced a novel technique named as RAPCHI (Robust Authentication Protocol for IoMT-based CHI). Without keeping information in a cloud database system, RAPCHI creates a session key between the patient and the doctor and creates an authentication and key agreement between the patient, cloud server and doctor.	Kumar et al.,(2022)
Blockchain based solution	The researchers develops a protocol in which cloud servers manage a blockchain where all medical data is kept, which makes it safe and impenetrable.	Garg et al., (2022)

Numerous organizations and experts have acknowledged the need for cyber security training for healthcare workers. In academia and the healthcare industry, there is an actual need for formal training and educational standards to help firms handle human components of cyber security and significantly reduce cyber risks. Several healthcare institutions provide cyber security training to their employees. It has been demonstrated that raising healthcare professionals' knowledge and training levels is crucial to successfully prevent phishing.

Additionally , studies have proposed a range of technical measures to mitigate cyber-risk:-

1. Installing network security device such as firewall
2. Performing regular backups
3. Turning off unnecessary physical ports to limit access to USBs
4. Placing authorized applications on a registry.
5. Issuing patches and updates on a regular basis;
6. Regulating user authentication and access permissions to medical resources by applying the least privilege concept.
7. Installing anti-virus

8. Establishing incident report tracking and audit trails.
9. Putting in place data encryption for use in transit and at rest
10. Installing intrusion detection and network monitoring software.
11. Secure system configurations.
12. Using apps to protect mobile devices.

REGULATORY FRAMEWORK

Some of the developed countries have their own regulatory frame work to control cyberthreats, as listed in the table below.

Table IV: Regulatory Framework for Cybersecurity in Healthcare

Regulations	Region	Descriptions
Health Insurance Portability and Accountability Act (HIPAA) 1996	United States	Sets standards for protecting sensitive patient health information from unauthorized access, ensuring privacy and security. It mandates healthcare organizations to implement safeguards for electronic health records (ePHI) and outlines breach notification procedures.**(CDC, 2024)**
General Data Protection Regulation (GDPR) 2016	European Union	Setsstrict guidelines for the collection, storage and processing of personal data to protect individuals' privacy and rights.**(European Union)**
Food and Drug Administration	United States	FDA oversees the cybersecurity of medical devices. It has designed guidelines to ensure that medical device manufacturers incorporate cybersecurity measures to protect patient safety**(US FDA.gov)**

Conclusion

In conclusion, the healthcare industry's quick adoption of digital technologies has transformed care delivery while simultaneously posing new and challenging cyber security issues. To safeguard sensitive patient data and maintain the integrity of healthcare operations, the growing reliance on telemedicine, IoT devices, AI systems and electronic health records necessitates strong and creative security measures. Although there is great potential for better patient outcomes and operational efficiencies as a result of the development of healthcare technologies, there are also risks which malicious agents could take advantage of. As a crucial element of their digital transformation strategies, cyber security must be given top priority by healthcare organizations. This entails not just making investments in state-of-the-art security solutions but also encouraging stakeholders and healthcare professionals to adopt a cyber security-aware culture. Standards for data protection are mostly determined by regulatory frameworks like the General Data Protection Regulation (GDPR) in Europe and Health Insurance Portability Accountability Act (HIPAA) in the United States, but ongoing adaptation to new risks is required. Furthermore, building a safe and robust healthcare

ecosystem will require cooperation from lawmakers, cyber security specialists and healthcare providers. In the end, safeguarding digital health in the era of innovation necessitates a comprehensive strategy that strikes a balance between the advantages of new technology and the necessity of protecting patient data and privacy. Healthcare organizations can guarantee that the digital health revolution benefits patients and practitioners while maintaining the security and confidentiality of sensitive health information by proactively tackling cyber security challenges.

References

Al-Qarni, Elham. (2023). Cybersecurity in Healthcare: A Review of Recent Attacks and Mitigation Strategies. International Journal of Advanced Computer Science and Applications. 14. 10.14569/IJACSA.2023.0140513.

Balaji, Dr & Raghunathan, Dr &Aravinth, Vetrivel &Sivasamy, Shyam & V, Swetha &Chaly, Dr. (2023). Cyber Attack - Envenom in Indian Healthcare – A Review. International Journal of Research Publication and Reviews. 4. 1262-1266. 10.55248/gengpi.4.623.45359.

Collier R. (2017). NHS ransomware attack spreads worldwide. *CMAJ : Canadian Medical Association journal journal de l'Associationmedicalecanadienne*, *189*(22), E786–E787. https://doi.org/10.1503/cmaj.1095434

Coventry, L., &Branley, D. (2018). Cybersecurity in healthcare: A narrative review of trends, threats and ways forward. *Maturitas*, *113*, 48–52. https://doi.org/10.1016/j.maturitas.2018.04.008

Dar, M. A., & Wani, S. A. (2022). COVID-19, Personal Data Protection and Privacy in India. *Asian bioethics review*, *15*(2), 125–140. https://doi.org/10.1007/s41649-022-00227-0

Dawson, J., & Thomson, R. (2018). The Future Cybersecurity Workforce: Going Beyond Technical Skills for Successful Cyber Performance. Frontiers in Psychology, 9, 1–12. https://doi.org/10.3389/fpsyg.2018.00744

Gudi, N., Lakiang, T., Pattanshetty, S.M., Sarbadhikari, S.N., & John, O. (2021). Challenges and prospects in india's digital health journey. *Indian Journal of Public Health, 65*, 209 - 212.

Hasegawa, K., O'Brien, N., Prendergast, M., Ajah, C. A., Neves, A. L., &Ghafur, S. (2024). Cybersecurity Interventions in Health Care Organizations in Low- and Middle-Income Countries: Scoping Review. *Journal of medical Internet research*, *26*, e47311. https://doi.org/10.2196/47311

Kapoor, Suraj. (2022). Digital Health Ecosystem in India: Present Status, Challenges, and Way Forward. D Y Patil Journal of Health Sciences. 10. 10.4103/DYPJ.DYPJ_27_22.

Luna, R.D., Rhine, E., Myhra, M., Sullivan, R., & Kruse, C.S. (2016). Cyber threats to health information systems: A systematic review. *Technology and health care : official journal of the European Society for Engineering and Medicine*, *24 1*, 1-9 .

Makal, S. (2023). A Study on Digital Healthcare in India. *International Journal of Social Science, Technology and Economics Management*.

Ms Mrithula[1],
[1] Studetnt,, Central University of Tamil Nadu,=

Abstract

Digital Health is the use of technology, such as smartphones, wearables, applications, and software, to improve and manage the health. Ultimately, the objective of digital health is to enhance the efficiency, accessibility, and personalization of healthcare through the use of digital tools. There have already been numerous technological innovations in healthcare, such as smartwatches that track users' step count, heart rate, sleep duration, and more. As digital health tools continue to evolve, they promise to improve overall healthcare outcomes, reduce costs, and make healthcare more inclusive and patient-centered. The tools became an essential advancement in the field of technology during the COVID-19 pandemic. People faced significant challenges in adapting to the new technology. This research paper examines the impacts of digital healthcare tools widely on Gen Y and Gen Z.

Keywords : COVID-19, technology, healthcare, psychological health, innovation.

Introduction

In the modern era, the digitalization of the medical field is of paramount importance. Digital technology has now been developed and applied to every aspect of health and health care. As technology advances, it is crucial for healthcare systems to continually evolve, just as humans do. This ongoing evolution can be facilitated by leveraging digital tools. According to the World Health Organization (WHO), "Digital technologies are now integral to daily life, and the global population has never been more interconnected. Innovation, particularly in the digital sphere, is happening at an unprecedented scale. Despite this, the application of these technologies to enhance population health remains largely untapped, presenting immense opportunities for the use of digital health solutions."

Literature Review

The paper takes a deep dive into how the COVID-19 pandemic accelerated the use of digital technology and what that means for both research and everyday life. It explores the major shift towards remote work and online education, bringing attention to challenges like constant workplace monitoring, digital burnout, and the expanding gig economy. The authors also raise important concerns about internet access and regulation, touching on issues like the digital divide, net neutrality, and government-imposed internet shutdowns.

Beyond that, the paper highlights the growing risks of online fraud, the increasing reliance on digital payments, and the delicate balance between public safety and personal privacy in the age of digital surveillance. In the end, it makes a strong case for further research to understand and navigate the lasting effects of this digital transformation, helping shape better policies and practices in a post-pandemic world. *(Rahul De'a, Neena Pandeyb, AbhipsaPalc, Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice, 2020).* The rapid rise of digital technology has reshaped healthcare, changing the way patients access and interact with medical services. This literature review explores how different generations perceive and use digital health technologies, with a particular focus on Healthcare Patient Portals (HCPPs). Highlights of some healthcare portals are as follows:

Digital Healthcare and Patient Experience:

Digital healthcare solutions, such as HCPPs, have given patients more control over their health by providing easy access to medical records, appointment scheduling, and secure communication with doctors. While these technologies make healthcare more accessible, they also come with challenges. Some patients feel overwhelmed by too much information, worry about privacy and security, or miss the personal connection with healthcare providers.

Generational Differences in Technology Adoption:

According to Generational Cohort Theory, people who grow up in the same era share similar life experiences, shaping their attitudes towards technology. This helps explain why different generations adopt digital health tools in unique ways.

Generation X (born 1961-1981): Gen Xers grew up as technology adopters rather than digital natives, making them more cautious about digital healthcare. They prioritize security, transparency, and personal connections in their healthcare experiences. They also rely on multiple sources for health information, preferring traditional communication methods over digital-only interactions.

Millennials (born 1982-2000): Having grown up with technology, Millennials are comfortable using digital health apps, social media, and online resources to manage their health. They value convenience, quick responses, and the ability to engage with healthcare providers online.

Ease of Use and Perceived Value in Digital Healthcare:

When it comes to adopting digital health platforms, ease of use and perceived benefits play a major role.

Generation X: For Gen Xers, how easy a platform is to use and the clear benefits it offers strongly influence their willingness to engage with digital health tools. Since they did not grow up with these technologies, they may require more intuitive design and clearer incentives to adopt *HCPPs.*

Millennials: Because Millennials are more accustomed to digital platforms, ease of use is less of a concern for them. They are more likely to use HCPPs regardless of complexity, as long as they see value in the service.

How Generations Differ in Digital Healthcare Usage:

Even with digital tools available, different generations prefer different ways of engaging with healthcare services. Gen Xers often prefer direct conversations with healthcare providers rather than relying solely on digital platforms. They may use HCPPs for convenience but still appreciate in-person interactions. Millennials tend to embrace digital communication, opting for mobile health apps, online consultations, and telemedicine over traditional office visits. Their preference for instant access and flexibility drives their reliance on digital healthcare tools.

Implications for Healthcare Providers and Policymakers:

Understanding these generational differences is key to improving patient experience and engagement with digital healthcare. Healthcare providers should design HCPPs and other digital tools with different levels of digital literacy in mind, ensuring they are accessible and user-friendly for all age groups. Policymakers must address concerns around privacy, security, and digital inclusion to ensure that no one is left behind in the shift to digital healthcare. *(Linda Alkire (n´ ee Nasr), et. al., Patient experience in the digital age: An investigation into the effect of generational cohorts, 2020)* This research paper explores how

the COVID-19 pandemic affected India, focusing on the country's policies and use of technology to manage the crisis. It looks at India's early response, including a strict lockdown and demographic factors that initially kept case numbers lower than in many developed nations. However, economic pressures led to a phased reopening, which caused a surge in cases. The study examines the challenges posed by limited healthcare spending and infrastructure while also highlighting how technological advancements helped mitigate some of the damage. It points to key strategies like asymptomatic testing and public-private partnerships as essential tools for managing the crisis until a vaccine became widely available. Additionally, the paper discusses the pandemic's economic toll, from job losses to financial instability, and underscores the urgent need to strengthen India's healthcare system to better prepare for future health emergencies. *(Isha Goel, at. el., Effects of the COVID-19 pandemic in India: An analysis of policy and technological interventions, 2021)*

World Health Organization (WHO) is an agency that was established on 1948, by the United Nations to work for the improvisation of the global health. WHO has been actively working to digitalize the medical field and promote the adoption of eHealth services.

In 2005, The Fifty-eighth World Health Assembly [WHA58.28] passed a resolution stating that, to formulate a long-term strategic plan for developing and implementing eHealth services. It aims to promote the equitability, affordability, and accessibility of eHealth services globally, ensuring that all populations, regardless of their geographical location or socioeconomic status, can benefit from these advancements. More than 120 Member States, including low and middle-income countries have developed those strategies and policies. In 2013, The Sixty-sixth World Health Assembly [WHA66.24] passed a resolution to standardize and develop the ability of systems that use different technologies to communicate and share data with each other. The resolution paved a way for the member states to frame policies and legislative mechanisms linked to the overall National eHealth strategy. According to the 2015 World Health Organization (WHO) global survey on eHealth, 70% of reporting countries in the WHO Europe region had an eHealth policy or strategy in place, but only 27% had one for telehealth. Nordic countries were reported to be further ahead in developing digital health policies and strategies than elsewhere. In general, digital tools are technological advancements designed to make human life easier. Those are essential in the field of healthcare to improve the efficiency and accessibility of the human beings to maintain the physical and mental health. These advancements can include devices, software, applications, or digital systems that help to manage, solve problems, and improve the quality of life across various fields. A central challenge has been generating the broad motivation to take this on and to invest time and energy in meeting the wider challenges of making best use of digital health tools. Though the digital tools are being evolved, it is vital to be aware of the challenges in making the effective usage by individuals and organizations level. Some digital tools that were invented for the healthcare are eHealth, Telemedicine, Wearable devices, Patient portals, Mobile apps. *(Fahy N, et.al. Use of digital health tools in Europe: Before, during and after COVID-19.)*

Research Gap

The psychological barriers that influence Gen Y's choices are uncovered. Factors like trust, perceived risk, and privacy concerns play a significant role in determining whether

someone embraces or avoids digital healthcare, but these aspects remain underexplored. Though Generation X acknowledge the convenience of digital healthcare tools, many still hesitate to fully adopt them.

Another area that deserves attention is the emotional and psychological impact of reduced face-to-face healthcare interactions. For many patients, especially those who value personalized communication with their healthcare providers, digital healthcare can feel distant or impersonal.

While digital health tools like Healthcare Patient Portals (HCPPs) have been widely studied, there's still limited research on how newer innovations—AI health assistants, wearable devices, and telemedicine—are received by different generations.

Statement of the Problem

1. Why are generation Y still hesitant to adopt to the digital technology?
2. Does the digital technology have any impact on the mental well-being of the generations who opt traditional approach?
3. Do these technologies enhance healthcare accessibility across generations, or do they contribute to the digital divide?
4. Are the social media and health apps truly improving health literacy, preventive care, and long-term habits?

Objectives

This article focuses on the development of the digital technology-

1. To maintain the mental health and well-being of the digital technology users in the healthcare.
2. To discuss the impact of digital technology on people who belong to Millennials (1981 – 1997) and Gen Z (1997 – 2012) especially during the COVID-19 pandemic.
3. To determine whether digital healthcare access is equitable for Millennials and Generation Z.
4. To analyze the health literacy and the way of understanding the digital technology by different generations.

Scope of the Study

This study explores how digital healthcare tools—like telemedicine, AI assistants, mobile health apps, and social media—are shaping the way Millennials (Gen Y) and Gen Z manage their health. While these generations are known for their tech-savviness, there is still a limited understanding of how much they trust, interact with, and benefit from these digital innovations. This study aims to bridge these gaps by examining how digital tools shape the healthcare behaviors, perceptions, and challenges of Gen Y and Gen Z, ensuring that digital health solutions are truly inclusive and effective for the next generation.

Methodology

This research takes a Doctrinal Approach, meaning it dives deep into existing studies, policies, and regulations to understand how digital healthcare has evolved. Instead of conducting experiments or surveys, it carefully examines past research, legal frameworks, and expert analyses to piece together a clear picture of how technology is transforming healthcare.

Findings

Digital healthcare during COVID-19:

Before COVID-19 pandemic emergence in the world, the digital health tools were seen as just a potential upgradation in the field of medicine. Before COVID-19, technological

advancements in healthcare progressed at a slower pace. However, during the pandemic, digital technology became an immediate necessity, requiring doctors, healthcare professionals, and the general public to rapidly adapt to its use. Digital technology had its main usage in four areas in the medical field.

1. Communication of information and also tackle the misinformation i.e., spreading of rumors everywhere.
2. Surveillance and Monitoring of patients.
3. Providing healthcare remotely because of lockdowns.
4. Monitoring the vaccination process.

Communication of information:

Many countries were using digital tools to convey information regarding the COVID-19 cases, either through existing tools or the new tools developed specially during this pandemic situation. Some webpages and dashboards are developed to display the live data like, number of cases, number of deaths, vaccination counting and so on. Even apps were developed to share the information about the spread of viruses with general civilians.

For Example, in Spain, the Ministry of Health has set up a web portal and a mobile app (in multiple languages) targeting tourists travelling to Spain, named 'Spain Travel Health'. This app provides information on the entry conditions, up-to-date information on the epidemic situation in Spain, and shows public health recommendations to follow upon arrival. A technology for tracking of mobile phone movements have also been used to monitor the effectiveness of social distancing.

Monitoring and Surveillance:

Most of the countries in Europe, like Estonia, were already using some digital tools for the purpose of monitoring and surveillance. The above said countries adopted the same digital tools, during the pandemic also. Digital tools were efficiently used and managed. Genomic Surveillance was emerged during that period. It is a digital tool, where the scientists track the spread of variants, monitor changes to the genetic code of SARS-CoV-2 variants. Collectively, this information is used to better understand how variants might impact public health. Many countries, such as Austria, Belgium, Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Georgia, Germany, Iceland, Ireland, Italy, Malta, Russia, Spain, Ukraine, and the United Kingdom, have introduced contact-tracing apps to help manage the spread of COVID-19. Most of these apps rely on Bluetooth technology to track potential exposures, while some, like those in Russia, also use geolocation services, including monitoring bracelets, to enhance tracking efforts.

Supporting Provision of health services:

Countries like France, Iceland, Italy, Luxembourg, and the Netherlands have embraced digital health solutions to help COVID-19 patients recover safely at home. These initiatives have provided support for those with mild symptoms as well as patients transitioning from hospital care. Some rely on simple self-monitoring, while others use more advanced methods like virtual doctor consultations, oximeters to track oxygen levels, and dedicated healthcare staff, such as nurses, actively checking in on patients. By leveraging technology, these efforts have made it easier for people to recover comfortably while staying connected to medical professionals.

Monitoring the vaccination process:

Digital health tools have been instrumental in identifying individuals eligible for vaccination and tracking those who have been immunized.

The challenges associated with COVID-19 vaccination programs extend beyond logistical concerns. Limited initial vaccine supplies and shortages of healthcare workers required countries to establish prioritization categories, identifying specific population groups based on factors such as age or chronic conditions. The ability to accurately identify and track these priority groups largely depends on the availability and capacity of digital health systems that store relevant information.

Additionally, effective prioritization often requires integrating data from external systems beyond the healthcare sector. For instance, identifying priority groups based on occupational criteria may necessitate linking health records with employment or government databases, ensuring a comprehensive and efficient vaccination rollout. *(Fahy N, et.al. Use of digital health tools in Europe: Before, during and after COVID-19.)*

In India, an application named AarogyaSetu, developed by the National Informatics Centre under the Ministry of Electronics and Information Technology (MeitY), along with initiatives like the National e-Health Authority and updated telemedicine guidelines, is helping shape the National Health Stack, which is set to be completed by 2022. These efforts are designed to bridge healthcare gaps, especially in remote areas, while also enabling smarter, data-driven public health policies. By leveraging technology, these initiatives are making healthcare more accessible and effective, particularly for those in the country's most underserved regions. Indian states have embraced technology in innovative ways to tackle challenges brought on by the COVID-19 pandemic. In Jharkhand, the government has introduced Collaborative Robots (Co-Bots) to assist in various tasks, while in Bengaluru, India's tech hub, drones are being used for disinfecting public spaces, monitoring containment zones, conducting surveys, and making public announcements.

Other states like Telangana, Karnataka, and Gujarat, as well as cities such as Varanasi, have implemented similar technological solutions to navigate the crisis. State governments are also using digital tools to track and manage the availability of essential medical supplies, including ventilators, N95 masks, and personal protective equipment (PPE), ensuring they reach those in need. Beyond healthcare, technology is playing a key role in improving livelihoods and access to essential services. By using aggregator apps, small vendors—such as neighborhood vegetable sellers and e-rickshaw drivers—can now offer home deliveries and receive monthly payments, helping them secure a stable income. In education, many schools have shifted to online learning, and for students and teachers with limited internet access, mobile phones have become a valuable tool for continuing education. By integrating technology into daily life, Indian states are not only addressing immediate pandemic-related concerns but also laying the groundwork for more connected and resilient communities in the future. *(COVID-19 has accelerated India's digital reset, World Economic Forum, 2020)*

Discussions

Maintaining mental health and well-being in the digital healthcare era is crucial. While digital tools offer convenience, they must not take the place of direct consultation with doctors. Online health information can be misleading, leading to stress and incorrect self-diagnosis. A balanced approach is essential—digital tools can assist in tracking health, but

professional medical advice remains irreplaceable. Healthcare providers, policymakers, and tech developers must collaborate to establish guidelines, awareness campaigns, and regulated, evidence-based platforms to provide appropriate health advice or information. Rather than replacing traditional medicine, digital healthcare should complement it. Informed decision-making is key to ensuring accessibility while safeguarding both physical and mental well-being.

Traits of Generation Y or Millennials: The persons who belong to the Generation Y period, are the first generation to grow synchronically with the globalization of the digital world. The Millennials are exposed to the technology from an early age, so they are technologically savvy.

Traits of Generation Z: The persons who belong to the Generation Z, has grown up in a world where the internet is always at their fingertips, surrounded by smart devices and social media from day one. This constant connection hasn't just influenced how they interact with technology—it's made it an essential part of their daily lives. Whether they're chatting with friends, picking up new skills, or hunting for the perfect meme, technology is woven into everything they do. But they're not just using it—they're redefining it. With their creativity and curiosity, they're pushing the boundaries of what's possible, shaping a future that's more innovative and tech-driven than ever before.

Digital tools have revolutionized healthcare, making it easier to access medical services, communicate with providers, and manage personal health. While Millennials (Gen Y) and Gen Z are often seen as tech-savvy, their actual engagement with digital healthcare remains uneven and poorly understood. Due to Gen Y's lack of proper knowledge or negligence, they often rely on unauthorized health advice

The above findings, discloses about the technological advancements introduced. The Generation Y, also known as Millennials, were concurrently growing with the technology. The technological development was witnessed by the Gen Y's, but could not get along with the technology. Many reasons like trust issues, privacy, lack of direct communication, feel difficult to open up their mind, unable to share the health issues remotely and so on.

To eliminate the fear of miscommunication with doctors through digital tools, double step confirmation process can be done. i.e., consult to a physician directly through traditional approach, after using digital technology. Even though it consumes excess time duration compared to the current technology, it is safe as it involves in the health of the patient.

The Gen Y prefer for human interaction over digital interfaces, as there is no emotional connect with the digital tools. Currently, everything around us falls under the light of Artificial Intelligence (AI). At this situation, there is a no connection or interaction between humans. Digital healthcare tools have made life easier in many ways, but not everyone finds them equally accessible. Millennials, unlike Gen Z, often struggle with adopting these technologies. Since they didn't grow up fully immersed in the digital world, navigating complex healthcare apps and platforms can feel overwhelming. One of the biggest challenges is lack of confidence and familiarity with these tools. Millennials may be hesitant to rely on technology they don't fully understand. As digital healthcare solutions become more advanced, they can sometimes feel even more intimidating and inaccessible to those who aren't naturally tech-savvy.

The key to solving this is making digital healthcare simpler and more user-friendly. Raising awareness, providing clear guidance, and offering digital literacy programs can help Millennials feel more comfortable using these tools. When digital healthcare is designed to be intuitive and inclusive, it becomes something that everyone—regardless of their tech background—can benefit from with confidence.

Impact of Digital Health Technology on Millennials (Gen Y)

Many Millennials struggle with differentiating credible health information online, leading to misinformation. Privacy concerns and fears of data breaches also hinder trust in digital healthcare. While mental health apps have improved access to psychological support, some Millennials feel they lack personal connection compared to traditional therapy.

Despite being tech-savvy, complex digital platforms and preference for face-to-face interactions slow adoption. To increase engagement, digital healthcare must be user-friendly, secure, and seamlessly integrated with traditional healthcare systems.

Impact of Digital Health Technology on Gen Z

Generation Z, having grown up in a digital world, experiences enhanced healthcare accessibility through telemedicine, mobile health apps, and AI-driven tools. These innovations improve health awareness via wearable devices and social media, promoting preventive care.

However, over-reliance on digital solutions may lead to self-diagnosis errors and misinformation, reducing face-to-face interactions with healthcare providers. While digital mental health platforms offer support, excessive screen time and online misinformation can contribute to stress and anxiety. Additionally, privacy concerns and data security risks remain significant challenges, affecting trust in digital healthcare. Balancing technology with human interaction is essential to ensuring an effective and secure healthcare experience for Gen Z.

Limitations

This study is limited by primarily a Doctrinal Research on the transformation of healthcare with the power of digital technology. Additionally, the scope of study is limited to existing technologies, and emerging technologies such as AI

Conclusion

In conclusion, digital technologies have revolutionized various fields, including healthcare, enhancing accessibility, efficiency, and patient care. However, alongside these advancements come challenges that affect key stakeholders, including patients, healthcare professionals, and clinical assistants. While digital transformation is inevitable, it is crucial to implement thoughtful policies and regulations to minimize its unintended consequences and ensure that technology remains a tool for progress rather than a source of disruption.

Beyond the physical aspects of healthcare, mental well-being must also be a priority. The increasing reliance on digital tools can sometimes lead to overuse or even addiction, affecting psychological health. Certain technologies, such as social media and excessive screen time, can contribute to stress, anxiety, and digital fatigue. It is essential to create awareness about these risks and promote healthier digital habits.

To strike a balance, proactive measures should be taken to support both the physical and mental well-being of individuals. This includes encouraging mindful technology use, integrating mental health support into digital platforms, and ensuring that healthcare professionals are equipped with the necessary resources to address digital-related mental health concerns. By fostering responsible technology usage, we can harness the benefits of digital advancements while safeguarding the well-being of future generations.

Most research focuses on the adoption of digital health tools like telemedicine, wearable devices, and AI assistants, but little is known about their impact on trust, decision-making, and overall healthcare experiences for these generations. Additionally, privacy concerns, psychological barriers, and generational preferences in digital healthcare need further exploration.

References

Rahul De'a, Neena Pandeyb, AbhipsaPalc, Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice, 2020.

Linda Alkire (n´ ee Nasr), et. al., Patient experience in the digital age: An investigation into the effect of generational cohorts, 2020.

Isha Goel, et. al., Effects of the COVID-19 pandemic in India: An analysis of policy and technological interventions, 2021.

Fahy N, et.al. Use of digital health tools in Europe: Before, during and after COVID-19.

COVID-19 has accelerated India's digital reset, World Economic Forum, 2020.

ENHANCING LEUKEMIA DETECTION WITH MACHINE LEARNING AND STATISTICAL ANALYSIS

Dr KS Karunya[1], Mr Deepaneesh R V [2],Mr Sanjay Saravanan P [3]

[1] Assistant Professor[1],Department of Statistics, PSG College of Arts & Science, Coimbatore

[2,3] Student, Department of Statistics, PSG College of Arts & Science, Coimbatore

Abstract

Leukemia is a type of blood cancer that affects both the blood and bone marrow, and it remains a significant health issue around the globe. Catching it early is really important because it can greatly improve survival rates. In this study a data-driven approach used to predicting leukemia status using a mix of statistical and machine learning techniques. Different machine learning algorithms have been applied to create predictive models and evaluate their performance using standard measures. Feature selection techniques were also utilized to pinpoint the most impactful predictors, which not only makes the models easier to understand but also helps streamline the analysis. By comparing several methods, the aim is to identify the best way to classify and predict leukemia. The findings shed light on how various clinical and lifestyle factors influence leukemia outcomes, showcasing the promise of machine learning in enhancing disease prediction.

This study demonstrates the power of machine learning in improving leukemia prediction, enabling early better patient outcomes. It emphasizes the potential of advanced models in medical diagnostics.

Keywords: Leukemia, Machine Learning Algorithms, Prediction Models, Accuracy Evaluation, Model Performance

Introduction

Leukemia is a cancer that affects the blood and bone marrow, caused by the uncontrolled production of abnormal white blood cells. These cells multiply excessively, crowding out healthy blood cells necessary for proper bodily function. This global health issue impacts all ages, with certain types more common in specific age groups. Early detection and accurate diagnosis are crucial for effective treatment and better recovery. Advances in medical research have incorporated machine learning techniques in leukemia diagnosis, prognosis, and treatment planning, enhancing accuracy and efficiency.

Types of Leukemia

Leukemia is categorized into two main types: acute (rapid progression) and chronic (slow progression), based on the kind of blood cells involved. The four main types are Acute Lymphocytic Leukemia (ALL), Acute Myelogenous Leukemia (AML), Chronic Lymphocytic Leukemia (CLL), and Chronic Myelogenous Leukemia (CML).

Symptoms of Leukemia

Symptoms vary but can include fatigue, frequent infections, easy bruising or bleeding, bone pain, swollen lymph nodes, enlarged liver or spleen, night sweats, weight loss, and fever. It's crucial to seek medical advice if these symptoms persist.

Diagnostic Tests for Leukemia

Diagnosis typically involves a Complete Blood Count (CBC), blood smear, and bone marrow biopsy. Additional tests may identify chromosomal abnormalities and gene mutations and use imaging to assess the leukemia's extent.

Treatment Options for Leukemia

Treatment varies based on leukemia type, patient health, and stage. Chemotherapy is the primary treatment, supplemented by radiation, targeted therapy, immunotherapy, and stem cell transplantation in high-risk cases.

Prognosis and Risk Factors

Prognosis varies depending on leukemia type, age, health, and treatment response. Acute forms can be aggressive and potentially curable, while chronic forms progress slowly. Risk factors include genetic conditions, chemical exposure, previous radiation, smoking, and family history**.**

Machine Learning Application & Techniques

Predictive modeling in leukemia research uses machine learning to analyze patient data, improving diagnosis, prognosis, and treatment responses. By examining blood test results, genetic markers, and symptoms, these models facilitate early detection and assess disease progression. They also refine predictions using patient histories and identify those at higher risk for complications, enabling timely interventions. Overall, this approach enhances leukemia diagnosis, treatment optimization, and patient care.

In this paper, machine learning and statistical analysis methods are used to predict the leukemia status in a patient.

Review of Literature

The article **"Blinatumomab Boosts Chemotherapy as Initial Treatment for Some Kids with ALL" by Carmen Phillips (2025)** highlights that adding blinatumomab to standard chemotherapy significantly improves disease-free survival in children with standard-risk B-cell acute lymphoblastic leukemia (ALL). A study with over 1,400 participants found a 96% disease-free survival rate after 2.5 years with both treatments, versus 88% with chemotherapy alone. With minimal side effects and FDA approval in June 2024, blinatumomab may become a new standard treatment, though its 28-day infusion may limit accessibility. The study "**Leukemia Incidence Trends (1990-2017)" by Ying Dong et al. (2020) shows a rise in total leukemia cases from 354,500 to 518,500**, despite a 0.43% annual decline in the age-standardized incidence rate (ASIR). Acute lymphoblastic leukemia (ALL) cases increased, chronic lymphocytic leukemia (CLL) cases more than doubled, and acute myeloid leukemia (AML) cases rose, while chronic myeloid leukemia (CML) ASIR fell. These trends signal significant public health concerns.

Chennamadhavuni et al. (2023) describe leukemia as a blood cancer characterized by abnormal white blood cell production, classified into acute and chronic forms. Chemotherapy is the main treatment, and an interprofessional healthcare team is crucial for improving outcomes.

Davis et al. (2014) explain leukemia involves abnormal growth of blood stem cells, with ALL being more common in children. Risk factors include genetics and ionizing radiation, and symptoms are nonspecific. Diagnosis involves blood tests and bone marrow examination,

and treatments focus on chemotherapy and stem cell transplantation, with long-term monitoring for complications. Survival rates are highest in younger patients and those with CML or CLL.

A Statistical Study of Mortality from Leukemia by Sacks and Seeman (1947) examines leukemia death rates from 1900 to 1944, revealing an increase from 1.9 per 100,000 in 1920 to 3.7 in 1940. Higher rates were seen among white males over 55. Factors like better diagnostic methods and more hospital resources contributed to this trend. The study notes classification challenges and underreporting, concluding that U.S. leukemia mortality trends are consistent with those in other countries, highlighting the need for further research.

Scope of the Study

This study focuses on predicting leukemia in patients using machine learning techniques. It analyzes the impact of medical and demographic factors on leukemia diagnosis. The research explores key risk indicators and their contribution to disease prediction. It also highlights the challenges posed by data limitations, such as selection bias and the absence of healthy individuals in the dataset. Lastly, the study aims to provide insights for improving early detection and guiding future research in leukemia prediction models.

Data Source: The dataset for this study was sourced from an open-source repository on GitHub. It was refined to include only high-quality responses, resulting in 402 records. Non-essential variables, such as 'Country' and 'Patient ID,' were removed to focus on relevant medical and demographic factors for leukemia prediction. The data was also filtered by age categories to target the most relevant patient groups. This refined dataset serves as the foundation for the machine learning models and statistical analysis

Objectives

- To develop highly optimized statistical and machine learning models by fine-tuning hyperparameters through a looping method for accurate leukemia prediction.
- To identify the most effective model by evaluating accuracy and determining the one with the highest predictive performance.
- To determine key variables influencing leukemia status by analyzing feature importance or model coefficients from the best-selected model**.**

Research Methodology

Methods for Binary Classification: This study employed various machine learning and statistical models for binary classification. Optimal hyperparameters were selected through a looping method, with the best model determined based on accuracy during tuning and final selection.

Logistic Regression: Logistic Regression is a statistical method for binary classification that estimates the probability of an outcome belonging to a class. It transforms a linear combination of input features to output values between 0 and 1. This simple yet effective model, commonly used as a baseline, is optimized using Maximum Likelihood Estimation to minimize binary cross-entropy loss and enhance predictive accuracy.

XGBoost (Extreme Gradient Boosting):

XGBoost is a gradient boosting algorithm that builds decision trees sequentially, with each tree correcting errors from previous ones. It uses regularization and second-order gradient approximation to improve efficiency and handles missing values well. Hyperparameters such as learning rate, tree depth, and number of estimators were optimized using a looping method to select the most accurate model.

CatBoost (Categorical Boosting):

CatBoost is designed for efficiently handling categorical data. It utilizes ordered boosting and target-based encoding to reduce overfitting and works well with imbalanced datasets, eliminating extensive preprocessing. Key hyperparameters were optimized iteratively, focusing on accuracy.

Random Forest:

Random Forest combines multiple decision trees to enhance classification performance and reduce overfitting. Each tree is trained on a different data subset, with final predictions made through majority voting. This method is effective for high-dimensional data, and hyperparameters like the number of trees and tree depth were optimized for best accuracy.

GLMNET (Generalized Linear Model with Regularization):

GLMNET incorporates Lasso (L1) and Ridge (L2) penalties to improve feature selection and prevent overfitting. Lasso automatically selects features by shrinking coefficients, while Ridge stabilizes predictions by distributing weights. The model was fine-tuned iteratively based on regularization strength and mixing parameters, again focusing on accuracy.

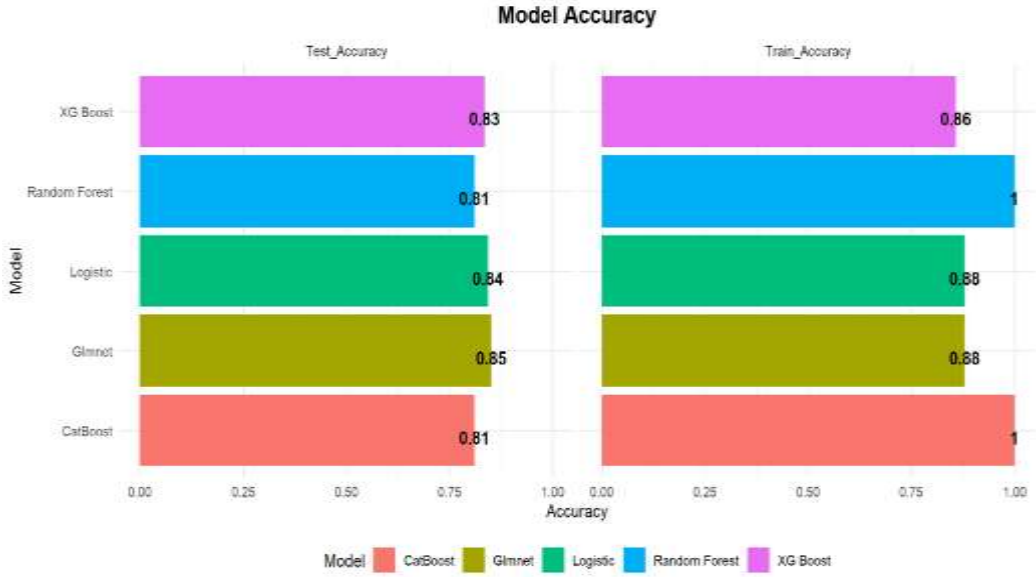
All models were fine-tuned to achieve optimal performance, with the final model selected based on accuracy during tuning and evaluation.

Analysis and Interpretation

Following the analysis, five machine learning models were developed using the optimal hyperparameters to achieve the best accuracy. These models were evaluated based on their training accuracy, test accuracy, and kappa values to assess their reliability and generalizability. The performance comparison allows us to identify well-fitted models while also addressing potential overfitting concerns. A summary of the model performances is provided in the table below:

	Training		**Testing**		
Model	**Accuracy**	**Kappa value**	**Accuracy**	**Kappavalue**	**Model type**
Logistic Regression	0.879	0.879	0.843	0.6477	Good Fitted
CatBoost	1	1	0.8099	0.5686	Over Fitted
XG Boost	0.8577	0.6804	0.8347	0.6312	Good Fitted
Random Forest	1	1	0.8099	0.5783	Over Fitted

Glmnet	0.879	0.7284	0.8512	0.6643	Good Fitted



From the above (Table 1 and Figure 1), compares the performance of different machine learning models in predicting leukemia presence. It includes training and testing accuracy, kappa values (a measure of agreement), and an assessment of model fitting.

Logistic Regression achieved a training accuracy of 87.90% and a testing accuracy of 84.30%, with a kappa value of 0.6477, indicating good generalization. CatBoost and Random Forest obtained perfect training accuracy (100%) but had lower testing accuracy at 80.99%, which suggests they may be overfitting the data. XGBoost and Glmnet demonstrated slightly lower testing accuracy compared to Logistic Regression but still performed well overall. Given its highest testing accuracy of 84.30%, Logistic Regression is considered the best model, as it effectively balances accuracy and generalization.

LOGISTIC REGRESSION CONFUSION MATRIX FOR TRAINING SET

	Reference		
		Negative	**Positive**
Prediction	**Negative**	168	18
	Positive	16	79

Table 2

Accuracy	0.8790
95% CI (Lower)	0.8350
95% CI (Upper)	0.9147
No Information Rate	0.6548
P-Value (Acc> NIR)	0.0000
Kappa	0.7310

Table 3

This confusion matrix shows the training performance of Logistic Regression

Accuracy: 87.90% (indicating a well-performing model). Kappa: 0.7310 (reflecting substantial agreement). Confidence Interval: 83.50% - 91.47% (demonstrating consistent accuracy). P-Value: 0.0000 (indicating statistical significance). Logistic Regression effectively distinguishes between positive and negative cases.

Coefficient of Logistic Regression Model

Variable	Estimate	Std. Error	z value	Pr(>|z|)
Age	-0.0032	0.0206	-0.1560	0.8759
Gender-Female	-11.9300	3.1646	-3.7700	0.0000***
Gender-Male	-12.1174	3.1921	-3.7960	0.0000***
WBC_Count	0.0005	0.0001	4.5140	0.0000***
RBC_Count	0.7706	0.3191	2.4150	0.0157*
Platelet_Count	-0.0007	0.0027	-0.2500	0.8024
Hemoglobin_Level	-0.2485	0.1301	-1.9100	0.0561
Bone_Marrow_Blasts	0.6445	0.1136	5.6740	0.0000***
Genetic_Mutation-Present	3.6621	0.5820	6.2920	0.0000***
Family_History-yes	3.0620	0.5448	5.6200	0.0000***
Smoking_Status-Smoker	1.3663	0.4839	2.8240	0.0047**
Alcohol_Consumption-yes	-0.6764	0.4813	-1.4060	0.1598
Radiation_Exposure-yes	2.0859	0.5924	3.5210	0.0004***
Infection_History-yes	0.5496	0.4695	1.1700	0.2418
BMI	0.0004	0.0521	0.0080	0.9939
Chronic_Illness-yes	-0.1834	0.4655	-0.3940	0.6936
Immune_Disorders-yes	0.0246	0.5291	0.0460	0.9630
Socioeconomic_Status-Low	-0.6729	0.6307	-1.0670	0.2860
Socioeconomic_Status-Medium	-1.4117	0.6492	-2.1740	0.0297
Urban_Rural-Urban	0.1174	0.4969	0.2360	0.8132

Higher white blood cell (WBC) counts (+0.0005, $p < 0.0001$) and the presence of bone marrow blasts (+0.6445, $p < 0.0001$) significantly increase leukemia risk. Genetic mutations (+3.6621, $p < 0.0001$) and family history (+3.0620, $p < 0.0001$) are also highly significant risk factors.

Additionally, smoking (+1.3663, $p = 0.0047$) and radiation exposure (+2.0859, $p = 0.0004$) contribute to this risk. In contrast, a medium socioeconomic status (-1.4117, $p = 0.0297$) is associated with a lower risk of leukemia. Other factors such as age, body mass index (BMI), platelet count, hemoglobin, infection history, alcohol consumption, chronic illness, immune disorders, and urban-rural status do not show statistical significance. Overall, key risk factors for leukemia include genetic factors, bone marrow condition, smoking, radiation exposure, and family history.

Confusion Matrix for Testing Set

	Reference		
		Negative	**Positive**
Prediction	**Negative**	71	11
	Positive	8	31

Table 5

Accuracy	0.8430
95% CI (Lower)	0.7657
95% CI (Upper)	0.9027
No Information Rate	0.6529
P-Value (Acc> NIR)	0.0000
Kappa	0.6477

Table 6

The confusion matrix reveals that the model accurately predicted 71 negatives and 31 positives, misclassifying 8 positives and 11 negatives. With an accuracy of 84.30% and a confidence interval of 76.57% to 90.27%, the model shows reliable performance. The No Information Rate (NIR) is 65.29%, indicating the model is significantly better than random guessing. The p-value is 0.0000, confirming statistical significance, and the Kappa value is 0.6477, indicating moderate to substantial agreement. Overall, the Logistic Regression model performs well in predicting leukemia. Subsequently, GLMNET is applied to select important variables and reduce overfitting. By combining Lasso (L1) and Ridge (L2) regularization, GLMNET eliminates irrelevant features and shrinks coefficient values, enhancing the model's generalizability for unseen data.

Generalized Linear Model with Regularization

glmnet(x = x_train, y = y_train)
family = "binomial"
alpha = 0.1
lambda = 0.01303

Table 7

Using a looping method like cross-validation or grid search, optimal values for alpha and lambda are determined to enhance model performance. This involves testing combinations of alpha (balance between Lasso and Ridge) and lambda (regularization strength) to reduce overfitting while maintaining accuracy. The selected alpha = 0.1 and lambda = 0.01303 indicate a 10% Lasso and 90% Ridge mix, offering an optimal balance between feature selection and coefficient shrinkage. For binary classification, setting family = "binomial" applies logistic regression, modeling the probability of one class. Each categorical variable's reference level acts as a baseline for comparison. Gender: Female is the reference, and the coefficient indicates the effect of being Male. For Genetic Mutation, Family History, Smoking, Alcohol, Radiation, Infection, Chronic Illness, and Immune Disorders, "No" is the reference, so coefficients show the impact of having these conditions. In terms of Socioeconomic Status, Low is the baseline, with coefficients measuring the effect of moving to Medium or High. Urban/Rural comparison has Rural as the reference, with coefficients showing the effect of urban living. Reference categories are baselines for comparison, allowing us to measure impacts of other variable levels. Positive coefficients indicate higher likelihood or risk of the outcome, while negative coefficients suggest lower impact.

Confusion Matrix for Training Set

	Reference		
		Negative	**Positive**
Prediction	**Negative**	170	20
	Positive	14	77

Table 8

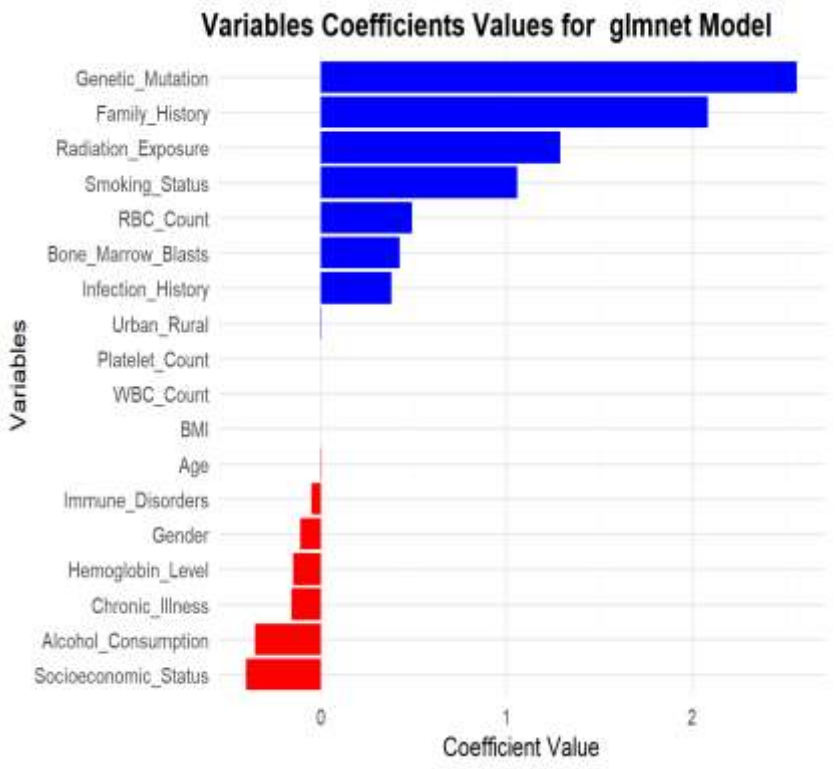
Accuracy	0.879
95% CI (Lower)	0.835
95% CI (Upper)	0.9147
No Information Rate	0.6548
P-Value (Acc> NIR)	0.0000
Kappa	0.7284

Table 9

The training set confusion matrix for GLMNET shows an accuracy of 87.9%, with a Kappa value of 0.7284, indicating substantial agreement. The model correctly classified 170 negatives and 77 positives, while misclassifying 20 negatives and 14 positives. The 95% confidence interval (83.5% – 91.47%) confirms reliability, and the p-value (0.0000) shows statistical significance. The No Information Rate (65.48%) highlights that the model performs significantly better than random guessing.

Co-Efficient of Generalized Linear Model

Variable	**Estimate**		**Variable**	**Estimate**
Age	-0.002		Smoking_Status	1.0599
Gender	-0.1094		Alcohol_Consumption	-0.3555
WBC_Count	0.0003		Radiation_Exposure	1.2889
RBC_Count	0.4918		Infection_History	0.3804
Platelet_Count	0.0005		BMI	0
Hemoglobin_Level	-0.147		Chronic_Illness	-0.1575
Bone_Marrow_Blast	0.4253		Immune_Disorders	-0.0507
Genetic_Mutation	2.5637		Socioeconomic_Status	-0.4009
Family_History	2.0862		Urban_Rural	0.0022



The table & figure shows the estimated coefficients from a GLMNET logistic regression model, illustrating how each variable affects the likelihood of leukemia presence. Positive estimates (e.g., Genetic Mutation = 2.5637, Family History = 2.0862) increase the probability of the outcome, while negative estimates (e.g., Gender = -0.1094, Hemoglobin Level = -0.1470) decrease it. Some variables have minimal impact (e.g., BMI = 0.0000, Urban/Rural = 0.0022). Strong predictors include Genetic Mutation, Family History, Smoking Status, and Radiation Exposure, all with high positive estimates.

Confusion Matrix for Testing Set

	Reference		
		Negative	**Positive**
Prediction	**Negative**	72	11
	Positive	7	31

Table 11

Accuracy	0.8512
95% CI (Lower)	0.7751
95% CI (Upper)	0.9094
No Information Rate	0.6529
P-Value (Acc> NIR)	0.0000
Kappa	0.6643

Table 12

The glmnet model's confusion matrix reveals an accuracy of 85.12%, with a 95% confidence interval of 77.51% to 90.94%, demonstrating strong generalization. It outperforms the No Information Rate (NIR) of 65.29%, and the Kappa score of 0.6643 indicates good agreement beyond chance.

Findings

- Key Risk Factors: Genetic mutations, family history, bone marrow blasts, smoking, and radiation exposure significantly increase the likelihood of leukemia.
- White Blood Cell (WBC) Count: A higher WBC count is strongly associated with leukemia, indicating abnormal cell production.
- Protective Factors: Individuals from a medium socioeconomic background showed a lower risk compared to those from a low-income background.
- Non-Significant Factors: Variables such as age, BMI, platelet count, hemoglobin levels, infection history, alcohol consumption, chronic illness, and immune disorders did not show a significant direct impact on leukemia prediction.
- Classification Performance: The model effectively distinguishes between leukemia-positive and negative cases with high accuracy and reliability.

Conclusion

Leukemia risk is influenced by genetic, lifestyle, and environmental factors. Genetic mutations and a family history of leukemia are strong predictors. High white blood cell counts and increased bone marrow blasts indicate blood and bone marrow abnormalities. Lifestyle factors like smoking and radiation exposure also elevate risk, while middle-income individuals may experience a protective effect, though the reasons are unclear. Despite analyzing factors like BMI, platelet count, and alcohol consumption, most did not show significant impacts on leukemia prediction. Early identification through screenings and genetic testing can improve disease management and survival rates. A comprehensive approach, including medical monitoring and lifestyle changes, is essential to reduce leukemia incidence and enhance patient outcomes.

Recommendations

To reduce leukemia risk and improve early detection, individuals with a family history or genetic predisposition should have regular screenings. Lifestyle changes like quitting smoking and minimizing radiation exposure can lower risk. Those with abnormal WBC counts and bone marrow changes should be closely monitored. Public health programs should raise awareness of risk factors and promote preventive healthcare. More research is needed on the effects of socioeconomic status and environmental influences on leukemia development.

Limitations of the Study

The dataset was sourced from an open repository and refined to 402 records, which may introduce selection bias and limit the applicability of results to a broader leukemia patient population.

Filtering by age categories may have excluded certain groups with different leukemia risk patterns, reducing the study's ability to generalize findings across all age groups.

The removal of variables like ‘Country’ helped focus on medical factors but may have eliminated useful contextual information, such as regional healthcare access and environmental influences.

The dataset consists of records from patients visiting the hospital, meaning it primarily includes individuals already experiencing health issues. As a result, healthy individuals who have not sought medical attention are not represented, limiting comparisons with a control group.

The absence of time-event data prevents tracking leukemia progression, making it difficult to assess how risk factors change over time and limiting early intervention strategies.

There is a lower representation of individuals from low socioeconomic backgrounds, which may impact the study's ability to assess leukemia risk factors and healthcare accessibility across different economic groups.

References

Brereton, R. G., & Lloyd, G. R. (2014). Partial least squares discriminant analysis: Taking the magic away. *Journal of Chemometrics, 28(4)*, 213–225.

Chennamadhavuni, A., Lyengar, V., & Al-Kali, A. (2023). Leukemia. *StatPearls Publishing.*

Davis, A. S., Viera, A. J., & Mead, M. D. (2014). Leukemia: An overview for primary care. *American Family Physician, 89(9)*, 731-738.

Dong, Y., Shi, O., Zeng, Q., Lu, X., Wang, W., Li, Y., & Zhang, L. (2020). Leukemia incidence trends at the global, regional, and national level between 1990 and 2017. *Frontiers in Oncology, 10*, 598072.

Hedegaard, M., Matthäus, C., Hassing, S., Krafft, C., Diem, M., & Popp, J. (2011). Spectral unmixing and clustering algorithms for assessment of single cells by Raman.

H., &Mullighan, C. G. (2020). Pediatric acute lymphoblastic leukemia. *Haematologica, 105(11)*, 2524–2539.

Inaba, K. (Year missing). Microscopic imaging. *Theoretical Chemistry Accounts, 130(4–6)*, 1249–1260.

Malard, F., &Mohty, M. (2020). Acute lymphoblastic leukaemia. *The Lancet, 395(10230)*, 1146–1162.

Phillips, C. (2025). Blinatumomab boosts chemotherapy as initial treatment for some kids with ALL. *National Cancer Institute.*

Roberts, K. G., &Mullighan, C. G. (2020). The biology of B-progenitor acute lymphoblastic leukemia. *Cold Spring Harbor Perspectives in Medicine, 10(4)*, 1–22.

Sacks, B., & Seeman, I. (1947). A statistical study of mortality from leukemia. *Blood, 2(6)*, 695-709.

ACCELERATING DIGITAL HEALTHCARE: ECONOMIC CHALLENGES AND OPPORTUNITIES IN INDIA

Mr Anand Vardhan Singh[1],

[1] Research Scholar, PSG College of Arts & Science, Coimbatore

Abstract

The rapid integration of digital technologies into healthcare systems has led to transformative changes across the global healthcare landscape. Digital healthcare encompasses a broad range of technologies, including telemedicine, electronic health records (EHRs), mobile health applications, and artificial intelligence (AI), which aim to improve healthcare delivery, increase efficiency, and reduce costs. While these technologies offer numerous benefits, their financial implications involve significant upfront investments, potential cost savings, and new revenue opportunities. This paper explores the financial challenges and opportunities associated with the adoption of digital healthcare particularly in developing countries such as India.

Keywords: Digital Healthcare, Financial Implications, Telemedicine, Electronic Health Records, Healthcare Infrastructure

Introduction

Digital healthcare refers to the integration of digital technologies into healthcare services and administration to improve the efficiency, accessibility, and quality of care. The increasing adoption of digital health tools, such as telemedicine, AI-driven diagnostics, electronic health records (EHRs), and mobile health applications, has created substantial shifts in the way healthcare is delivered and managed. These technologies have the potential to reduce healthcare costs, improve patient outcomes, and enhance accessibility to care. However, the transition to digital healthcare involves significant financial considerations for healthcare providers, patients, insurers, and policymakers. While digital health solutions promise cost reductions and enhanced revenue opportunities, the initial investment required for infrastructure, the uncertainty surrounding reimbursement policies, and the integration challenges remain major financial obstacles. This research aims to explore the financial implications of digital healthcare, focusing on both the challenges and opportunities associated with its adoption and the financial sustainability of digital health models.

The Financial Landscape of Digital Healthcare

Costs Associated with Digital Healthcare Implementation:

While digital healthcare technologies have the potential to offer long-term savings, their initial implementation comes with substantial costs. Healthcare systems must invest in technology infrastructure, cybersecurity measures, and training to ensure the successful deployment of digital tools.

Technology and Infrastructure Investment:

One of the most significant financial implications of digital healthcare is the investment in infrastructure. Healthcare providers must allocate funds for purchasing and integrating technologies such as telemedicine platforms, AI tools for diagnostics, mobile health applications, and EHR systems. According to a study by **Buntin et al. (2011),** the

transition to digital record-keeping and the adoption of new technologies requires significant capital expenditures, including software licensing, cloud storage, and IT infrastructure.

Cybersecurity and Compliance Costs:

As digital healthcare solutions involve the collection and storage of sensitive patient data; the implementation of robust cybersecurity measures is essential. Healthcare providers must invest in encryption, firewalls, secure data storage solutions, and ongoing system updates to safeguard patient information. Compliance with regulations such as the Health Insurance Portability and **Accountability Act (HIPAA)** and the **General Data Protection Regulation (GDPR)** can also add to these costs **(Shin & Kang, 2021).**

Training and Workforce Development:

Healthcare professionals must be trained to effectively use new digital tools, which involves additional costs for training programs and staff education. Ensuring that clinicians and administrative staff are proficient with digital systems is essential for maximizing the effectiveness of these technologies.

Potential for Cost Savings in Digital Healthcare

Despite the significant initial investment, digital healthcare has the potential to generate substantial long-term cost savings by improving operational efficiency and reducing resource waste.

Telemedicine and Remote Consultations:

Telemedicine services allow healthcare providers to offer virtual consultations, reducing overhead costs associated with office space, utilities, and in-person consultations. According to a study by **Mehrotra et al. (2016),** telehealth consultations are often less expensive than traditional face-to-face visits, benefiting both patients and providers by reducing time and travel costs. Furthermore, telemedicine improves access to healthcare for underserved populations, especially in rural and remote areas.

EHR Systems and Data Management:

The adoption of electronic health records (EHRs) has been shown to improve the efficiency of healthcare delivery. By digitizing patient records, healthcare organizations can reduce administrative costs related to paper-based record-keeping, streamline workflows, and minimize duplication of diagnostic tests. A study by **Buntin et al. (2011)** found that EHR systems could lead to reductions in healthcare costs by improving communication among providers and reducing medical errors.

Remote Monitoring and Chronic Disease Management:

Digital health tools such as wearable devices and remote monitoring technologies enable continuous health tracking, particularly for patients with chronic conditions. By providing real-time data to healthcare providers, these tools help prevent costly complications, reduce hospital readmissions, and improve patient outcomes **(NIH, 2017**). This proactive approach to healthcare reduces the overall cost burden associated with managing chronic diseases.

New Revenue Streams and Financial Opportunities

Digital healthcare technologies also create opportunities for healthcare providers to generate new revenue streams and improve financial performance.

Subscription Models and Digital Health Services:

Digital health platforms, including mobile health applications and wearable devices, can be monetized through subscription models. Providers may offer paid services, such as personalized health coaching, wellness monitoring, or digital therapeutics. These new revenue models enable healthcare organizations to diversify their income streams beyond traditional fee-for-service arrangements.

Expansion of Patient Base:

Telemedicine and mobile health applications expand the reach of healthcare providers, enabling them to serve a broader patient base, including those in remote or underserved areas. A report by the **World Health Organization (2020)** highlighted the potential of telemedicine to increase healthcare access, particularly in low- and middle-income countries. This expansion can lead to higher patient volumes and increased revenue for healthcare organizations.

Increased Patient Retention:

Digital health tools that facilitate ongoing engagement, such as patient portals and mobile apps for chronic disease management, improve patient satisfaction and retention. Healthcare providers who can deliver continuous care through digital platforms are more likely to foster long-term patient relationships, increasing the likelihood of repeated visits and a more predictable revenue stream **(Kruse et al., 2017).**

Value-Based Care and Digital Health:

The shift toward value-based care, where providers are reimbursed based on patient outcomes rather than the volume of services provided, has incentivized the use of digital health tools. Remote monitoring devices and AI tools that improve patient outcomes can help providers achieve better care quality and reduce the need for costly interventions. According to the Centres for Medicare & Medicaid Services **(CMS, 2021**), digital health technologies are increasingly incorporated into value-based care models, which could lead to improved financial sustainability for providers.

Challenges in Achieving Financial Sustainability

While digital healthcare holds great promise, achieving long-term financial sustainability is challenging due to several factors:

Out-of-Pocket Expenditure and Health Inequality One of the primary barriers to financial sustainability in healthcare systems is the high out-of-pocket (OOP) expenditure faced by patients. According to **Xu et al. (2003),** OOP expenses account for a large portion of healthcare costs in low- and middle-income countries, leading to catastrophic health expenditures for many families. This situation exacerbates health inequality as individuals from lower-income backgrounds are often unable to afford necessary treatments. In India, **Sundararaman et al. (2014)** report that despite the introduction of government insurance programs like Ayushman Bharat, a significant proportion of the population still faces financial hardship due to OOP spending, especially for outpatient care and medications.

Underfunding of Public Healthcare Systems Many healthcare systems, particularly in developing countries, struggle with underfunding and a lack of investment in public health infrastructure. **World Health Organization (WHO, 2017)** indicates that health systems in developing economies often lack sufficient funding from government sources, leading to an over-reliance on private healthcare providers. This imbalance creates a two-tiered healthcare

system, where wealthier individuals can afford better care, while the poor are left with limited and sometimes substandard services. In India, **Kumar and Ghosh (2019)** found that despite the increasing burden of disease, public healthcare funding remains inadequate, causing patients to turn to costly private hospitals, further escalating the financial burden.

Cost Escalation and Technological Advancements The introduction of high-cost medical technologies and advanced treatments has contributed significantly to the escalation of healthcare costs. **Bhat (2018)** discusses how the rising costs of pharmaceutical drugs, diagnostic procedures, and medical technologies place an immense strain on both healthcare providers and patients. While these technologies improve patient outcomes, they often do so at a significant financial cost, leading to challenges in sustaining these innovations in the long run, especially in resource-constrained settings.

Inefficiencies in Resource Allocation Financial sustainability is also hampered by inefficiencies in the allocation of resources within healthcare systems. **Mugisha et al. (2019)** highlight that poor resource management, lack of coordination between different healthcare sectors, and inadequate governance can result in wasted financial resources. In India, **Chaudhuri et al. (2020)** argue that the inefficient use of funds, combined with administrative inefficiencies and corruption, reduces the overall effectiveness of healthcare expenditures, making it harder to achieve sustainable funding.

Private Sector Dominance and Financial Fragmentation The dominance of the private healthcare sector in many developing countries, including India, further complicates efforts to achieve financial sustainability. **Patel et al. (2018)** note that the private sector often operates with a profit motive, leading to high costs for services and treatments. As a result, financial sustainability becomes difficult because the private sector is not always aligned with public health goals, and the costs incurred by patients may not be covered adequately by insurance programs or government subsidies. This fragmentation of the healthcare system leads to inefficiencies and disparities in access to care.

Lack of Universal Health Coverage (UHC) The absence of **Universal Health Coverage (UHC)** in many countries remains a critical barrier to financial sustainability. According to **Kruk et al. (2018),** UHC is essential for ensuring equitable access to healthcare without financial hardship. Countries like India have made strides in expanding health coverage through programs like Ayushman Bharat, but as **Reddy et al. (2021)** point out, the coverage remains limited, with many individuals falling through the cracks due to exclusions, particularly in rural areas or among informal workers.

Regulatory and Policy Challenges The **regulatory environment** surrounding healthcare can also impact its financial sustainability. **Sharma and Sharma (2019)** argue that complex regulations and policy bottlenecks in the healthcare sector can hinder investments, delay infrastructure projects, and increase costs. In India, regulatory challenges, coupled with inconsistent policy implementation, have led to financial instability in both public and private healthcare sectors. Moreover, the fragmented nature of healthcare delivery across states in India contributes to uneven financial sustainability across regions.

Conclusion

The "New Age of Healthcare" represents a transformative period driven by technological advancements such as telemedicine, AI, wearable devices, and genomic medicine, enhancing accessibility, efficiency, and personalized care. These innovations are

improving patient outcomes, reducing costs, and expanding healthcare access globally. However, challenges such as data security, privacy, and ethical considerations must be addressed to maintain patient trust and safety. Technologies like electronic health records (EHRs) and AI-driven diagnostics are streamlining care delivery, while wearable devices enable real-time health monitoring. In India, the adoption of digital health platforms and government initiatives like Ayushman Bharat is improving accessibility, particularly in remote areas. Despite these advancements, challenges remain, including infrastructure limitations, data privacy concerns, and the need for skilled professionals. To fully leverage digital healthcare, overcoming barriers like high initial costs and health inequalities is essential for sustainable growth and improved patient outcomes. The success of digital healthcare depends on investing in rural infrastructure, strengthening data security, and enhancing digital literacy. Expanding initiatives like Ayushman Bharat, supporting research, and addressing health inequality will improve accessibility. Harmonizing regulations and fostering global collaboration will ensure seamless integration, ultimately improving patient outcomes and access to healthcare.

References

Bhat, R. (2018). Cost escalation in healthcare: The role of medical technologies. *Indian Journal of Health Economics, 10*(1), 30-39.

Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The benefits of health information technology: A review of the recent literature shows predominantly positive results. *Health Affairs, 30*(3), 464-471. https://doi.org/10.1377/hlthaff.2011.0178

Chaudhuri, S., Kumar, A., & Ghosh, S. (2020). Governance and financial management in healthcare systems in India. *Health Policy and Planning, 35*(5), 550-558. https://doi.org/10.1093/heapol/czaa003

Centres for Medicare & Medicaid Services (CMS). (2021). *Telemedicine and digital health in value-based care*. CMS.gov. Retrieved from https://www.cms.gov

Kruse, C. S., Mileski, M., &Ozdinler, A. (2017). The value of patient portals and health apps: Benefits for patients and healthcare providers. *Healthcare Management Review, 42*(2), 128-136. https://doi.org/10.1097/HMR.0000000000000136

Kruk, M. E., et al. (2018). The importance of universal health coverage in global health sustainability. *Lancet Global Health, 6*(10), 1145-1151. https://doi.org/10.1016/S2214-109X(18)30385-4

Kumar, A., & Ghosh, S. (2019). Public health financing in India: An overview. *Journal of Health Management, 21*(2), 191-199. https://doi.org/10.1177/0972063419832434

Mehrotra, A., et al. (2016). The impact of telemedicine on cost and quality of care: A review of the evidence. *Telemedicine and e-Health, 22*(3), 207-213. https://doi.org/10.1089/tmj.2015.0201

HEALTH AWARENESS AND TECHNOLOGY – BASED CONSUMPTION PATTERN OF MILLET PRODUCT BY WOMEN WITH SPECIAL REFERENCE TO COIMBATORE CITY

DrM Nithya[1],Ms S Ilakkiya[2]

[1] Assistant professor, Department of Commerce
PSG College of Arts & Science, Coimbatore

[2] Student, Bachelor of Business Administration
PSG College of Arts & Science, Coimbatore

Abstract

This study investigates the health awareness and technology-driven consumption patterns of millet-based products among women in Coimbatore. Millets, known for their high nutritional value and health benefits, are gaining popularity as a sustainable food choice. However, their consumption is influenced by factors such as awareness, accessibility and technological advancements in food marketing. A structured survey was conducted among 210 women in Coimbatore to assess their knowledge, perception and purchasing behaviour regarding millet products. The study examines key factors such as health consciousness, affordability, taste preferences and the role of technology, including social media and online platforms, in shaping consumption patterns. Statistical tools such as Chi-Square and ANOVA were used to analysis the data. Findings reveal that while a significant number of women are aware of the health benefits of millets, regular consumption remains moderate. Factors such as taste preferences, ease of preparation and the influence of digital platforms significantly impact purchasing decisions. The study highlights the need for increased awareness programs better product availability and innovative millet-based recipes to enhance consumption. Encouraging women to incorporate millets into their daily diet can contribute to improved health outcomes and sustainable food practices.

Keywords: Millets, Health Awareness, Technology-Driven Consumption, Women in Coimbatore, Nutritional Value, Purchasing Behaviour, Health Consciousness, Affordability and Consumption Patterns.

Introduction

Millets often referred to as "Nutri-cereals," have gained global recognition for their nutritional and environmental benefits. These ancient grains are rich in essential nutrients, gluten-free and resilient to harsh climatic conditions, making them a sustainable food choice. In India, the government's declaration of 2023 as the "Year of Millets" underscores their importance in promoting nutrition security and sustainable agriculture. Women as primary caregivers and decision-makers in households play a pivotal role in shaping dietary habits. Their awareness and consumption patterns of millets significantly influence the overall health and well-being of their families. This study focuses on understanding the health awareness and technology-based consumption patterns of millet products among women in Coimbatore a rapidly urbanizing city in Tamil Nadu.

Objectives of the Study

- To assess women's awareness of the nutritional value and health benefits of millets.
- To analysis the role of technology, including social media and online platforms, in influencing millet consumption patterns.

- To identify factors affecting the purchase and consumption of millet-based products

Scope of the Study

The study explores the intersection of health awareness and technology in shaping millet consumption patterns among women in Coimbatore. It provides insights into dietary preferences, nutritional knowledge and the impact of digital marketing on food choices.

Need for the Study

With the rise of lifestyle diseases such as diabetes and obesity, promoting millet consumption can contribute to better health outcomes. Understanding the role of technology in influencing dietary choices is crucial for designing effective awareness campaigns and marketing strategies.

Limitations of the Study

- The study is limited to Coimbatore city and may not reflect rural consumption patterns.
- The reliance on self-reported data may introduce bias.

Statement of the Problem

Despite the growing awareness of millets' health benefits, their consumption remains limited among urban women. This study aims to identify the barriers and facilitators of millet consumption, with a focus on the role of technology and health awareness.

Review of Literature

Singh, R., & Raghuvanshi, R. S. (2012). This study emphasizes the nutritional importance of Millets in diets, especially among women in rural India. The authors highlight how low awareness and traditional methods of millet processing affect women's consumption patterns. Cultural factors, lack of education, and limited access to information are cited as major barriers. The authors argue for educational interventions to improve the understanding of Millets' health benefits.

Patil, S., & Joshi, P. (2015). This research focuses on how socio-economic status influences millet consumption patterns among urban and rural women in Karnataka. The findings show that higher-income women are less likely to consume Millets due to lifestyle choices, while women from lower-income backgrounds consume Millets out of necessity rather than awareness of health benefits.

Devi, P. B., &Vijayabharathi, R. (2014).Devi and Vijayabharathi investigate the health benefits of Millets and how these are perceived by women. The study reveals low levels of awareness among women, particularly regarding the anti-diabetic properties of Millets. The authors recommend widespread campaigns to promote millet consumption among women for long-term health benefits.

Research Methodology

Research methodology is the systematic and logical way to conduct a research problem. It details the methods and tools employed to gather, analyse, and interpret the data. It mainly focuses on the logical reasoning behind the research problem.

Population of the Study

Population refers to total group that a researcher wants to collect data about. It refers to the total respondents of the research problem. The population of the study is mostly infinite since it cover the all the women in Coimbatore.

Sample Size

The sample size of this study is 210 respondents.

Sampling Technique

The sampling technique used for this research is non probability convenience sampling Technique.

Methods of Data Collection

The data have been collected in two ways. Primary and secondary data collection. The primary data was gathered using a carefully designed questionnaire. The secondary data collection is made through websites, articles, magazines, journals and books.

Tools Used for Data Analysis :

Simple percentage methods

Analysis And Interpretation

Analysis involves calculating specific indices or measures and identifying patterns of relationships among data groups.

Interpretation

Data interpretation entails analyzing data through defined methods to derive meaning and arrive at pertinent conclusions. It includes taking the results of data analysis, drawing inferences about the relationships explored, and using these insights to form a conclusion.

Simple Percentage Analysis

Simple percentage analysis provides concise informational metrics that summarize a given data set, which may represent either the entire population or a sample. It helps to describe and highlight key characteristics of the data set.Formula: Simple Percentage Analysis = No of respondents / Total no of respondents *100

Chi – Square Analysis:

The Chi-Square statistic is frequently used to test relationships between categorical variables. The null hypothesis in a Chi-Square test states that no relationship exists between the categorical variables in the population, meaning they are independent of each other.

Chi-Square Analysis:

Platforms * Influence on Millet Consumption Independent Factor
Online Platforms Used (Instagram, YouTube, Facebook, Blogs/Websites).

Dependent Factor Influence on Millet Consumption Habits (Very High, High, Neutral, Low, Very Low).

Null Hypothesis (H_0):

There is no significant association between the online platform used and the influence on millet consumption habits.

Alternative Hypothesis (H_1):

There is a significant association between the online platform used and the influence on millet consumption habits.

Calculation

Platforms * Influence on Millet Consumption Platforms * Influence on Millet Consumption

Count

Platforms	InfluenceonMilletConsumption					Total
	VeryHigh	High	Neutral	Low	VeryLow	
Instagram	9	25	26	1	1	62
YouTube	33	60	34	2	0	129
Facebook	2	7	4	0	0	13
Blogs/Websites	0	5	0	1	0	6
Total	44	97	64	4	1	210

Chi-squaretest

PearsonChi-Square	21.247
DegreesofFreedom(df)	12
AsymptoticSignificance(2-sided)	.047

Interpretation

Based on the p-value of .047, which is greater than the significance level of 0.05, we fail to reject the null hypothesis. This means that There is no significant association between the online platform used and the influence on millet consumption habits.

Findings

Simple Percentage Analysis

- Most of the respondents belongs to the age category of 18-25 years (32.4%).
- Majority of the respondents has completed their Under-graduates (52.4%).
- Most of the respondents monthly household income is 50,000-70,000(29.5%).
- Most of the respondents are married (61.4%).
- Most of the respondents employment status are students (24.85%).
- Majority of the respondents household size is medium(4-6 members) (68.6%).
- Majority of the respondents are somewhat familiar with Millets as a food source (52.9%).
- Most of the respondents have been using Millets products more than 2 years (32.4%).
- Most of the respondents often include Millets in their diet (36.7%).
- Majority of the respondents consume 1 serving (66.2) per day.
- Majority of the respondents prefer to consume Millets as a breakfast (59.5).
- Majority of the respondents typically consume finger Millets(ragi) (71.4).
- Majority of the respondents prefer Millets recipes as breakfast dishes (57.1).
- Most of the respondents try new Millets – based recipes or dishes occasionally (42.4).
- Majority of the respondents are influence by YouTube (61.4).
- Most of the Respondents exposure to online content about millets influence their consumption habits (46.2).
- Most of the respondents spend 500-1,000 (48.6%) on Millets per month.

- Majority of the respondents buy Millets 1-2 times (54.3) in a month.
- Majority of the respondents purchasing Millets when they needed (68.1%).
- Majority of the respondents strongly agree (75.24%) that nutritional value influence their decision to consume Millets.
- Majority of the respondents agree (51.43%) that taste preference influence their decision to consume Millets.
- Most of the respondents agree (37.14%) that accessibility influence their decision to consume Millets.
- Most of the respondents agree (41.90%) that price influence their decision to consume Millets.
- Most of the respondents agree (38.57%) that traditional reason influence their decision to consume Millets.
- Majority of the respondents strongly agree (59.52%) that health benefits influence their decision to consume Millets.
- Most of the respondents agree (38.57%) that peer influence impact their decision to consume Millets.
- Most of the respondents agree (32.86%) that social status influence their decision to consume Millets.
- Majority of the respondents strongly agree (60%) that Reasons for consumption of Millets is for weight loss.
- Majority of the respondents agree (50.47%) that reason for consumption of Millets to maintain blood sugar level.
- Majority of the respondents strongly agree (50%) that reason for consumption of Millets to boost immunity.
- Most of the respondents agree (44.76%) that reason for consumption of Millets to avoid cardiovascular risk.
- Most of the respondents agree (44.76%) that reason for consumption of Millets for gluten free consumption.
- Most of the respondents agree (46.19%) that reason for consumption of Millets to enhancing digestion.
- (46.19%) of the respondents agree with the reason for consumption of Millets as an alternate to rice and wheat.
- Most of the respondents agree (46.19%) that reason for consumption of Millets is to enrich hemoglobin.
- Majority of the respondents strongly agree (52.28%) that reason for consumption of Millets is to get nutritional benefits.
- Majority of the respondents strongly agree (52.38%) that reason for consumption to maintain overall health.
- Most of the respondents consumption remain the same (45.2%) over the past year.
- Most of the respondents purchase Millets in local grocery store (32.9%).

Chi- Square

The p-value is .047. This means that There is no significant association between the online platform used and the influence on millet consumption habits.

Suggestions

The data on the awareness and consumption patterns of Millets among women in Coimbatore highlights the need for targeted nutritional awareness programs. These programs could focus on educating women about the health benefits of Millets and their potential role in combating lifestyle diseases. The fact that respondents are primarily consuming Millets at breakfast but not incorporating them into their daily meals suggests an opportunity to promote millet-based alternatives for lunch and dinner. This could be achieved through awareness campaigns that provide easy, diverse and culturally appealing millet recipes for all meals. Partnering with local influencers and nutrition experts on platforms like Instagram and YouTube can help disseminate information on millet-based recipes and their health benefits effectively.

Conclusion

From the above study, we can understand the awareness and consumption patterns of Millets among women in Coimbatore and the factors influencing their dietary choices. While there is a growing recognition of the health benefits of Millets, their consumption is largely confined to specific meals, such as breakfast, rather than being a consistent part of daily diets. Factors such as limited knowledge of millet varieties, traditional food preferences, and accessibility play a role in shaping these consumption habits. The study highlights the influenced significantly by social media and online platforms and initiatives to promote the regular inclusion of Millets in daily meals. Overall, the data emphasizes the potential for Millets to become a staple in women's diets, provided there is ongoing support in terms of education, accessibility and cultural integration.

References

Singh, R., & Raghuvanshi, R. S. (2012). Title: Nutritional Composition, Processing, and Utilization of Millets .Nutritional Composition, Processing, and Utilization of Millets. Agricultural Research, 45(3), 167-175.

Patil, S., & Joshi, P. (2015). Title: Impact of Socio-Economic Status on Millet Consumption Among Women .Impact of Socio-Economic Status on Millet Consumption Among Women. Indian Journal of Nutrition, 12(2), 102-110

Devi, P. B., &Vijayabharathi, R. (2014). Title: Health Benefits of Millets: A Nutritional and Therapeutic Perspective Health Benefits of Millets: A Nutritional and Therapeutic Perspective. International Journal of Food Science and Nutrition, 65(5), 645-652.

Books:

https://drive.google.com/file/d/1XBslFv864x-k2kG-gGxlc35IlDL8_3Z1/view

https://www.researchgate.net/publication/340622644_Fundamentals_of_Rese arch_Methodology

https://www.Millets.res.in/m_recipes/Nutritional_health_benefits_Millets.pdf

TECHNOLOGY ADOPTION BY FARMERS TO CHANGE FROM INORGANIC TO ORGANIC FARMING WITH SPECIAL REFERENCE TO HEALTH ENRICHMENT

Dr PMenakadevi[1],Ms S Bhavanethra[2]

[1]Associate Professor, Department of Commerce, PSG College of Arts & Science

[2]Student, Bachelor of Business Administration, PSG College of Arts & Science

Abstract

A rising trend towards environment friendly and sustainable farming practices has been observed in recent years. This study aims to explore farmer's opinions on transitioning from inorganic to organic farming, with a special focus on health enrichment. The research examines how farmers perceive the shift to organic agriculture, particularly in terms of its impact on health. For this study, data was collected from 155 farmers across the Coimbatore, Erode, and Tirupur regions. Key motivating factors for adopting organic farming include concerns about soil health, reduced chemical exposure and the long-term health benefits for both farmers and consumers. However, despite recognizing these advantages, many farmers face significant challenges, such as the need for new skills, high initial investment costs, and difficulties in pest and disease management. These barriers influence their decision-making process and willingness to transition to organic farming.

Keywords: Sustainable farming practices, Health enrichment, Disease management, Organic agriculture

Introduction

In recent years, there has been a significant shift in global agriculture towards more sustainable and environmentally friendly farming practices. Among these transformations, the transition from conventional, inorganic farming to organic farming has received considerable attention. Organic farming promotes natural and holistic approaches to agricultural production, emphasizing the absence of synthetic fertilizers and pesticides. This shift has the potential to enhance soil health, reduce the environmental impact of agriculture, and provide consumers with healthier, chemical-free produce. The role of technology in facilitating this transition is crucial. Farmers' adoption of modern agricultural technologies can determine the success of their move to organic farming. The integration of advanced techniques, precision farming tools, and bio-fertilizers can significantly ease the transition process. However, this transformation also presents challenges that depend largely on farmers' awareness, willingness, and ability to adapt to new agricultural technologies. Various factors, such as economic considerations, technological expertise, traditional farming practices, and market demand, influence their decision to embrace organic farming with technological interventions. This study aims to explore the role of technology adoption in aiding farmers to switch from inorganic to organic farming, with a special focus on health enrichment.

Through in-depth research, surveys, and interviews, the study will investigate the challenges, benefits, and experiences of farmers who have incorporated technology to facilitate organic farming. The findings will contribute to a broader understanding of the impact of technology on sustainable agriculture and public health.

About Technology-Enabled Organic Farming

Technology adoption in organic farming involves utilizing modern innovations to replace synthetic chemicals while ensuring high yields, soil fertility, and pest management.

Unlike conventional farming that relies heavily on artificial fertilizers, herbicides, and pesticides, organic farming with technology employs precision farming techniques, organic bio-fertilizers, and smart pest control measures to maintain agricultural productivity.

Key Technological Interventions in Organic Farming

Precision Agriculture: Utilization of data-driven farming techniques, including sensors, drones, and satellite imagery, to monitor soil health, moisture levels, and pest infestations.

Bio-Fertilizers: The use of natural fertilizers such as compost, vermicompost, and microbial inoculants to enhance soil fertility without synthetic chemicals.

Integrated Pest Management (IPM): Employing biological control agents, pheromone traps, and natural pesticides to minimize pest infestations.

Automation and Smart Irrigation: Adoption of drip irrigation and AI-powered irrigation systems to optimize water usage and maintain soil moisture.

Soil Health Monitoring: Digital tools and mobile applications that help farmers analyze soil conditions and recommend organic treatment solutions.

Organic Certification and Blockchain Traceability: Utilizing blockchain and digital platforms to ensure transparency, traceability, and certification compliance in organic farming practices.

Key Benefits of Technology-Enabled Organic Farming

Healthier Produce: Reduction in chemical residues leading to safer and nutrient-rich food for consumers.

Enhanced Soil Fertility: Adoption of bio-fertilizers and composting improves soil quality and microbial activity.

Efficient Pest and Weed Management: Use of technology-assisted biological pest control minimizes crop damage and enhances yields.

Water Conservation: Smart irrigation systems reduce excessive water use and promote sustainability.

Increased Productivity: Precision farming tools help optimize land use and boost crop yields.

Consumer Trust: Block chain-enabled certification builds consumer confidence in organic food products.

Objectives of the Study

- To analyse the role of technology in facilitating the transition from inorganic to organic farming.
- To study farmers' attitudes towards adopting technology for organic agriculture.
- To evaluate government policies, subsidies, and regulations that support technology adoption in organic farming.
- To examine the health benefits associated with organic food.

Need for the Study

- To reduce the excessive use of chemical fertilizers that degrade soil fertility.
- To promote sustainable agricultural practices through technological advancements.
- To protect ecosystems and ensure long-term agricultural productivity.
- To meet the increasing consumer demand for organic and health-enriched food.
- To address challenges faced by farmers in transitioning to organic farming.

Scope of the Study

- Improved knowledge of organic farming technologies can enhance product quality and soil fertility.
- Adoption of technology-driven organic farming can contribute to better public health outcomes.
- Sustainable agriculture practices can strengthen food security and environmental protection.
- Implementation of advanced organic farming techniques can help achieve national sustainability goals.

Statement of the Problem

- Conventional inorganic farming negatively impacts the environment and human health.
- Technology-enabled organic farming offers a viable, sustainable alternative.
- Health-enriched organic produce can benefit both farmers and consumers.
- There is a need for extensive awareness and support for technology adoption in organic farming.

Limitations of the Study

- Limited awareness among farmers regarding advanced organic farming technologies.
- Initial cost barriers in adopting smart agricultural tools.
- Organic farming yields may initially be lower than inorganic farming.
- Need for better infrastructure and market access to promote organic produce.

Review of Literature

Rogers' Diffusion of Innovation Theory (2003) Rogers' theory explains how technology adoption occurs in stages: awareness, interest, evaluation, trial, and adoption. Farmers transitioning to organic farming often follow this pattern, with early adopters leading the change and influencing others.

Pretty & Bharucha (2014) - Sustainable Intensification in Agriculture: This study highlights the role of sustainable farming practices in improving soil health, biodiversity, and food security. It discusses how farmers adopting organic methods benefit from long-term sustainability despite initial challenges.

Wheeler (2008) - Barriers to Organic Farming Adoption: Wheeler identifies major barriers, including high initial costs, lack of technical knowledge, and market uncertainties. The study emphasizes the need for better government support and farmer education programs.

Padel (2001) - Conversion to Organic Farming: A Typical Example of the Diffusion of an Innovation?This research explains that organic farming adoption is influenced by economic viability, social networks, and individual farmer attitudes. Peer influence plays a crucial role in the transition process.

Sahota (2018) - The Global Market For Organic Food & Drink Sahota's study highlights increasing consumer demand for organic products and its impact on farmers' decision-making. It discusses how organic certification and technology adoption can enhance market opportunities.

Research Gap

- There is a need to study the role of technology in facilitating the transition from inorganic to organic farming with a focus on health enrichment.

- Previous studies have primarily examined the benefits and challenges of organic farming but have not extensively explored the impact of modern agricultural technologies in this transition.
- This study focuses on farmers' opinions on adopting technology for shifting to organic farming and the associated risks and benefits in terms of health enrichment

Methodology

Sample Size:

The sample size of this research study is 155 respondents.

Sampling Technique:

The sampling design used in this study is CONVENIENT sampling, where the individuals in the population are selected on the basis of the easy accessibility such as using the individuals who are friends and family.

Methods of Data Collection:

Data collection is an essential part of a study which helps in gaining insights about the research problem. This study consists of both primary data collected through Questionnaires and secondary data collected from articles, journals and past studies.

Tools Used for Data Collection:

The study primarily uses Questionnaires to collect required data.

Analysis Tool: Chi-Square Test

Formula for Chi square test

$x2 = \sum(Oi - Ei)\ 2/\ Ei$

x 2 = chi squared Oi = observed value Ei = expected value

The null hypothesis and the alternative hypothesis is formed

- If the probability value (P) is greater than the significance level, null hypothesis is accepted and alternative hypothesis is rejected.
- If the probability value (P) is lesser than the significance level, an alternative hypothesis is accepted and the null hypothesis is rejected.

Chi Square Test

A statistical test called the chi-square test is used to compare actual results to predictions. The goal of this test is to establish whether a discrepancy between observed and expected data is the result of chance or a correlation between the variables you are researching.

Chi Square Analysis

Independent Variable: Increasing environment pollution and awareness about its effects

Dependent Variable: Realizing the need to choose eco-friendly practices on an everyday basis

Hypothesis

Hypothesis is the mere assumption between an independent variable and the dependent variable of the study.

Null Hypothesis (Ho): There is no association between Increasing environment pollutionand awareness about its effects and realizing the need to choose eco-friendly practices on an everyday basis

Alternative Hypothesis (Ha): There is association between Increasing environment pollution and awareness about its effects and realizing the need to choose eco-friendly practices on an everyday basis

Level of Significance

The significance level is a measure of statistical significance. This means that the null hypothesis is accepted or rejected based on the significance level. It should determine whether the hypothesis is wrong and how significant the results are. The significance level is 0.05, if the significance level is less than 0.05 null hypothesis is accepted and alternative hypothesis is accepted and vice versa.

Analysis

Significant Difference Between Age and Problems Faced by Farmers While Changing from Inorganic to Organic Farming

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.790[a]	16	.399
Likelihood Ratio	16.546	16	.416
Linear-by-Linear Association	.005	1	.942
N of Valid Cases	155		
a. 18 cells (72.0%) have expected count less than 5. The minimum expected count is .09.			

Interpretation

From the above table 26 it is inferred that the Pearson Chi-Square test satisfies 16.790 with 6 degrees of freedom.The associated two-sided asymptotic p-value is 0.399 . Since p-value (0.399) is greater than the commonly used significance level of 0.05, we do not have strong evidence to reject the null hypothesis. This suggests that there is no significant association between the age and problems faced by farmers while changing from inorganic to organic farming.

Findings

Based on Percentage Analysis:

- 46.5% of the respondents are at the age of 40-50 years .
- 61.3% of the respondents are male.
- 49.7% of the respondents families annual income is between 4-8 lakhs .
- 51.6% of the respondents' family members ranged between 3-5.
- 41.3 % of the respondents cultivate vegetables currently in their field .
- 69% of the respondents are doing organic farming as their current farming methods .
- 38.1% of the respondents consider environmental impact as the factor while choosing farming methods .
- 84.51% of the respondents strongly agree that it is better for the environment.
- 92.90% of the respondents strongly agree for higher market demand .
- 72.90 % of the respondents strongly agree that it requires more labor .
- 70.32 % of the respondents strongly agree that it requires additional costs.
- 71.61%of the respondents strongly agree that it is easy to manage .
- 71.61% of the respondents strongly agree that it leads to higher prices .

- 41.3% of the respondents consider cost saving as the primary reason for switching to organic farming.
- 67.74% of the respondents strongly agree with their opinion on effective management of pests and disease .
- 70.96 % of the respondents strongly agree that it can reduce the need for chemical fertilizers 72.25% of the respondents agreed that it requires proper planning.
- 65.16% of the respondents strongly agreed it is cost effective
- 65.80% strongly agreed that it takes time to show results .
- 51% of the respondents are somewhat concerned about the long term effects of using chemical pesticides and fertilizers
- 51% of the respondents are managing the pests and diseases by using crop rotation method
- 32.9% of the respondents somewhat believe that organic farming can contribute to soil health.
- 38.7% of the respondents agree that organic farming can help negative climate change effects
- 67.74% of the respondents strongly agree that it is economically challenging .
- 67.09% of the respondents strongly agree that there is more risk in managing pests and diseases.
- 64.51% of the respondents strongly agree that marketing is difficult.
- 67.09% of the respondents strongly agree that it requires more time.
- 60.64% of the respondents strongly agree that the government provides sufficient support.
- 61.9% of the respondents are somewhat concerned about the decrease in crop yield during the transition.
- 51.6% of the respondents opted low risk in transitioning to organic farming
- 65.8% of the respondents foresee challenges in managing pests and diseases .
- 40.6% of the respondents consider it is somewhat important for consumer perception towards organic products .
- 63.22% of the respondents strongly agree that their choice is influenced by the availability of subsidies .
- 63.22% of the respondents strongly agree that it is easy to understand and act .
- 63.87% of the respondents strongly agree that it has a positive impact on the decision .
- 58.70% strongly agree that current support is enough .
- 56.1% of the respondents opted for justified investment.
- 40% of the respondents somewhat believe that organic farming can lead to increased biodiversity
- 65.2% of the respondents are somewhat knowledgeable about the nutritional benefits of organic products
- 36.1% of the respondents primarily seek information from farming associations.
- 61% of the respondents agree that there is significant improvement in health benefits for consumers who prefer organic products.

- 73% of the respondents believe in the digital marketing for organic products.

Based on Chi-Square Analysis

This suggests that there is no significant association between the age and problems faced by farmers while changing from inorganic to organic farming.

Suggestions

Educational Initiatives:

Create and put into action educational workshops and programmes to give farmers the information and abilities they need to successfully switch to organic farming. These programs should educate farmers on smart irrigation, AI-based crop monitoring, precision farming, and digital tools for pest and soil health management.

Financial Support for Technological Adoption:

Governments and agricultural organizations should offer subsidies, low-interest loans, and incentives for farmers to invest in technology that facilitates organic farming, such as bio-fertilizers, automated composting systems, and drone-based crop analysis.

Market Access:

Foster local demand for organic produce or increase export possibilities to create and promote markets. For farmers, a steady and lucrative market for organic goods can be a powerful motivator. Encourage farmers to join or **establish cooperatives and associations** that are devoted to organic farming. These networks can act as venues for exchanging knowledge, best practices, and market data.

Invest in **research and development** to enhance organic farming practices, crop varieties, and pest management strategies. Enhancing crop yields and resilience in organic farming should be the goal of this research.

Enhanced Market Access through Digital Platforms:

Encourage the use of e-commerce platforms, blockchain-based traceability systems, and digital marketing strategies to connect organic farmers with a larger consumer base, ensuring better pricing and reducing dependency on middlemen.

Health and Environmental Awareness Campaigns:

Highlight the health benefits of organic produce by integrating technology to provide scientific data on nutrient content, chemical-free farming benefits, and long-term health impacts. Use mobile apps and social media to educate both farmers and consumers on the advantages of organic farming.

Conclusion

Understanding farmers' perspectives on transitioning from inorganic to organic farming is crucial in the context of sustainable agriculture and environmental conservation. This transition is influenced by a range of motivations, challenges, and potential benefits, particularly when integrating technological advancements into organic farming practices.

Farmers are increasingly motivated by concerns over environmental sustainability, human health, and market demand for organic produce. The perceived economic advantages of organic farming also play a key role in their decision-making. However, significant

challenges hinder this shift, including the need for new skills, upfront investment costs, pest and disease management, and the complexities of integrating technology into farming practices. The adoption of smart agricultural tools, digital literacy, and efficient soil and pest management strategies requires additional resources and expertise.

To facilitate this transition, a multifaceted approach is essential. Educational programs, financial aid, and technical support can empower farmers with the necessary skills and resources. Expanding market access, fostering research in bio-based solutions, and implementing favorable government policies will further encourage organic farming. Additionally, digital literacy programs, financial incentives for smart agricultural tools, and improved access to digital marketplaces will enhance efficiency and sustainability in organic farming.

In conclusion, while the shift from conventional to organic farming presents challenges, it also offers immense benefits for farmers, consumers, and the environment. By addressing these barriers and leveraging technological advancements alongside supportive policies, we can create a more resilient and health-enriching organic farming ecosystem, ensuring a sustainable future for agriculture.

References

https://www.sciencedirect.com/science/article/abs/pii/S0921800915306212

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=farmers+changing+to+organic+farming&oq=#d=gs_qabs&t=1696856973626&u=%23p%3DfYBhbb32DpwJ

https://www.sciencedirect.com/science/article/abs/pii/S0308521X07000388

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=farmers+changing+to+organic+farming&oq=#d=gs_qabs&t=1696857077927&u=%23p%3DJ5ECZkjXWM8J

https://scholar.google.com/scholar?start=10&q=farmers+changing+to+organic+farming&hl=en&as_sdt=0,5#d=gs_qabs&t=1696857155066&u=%23p%3DL3Wx8Mu-3icJ

https://scholar.google.com/scholar?start=10&q=farmers+changing+to+organic+farming&hl=en&as_sdt=0,5#d=gs_qabs&t=1696857223474&u=%23p%3DQhGxbgOpJsoJ

https://scholar.google.com/scholar?start=10&q=farmers+changing+to+organic+farming&hl=en&as_sdt=0,5#d=gs_qabs&t=1696857251024&u=%23p%3DxzEWw5TtT_MJ

PEOPLE'S PERCEPTION TOWARDS DIGITAL HEALTH

Ms Kaviya[1]

[1] Student, Department of Hospital Administration, PSG College of Arts & Science, Coimbatore

Abstract

Digital health technology is revolutionizing the delivery of healthcare, enhancing accessibility, efficiency, and health outcomes. However, the perceived attitude towards the innovations among individuals differs depending on digital literacy levels, trustworthiness, confidentiality, and perceived ease of use. This study investigates public perception of digital health with 110 feedback by conducting the survey with set of questionnaires for common opinion, examining elements that drive the acceptance, rejection, and engagement of digital solutions in healthcare such as telemedicine, wearable devices, and electronic health records. Results show that while numerous individuals acknowledge the advantages of digital health in increasing convenience and remote care, concerns regarding data security, technological difficulty, and absence of human interaction persist as roadblocks to mass appeal. Knowledge of these attitudes is important for healthcare providers and policymakers to gain user trust, develop better digital health literacy, and create more patient-centric technologies.

Key words: *Digital Health Service (DHS), Telemedicine, Digital literacy, People's perception.*

Introduction

The embedding of digital technology in healthcare has transformed the delivery of medical care, enhancing healthcare accessibility, efficiency, and personalization. Digital health is a general term applied to a variety of innovations, such as electronic health records (EHRs), telemedicine, mobile health applications, wearable technology, artificial intelligence (AI), and blockchain-based health data protection. As the healthcare sector rapidly digitalizes, it is essential to identify people's attitudes towards digital health to ensure effective implementation and utilization.As the world grapples with rising diseases, higher healthcare expenses, and a growing need for patient-centric care, digital health technologies have been identified to address gaps in the quality and access of healthcare. The COVID-19 pandemic compelled the world toward the accelerated implementation of digital health technologies, and their utility was demonstrated through telemedicine consultations, virtual monitoring, and health data management. Yet, despite the advantages, people's perception—initiated by trust, awareness, digital literacy, and security—mobilizes the masses toward the use of such technologies.This research will attempt to investigate the current status of the digitalization of health services. The aim of this study is to determine more about individuals who utilize digital technology or a mobile phone and their attitudes towards digital acceptability in health. Thus, the study's purpose was to explore the manner variables such as perceived social and cultural, technological, economic, convenience, security, and perceived usefulness influence the perception of the user's digital health service.

Review of Literature

The article "Readiness for Delivering Digital Health at Scale: Lessons from a Longitudinal Qualitative Evaluation of a National Digital Health Innovation Program in the United Kingdom" by Marilyn R. Lennon et al. presents the enablers and barriers to the implementation of digital health solutions at scale. The study is aimed at the "Delivering

Assisted Living Lifestyles at Scale" (dallas) program, a £37 million national digital health program initiated in 2012-2015.

The study "Perception towards the Acceptance of Digital Health Services among the People of Bangladesh" by K.M. Salah Uddin, Mohammad Rakibul Islam Bhuiyan, and Marufa Hamid examines determinants of digital health service acceptance in Bangladesh. The study offers valuable insights for policymakers, health workers, and technology entrepreneurs to tailor their plans and interventions to more effectively meet the needs and dispositions of Bangladeshis. With the improvement of positive perceptions and elimination of hindrances identified, the potential lies to improve adoption of digital health services, ultimately improving healthcare access and outcomes in Bangladesh.

The study "Healthcare professionals' perceptions of digital health competence: A qualitative descriptive study" by Erika Jarva et al. (2022) discusses healthcare professionals' perceptions and experiences of digital health competence. Based on semi-structured interviews of Finnish and Swedish nurses and allied health professionals, the study finds that there exist some significant aspects of digital health competence. The participants were uncertain about their digital health competence, with some being confident and others proposing areas for improvement. The study concludes that digital health competence, according to healthcare professionals, is perceived as being part of patient-centered care, in terms of the proper mix of digital and traditional means. The authors suggest that the factors influencing digital health competence and how it evolves are to be studied further.

Deborah Lupton's paper "Critical Perspectives on Digital Health Technologies" analyzes the increasing power of digital health technologies and their implications for healthcare, self-care, and surveillance. She adopts a sociological and critical approach, discussing the effects of these technologies on people and healthcare systems. Lupton contends that while digital health technologies provide advantages in the form of enhanced access to health information and personalized care, they also create significant ethical, social, and political issues. These involve concerns of privacy, surveillance, commercialization, and inequality, which need to be examined further. She advocates an evidence-based approach that weighs both the benefits and probable detriments of digital health technologies.

Perceptions of Digital Health Education Among European Medical Students: Mixed Methods Survey, Authors: Felix Machleid, Robert Kaczmarczyk, Doreen Johann, Justinas Bal iūnas, Beatriz Atienza-Carbonell, Finn von Maltzahn, Lina Mosch. This paper adds to the increasing debate around digital transformation in medical education. It resonates with current literature highlighting the role of digital literacy in healthcare. The results can inform policy suggestions on how to implement digital health skills in medical education programs.

The research "Perception, Willingness, and Practices of Telemedicine in Patients with Chronic Diseases: Implication of Digital Health in Patients' Perspective at a Tertiary Care Hospital in Ethiopia" by Belachew et al. (2023) examines the perception and utilization of telemedicine services by patients suffering from chronic diseases at the University of Gondar Comprehensive Specialized Hospital (UoGCSH) in Northwest Ethiopia. The research reveals that patients with chronic illnesses in UoGCSH hold a positive perception of TM and are open to availing such services but still underutilize them. The gap is indicative of the importance of greater awareness and establishment of favorable environments for TM usage. The research "COVID-19 awareness, knowledge and perception towards digital health in an

urban population of Kerala, India" examines the public's perception and knowledge about COVID-19 and digital health technologies in Kerala. The research was carried out during the pandemic period using a cross-sectional survey to evaluate the awareness of COVID-19 transmission, prevention strategies, and their perceptions of digital health interventions among participants.

The study "ChatGPT and the Future of Digital Health: A Study on Healthcare Workers' Perceptions and Expectations" explores the perceptions, attitudes, and planned use of ChatGPT—a state-of-the-art AI chatbot—among HCWs in Saudi Arabia in the first three months since its launch. The study further reveals the probable barriers to adopting AI chatbots in healthcare facilities.

The Australian General Public's Perceptions of Having a Personally Controlled Electronic Health Record (PCEHR) by Lynda Andrews, RandikeGajanayake, and Tony Sahama. The research considers the Australian general public's perception of the Personally Controlled Electronic Health Record (PCEHR) system. The PCEHR was implemented with the aim of enhancing healthcare efficiency through giving control of electronic health records to the patients, increased accessibility, and improved communication between healthcare providers.

YoesoepEdhieRachmad's paper, "MediVerse: Challenges and Development of Digital Health Transformation Towards Metaverse in Medicine," discusses the incorporation of metaverse technologies into the medical field, noting opportunities as well as challenges. The paper concludes that, although the MediVerse has immense potential for healthcare delivery and medical education transformation, there is a need for cautious and collaborative measures to overcome the inherent challenges and facilitate successful incorporation into the healthcare system.

OBJECTIVES OF THE STUDY

- To examine public knowledge and understanding of digital health solutions.
- To investigate the drivers of people's perception of digital health.
- To assess the advantages and disadvantages of digital health from the user point of view.
- To determine the extent of trust and acceptance of digital health services.
- To compare the perception of digital health across demographics.

Hypothesis Testing

Ho: There is no significant variation in individuals' perception of digital health across various demographic segments (age, education, income, etc.).

H_1: There is a significant difference exists between individuals' perception of digital health between different demographic segments.

Statement of the Problem

The accelerated development of digital health technologies such as telemedicine, mobile health applications, and electronic health records has reformed healthcare provision. The use and performance of these innovations, though, largely rely on individuals' perception, confidence, and readiness to use digital health technologies. Although digital health provides enhanced availability, productivity, and patient-oriented care, patients are still uneasy about data protection, digital competence, and the trustworthiness of online consultations. This research seeks to investigate individuals' perception towards digital health, determining drivers of their acceptance or resistance. Knowledge of these perceptions is important for

policymakers, healthcare professionals, and technology developers to close gaps in trust, accessibility, and usability, thereby ensuring the design

Methodology

Research Method:

This research regarding the view point or opinion of Digital Health Service (DHS) among general public and specifically students.

Data Collection:

When it comes to data collection, this study followed the primary data collection which includes the questionnaire based on the basic understanding of the digital health service to grab the attitudes of public towards DHS.

Sampling:

Sampling is basically defined into two types of sampling which are probability and non-probability. This research followed the probability sampling to proceed the simple random sampling method to confine the responses from different demographic segments eg: age, gender and occupation.

Sample Design:

The approached public and students are conducted with set of questionnaires through electronical survey.

Sample Size:

The population consists of general public and students from Coimbatore and also from some of the other areas and the questionnaire was created with simple language to reduce the misinterpretation while data analysis.

Questionnaire Design:

The questionnaire has been carefully crafted to satisfy the parameters of the research. To validate the research further, questions have been self-structured to cover the breadth of research topics aims to collect the current opinion of DHS.

Limitations

The sample could not be representative of the large amount of general population, thereby limiting the ability to generalize the finding. Personal opinions, social desirability, or a lack of complete knowledge of digital health may shape the responses given by the respondents. Additional investigation with experimental or longitudinal designs is required. Digital health is changing, and individuals' perceptions can change over time, so the results are time-sensitive. These should be considered when interpreting the results and designing future research.

Data Analysis and Interpretation Analysis

Table 1 – Gender

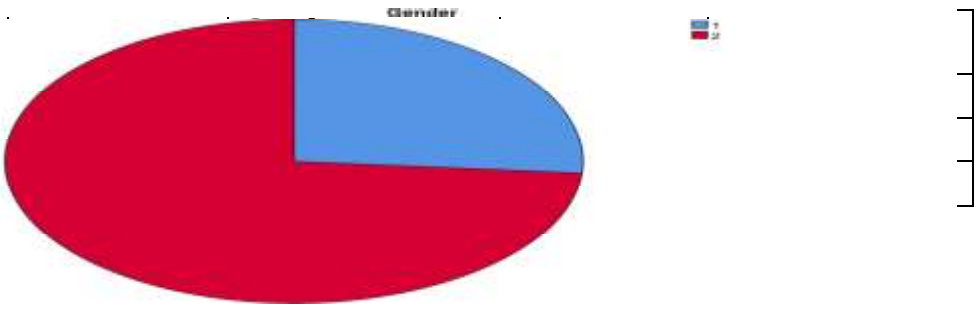


Table 2 – Occupation

	Occupation	frequency	Percent
Valid	Students	65	57.0%
	Employed	38	33.3%
	Unemployed	11	9.6%
	Total	114	100.0%

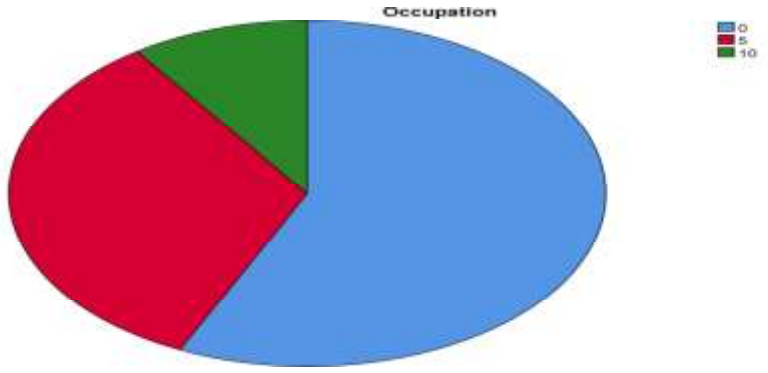


Table 3 – Correlation

S. no	Gender	No. of respondents	Mean rank	Sum of rank
Occupation	Male	30	68.15	2044.50
	Female	84	53.70	4510.50
	Total	114		
How often do you use digital health services (eg: telemedicine, health apps, online consultation)?	Male	30	52.72	1581.50
	Female	83	58.55	4859.50
	Total	113		
what is your primary reason for using digital health services?	Male	30	54.00	1620.00
	Female	83	58.08	4821.00
	Total	113		

Table 4 – Correlation

	Gender	No. of Respondents	Mean rank	Sum of rank
Occupation	Male	30	68.15	2044.50

	Female	84	53.70	4510.50
	Total	114		
How satisfied are you with the quality of digital health services?	Male	30	60.35	1810.50
	Female	83	55.79	4630.50
	Total	113		
which digital health service do you trust the most?	Male	30	51.33	1540.00
	Female	83	59.05	4901.00
	Total	113		

Table 5

	Gender	**No. of respondents**	**Mean rank**	**Sum of rank**
Occupation	Male	30	68.15	2044.50
	Female	84	53.70	4510.50
	Total	114		
How do you feel about AI powered health advice?	Male	30	65.65	1969.50
	Female	83	53.87	4471.50
	Total	113		
would you recommend digital health services to others?	Male	30	64.10	1923.00
	Female	83	54.43	4518.00
	Total	113		

Table 6 – Chi Square value

	Gender	**Occupation**
Chi-Square	25.579[a]	38.368[b]
df	1	2
Asymp. Sig.	.000	.000

Major Findings

- The majority (75.2 %) of the respondents are between the ages of 18 and 25.
- The majority (73.3) of the respondents are female.
- The majority (57.0) of the respondents are bachelor degree students from various cities.
- The majority (58.55) respondents are frequently using the digital health service and the majority (58.08) respondent's primary reason for using DHS is for convenience and accessibility.

- The majority (60.35) of the respondents are very satisfied with quality of DHS and the majority (51.33) of the respondents are trust the most about telemedicine in DHS.
- The majority (65.65) of the respondents are feels the AI powered health advice is very helpful and innovative.
- The majority (64.10) of the respondents are tells that they definitely recommend digital health service to others.
- 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 57.0.
- 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 38.0.
- The results of the chi-square tests show statistically significant relationships between *Gender and Occupation*. The test statistics are:

- *Chi-square value for Gender* = 25.579, *df* = 1, *p-value* = 0.000
- *Chi-square value for Occupation* = 38.368, *df* = 2, *p-value* = 0.000

As the *p-values (Asymp. Sig.) are both 0.000, which is smaller than the standard significance level (0.05 or 0.01), we reject the null hypothesis. * This indicates that there is a statistically significant association between Gender and Occupation.

Also, the assumption of the chi-square test holds, since *0 cells* have expected frequencies less than 5, thereby making the test valid. The lowest expected frequencies are **57.0* and *38.0*, which are more than adequate for a strong chi-square test.

Result and Discussion

The results of the Chi-Square test confirm that gender and occupation have a significant impact on people's perception of digital health. The test statistics are:

- Gender: χ^2 (1) = 25.579, p =.000
- Occupation: χ^2 (2) = 38.368, p =.000

Because the p-values for both variables are below 0.05, we can reject the null hypothesis, implying that gender and occupation have significant effects on digital health perceptions. Moreover, none of the expected cell frequencies were less than 5, maintaining the validity of the test.

The results emphasize that demographic factors are vital in influencing attitudes towards digital health technologies.

Gender Differences:

The high Chi-Square value indicates that attitudes towards digital health differ between males and females. The reasons for this could be related to variations in technology uptake, trust in digital health platforms, or health-seeking behavior. Literature has shown that women are likely to be more active in employing digital health platforms for family and self-care, while men would be resistant based on privacy issues or preference for conventional healthcare.

Occupational Influence:

The close link between occupation and perception indicates that individuals in various professional occupations view digital health differently. For example, healthcare professionals are likely to have a more optimistic view because they are familiar with digital health applications, while those in non-health occupations may be doubtful about their usability and reliability.

Implications for Digital Health Adoption:

The implication of these results is the call for awareness drives and educational interventions. Dealing with specific concern areas among varying demographic groups could improve trust and acceptance towards digital health solutions. For instance:

- For women: Highlighting ease of use, accessibility, and data security might enhance acceptance.

- For men: Demonstrating real-world effectiveness and professional support may be able to overcome skepticism.

- For other occupations: In-service sessions or work-based health programs could increase understanding and promote more widespread adoption.

Conclusion

The research verifies that occupation and gender have a large impact on individuals' attitudes towards digital health. To further optimize the uptake of digital health technologies, interventions must be specialized to address particular needs of various demographic groups. Future research might investigate further factors, e.g., education level, digital literacy, to further understand digital health acceptability.

References

Baines, R., Bradwell, H., Edwards, K., Stevens, S., Prime, S., Tredinnick-Rowe, J., Sibley, M., & Chatterjee, A. (2022). Meaningful patient and public involvement in digital health innovation, implementation and evaluation: A systematic review. Health Expectations, 25(4), 1232–1245. https://doi.org/10.1111/hex.13506.

Belachew, E. A., Getachew, D., Netere, A. K., Gizachew, E., &Sendekie, A. K. (2023). Perception, willingness, and practices of telemedicine in patients with chronic diseases: implication of digital health in patients' perspective at a tertiary care hospital in Ethiopia. Frontiers in Public Health, 11. https://doi.org/10.3389/fpubh.2023.1234436.

Fritsch, S. J., Blankenheim, A., Wahl, A., Hetfeld, P., Maassen, O., Deffge, S., Kunze, J., Rossaint, R., Riedel, M., Marx, G., &Bickenbach, J. (2022). Attitudes and perception of artificial intelligence in healthcare: A cross-sectional survey among patients. Digital Health, 8, 205520762211167. https://doi.org/10.1177/20552076221116772.

Kossman, S. P., &Scheidenhelm, S. L. (2008). Nurses' perceptions of the impact of electronic health records on work and patient outcomes. CIN Computers Informatics Nursing, 26(2), 69–77. https://doi.org/10.1097/01.ncn.0000304775.40531.67

INTEGRATING IOT-BASED HEART RATE MONITORING WITH DYNAMIC HRV VISUALIZATION FOR PROACTIVE MENTAL WELLBEING: AN INFORMAL PILOT STUDY

DrAghosh B Prasad [1]

[1] Junior Resident, Department of Materia Medica

White Memorial Homoeopathic Medical College,Kanyakumari

Abstract

Objectives:

This study explores the feasibility of integrating IoT-based heart rate monitoring with dynamic heart rate variability (HRV), specifically RMSSD, visualization for proactive mental wellbeing interventions, building upon the author's prior experience in basic heart rate monitoring systems. This is demonstrated through a simulation-based pilot study.

Methodology:

Simulated heart rate data was used to demonstrate a system concept. Python scripts simulated RR intervals, calculated RMSSD-HRV, and generated dynamic Plotly visualizations. A threshold algorithm triggered simulated stress alerts via console output, mimicking email/SMS. This simulation focused on visualizing HRV dynamics for proactive stress management.

Findings:

Simulated results show effective dynamic visualization of HRV (RMSSD) trends. The visualization displays a clear HRV dip during simulated stress. The threshold algorithm successfully triggered simulated alerts during low HRV.

Discussion and Conclusion:

This simulation-based pilot study successfully demonstrates the proof-of-concept for IoT-based HRV monitoring with dynamic visualization for proactive stress indication. Building on prior heart rate system experience, this work extends functionality to HRV and dynamic visual feedback. Future work should incorporate wearable technology and real-world data for enhanced stress detection and practical application.

Keywords: IoT, Heart Rate Variability, Wearable Electronics, Proactive Healthcare, Stress Detection, Pilot Study, Simulation

Introduction

Continuous monitoring of cardiac activity using wearable devices has evolved from basic step counting to sophisticated physiological assessment. Heart rate variability (HRV) is a key indicator of autonomic nervous system balance and stress, traditionally measured via ECG.[1] However, advances in wearable electronics now enable more comfortable, long-term monitoring using alternative sensors such as PPG, BCG, and radial pulse devices.[2] Although previous IoT systems have focused primarily on abnormal heart rate detection, integrating HRV visualization offers a proactive approach to mental wellbeing by providing real-time insights into physiological stress indicators. Building upon the author's prior experience in the field of IoT-based heart rate monitoring, this study addresses the limitations of basic heart rate systems by exploring the integration of dynamic HRV visualization. Approximately six years ago, in 2019, the author developed an initial IoT-based heart rate monitoring system using an Arduino Mega 2560, a pulse sensor module, and a Bolt Wi-Fi module. This earlier

project successfully demonstrated the feasibility of real-time heart rate monitoring and cloud-based alerting via email and SMS for abnormal heart rate detection. It utilized a Digital Ocean VPS for running the monitoring code and services like Mailgun and Twilio for alerts.[3] While this project provided valuable insights into IoT-based health monitoring, it primarily focused on basic heart rate thresholds and lacked the capability for sophisticated HRV analysis and dynamic visual feedback.

Recognizing the limitations of solely relying on abnormal heart rate alerts and the growing importance of HRV for comprehensive stress assessment, this pilot study investigates the integration of dynamic HRV visualization into an IoT-based system concept. This work shifts focus to the proactive potential of real-time HRV feedback to provide users with more nuanced insights into their physiological state and potential stress responses. To demonstrate this concept, a simulation-based system was developed to visualize dynamic HRV and explore its utility for early stress indication. This informal pilot study, utilizing simulated data, builds on these developments by demonstrating the concept of continuous monitoring with dynamic HRV visualization to detect early signs of stress in a simulated environment. The focus is on showcasing the visualization and alert functionalities as a proof-of-concept, drawing motivation from the author's prior practical experience in the domain.

Literature Review

Recent reviews (Yin et al., 2025) have detailed significant progress in wearableelectronics for HRV assessment[2]. Innovations include:

- Advanced Sensors: Transition from bulky, wired ECG systems to flexible, textile-based electrodes, non-contact capacitive sensors, and optical PPG modules that provide high-fidelity cardiac signals.
- HRV Analysis Methods: Comprehensive HRV evaluation now incorporates time-domain, frequency-domain, and non-linear measures. Techniques such as the continuous wavelet transform (CWT-SST) and machine learning–based classifiers are emerging to enhance stress detection accuracy.
- Applications: New wearable platforms have been applied in stress estimation, drowsiness detection, and cardiovascular health monitoring, demonstrating improved user comfort and real-time analysis capabilities.

Research Gap

Despite these advances, few studies have combined a real-time IoT system with dynamic HRV visualization for proactive stress management. Most current systems rely on cloud-based processing and traditional alert methods (email/SMS), similar to basic systems like the author's previous heart rate monitor. There is a need to bridge the gap between cutting-edge wearable technology and practical, user-friendly digital health applications that offer real-time, visual feedback of HRV for proactive stress awareness, moving beyond simple threshold-based alerts.

Statement of the Problem

There is an unmet need for a system that continuously monitors heart rate and dynamically visualizes HRV to provide early warnings of stress, while remaining comfortable and accessible for long-term use and offering more insightful feedback than basic alerts. This pilot study addresses the visualization and enhanced feedback aspect of this problem using

simulated data to demonstrate the dynamic HRV display concept and its potential for proactive stress awareness, building upon the foundation of earlier IoT-based monitoring systems.

Objectives

- Develop a simulated IoT platform concept that integrates real-time heart rate monitoring with dynamic HRV visualization, expanding upon the capabilities of basic heart rate alert systems.
- Implement a threshold-based algorithm for detecting HRV deviations associated with simulated stress, going beyond simple heart rate abnormality detection.
- Demonstrate the system concept through a simulation-based pilot study, showcasing the added value of dynamic HRV visualization.
- Compare current methodologies with emerging wearable technologies and propose future improvements for real-world implementation, potentially informed by lessons from prior hardware-based projects like the author's 2019 heart rate monitor.

Scope of the Study

This study represents an informal pilot investigation using simulated data to demonstrate the functionality of an IoT-based HRV monitoring system with dynamic visualization. It focuses on the development and preliminary demonstration of dynamic HRV visualization and alert mechanisms, with an emphasis on potential future enhancements based on recent literature and real-world application, and drawing context from the author's prior practical work in IoT-based health monitoring. The findings are based on simulated data and serve as a proof-of-concept for the visualization and alert components, representing an advancement beyond basic heart rate monitoring systems.

Methodology

A simulation-based approach was employed to demonstrate the system concept, motivated by the author's previous experience with hardware-based IoT monitoring systems:

Data Simulation:

Python scripts were used to generate simulated RR interval data, mimicking heart rate signals and incorporating a period of simulated stress to induce HRV changes.

Software and Analysis:

Python scripts utilizing the Plotly[4] library were used to visualize RMSSD-based HRV in real-time in a dynamic graph. A simple threshold-based algorithm was implemented to trigger simulated alerts (displayed in the console output) upon detecting significant HRV drops, conceptually similar to the threshold-based alerts in the author's prior heart rate monitoring project.

Procedure:

The simulation was run for a defined duration, generating a dynamic HRV visualization and demonstrating the alert mechanism when simulated HRV fell below a threshold.

Data Analysis:

The dynamic HRV visualization was visually inspected to observe trends and responses to simulated stress. The console output was reviewed to confirm the triggering of simulated alerts under low HRV conditions. This analysis is qualitative and focused on demonstrating the intended system behavior within the simulation, highlighting the added value of dynamic HRV visualization compared to basic threshold alerts.

Findings

Simulated Dynamic HRV Visualization:

Fig.1 presents the dynamic visualization of simulated RMSSD values over a simulated time period. As shown in Fig.1, the RMSSD values, representing HRV, are dynamically plotted and updated as the simulation progresses, offering a more detailed view of cardiac activity than basic heart rate readings. The graph visually demonstrates the system's capability to track and display HRV changes over time. Notably, a discernible dip in the simulated RMSSD values is observed during the period of simulated stress, starting approximately at time window 3 on the x-axis, indicating a reduction in HRV during this simulated stress episode. Following the simulated stress period, the RMSSD values show a trend towards recovery. This visualization effectively demonstrates the dynamic HRV display component of the proposed system, offering a richer information stream compared to simple heart rate values.

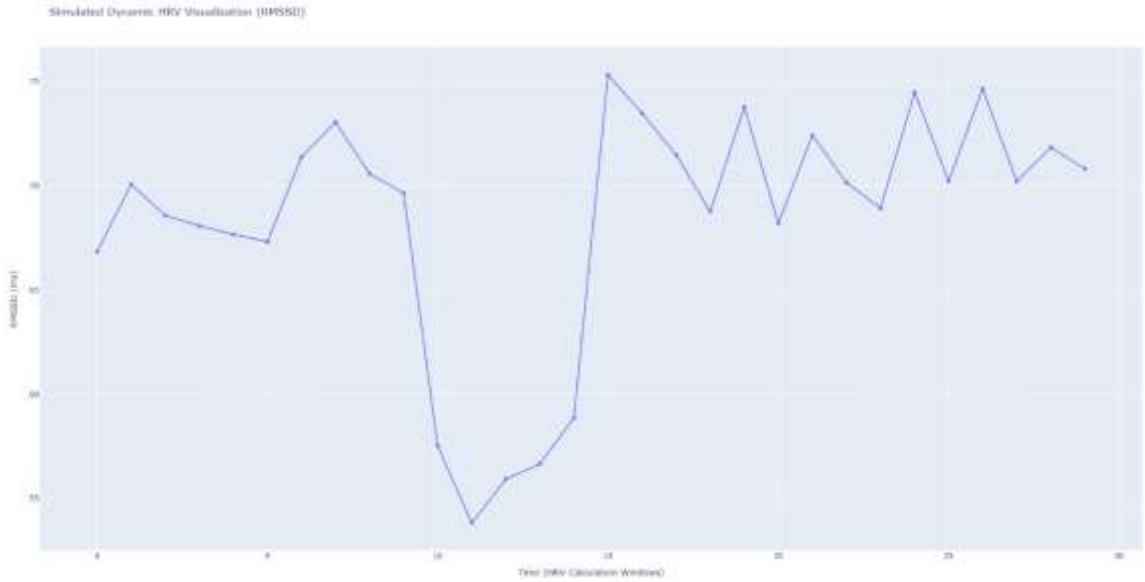


Fig.1 Simulated Dynamic HRV Visualization (RMSSD) during a Simulated Stress Scenario.

[This figure shows the dynamic visualization of RMSSD (Root Mean Square of Successive Differences) values over time, generated by the HRV simulation. The x-axis represents time in HRV calculation windows (each window is 60 seconds). The y-axis shows the RMSSD value in milliseconds (ms). The simulation includes a period of simulated stress starting around time window 3. Note the noticeable dip in RMSSD values around the simulated stress period, followed by a gradual recovery. This visualization demonstrates the system's capability to dynamically track HRV changes in response to simulated conditions, providing a more nuanced view than basic heart rate monitoring. ***Note:*** *This data is simulated and for illustrative purposes only.]*

Simulated Alert System:

The threshold-based algorithm implemented in the simulation successfully triggered. These alerts were displayed as text messages in the console output (Fig.2), simulating email and SMS notifications, similar in concept to the alert system in the author's previous heart rate monitoring project, but triggered by HRV deviations rather than just abnormal heart rate. This demonstrates the functionality of the alert mechanism to provide potential proactive

notifications based on HRV deviations in the simulated environment, offering a potentially more sensitive stress indicator than heart rate alone.

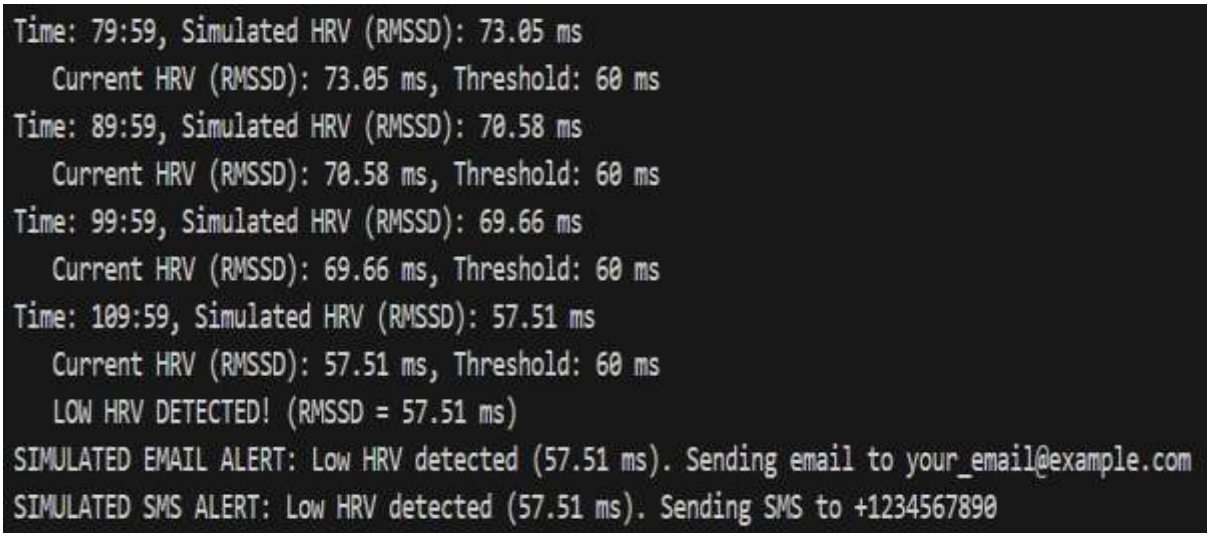


Fig.2 Simulated Alert System Console Output.

[This figure shows a screenshot of the console output from the Python simulation, demonstrating the simulated alert system. The output displays simulated email and SMS alert messages triggered when the RMSSD value fell below the threshold of 60 ms, indicating a low HRV event.]

Discussion

This pilot study successfully demonstrates the proof-of-concept for integrating IoT-based HRV monitoring with dynamic visualization for proactive stress indication using simulated data. The simulated dynamic HRV visualization, as shown in Fig.1, provides a visual representation of HRV trends and fluctuations, including a discernible response to simulated stress. This highlights the potential of such visualizations to provide users with real-time feedback on their physiological stress levels, offering a richer and more informative feedback mechanism compared to simple binary alerts based on heart rate thresholds, as explored in the author's prior work. While the alert system in this simulation is basic (console-based), it demonstrates the feasibility of using threshold-based algorithms to trigger notifications based on HRV deviations, potentially offering a more nuanced and early indication of stress than heart rate-based alerts.

However, it is crucial to acknowledge the limitations of this simulation-based study. The findings are based on simulated data, which is a simplified representation of real-world physiological signals. The system was not tested with actual wearable sensors or real human data. The alert mechanism is rudimentary and lacks the sophistication of a user-friendly notification system. Furthermore, the study focuses on RMSSD, a single HRV metric, and future work should explore more comprehensive HRV analysis.

In light of recent advances (Yin et al., 2025)[2], future implementations should move beyond simulations and incorporate:

Enhanced Wearable Electronics: Adoption of flexible, textile-based, or non-contact sensors for improved comfort and accuracy in real-world data acquisition, potentially drawing upon

the practical experience gained from implementing sensor interfaces in prior hardware projects.

Dual-Processing Architectures: Incorporating local (edge) processing for real-time HRV analysis and push notifications via smartphone apps to reduce latency and improve user interaction, moving beyond cloud-dependent systems and basic email/SMS alerts.

Advanced Signal Processing: Utilizing time-frequency and non-linear methods, supported by machine learning, to refine stress detection algorithms and improve the accuracy of HRV-based stress assessment in real-world scenarios, going beyond simple threshold-based approaches. These improvements could lead to more robust and user-friendly digital health solutions for proactive mental wellbeing monitoring, moving beyond simulated demonstrations and basic heart rate systems to practical and insightful applications.

Limitations

This study utilizes simulated data, which limits the generalizability of the findings to real-world scenarios and actual human physiological responses.

The informal nature of the pilot study and lack of real human data collection are significant limitations, requiring future validation with human subjects.

The alert system is rudimentary and demonstrated only through console output, not a functional user notification system, representing a simplification compared to practical alert mechanisms.

The simple threshold-based algorithm may not capture complex HRV dynamics or accurately reflect real-world stress responses, highlighting the need for more sophisticated analysis techniques in future iterations.

Conclusion

This informal pilot study, using simulated data, demonstrates the potential of integrating IoT-based heart rate monitoring with dynamic HRV visualization for proactive stress detection, building upon the foundation of basic heart rate monitoring systems. While preliminary findings from the simulation are promising in showcasing the visualization and alert concepts, future work should incorporate advanced wearable electronics, real-time data acquisition from human subjects, and edge-based processing to enhance system performance, user comfort, data privacy, and real-world applicability, and move beyond the limitations of basic heart rate monitoring to more insightful HRV-based approaches. This simulation-based study provides a foundational step towards developing a practical and user-friendly digital health solution for proactive mental wellbeing monitoring, representing an evolution from simpler IoT-based heart rate alert systems.

References

Vanderlei, L. C., Pastre, C. M., Hoshi, R. A., Carvalho, T. D., & Godoy, M. F. (2009). Basic notions of heart rate variability and its clinical applicability. *Revistabrasileira de cirurgia cardiovascular : orgaooficial da SociedadeBrasileira de Cirurgia Cardiovascular*, *24*(2), 205–217. https://doi.org/10.1590/s0102-76382009000200018

Yin, F. F., Chen, J., Xue, H. Y., Kang, K., Lu, C., Chen, X. Y., & Li, Y. (2025). Integration of wearable electronics and heart rate variability for human physical and mental well-being

assessment. *Journal of Semiconductors*, *46*(1), 011603. https://doi.org/10.1088/1674-4926/24080026

Prasad, A.B. (2019). Get Notified by Email and SMS When Your Pulse Is Abnormal. *Hackster.io*. https://www.hackster.io/aghoshbprasad/get-notified-by-email-and-sms-when-your-pulse-is-abnormal-737cf5

Plotly Technologies Inc. (2024). *Plotly Python Graphing Library*. Plotly Technologies. https://plotly.com/python/

ORGANIZING COMMITTEE

Chief Patron
Thiru. L. Gopalakrishnan
Managing Trustee, PSG & Sons' Charities

Patron
Dr. T. Kannaian
Secretary

Chairperson
Dr. M. Senguttuvan
Principal (i/c)

Advisory Committee

Dr.J.S.Bhuvaneswaran
Director
PSG Super Speciality Hospital

Dr.K.Banumathi
Director, MSc HA Programme(PSG SSH)
PSG OHMS & Vishnugranti

Dr.M.Jayanthi
Vice Principal

Dr.M.Umarani
Vice Principal

Convenor & Chief Editor

Dr.M.Amaravathi
Associate Professor & Head
Department of Management Science – Hospital Administration

Co-Editors

Dr.R.Ashok Kumar, Assistant Professor, MSc HA,PSGCAS
Dr.G.Dinesh Kumar, Assistant Professor, MSc HA,PSGCAS

Editorial Board

Mrs.R.M.Nandhini, Research Scholar, MSc HA,PSGCAS
Ms.S.Kanagathara, Research Scholar, MSc HA,PSGCAS
Ms.G.Shakthi Roshini, Teaching Assistant, MSc HA,PSGCAS
Ms.S.Amritha Shree, Student & Chairperson, II MSc HA,PSGCAS
Ms.M.Vaishnavi, Student, I MSc HA,PSGCAS
Ms.S.Shridhanya, Student, I MSc HA,PSGCAS

Multi Spectrum Publications
Kanyakumari, Tamilnadu, India.

ISBN : 978-81-990257-4-5
978-81-990257-4-5
www.multispectrum.org