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EDITORIAL Open Access

DIGITAL HEALTH: ADVANCES AND CHALLENGES

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Digital technology is rapidly transforming every sector of society, and the health sector is no exception. The integration of digital tools, ranging from mobile health (mHealth), telemedicine, applications to artificial intelligence (AI), big data analytics, and the Internet of Things (IoT), has led to the emergence of Digital Health as a new paradigm in population health management. This editorial discusses key advances and enduring challenges, finally 'way forward' in digital health development.

DIGITAL TRANSFORMATION IN HEALTH AND ITS ADVANCES

The foundation of electronic health records (EHRs) was laid in the 1960s with the emergence of computer technology. However, it was not until the 1990s that EHRs became an affordable and practical reality. With the advent of faster computers, improved data storage, and enhanced interoperability, EHR systems enabled the development of early telemedicine solutions (Evans, 2016). This progress paved the way for mobile health (mHealth), wearable technologies, artificial intelligence (AI) applications, and increasingly sophisticated telemedicine platforms.

Digital health offers transformative opportunities for addressing longstanding health challenges with innovative solutions. It not only improves patient care through accurate diagnosis, faster communication, and enhanced services, but also accelerates medical and health research by providing deeper insights into health problems and enabling more effective management strategies. Not only for curative, but digital health also empowers individuals and healthcare providers early disease detection, disease surveillance, prevention, and health promotion through mobile applications, wearable devices, cloud technology, big data analytics, and artificial intelligence. By leveraging digital platforms, health data can be collected, analyzed, and processed in real time, enabling faster and more targeted community interventions.

During the COVID-19 pandemic, many countries rapidly developed national applications to support contact tracing, risk stratification, and vaccination campaigns. After the pandemic, these applications evolved into broader digital health platforms. For example,

Brunei's BruHealth app introduced multiple new features, including expanded national health screening programmes (such as cervical cancer screening), an AI-powered Health Index that considers diet, sleep, and stress levels, a feature to track individual health habits, and gamified wellness challenges (EVYD Technology, 2025). Similarly, Malaysia's MySejahtera app is now repositioned as a comprehensive digital health platform, incorporating vaccination services, digital health records, MyDAR (My Diabetes Action Record), and other health information services (MySejahtera, 2022; MySejahtera, 2025). These innovations highlight the potential of digital health to enhance access, reduce disparities, and improve the effectiveness of interventions, particularly in geographically dispersed and resource-limited settings.

CHALLENGES AND CONSTRAINTS

Despite promising prospects and notable progress, several challenges persist in implementing and sustaining digital health systems.

Digital Divide and Equity Concerns

A significant challenge during digital transformation in health is the digital divide, unequal access to technology, internet, and digital literacy. The WHO warns that without equitable design and implementation, digital health solutions may worsen disparities, particularly among older adults, rural residents, and low-income groups (World Health Organization, 2021). UNESCO emphasizes that lack of affordable connectivity, devices, and digital skills hinders access not only to health services but also to education and broader civic engagement (United Nations Educational, Scientific and Cultural Organization, 2024). Consequently, addressing digital equity, through inclusive infrastructure, training, and user centered design, is essential to ensure digital health benefits all populations.

Data Fragmentation and Governance

Health data are often stored in siloed systems with limited interoperability. Data privacy laws remain underdeveloped or inconsistently enforced across the region. There is a pressing need for standardized health information exchange frameworks and robust governance policies that ensure confidentiality, accountability, and ethical use of digital health data (World Health Organization, 2021).

Workforce Capacity

The successful implementation of digital health solutions requires a workforce skilled in both health and digital technologies (World Health Organization, 2021). However, many health professionals in the region lack training in data analytics, informatics, or digital ethics (World Health Organization, 2025).

Regulatory and Ethical Challenges

Existing health regulations often struggle to keep pace with rapid technological advancements. For instance, the legal status of AI-driven diagnostics, cross-border telemedicine, and algorithmic decision-making remains unclear in many jurisdictions. Additionally, ethical concerns such as algorithmic bias, informed consent, and data ownership, further complicate the implementation of digital health solutions (World Health Organization, 2022).

Sustainability of Digital Initiatives

Many digital health projects in Southeast Asia are donor-funded or operate as pilot programmes without long-term sustainability planning. A shift toward integrating these technologies into routine health system financing and governance structures is essential (World Health Organization, 2021).

Cybersecurity and Data Privacy

As health data become digital and often cloud-based, they are more vulnerable to breaches, hacking, and misuse. Many health ministries and digital health providers in the region struggle with implementing robust cybersecurity measures, leading to potential threats to patient confidentiality and trust (World Health Organization, 2022).

THE HEALTH ECONOMICS PERSPECTIVE FOR DIGITAL HEALTH

Although the initial costs of digital transformation are undeniably high, including those related to infrastructure development, capacity building, and system integration, the long-term economic returns can be significant.

From a health economics standpoint, digital health offers multiple pathways for cost-effectiveness and value generation. More effective early detection and prevention can reduce costly complications of chronic diseases. Remote care delivery saves indirect costs such as travel, lost productivity, and caregiver burden. Administrative efficiency through digital records helps lower workforce costs and minimize system delays. Moreover, the scalability of digital tools enables marginal cost savings as the user base expands (Organisation for Economic Co-operation and Development, 2022; World Health Organization, 2021).

THE WAY FORWARD FOR DIGITAL HEALTH DEVELOPMENT

To harness the full potential of digital health development in the region, the following strategic actions are recommended:

Invest in Digital Equity

Ensure inclusive access through universal digital infrastructure, digital literacy programmes, and human-centered design for marginalized populations.

Strengthen Governance and Interoperability

Develop unified digital health architectures (roadmap, strategies, funding), cross-border data exchange standards, and comprehensive data governance frameworks to protect individual rights and enhance trust.

Develop Policies, Laws, and Ethical Guidelines

Establish robust regulatory frameworks, ethical standards, and guidelines to guide the implementation and oversight of digital health solutions, ensuring accountability and alignment with national health objectives.

Build Workforce Capacity

Expand training opportunities and institutional support for digital health education and research.

Integrate Health Economic Evaluations

Institutionalize cost-effectiveness and value-for-money analysis in digital health policy and procurement processes to guide sustainable investment.

Foster Regional Collaboration

Leverage ASEAN and other regional bodies as platforms for policy harmonization, knowledge sharing, and joint innovation.

With regard to capacity building, universities across the region have launched specialized programmes to train professionals in this emerging field. For example:

i. **Brunei Darussalam:** Universiti Brunei Darussalam (UBD) offers both a Master of Digital Public Health (coursework and research tracks) and a PhD in Digital Public Health. These programmes, delivered through the PAPRSB Institute of Health Sciences in collaboration with the School of Digital Science, are designed to build local and regional capacity in areas such as epidemiological modeling, machine learning, and health data science (Universiti Brunei Darussalam, 2023).

ii. **Malaysia:** The International Medical University (IMU) offers an undergraduate programme in Digital Health, which integrates computing, data analytics, and health sciences (International Medical University, 2024). Universiti Malaya also offers an online course titled Digital Health Essentials, which covers practical aspects of digital health technologies and their implications for public health practice (Universiti Malaya, 2021).

These initiatives demonstrate the region's strong commitment to capacity building, ensuring that future health professionals are well-prepared to lead the digital transformation with competence and confidence.

CONCLUSIONS

Digital health stands at the intersection of technology, health equity, and sustainable development. In many countries, progress has been encouraging, yet challenges remain. As we navigate the post-pandemic era, there is an urgent need to design digital health ecosystems that are not only innovative but also inclusive, ethical, and economically viable. However, too often, countries rush into digital health without sufficient funding, strategic planning, or coordination, leading to fragmented systems and inefficiencies. It is therefore essential to prioritize strategic development (phase-by-phase), integrated planning, and sustainable funding to ensure that digital health investments are both effective and transformative.

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ORIGINAL ARTICLE Open Access

COST ANALYSIS OF PHARMACY ON DELIVERY (POD) AND CONVENTIONAL COUNTER DISPENSING (CCD) IN PUSAT RAWATAN WARGA (PRW) UMS

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Abstract

As the demand for more efficient and accessible healthcare services grows, pharmacy services are evolving to better meet patient needs, offering distinct advantages and challenges in terms of cost, convenience, and accessibility. Pharmacy delivery, whereby one's medicine being delivered to the comfort of their home or workplace, is one example of pharmacy services evolution, as compared to a standard dispensing at the clinic. This study aims to determine the cost differences between two pharmacy service models implemented at Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS): Pharmacy On-Delivery (POD) and Conventional Counter Dispensing (CCD). This cross-sectional study was conducted at Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS), over a two-week period. We analysed both fixed and variable costs associated with the Conventional Counter Dispensing (CCD) and Pharmacy On-Delivery (POD) services, with a particular focus on personnel and transportation expenses. Descriptive analysis was performed using Microsoft Excel to calculate means and standard deviations. The findings showed the cost of POD averaging RM6.55 per prescription compared to RM3.44 for CCD, while the time taken averaging 9.80 minutes per prescription for POD compared to CCD's 5.69 minutes per prescription. The delivery process was the primary driver of the total time required for POD prescriptions, accounting for approximately 54% of the total time involved. Despite the higher costs, the popularity of POD has grown steadily, with its adoption increasing from 2.49% in 2022 to 6.70% in 2024. This study highlights the need to balance the higher operational costs of Pharmacy On-Delivery (POD) services with their benefits in enhancing medication adherence and convenience, especially for patients with chronic conditions. To support sustainability, strategic improvements such as optimizing delivery routes, using GPS-based tracking, and adopting computerized Hospital Information Systems (HIS) are recommended. These findings provide critical insights for improving the efficiency and cost-effectiveness of POD services at PRW, UMS, particularly in resource-limited healthcare settings.

Keywords: Pharmaceutical service, medication access, cost analysis, economic evaluation.

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INTRODUCTION

The increasing demand for efficient healthcare services has driven many institutions to explore innovative approaches to pharmaceutical care (Smith et al., 2018). At Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS), pharmacy services play a crucial role in ensuring timely access to medications, particularly for patients with chronic conditions requiring continuous medication refills. To address issues such as time constraints and busy working schedules of UMS staff, beginning of February 2022, Value-Added Service (VAS) models have been implemented: Pharmacy On-Delivery (POD) service, which is offered exclusively to UMS staff, involve delivering medications to their offices, and WhatsApp & Ambil, whereby patients will receive a WhatsApp messaging prior to collecting their medicines at the clinic's dispensary counter (Yussof et al., 2022). World Health Organization (WHO) describes VAS in the context of healthcare delivery as supplementary services that support or enhance patient care, such as mobile health initiatives, adherence support, and community outreach (World Health Organization, 2016). These two pharmacy VAS offered on top of the Conventional Counter Dispensing (CCD), where patients collect medications in person. While CCD remains the standard practice, pharmacy VAS models have gained attention due to their potential to improve medication access and patient adherence, particularly for patients with chronic conditions (Cardoso et al., 2020; Yussof et al., 2022). Each approach has unique advantages and limitations in terms of cost, accessibility, patient satisfaction, and resource utilization (Derqui et al., 2021; Rupp, 2011; Tran et al., 2022).

Previous studies have demonstrated the growing adoption of home delivery and pharmacy services in various healthcare settings, showing both increased patient satisfaction and improved adherence to medication regimens (Smith et al., 2018). For example, Cardoso et al. (2020) highlighted that medication dispensing services in community pharmacies, including home delivery models, incur higher operational costs but are associated with increased patient convenience and satisfaction. Similarly, studies by Yussof et al. (2022) in Malaysia found that these pharmacy delivery services, including POD, were well-received by patients, although they came at a higher cost compared to traditional dispensing methods.

Pharmacy delivery services are increasingly being implemented as part of healthcare reforms aimed at reducing barriers to medication access (Rosli et al., 2021). Based on the report produced by PRW UMS in 2023, the implementation of these VAS since February 2022 has shown positive results in enhancing patients' access to medications (Norlida Che Yaacob & Hanies Yuhana Othman, 2023). Statistical data highlights that from February 2022 to April 2023, PRW recorded a total of 24,568 prescriptions, of which 5.2% (1,278) were delivered through

VAS. Specifically, there has been an increase in adoption rate of VAS from 4.6% in 2022 to 6.3% by April 2023, indicating growing patient preference for POD and WhatsApp & Ambil services.

This trend can be ascribed to the time-saving benefits for busy UMS staff who no longer have to visit the pharmacy in person, as well as enhanced pharmaceutical accessibility, which assures prompt refills for patients with chronic diseases. The use of technology, particularly WhatsApp & Ambil, has improved patient-pharmacy communication, making pre-arranged pick-ups more efficient. Patient satisfaction has increased as a result of favourable experiences with precise and dependable medicine administration, encouraging further uptake and word-of-mouth advertising (Yussof et al., 2022). Furthermore, post-pandemic behavioural changes have increased reliance on remote and contactless healthcare solutions, reinforcing the desire for VAS (Poudel & Nissen, 2016; Rosli et al., 2021). This adoption highlights their vital role in meeting patients' needs for convenience, adherence, and better healthcare experiences while also emphasizing the significance of managing operational expenses for long-term viability (Cardoso et al., 2020; Rupp, 2011).

However, these innovations often come with additional costs associated with logistics and staffing (Poudel & Nissen, 2016; Wlamyr et al., 2022). On the other hand, conventional dispensing remains a widely used method due to its straightforward implementation and lower logistical requirements (Cardoso et al., 2020). While the success rate for delivered medications via VAS has improved from 86% to 90.3% (Norlida Che Yaacob & Hanies Yuhana Othman, 2023), understanding the costs associated with these services remains critical for informed decision-making at PRW, UMS. The logistical and operational costs associated with delivery services may impose additional strain on limited healthcare resources. In contrast, conventional dispensing, while requiring less logistical effort, may not address issues such as medication adherence or accessibility for time-constrained patients. The workflows of completing a prescription for CCD and POD are compared in Figure 1.

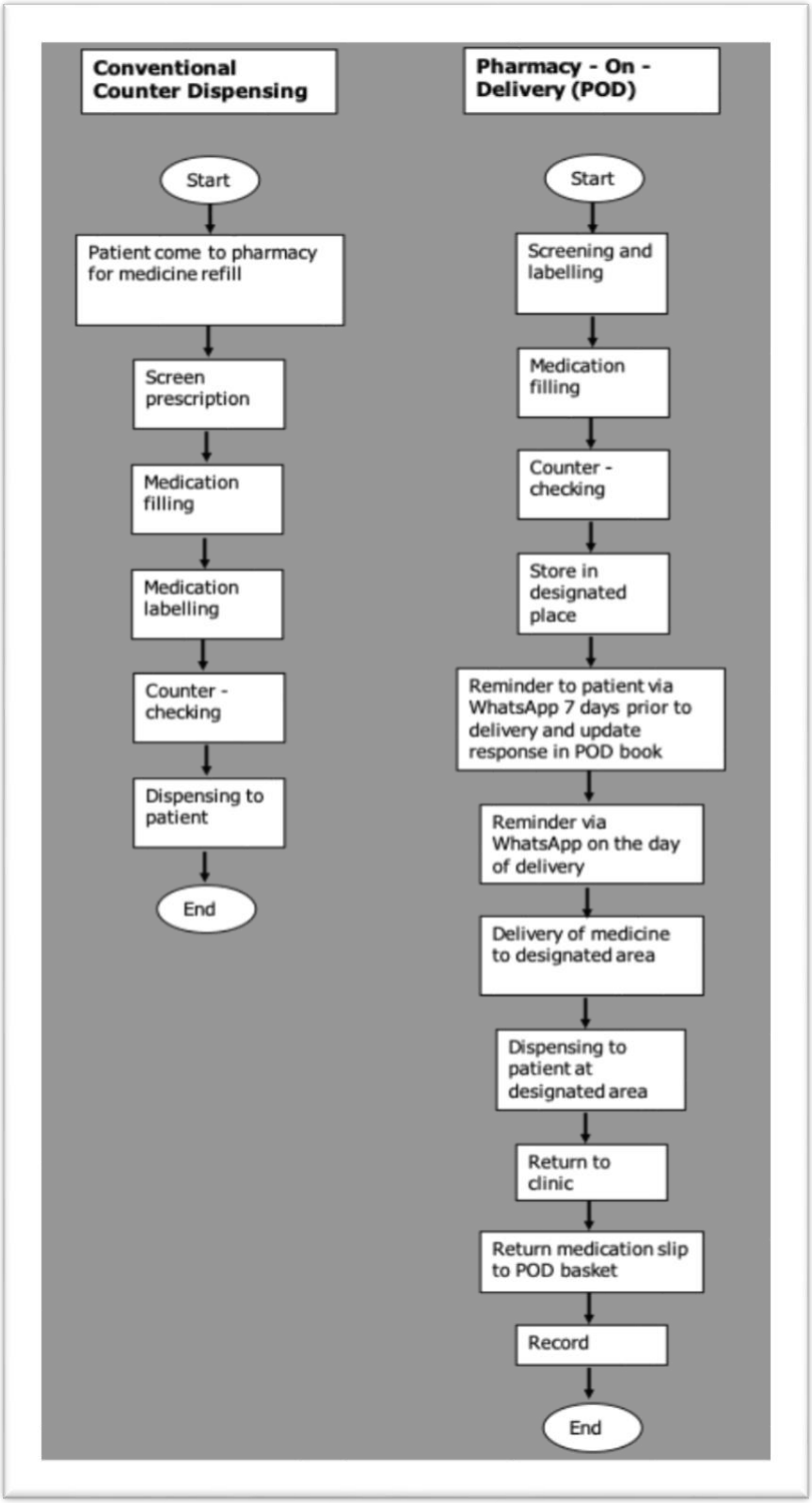

Figure 1: Flow process of CCD and POD

Given that 5.2% of prescriptions were delivered via VAS since its inception until April 2023 and this figure continues to grow, a detailed cost analysis is essential (Norlida Che Yaacob & Hanies Yuhana Othman, 2023). PRW must evaluate whether pharmacy delivery provides value for money compared to conventional dispensing and whether these services can be scaled without compromising quality or financial sustainability. Without this evidence, decision-makers may face challenges in prioritizing resources and optimizing pharmacy service delivery. Cost analysis of both models is essential to ensure economic stability and efficient resource allocation in healthcare systems, particularly in a resource-limited setting such as PRW, UMS (Aniza et al., 2011; Surendra et al., 2018). Furthermore, there are limited research exists on comparing these costs between POD and CCD services in Malaysia public healthcare settings. Hence, this study aimed to determine cost analysis, and to fill the research gap by comparing the fixed and variable costs associated with both POD and CCD services at PRW, UMS. By analysing these costs, this study seeks to contribute to the broader discussion on optimizing healthcare resource allocation and service delivery in resource-limited settings. For the purpose of this study, we are comparing the cost of completing one prescription, which is from the screening of prescription until the end of the process, for CCD (including WhatsApp & Ambil due to similarity in their process) and POD.

METHODS

Study Design

This study employed a cross-sectional design conducted at the Pusat Rawatan Warga (PRW) at Universiti Malaysia Sabah (UMS). The convenience sampling method was used, which may introduce sampling bias, and this limitation is acknowledged in the discussion. Data collection took place over a two-week period, from December 2 to December 13, 2024, due to limited resources and time constraints. Despite this, the timeframe was considered sufficient to capture representative data on the two service models.

Data Collection

The cost analysis was conducted from the healthcare provider's perspective, focusing on personnel expenses and transportation costs associated with preparing and delivering repeat prescriptions. Medication costs were intentionally excluded from this analysis. The study specifically targeted repeat prescriptions for chronic conditions, including non-communicable diseases, while excluding new prescriptions and those related to acute conditions. Due to time constraints, the data collection was limited to 30 prescriptions for each service model.

To ensure data consistency, PRW staff underwent training in standardized recording methods. A predefined workflow was established for each dispensing approach, supported by a standardized data collection form and a time-motion sheet to guide the process. The analysis encompassed only fixed costs (personnel salaries; delivery is carried out only during office hours, therefore, it does not involve overtime allowance) and variable costs (transportation expenses). Capital expenditures, such as facility and vehicle costs, were excluded as both services utilized the same infrastructure and the vehicle was primarily used for other purposes. Similarly, patient-incurred expenses, such as travel to collect prescriptions, were not included, as the analysis focused solely on the provider’s perspective.

Personnel costs were calculated using a formula adapted from Carrol et al., 2016. Monthly gross income for each personnel was divided by 8,640 minutes (an 18-day work month

with 8 working hours per day) to estimate the cost per minute. PRW provided salary data for the involved personnel, and the average cost for each group of personnel was applied in the analysis.

Transportation costs for delivery were calculated based on mileage claims for the journey between PRW and the destination. The vehicle used for every delivery was a Diesel fuelled van. Since the delivery was carried out in batches, we averaged the distance of travelling for each prescription's delivery by dividing the total distances covered and the number of prescriptions dispensed during that particular delivery. For the cost, it was determined by dividing the total fuel refill, in Ringgit Malaysia (RM), and total mileage (kilometer) for a period of 1 month (4th of November 2024 to 4th of December 2024). The total fuel refill (RM) derived from the sum of refilling on the 4th of November 2024 to the last refill on the 28th of November 2024. As for the total mileage (kilometer), it was calculated by subtracting the odometer reading prior to the first December refilling on the 4th of December, and the odometer reading before the fuel refill on the 4th of November 2024. The price of diesel remained constant at RM2.15 per litre during this period. Table 1 provides a detailed summary of the processes and cost calculations for each service.

Table 1: Summary of processes involved and cost calculation for each service.

Service	Cost Calculation
Conventional Counter Dispensing	Time needed for Screening + Drug filling + Labelling + Counter-checking + Dispensing
Pharmacy On Delivery	Time needed for Screening and Labelling + Drug filling + Counter-checking + Storage + Reminder + Delivery + Dispensing + Returning of medication slip

Statistical Analysis

Data were recorded in Microsoft Excel Version 16. The mean and standard deviation was obtained from Microsoft Excel as well and used for continuous data. This study only provides descriptive analysis. No inferential statistics analysis was carried out.

RESULTS

The summary of total number of prescriptions are summarised in Table 2. There was a marked increase of POD service from 2022 (from February onward) to 2023 (2.49% and 6.21%). The demand on POD service increased further in 2024 (up to November 2024) at 6.70%.

Table 2: Summary of total number of prescriptions.

Service	Year					
	2022		2023		2024	
	N	%	N	%	N	%
Counter	17681	97.51	20889	93.79	19772	93.30
Pod	451	2.49	1382	6.21	1420	6.70
Total	**18132**		**22271**		**21192**	

The mean (+ Standard Deviation, SD) for number of items per prescription was 2.43 (+ 1.43) for CCD and 2.03 (+ 1.25) for POD. The cost of personnel per minute and cost of

transportation per kilometer (KM) in Ringgit Malaysia (RM) are summarised in Table 3. Meanwhile, Table 4 summarised the average time, distance and cost needed to complete one prescription.

Table 3: Summary of cost of personnel per minute and transportation per KM.

Item	Salary (RM)/ Mean ± SD	Personnel Cost (RM) per minute	Cost (RM) per KM
Personnel			
Pharmacy Officer (PF)	6483.50 ± 445.48	0.75	-
Assistant Pharmacy (PPF)	3455.50 ± 361.33	0.40	
Healthcare Assistant (PPK)	2728.40 ± 0.85	0.32	
Transport	-	-	0.16

SD=Standard Deviation; RM=Ringgit Malaysia; KM=Kilometer

Table 4: Summary of time, distance and cost needed to complete one prescription.

Services	N	Distance (KM)/ Mean ± SD	Average Number of Items per Prescription	Time per Prescription (Minutes)/ Mean ± SD	Cost per Complete Prescription (RM)/ Mean ± SD
Counter	30	-	2.43	5.69 ± 3.06	3.44 ± 1.97
Pharmacy On Delivery	30	0.90 ± 0.35	2.03	9.80 ± 2.40	6.55 ± 1.55

N=Number of prescriptions; SD=Standard Deviation; RM=Ringgit Malaysia; KM=Kilometer

There were 3 groups of personnel involved in completing a prescription for POD, while for CCD, only 2 of those groups of personnel were involved. Based on the formula adapted from Carrol et al. (2016), the cost of personnel per minute were RM0.75 for Pharmacy Officer (PF), RM0.40 for Assistant Pharmacy (PPF) and RM0.32 for Healthcare Assistant (PPK). As for the transportation cost, the average was RM0.16 per KM.

The mean time and cost (± SD) needed for CCD were 5.69 (± 3.06) minutes and RM3.44 (± 1.97) per prescription, while for POD were 9.80 (± 2.40) minutes and RM6.55 (± 1.55). The mean distance for POD was 0.90 (± 0.35) KM. The average time needed to prepare each step of the medication preparation process was compared and shown in Figure 2. The time needed for screening, labelling and drug filling were longer in CCD as compared to time taken in POD. Meanwhile, the time for delivery contributed 54% of the total average time to complete one prescription in POD, which causing the longer duration needed to complete as compared to CCD.

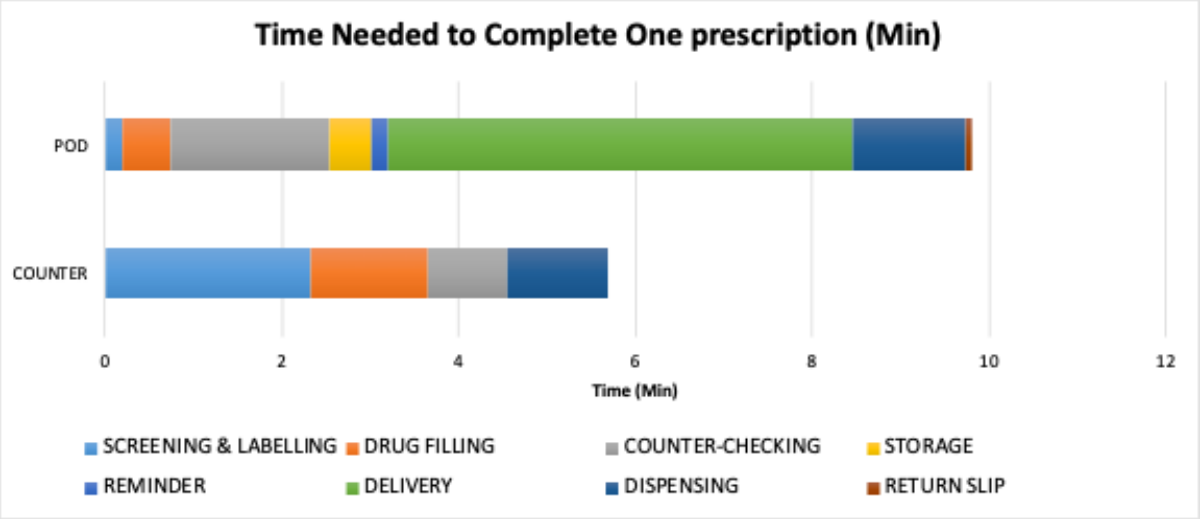

Figure 2: Average time needed to complete each prescription.

DISCUSSION

The study's findings underline the significant cost and time differences between Pharmacy On-Delivery (POD) service and Conventional Counter Dispensing (CCD) at PRW, UMS. While POD service offers notable benefits in terms of convenience and patient adherence, particularly for those with chronic conditions, they come with higher operational costs. The average time and cost to complete a prescription with POD was higher as compared to CCD. The delivery process, which accounted for slightly more than half of the total time taken for POD, and an additional number of personnel required to complete a single prescription in POD, are a major contributor to these higher costs (Yussof et al., 2022).

These results are consistent with previous studies that have highlighted the higher operational costs associated with home delivery services, especially in terms of transportation and personnel time (Carrol et al., 2016; Smith et al., 2018). Yussof et al., 2022, who conducted a similar study in Peninsular Malaysia found the time needed and cost preparation per prescription for counter and Medibox (workflow process almost equivalent to POD) services were 3.99 and 10.25 minutes, and RM1.75 and RM5.49. Comparing the time needed found in this study shows a longer duration taken for the counter service, but a shorter duration for POD. The discrepancies in time needed in counter service may be explained due to the differences in the total workflow process assessed between this study and the previous study as they excluded time of dispensing the medicines, and the average items per prescription (2.43 versus 4.05). However, this study shows the time needed for POD was shorter (9.80 and 10.25 minutes), that may indicate a shorter journey from the PRW to the destination (within UMS campus) and the efficiency in completing one prescription in PRW. In terms of cost per prescription, our study found that both services were higher than the previous study which can be explained by the different method in calculating the personnel cost.

While the higher costs of POD are evident, the potential benefits of enhanced patient adherence and satisfaction could influence healthcare policy decisions, particularly in resource-limited settings. Policymakers should weigh these factors when considering scaling POD services. From February 2022 to April 2023, the adoption rate of VAS at PRW rose from 4.6% to 6.3% (Norlida Che Yaacob & Hanies Yuhana Othman, 2023). Recent data from PRW report

shows total number of prescriptions from 2022 to 2024, were predominantly dispensed through CCD but decline from 97.51% in 2022 to 93.30% in the year of 2024. Meanwhile, POD shows an increment from 2.49% (in 2022) to 6.70% in year 2024, indicating a growing patient preference for these services. The difference in POD latest data as compared to the previous data reported by Norlida et al., 2023, was due to the method of data collection adopted by PRW whereby, currently, the WhatsApp & Ambil data was included in the CCD data.

The economic evaluation of pharmacy services is crucial for healthcare decision-makers to select effective interventions. Studies have shown that pharmacy services, including home delivery, can be cost-effective or cost-saving, particularly in developed countries (Phimarn et al., 2023). For instance, a systematic review of economic evaluations of pharmacy services found that these services often improve patient health outcomes and are cost-effective in various settings, including hospital-based, community pharmacy, and primary care (Phimarn et al., 2023). This aligns with the findings at PRW, where POD services, despite higher costs, have shown positive impacts on patient adherence to medications.

The study also highlights the need for ongoing evaluation and cost-saving strategies to optimize service delivery. While POD services provide substantial benefits in terms of accessibility and patient satisfaction, their higher costs necessitate careful cost management.

To mitigate these costs, strategies such as optimizing delivery routes, improving workflow efficiency, and enhancing staff efficiency could help reduce these costs (Derqui et al., 2021; Wlamyr et al., 2022). Additionally, leveraging on technology, such as GPS tracking and route optimization software, could be used to streamline the POD delivery process, reducing time and operational costs. Studies have shown that optimizing delivery routes significantly enhances the efficiency of home delivery services, reducing both costs and time spent on each delivery (Smith et al., 2018). Additionally, investing in a fully computerized Hospital Information System (HIS) or Clinic Management System (CMS) would improve data management, patient tracking, and prescription accuracy, facilitating seamless communication between pharmacy staff and healthcare providers (Poudel and Nissen, 2016). Automation tools for medication order processing, inventory management, and real-time updates on delivery status could further enhance service efficiency, reduce human error, and ensure timely deliveries (Rosli et al., 2021). Integrating these technologies would not only improve operational efficiency but also enhance patient satisfaction and service sustainability, as they can be tailored to meet the needs of busy patients and healthcare professionals alike (Cardoso et al., 2020; Yussof et al., 2022).

The results from the study indicate that the personnel costs per minute were RM0.75 for Pharmacy Officers, RM0.40 for Assistant Pharmacists, and RM0.32 for Healthcare Assistants. The transportation cost was RM0.16 per kilometer. These costs contribute significantly to the overall expenses of POD services (Cardoso et al., 2020). The mean time and cost needed for CCD were 5.69 minutes and RM3.44 per prescription, while for POD, they were 9.80 minutes and RM6.55 per prescription. The longer time required for POD is largely due to the delivery process, which adds to the overall cost (Yussof et al., 2022).

In essence, these findings carry important implications for key stakeholders. For policymakers, the growing adoption of POD services suggests a shifting patient preference that warrants strategic investment in infrastructure and digital technologies to support efficient, scalable delivery models. Policy decisions should also consider integrating POD into national health delivery frameworks, especially for chronic disease management, while balancing cost

sustainability. For healthcare providers, particularly pharmacy managers and administrators, the results highlight the need to re-evaluate staffing models, workflow processes, and technological integration to reduce inefficiencies and manage costs without compromising service quality. Training programs and operational protocols can be optimized to support the transition toward hybrid service models. For patients, especially those with mobility constraints or chronic conditions, POD services enhance access and convenience, contributing to improved medication adherence and satisfaction. However, there must be clear communication regarding service availability, cost structures, and expectations to ensure equitable and informed utilization. By addressing these different perspectives, future service planning can be more responsive, sustainable, and patient-centred.

This study has several limitations that should be acknowledged. Firstly, the use of convenience sampling may have introduced selection bias, potentially limiting the generalizability of the findings. Secondly, the relatively small sample size and short data collection period, both due to time constraints, may not fully capture cost variability over time. Additionally, the cost analysis was conducted from the provider's perspective and was not comprehensive, as it excluded capital expenditures and recurring costs such as maintenance or long-term infrastructure. While the primary focus was on evaluating the operational cost differences between POD and CCD services, this study did not include an assessment of client or staff perspectives. Future research should incorporate qualitative insights to better understand user satisfaction, adherence factors, and the operational challenges faced by service providers.

CONCLUSION

In conclusion, although POD services at PRW, UMS, are associated with higher operational costs compared to CCD, their growing adoption and demonstrated benefits in improving patient adherence underline their overall value. To ensure the sustainability and scalability of POD services, healthcare administrators should consider practical cost-reduction strategies, such as optimizing delivery routes, leveraging GPS tracking, implementing route optimization software, and adopting computerized Hospital Information Systems (HIS) or Clinic Management Systems (CMS). These technological and operational improvements can streamline workflows, enhance staff efficiency, and reduce unnecessary expenditures. Ongoing evaluation of service efficiency, combined with qualitative insights from patients and providers, will be essential in guiding future enhancements. Future studies should further explore these dimensions to support the development of more cost-effective and patient-centred pharmacy service delivery models. Additionally, a more robust cost-benefit analysis that includes both provider and patient perspectives would offer valuable insights into the long-term sustainability and impact of these services.

Data Availability Statements

The datasets generated and analyzed during the current study are not publicly available due to institutional privacy policies at Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS). However, they are available from the corresponding author upon reasonable request and with the permission of PRW, UMS. For further information or access to the data, please email to abdul.rahman@ums.edu.my.

Ethical Considerations

As the study involved the analysis of routine pharmacy service data, ethical approval was not sought because no direct interaction with participants occurred, and the data was anonymized and used in aggregate form. Nevertheless, data privacy and confidentiality were prioritized, and the dataset was handled in compliance with the privacy policies of Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS).

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Conflicts of Interest

The authors have no conflicts of interest to declare.

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Authors' contributions

Conceptualization: all authors; Data curation: all authors; Formal analysis: all authors.; Methodology: all authors; Resources: all authors; Supervision: ARR; Writing-original draft: all authors; Writing-review & editing: all authors. All authors read and approved the final manuscript.

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DEVELOPMENT AND VALIDATION OF A CULTURE-SPECIFIC FOOD FREQUENCY QUESTIONNAIRE AMONG PULMONARY TUBERCULOSIS PATIENTS IN SABAH, MALAYSIA

Khalid Mokti[1*], Zaleha Md Isa[2]

Abstract

Accurate dietary assessment among populations with infectious diseases remains a challenge, particularly in culturally diverse and low-resource settings. This study aimed to develop and validate a region-specific Food Frequency Questionnaire (FFQ) to assess nutrient intake among patients with pulmonary tuberculosis (PTB) in Kota Kinabalu, Sabah, Malaysia. A semi-quantitative FFQ comprising 62 food items grouped into 13 categories was developed based on three-day 24-hour dietary recalls (24HR) from 41 newly diagnosed adult PTB patients. The FFQ was validated by comparing nutrient intake estimates with the mean values obtained from 24-hour recalls using Pearson correlation, energy-adjusted correlation, cross-classification, and intra-class correlation coefficient (ICC) analysis. Reproducibility was assessed by administering the FFQ twice, with a three- to five-week interval between administrations. Unadjusted Pearson correlation coefficients between the FFQ and 24HR ranged from 0.39 (carotene) to 0.90 (energy), with a mean of 0.66 ± 0.17. Energy-adjusted correlations ranged from 0.23 (niacin) to 0.76 (vitamin B1), averaging 0.55 ± 0.16. The proportion of participants classified into the same nutrient intake quartile ranged from 27% to 61%, while the proportion of extreme misclassification ranged from 5% to 24%. ICCs for reproducibility between FFQ1 and FFQ2 were high, ranging from 0.79 (vitamin C) to 0.99 (protein). We validated an FFQ specifically designed for Malaysian patients with pulmonary tuberculosis, providing a culturally relevant and reproducible dietary assessment tool. The FFQ showed strong correlation with reference recalls (mean Pearson r = 0.66), and excellent reproducibility (ICC range 0.79–0.99). It is particularly suited for epidemiological research examining the association between nutrition and TB treatment outcomes, and can inform future nutritional surveillance and targeted interventions in TB control programs.

Keywords: Food Frequency Questionnaire (FFQ), Pulmonary Tuberculosis, Nutritional Assessment, Validation Study, Dietary Intake

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INTRODUCTION

Tuberculosis (TB) remains a significant public health concern, with over 10.6 million new cases and 1.6 million deaths globally in 2021 alone, surpassing HIV/AIDS in infectious disease mortality burden (World Health Organization, 2025). Pulmonary TB (PTB), the most common form, disproportionately affects low- and middle-income countries, including Malaysia. Nutritional status plays a crucial role in TB progression and recovery, with undernutrition both a risk factor for disease activation and a consequence of active infection. Malnourished TB patients face delayed sputum conversion, reduced treatment efficacy, and higher relapse and mortality rates (Bhargava et al., 2013).

This bidirectional relationship creates a vicious cycle: undernutrition impairs host immunity, increasing susceptibility to TB, while TB induces nutrient depletion through anorexia, malabsorption, and metabolic alterations (Cegielski J & McMurray D., 2004). Recognizing this, the World Health Organization's End TB Strategy emphasizes addressing social determinants, including nutrition as a pillar of integrated, patient-centred TB care (Uplekar et al., 2015).

Assessing dietary intake among PTB patients is, therefore, not only clinically relevant but essential for effective public health intervention. However, accurately assessing dietary intake in low-resource and culturally diverse populations remains a methodological challenge. Among the available tools, Food Frequency Questionnaires (FFQs) are widely favoured for epidemiological research due to their low cost and ability to capture habitual intake over time (Aoun et al., 2019). Yet FFQs must be population-specific to yield valid results, particularly in disease contexts where clinical symptoms and socioeconomic factors influence food intake patterns.

Undernutrition is strongly linked to delayed sputum conversion and poor treatment outcomes among PTB patients (Bhargava et al., 2013; Ma et al., 2022). Validated PTB-specific FFQs have been reported in Georgia (Frediani et al., 2013), Ethiopia (Regassa et al., 2021), and Peru (Rodriguez et al., 2017), yet none are available for South-East Asia. Our study, therefore, fills this critical gap by developing and validating a culturally tailored FFQ for Sabah. This is a critical gap, especially in regions like Sabah, where TB incidence is among the highest in the country and where local diets diverge significantly from peninsular norms.

This study aims to address that gap by developing and validating a culturally specific semi-quantitative FFQ to assess habitual macronutrient and micronutrient intake among adult PTB patients in Kota Kinabalu, Sabah. Specifically, the objectives were to: (1) construct the FFQ based on commonly consumed foods identified through 24-hour dietary recalls; (2) evaluate its relative validity against three-day 24HRs using correlation and classification techniques; and (3) assess its reproducibility over a three- to five-week interval. The validated tool is expected to contribute to clinical management, nutritional surveillance, and policy planning within TB control programs in Malaysia.

METHODS

Study Design and Setting

This cross-sectional validation study was conducted from May to July 2019 in outpatient tuberculosis (TB) treatment centres across Kota Kinabalu, Sabah, Malaysia. The primary objective was to develop and validate a culturally appropriate Food Frequency Questionnaire (FFQ) to assess habitual dietary intake among adults newly diagnosed with pulmonary tuberculosis (PTB). The study was embedded within a larger investigation to evaluate the relationship between nutritional intake and delayed sputum smear conversion in PTB patients. As illustrated in Figure 1, the study proceeded in two phases: the development phase used three 24-hour recalls from 41 participants to identify and group 131 foods into 13 categories before refining them to a 62-item FFQ, and the validation phase compared FFQ results with mean recall data and repeated the FFQ to assess reproducibility.

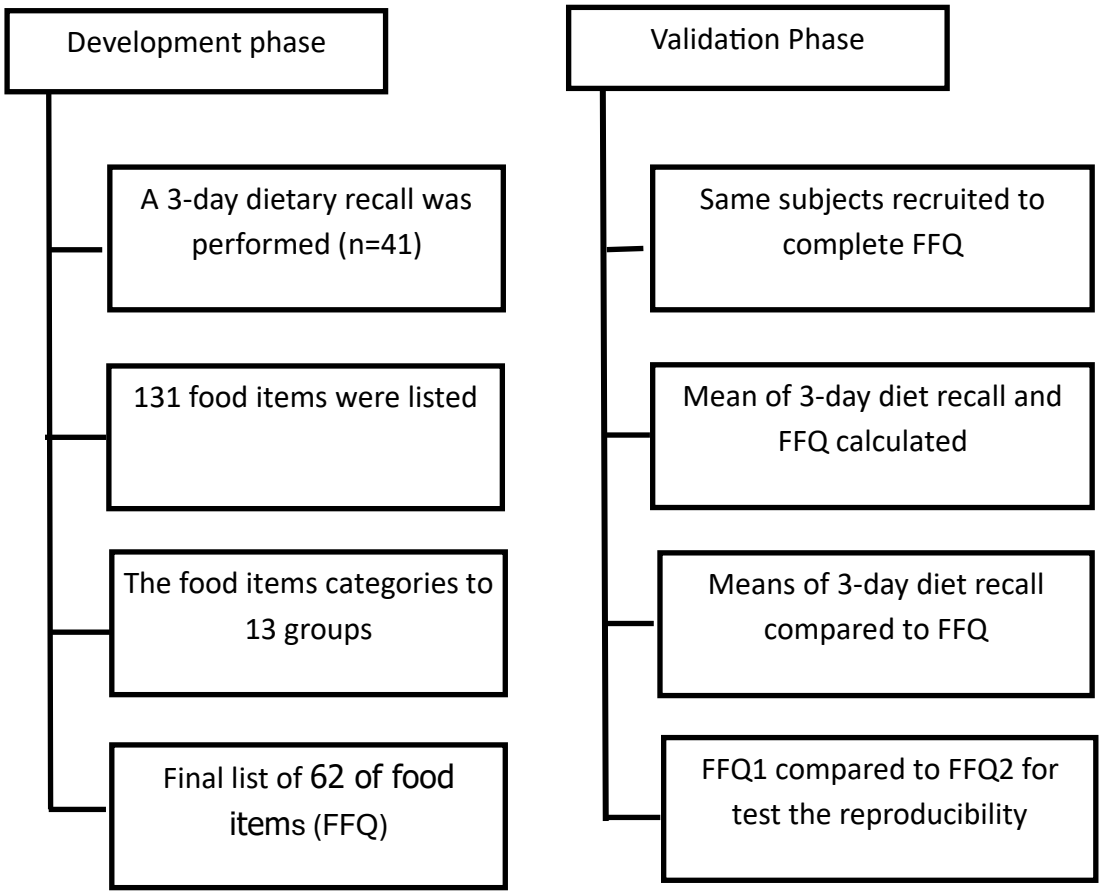

Figure 1: Flow chart to depict the development and validation phase of the FFQ.

Study Population and Sampling

Participants were recruited via purposive sampling because newly diagnosed PTB patients must begin treatment within two weeks of diagnosis. Random sampling would have missed rapidly hospitalized individuals or lost to follow-up. The inclusion criteria required patients to be Malaysian adults aged between 18 and 65, newly diagnosed with PTB and initiated on treatment within two weeks, receiving outpatient care at TB treatment centres, and willing to provide informed consent and complete dietary assessments. Exclusion criteria included pregnancy or lactation, institutionalization or incarceration, and any comorbid condition likely to affect dietary intake or nutrient metabolism, such as recent cancer (within five years), liver cirrhosis, seizure disorders, nephrolithiasis, organ transplant history, or current use of corticosteroids or immunosuppressive agents.

From the 42 patients approached, one participant was excluded due to loss to follow-up, resulting in a final analytical sample of 41 participants. Although modest, this exceeds the ≥30 participants recommended for dietary validation studies (Cade et al., 2002; Zhang et al., 2021). This sample size was deemed adequate for dietary validation studies, aligning with methodological recommendations that a minimum of 30 participants is sufficient to detect moderate correlations with 80% power and $\alpha = 0.05$ (Cade et al., 2002; Willett W., 2012).

Development of the Food Frequency Questionnaire (FFQ)

The FFQ was developed based on detailed dietary information obtained from three non-consecutive 24-hour dietary recalls (24HRs) collected from each participant, comprising two weekdays and one weekend day to capture intra-individual variation. Trained dietitians conducted face-to-face interviews using food models and standardized household utensils (e.g., cups, tablespoons, plates) to improve portion size estimation. The 24HRs data yielded a list of 131 distinct food items, categorized into 13 major food groups, including cereals and cereal products, meats, vegetables, fruits, beverages, and condiments. Food items consumed by ≥10 % of participants were retained. Rarely eaten items with similar nutrient profiles (e.g., sago, tapioca) were aggregated under a single representative item. Nutrient similarity was verified with the Malaysian Food-Composition database, yielding a final list of 62 items. A condensed list of 62 food items was selected based on frequency and cultural relevance to the local dietary patterns of PTB patients in Kota Kinabalu. The finalized FFQ was interviewer-administered and included information on intake frequency (daily, weekly, monthly), portion size, and cooking methods. The instrument was available in both Malay and English and included local food items and everyday dishes reflective of the region's dietary culture (see Table 1).

Table 1: Food groups and total food items in the initial of FFQ

Category of food	Number of food items
Cereals and cereals product	7
Fast food	1
Meat and meat products	3
Fish and seafood	6
Egg	2
Nuts and nuts products	1
Milk and dairy products	2
Bread spread	2
Vegetables	9
Fruits	10
Drinks	7
Confection	5
Seasoning	7
Total number of the food item	**62**

Reference Method: 24-Hour Dietary Recalls

The 24HRs served as the reference method for validating the FFQ, following recommendations for dietary validation studies to improve the reliability of habitual intake assessment. The same 41 participants who completed the development recalls also provided the validation recalls to maintain consistency. We acknowledge that such overlap may slightly inflate correlation coefficients. The first recall was conducted in person during a clinic visit, while the second and third recalls were obtained during subsequent visits or via telephone. Participants were guided to recall all food and beverages consumed in the preceding 24 hours, including preparation details, meal timing, and portion sizes. Food models and probing techniques were employed to reduce recall bias and underreporting. The average intake from the three 24HRs was used to estimate each participant's habitual nutrient intake.

Reproducibility Assessment

To assess the reproducibility of the FFQ, the same instrument was administered to all participants a second time after a three- to five-week interval. This interval was chosen to minimize respondent recall of previous answers while allowing for normal dietary variation. Only clinically stable participants (weight change < 2 kg and no change in TB stage) were re-tested. The same trained interviewer conducted both FFQ administrations (FFQ1 and FFQ2) to reduce inter-interviewer variability. This timing is supported by previous reproducibility studies on FFQ, which recommend a 3–6-week window when the recall period spans the past month.

Nutrient Analysis

Nutrient intake from the FFQ and the 24HRs was analysed using DIET 4, a nutrient analysis software developed explicitly for Malaysian foods. The software utilizes the Malaysian Food Composition Database curated by the Institute for Medical Research, which includes nutrient profiles for locally consumed foods. Mixed dishes were deconstructed into core ingredients using a Sabah recipe database. Household measures were converted to grams with standard conversion tables. For foods available in fried and soup variants, weighted nutrient profiles were calculated according to reported frequency. Nutrient outputs included daily intake estimates of total energy, macronutrients (carbohydrates, proteins, fats), and selected micronutrients, including calcium, phosphorus, iron, carotene, retinol equivalents (RE), vitamins B1, B2, niacin, and vitamin C. All data were double-entered and verified for accuracy. Range checks and consistency screening were applied to minimize data entry errors. Data were anonymized and stored in a secure, password-protected database accessible only to authorized research personnel.

Statistical Analysis

All statistical analyses were performed using SPSS version 27. Pearson correlation coefficients were calculated to assess relative validity using the residual method to compare nutrient intakes estimated from the FFQ with those from the reference 24HRs, both before and after energy adjustment. Cross-classification analysis was performed by categorizing participants into quartiles based on nutrient intake levels from each technique, determining the percentage of individuals classified into the same, adjacent, or extreme quartiles. Agreement between methods was further assessed with Bland-Altman plots for energy and each nutrient, yielding mean bias and 95 % limits of agreement. Reproducibility was assessed using intra-class correlation coefficients (ICC) between FFQ1 and FFQ2, employing a two-way mixed-effects model with absolute agreement. ICC values were interpreted as follows: values less than 0.50 indicated poor reliability, 0.50 to 0.75 indicated moderate reliability, 0.75 to 0.90 indicated good reliability, and values greater than 0.90 indicated excellent reliability (Koo T.K. & Li M.Y., 2016). A two-sided p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

A total of 41 participants completed the study and were included in the final analysis. The mean age of the participants was 37.2 years (SD = 13.7), with a slightly higher proportion of females (53.7%) than males (46.3%). Indigenous groups predominated, Bajau (22.0 %), Dusun (13.0 %), and Murut (6.5 %), while 24.4 % were non-native residents. Most respondents had completed at least secondary education (61.0%) and were employed (70.7%). Full sociodemographic characteristics are presented in Table 2. Baseline clinical characteristics, including BMI (18.9 ± 2.2 kg/m²), sputum smear grade, and weeks since treatment initiation, are summarised in Table 2.

Table 2: Sociodemographic and clinical data of participants

Characteristic	Frequency(n=41)	Percentage (%)
Age (years)	**Mean (SD):** 37.2 (13.7)	
Gender		
Male	19	46.3
Female	22	53.7
Ethnicity		
Muslim native	17	41.5
Non-Muslim native	10	24.4
Non-native	10	24.4
Non-Malaysia	4	9.8
Education		
Illiterate	4	9.8
Primary	9	22.0
Secondary	25	61.0
Tertiary	3	7.0
Employment		
Employed	29	70.7
Unemployed	12	29.3
Marital Status		
Married	28	68.3
Single/Divorced/Widow	13	31.7
Body-mass index, BMI (kg m^{-2})	**Mean (SD):** 18.9 (2.2)	
Underweight (<18.5 kg m^{-2})	24	58.5
Normal (18.5–24.9 kg m^{-2})	17	41.5
Overweight/Obese	-	-
Sputum-smear grade, n (%)		
1 +	12	29.3
2 +	16	39.0
3 +	13	31.7
Weeks since treatment initiation	**Mean (SD):** 1.4 (0.6)	

Nutrient Intake Estimations: FFQ vs. 24HR

Nutrient intake data derived from the first FFQ administration (FFQ1) and the average of three 24-hour recalls (24HR) are summarized in Table 3. Across all nutrients, FFQ estimates were significantly higher than 24HR for energy (mean difference = 169 kcal, $p = 0.002$) and vitamin C (mean difference = 33.9 mg, $p < 0.001$) (Table 3). The mean daily energy intake estimated by the FFQ was 2009.4 ± 366.4 kcal, compared to 1840.2 ± 340.0 kcal from the 24HR, representing a relative overestimation of 9.2%. Macronutrient intake showed a similar pattern, with overestimations of 4.1% for protein, 10.5% for carbohydrates, and 10.0% for fat.

Table 3: Validation study: mean daily intake of the nutrient, relative difference, Pearson correlation coefficient, and cross-classification to compare FFQ1 and 24 HR in PTB patients (n=41).

Nutrients	Mean±SD		Relative Difference (%)	Pearson (r)	
	FFQ1	24HR		**Un-adjusted**	**Energy-Adjusted**
Energy	2009.36±366.4	1840.22±340.03	9.19	0.90**	-
Protein	85.45±23.54	82.1±25.87	4.08	0.84**	0.60**
Fat	58.92±11.4	44.5±11.96	9.96	0.70**	0.49**
Carbohydrate	307.18±61.22	277.90±54.38	10.54	0.85**	0.57**
Calcium	377.17±121.01	303.31±116.16	19.58	0.61**	0.59**
Phosphorus	1203.22±322.61	1160.82±339.04	3.65	0.80**	0.41**
Iron	14.89±4.61	11.04±4.45	34.87	0.62**	0.61**
Retinol	717.68±235.47	634.59±221.77	13.09	0.67**	0.65**
Carotene	793.98±403.14	789.77±477.69	0.53	0.39*	0.37*
RE	849.92±260.71	766.27±233.72	10.92	0.68**	0.65**
B1	0.72±0.17	0.58±0.28	19.35	0.73**	0.69**
B2	1.25 ±0.41	0.97±0.41	23.97	0.63**	0.63**
Niacin	13.05±3.41	10.61±3.31	23.00	0.39*	0.23
Vitamin C	68.35±26.8	34.49±17.56	98.17	0.40*	0.34*

FFQ1, food frequency questionnaire during first administration; 24 HR, dietary recall; RE, retinol equivalents; SD, standard deviation

‡ Relative difference = [(FFQ1 – 24 HR)/ 24 HR] *100

* $P<0.05$; ** $P<0.01$

Among micronutrients, iron, vitamin B2, and vitamin C exhibited the most significant relative differences between the FFQ and 24HR, with vitamin C intake nearly doubling in the FFQ estimates (98.2% difference). The slightest discrepancy was observed for carotene (0.5%). Despite these differences, the FFQ provided reasonable estimates for most nutrients compared to the reference method.

Validity Assessment

The unadjusted Pearson correlation coefficients between the FFQ and 24HR ranged from 0.39 for carotene to 0.90 for energy intake, with an overall mean correlation of 0.66 ± 0.17. These correlations indicate moderate to strong agreement between the two methods for most nutrients. Following energy adjustment using the residual method, correlations remained statistically significant for most nutrients, except niacin and vitamin C. The energy-adjusted correlation coefficients ranged from 0.23 (niacin) to 0.76 (vitamin B1), with a mean of 0.55 ± 0.16. These results support the relative validity of the FFQ for assessing energy and nutrient intake in this population.

Bland-Altman plots were used to assess agreement between FFQ and 24HR estimates for energy and individual nutrients (Figure 2). The plots showed a small positive mean bias for most nutrients, indicating slight overestimation by the FFQ. The 95% limits of agreement were narrow for energy, protein, and carbohydrates, but wider for vitamin C and niacin, reflecting higher variability in micronutrient estimation.

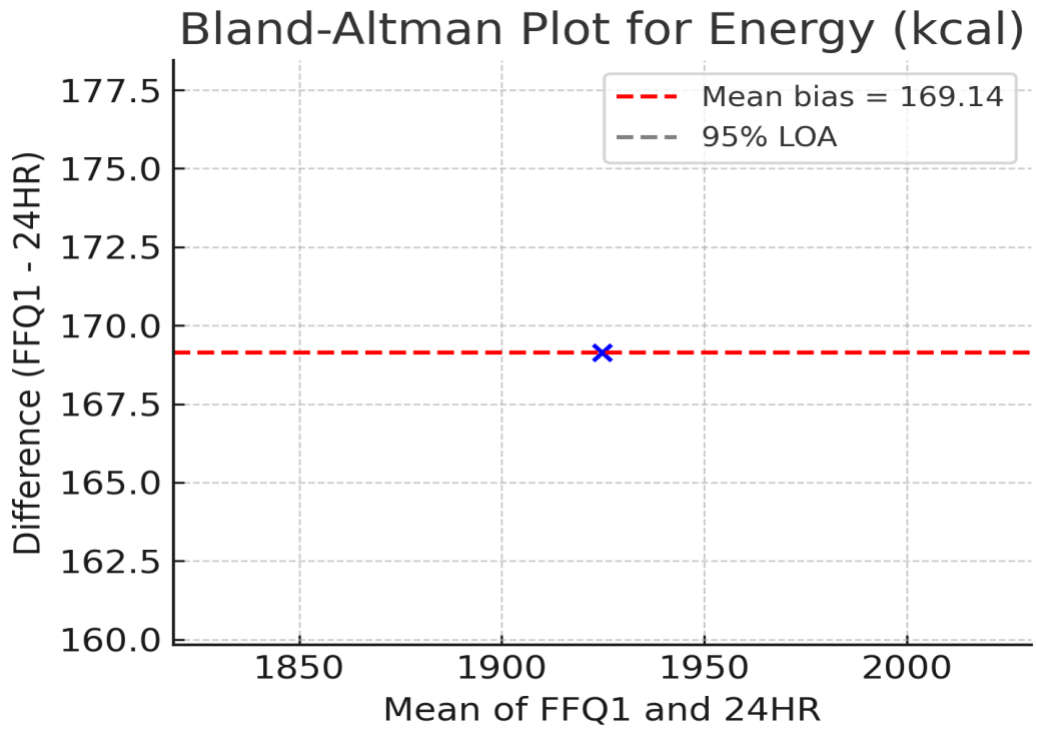

Figure 2: Bland-Altman Plot Showing Agreement Between FFQ1 and 24HR for Energy Intake (kcal)

Cross-Classification Analysis

The agreement between FFQ and 24HR estimates was further evaluated using quartile classification (Table 4). The percentage of participants classified into the same intake quartile by both methods ranged from 27% (carotene) to 61% (energy), with a median of 45.4%. Adjacent quartile agreement ranged from 34% to 56%, while extreme misclassification into opposite quartiles occurred in 5% to 24% of cases. The highest rates of extreme misclassification were observed for vitamin C (24%), carotene (17%), and calcium and iron (14% each). These findings indicate that the FFQ demonstrates acceptable ability to rank participants according to nutrient intake, though caution is warranted for certain micronutrients.

Table 4: Cross-classification of quartiles by 62 food items listed FFQ and three 24-hour dietary recalls (24 HR) in PTB patients.

Nutrients	FFQ/ 24 HR		
	% in the same quartile‡	% in adjacent quartiles§	% in extreme quartiles††
Energy	61	34	5
Protein	56	39	5
Fat	46	44	10
Carbohydrate	49	44	7
Calcium	49	37	14
Phosphorus	46	44	10
Iron	49	37	14
Retinol	32	54	14
Carotene	27	56	17
RE	39	49	12
B1	49	41	10
B2	56	34	10
Niacin	37	49	14
Vitamin C	39	37	24

‡The two methods categorized nutrient intake into the same quartile

§The two methods categorized nutrient intake into adjacent quartiles (difference within two quartiles)

††The two methods categorized nutrient intake into extreme quartiles (difference within more than two quartiles)

Reproducibility of the FFQ

The reproducibility of the FFQ was evaluated by comparing nutrient intake data from FFQ1 and FFQ2, collected three to five weeks apart (Table 5). Intra-class correlation coefficients (ICCs) ranged from 0.786 (vitamin C) to 0.986 (protein), indicating good to excellent test-retest reliability across all nutrients. Most nutrients demonstrated ICC values above 0.90, including energy, protein, carbohydrate, calcium, phosphorus, retinol, and several B vitamins, reflecting excellent reproducibility. These results affirm the stability of the FFQ in capturing habitual dietary intake over time.

Table 5: Reproducibility study: mean daily nutrient intake, relative difference, Spearman correlation coefficient, and cross-classification for comparing FFQ1 and FFQ2 in PTB patients (n=41).

Nutrient	FFQ 1 Mean ± SD	FFQ2 Mean ± SD	ICC (95% CI)
Energy	2009.36 ± 366.42	2109.03 ± 365.18	0.963 (0.730-0.988) **
Protein	85.45 ± 23.54	89.54 ± 23.24	0.986 (0.857-0.996) **
Fat	58.92 ± 11.40	52.95 ± 11.98	0.936 (0.641-0.978) **
Carbohydrate	307.18 ± 61.22	318.97 ± 59.24	0.963 (0.897-0.984) **
Calcium	377.17 ± 121.01	396.26 ± 119.20	0.974 (0.930-0.988) **
Phosphorus	1203.22 ± 322.61	1262.95 ± 4.34	0.985 (0.812-0.996) **
Iron	14.89 ± 4.61	16.57 ± 4.34	0.845 (0.632-0.927) **
Retinol	717.68 ± 235.47	774.64 ± 225.56	0.945 (0.840-0.976) **
Carotene	793.98 ± 403.14	933.79 ± 543.43	0.635 (0.326-0.803) *
RE	849.92 ± 260.71	930.17 ± 245.44	0.905 (0.742-0.957) **
B1	0.72 ± 0.17	0.74 ± 0.17	0.965 (0.930-0.982) **
B2	1.25 ± 0.41	1.32 ± 0.40	0.979 (0.923-0.986) **
Niacin	13.05 ± 3.41	13.85 ± 3.25	0.957 (0.845-0.983) **
Vitamin C	68.35 ± 26.8	75.11 ± 31.37	0.786 (0.601-0.886) **

‡FFQ1, food frequency questionnaire during first administration; FFQ2, food frequency questionnaire during second administration; RE, retinol equivalents
*p>0.001, **p>0.0001

DISCUSSION

We developed a culturally specific semi-quantitative FFQ for PTB patients in Kota Kinabalu and showed moderate-to-strong validity (Pearson r = 0.39–0.90, energy-adjusted r = 0.23–0.76) and excellent reproducibility (ICC = 0.79–0.99). These findings align well with recent validation results in similar contexts. For example, Md Ali et al. (2020) reported unadjusted correlations of 0.35–0.47 in Malaysian haemodialysis patients, reinforcing the reliability of culturally adapted FFQs within clinical populations (Md Ali et al., 2020). Similarly, Regassa et al. (2021) validated a culturally adapted FFQ in Southern Ethiopia and reported crude food-group correlations ranging from 0.12 to 0.78, and de-attenuated correlations from 0.24 to 1.00, demonstrating good performance in ranking dietary intake. (Regassa et al., 2021).

The high reproducibility of our instrument (protein ICC up to 0.99) exceeds benchmarks from other disease-specific FFQ validations, such as those in Peru, where Cronbach's alpha ranged from 0.65 to 0.85 (Wennberg et al., 2024). This supports our choice of a 3–5-week re-test interval, consistent with methods used in recent FFQ validations to capture habitual intake while minimizing recall bias.

Our observation of overestimating certain micronutrients (e.g., vitamin C, niacin) is not unexpected. This trend is documented in multiple FFQ validations and is attributed to the high intra-individual variability of such nutrients (Frediani et al., 2013). Despite this, the FFQ reliably ranks individuals, with 45.4% correctly classified into the same intake quartile and ≤24% extreme misclassification, making it a valuable tool for epidemiological studies assessing dietary risk factors.

The FFQ addresses a gap in Malaysia, where most validated dietary tools target non-communicable diseases rather than PTB (Hong et al., 2010). As a result, this instrument can support improved nutritional monitoring within the TB care continuum, which is an objective in Malaysia's National Strategic Plan to End TB (2021–2030) (Arinah et al., 2016) and aligns directly with the WHO's global strategy, emphasizing integrated, patient-centered TB care, which includes addressing nutritional vulnerability.

The high prevalence (33–88%) and prognostic significance of malnutrition among PTB patients, linked to increased mortality and delayed treatment response, underscores the necessity for tailored dietary assessment tools in this population (Ma et al., 2022). Indeed, recent cohort data from Ethiopia showed that undernutrition in PTB patients contributed substantially to unsuccessful treatment outcomes (Population Attributable Fraction ~20%) (Wagnew et al., 2024). Reviews have also documented that nearly 48% of TB patients in diverse contexts present with nutritional deficits, thereby reinforcing the imperative to integrate nutrition into TB care, both clinically and in policy.

Clinically, the FFQ can help identify patients who need nutritional support. It could be used by clinicians and dietitians to proactively identify PTB patients at nutritional risk, enabling referrals for dietary counselling or supplementation. It also provides a practical dietary outcome measure for future randomized trials evaluating nutritional interventions aimed at optimizing sputum conversion rates, immune recovery, or medication bioavailability.

Adapting the FFQ to a mobile-health platform would broaden access. The Norwegian DIGIKOST-FFQ and similar web-based FFQs have demonstrated validity and reproducibility comparable to paper-based formats (Henriksen et al., 2022). The WHO's End TB Strategy

identifies digital tools as foundational to future TB care (Falzon et al., 2016). Implementation toolkits have begun supporting mobile adoption in national TB programs. Implementing a validated digital food frequency questionnaire (FFQ) for PTB populations could enable remote dietary monitoring, especially in rural Sabah and during public health emergencies.

Key strengths include the use of three non-consecutive 24-hour recalls, culturally specific food items, standardized interviewing, and rigorous validation. At the same time, limitations include a sample size that, while consistent with validation guidelines, could be expanded in multi-centre studies to increase generalizability. Future research could also incorporate objective dietary biomarkers (e.g., serum retinol or vitamin C) and test the FFQ's external validity in other high-risk populations like HIV-infected TB patients or individuals from diverse indigenous backgrounds.

CONCLUSION

This study presents the first validated Food Frequency Questionnaire (FFQ) tailored explicitly for pulmonary tuberculosis (PTB) patients in Malaysia. Developed using culturally relevant food items and rigorously validated against three-day 24-hour dietary recalls, the FFQ demonstrated strong relative validity and excellent reproducibility. It provides a reliable and practical tool for assessing habitual intake of both macronutrients and micronutrients among PTB populations in Kota Kinabalu.

Beyond its research value, the FFQ offers clinical utility in identifying patients at nutritional risk and supporting targeted dietary interventions. Its application can enhance both epidemiological surveillance and patient-cantered care, contributing to Malaysia's National Strategic Plan to End TB and aligning with the World Health Organization's 2030 End TB Strategy. Future efforts should focus on expanding the tool to broader populations, integrating objective biomarkers, and adapting it into a digital or mHealth format to facilitate scalable and contactless administration, especially in remote or resource-limited settings.

Conflict of interest statement

The authors state that the study was conducted independently of any commercial or financial associations that could lead to a future interest conflict being misinterpreted.

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Ethical Considerations

The Medical Research and Ethics Committee granted ethical approval for this study (MREC) of the Ministry of Health Malaysia (Ref: KKM/NIHSEC/P19-443(11)) and registered in the National Medical Research Register (NMRR-18-3698-40627). Written informed consent was obtained from all participants prior to data collection.(Md Ali et al., 2020)

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COST ANALYSIS OF SMOKING CESSATION PROGRAMME IN PUSAT RAWATAN WARGA, UNIVERSITI MALAYSIA SABAH

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Abstract

Despite ongoing tobacco control measures, data on the direct costs of local smoking cessation programmes in Malaysian tertiary educational settings remain scarce. This study evaluates the cost implications of nicotine replacement therapy (NRT) at Universiti Malaysia Sabah (UMS) Quit Smoking Clinic, focusing on 2 mg and 4 mg Nicorette gum dosages. A retrospective cost analysis using a bottom-up micro-costing approach was conducted at Pusat Rawatan Warga, UMS, in 2023. Twenty patients were enrolled in the programme: those receiving 2 mg gum (follow-up every two months) and those receiving 4 mg gum (follow-up monthly). Direct programme costs, including counselling sessions, annual blood tests, and daily Nicorette gum consumption, were calculated. The annual cost per patient was RM 3,249.67 for the 2 mg gum group and RM 4,860.33 for the 4 mg gum group, with a mean annual cost of RM 4,055.00. Cost variations were influenced by gum dosage strength, frequency of follow-ups, and associated clinical procedures. The study highlights the substantial financial requirements of operating a structured smoking cessation programme in a tertiary educational setting. Policymakers and healthcare planners may use this evidence to inform budgeting, optimize resource allocation, and evaluate the sustainability of smoking cessation services. Future research should assess the cost-effectiveness of different NRT dosages to guide policy on scaling up cessation programmes.

Keywords: Cost Analysis, Nicotine Replacement Therapy, Smoking Cessation, Tobacco Control, Universiti Malaysia Sabah

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INTRODUCTION

Smoking-related morbidity and mortality remain a major global public health concern. An estimated 3 million deaths occur annually due to smoking-related diseases, with projections indicating a rise to 10 million by 2030. The main contributors to smoking-related mortality include cancer, respiratory diseases, and cardiovascular conditions (K. H. Lim et al., 2022). Approximately 70% of these deaths are expected to occur in developing countries, where smoking prevalence remains high (K. Lim et al., 2018). Within the Western Pacific Region, smoking prevalence varies considerably from 14.1% in Australia to as high as 52% in some areas contributing to nearly one million tobacco-related cardiovascular deaths annually (MacKay et al., 2022). Despite global tobacco control measures, both smoked and smokeless tobacco use continue to pose persistent public health challenges.

In Malaysia, smoking prevalence has shown a modest decline, from 23.1% in 2011 to 21.3% in 2019 (Yusoff et al., 2022). Nevertheless, smoking is still responsible for about 20,000 deaths annually and remains a major contributor to disability-adjusted life years (DALYs) and years of life lost (YLL) (K. Lim et al., 2018). To address this, Malaysia has committed to the World Health Organization's Framework Convention on Tobacco Control (FCTC) and has implemented multiple initiatives, including the establishment of Quit Smoking Clinics under the Ministry of Health (MOH). These clinics provide free access to pharmacological interventions such as nicotine patches and Nicorette gum, as well as psychological support like motivational interviewing (Lee et al., 2014).

At Universiti Malaysia Sabah (UMS), a Quit Smoking Clinic was established in August 2022 at Pusat Rawatan Warga (PRW) to support staff and students in smoking cessation. The clinic combines physician-led counselling with pharmacological interventions, primarily Nicorette gum available in 2mg and 4mg dosages. Evidence on the comparative effectiveness of these dosages is mixed: while some studies report higher abstinence rates with 4mg gum (Kornitzer et al., 1987), others show no significant difference (Garvey et al., 2000).
Despite the existence of such clinics, there is a lack of localized cost analyses of smoking cessation interventions in Malaysia, particularly within tertiary educational settings. This represents a critical knowledge gap, as understanding the costs associated with manpower, clinical services, and medications is essential for resource allocation, programme sustainability, and policy planning.

Therefore, this study aims to determine the costs involved in delivering nicotine replacement therapy through the Quit Smoking Clinic at PRW, UMS. Specifically, it compares the annual costs of providing 2mg and 4mg Nicorette gum regimens, offering insights into the financial implications of smoking cessation services in a university healthcare setting.

METHODS

This study employed a retrospective cost analysis using a bottom-up micro-costing approach to estimate the direct costs of a smoking cessation programme at Pusat Rawatan Warga (PRW), Universiti Malaysia Sabah (UMS). PRW is the primary healthcare centre for UMS staff and students, although members of the public may also seek services without subsidy. The clinic

provides comprehensive primary care services delivered by medical officers, nurses, assistant medical officers, and medical specialists. The analysis focused on patients enrolled in the Quit Smoking Clinic at PRW during January to December 2023, the first full year since the programme's launch in August 2022. A total of 20 patients (UMS staff and students) actively participated in the programme and were included in the study.

Two nicotine replacement therapy (NRT) regimens were provided to patients in the Quit Smoking Clinic. The first regimen, referred to as the usual dosage group, involved the use of 2mg Nicorette gum with an average of six pieces consumed daily, accompanied by follow-up appointments every two months. The second regimen, or maximum dosage group, consisted of 4mg Nicorette gum with the same daily consumption of six pieces, but with follow-up appointments scheduled monthly to allow closer monitoring. Direct programme costs included staff time, counselling sessions, laboratory investigations, consumables, and medication. Capital costs (e.g., equipment) were annualised using a 5% discount rate. All costs were expressed in Malaysian Ringgit (RM) for the year 2023. The information for price for all capital and recurrent costs was also obtained from Pusat Warga UMS as in Table 1.

Table 1: Capital and Recurrent Costs Involved in the Smoking Cessation Programme in Pusat Rawatan Warga, UMS

Category	Number	Cost
Capital Cost		
Instrument cost		
Peak Flow meter	1	RM286.60
Blood Pressure Monitor	1	RM132.00
Height Weight BMI Scale	1	RM2798.70
Recurrent Cost		
Healthcare staff (monthly emolument)		
Healthcare Assistant (U11)	1	RM1204.00
Registered Nurse (U29)	1	RM1797.00
Medical Officer (UD44)	1	RM3611.00
Assistant Medical Officer (U29)	1	RM1797.00
Pharmacy Officer (UF41)	1	RM2740.00
Assistant Pharmacy Officer (U29)	1	RM1797.00
Medications		
Nicorette gum (2mg)	1	RM1.22 / gum
Nicorette gum (4mg)	1	RM1.75 / gum
Blood screening		
Full blood count (FBC)	1	RM25.30

Lover function test (LFT)	1	RM29.00
Renal profile and serum electrolytes (RP + SE)	1	RM31.50
Fasting blood sugar (FBS)	1	RM4.70
Fasting lipid profile (FLP)	1	RM23.00
Uric acid (UA)	1	RM7.50
Consumables		
Disposable face mask	1	RM0.16 / pcs
Hand glove	1	RM0.186 / pcs
Syringe (10ml)	1	RM0.2780 / pcs
Blue needle	1	RM0.0842 / pcs
Mouthpiece for peak expiratory flow rate (PEFR)	1	RM0.5500 / pcs

RESULTS AND DISCUSSION

The cost analysis was conducted using a bottom-up (micro-costing) and activity-based approach. As the programme operated on an outpatient basis, costs were calculated based on appointment visits and daily medication consumption only, without including any inpatient or hospitalisation costs. To ensure a comprehensive assessment, all consumables, procedures, and staff salaries were included in the calculations. Three main activities contributed to the overall programme cost: smoking cessation counselling, annual blood profile assessments, and daily Nicorette gum consumption. These activities represented the core components of the smoking cessation service provided at Pusat Rawatan Warga, UMS.

Given the variation in follow-up schedules and gum dosages, patients were categorised into two groups. The usual dosage group consisted of individuals who received 2mg Nicorette gum, taken as six pieces daily, with follow-up appointments scheduled every two months. In contrast, the maximum dosage group comprised patients prescribed 4mg Nicorette gum at the same daily frequency, but with monthly follow-up appointments for closer monitoring. As there were varied data in terms of appointments and Nicorette gum intake, the calculation was divided into two main categories and different frequency of activities which were shown below in Table 2.

Table 2: Comparison and Differences in Activities Between Usual and Maximum Dosage Groups

Activity	Usual dosage group	Maximum dosage group
Smoking cessation counselling	Every two months	Every month
Annual blood profile	Once per year	Once per year
Daily Nicorette gum consumption	2mg 6 pieces daily	4mg 6 pieces daily

The annual cost per patient in the usual dosage group was RM 3,249.67, while the maximum dosage group incurred an annual cost of RM 4,860.33. The overall mean annual cost across both groups was RM 4,055.00. Capital costs were annualised using a 5% discount rate. In total, 20 patients were treated under this programme at Pusat Rawatan Warga, UMS, during 2023.

Table 3: Costs for Annual Blood Profile

Activity		Frequency		
Annual Blood profile		1 / year		
Recurrent cost				
Assistant Medical Officer (U29)	1	RM1797.00	30 minutes	RM6.24
FBC	1	RM25.30	Once per year	RM25.30
LFT	1	RM29.00	Once per year	RM29.00
RP + SE	1	RM31.50	Once per year	RM31.50
FBS	1	RM4.70	Once per year	RM4.70
FLP	1	RM23.00	Once per year	RM23.00
UA	1	RM7.50	Once per year	RM7.50
Disposable face mask	1	RM0.16 / pcs	Once per year	RM0.16
Hand glove	1	RM0.186 / pcs	Once per year	RM0.19
Syringe (10ml)	1	RM0.2780 / pcs	Once per year	RM0.28
Blue needle	1	RM0.0842 / pcs	Once per year	RM0.08
			Total cost	RM127.95
			Total cost per year	RM127.95

Table 4: Costs for Smoking Cessation Counselling Session in the Usual Dose Group

Activity		Frequency		
Smoking cessation counselling		Once every 2 months		
Capital cost				
Category	**Number**	**Cost**	**Frequency / Age**	**Total Cost**
Peak Flow meter	1	RM286.60	2 years	RM7.70
Blood Pressure Monitor	1	RM132.00	4 years	RM1.86
Height Weight BMI Scale	1	RM2798.70	3 years	RM52.35
Recurrent cost				
Medical Officer (UD44)	1	RM3611.00	30 minutes	RM12.53
Mouthpiece (PEFR)	1	RM0.5500 / pcs	Once per patient	RM0.55
			Total cost	RM74.99
			Total cost per year	RM449.94

Table 5: Costs for Smoking Counselling Session in the Maximum Dose Group

Activity		Frequency		
Smoking cessation counselling		Once every month		
Capital cost				
Category	**Number**	**Cost**	**Frequency / Age**	**Total Cost**
Peak Flow meter	1	RM286.60	2 years	RM7.70
Blood Pressure Monitor	1	RM132.00	4 years	RM1.86
Height Weight BMI Scale	1	RM2798.70	3 years	RM52.35
Recurrent cost				
Medical Officer (UD44)	1	RM3611.00	30 minutes	RM12.53
Mouthpiece (PEFR)	1	RM0.5500 / pcs	Once per patient	RM0.55
			Total cost	RM74.99
			Total cost per year	RM899.88

Table 6: Cost for Daily Nicorette Gum Usage in the Usual Dose Group

Activity		Frequency		
Daily Nicorette gum usage		Average 6 pieces per day		
Recurring cost				
Category	**Number**	**Cost**	**Time**	**Total Cost**
Nicorette gum (2mg)	30 days	RM1.22 / gum / day	Average 6 pieces per day	RM219.60
			Total cost	RM219.60
			Total cost per year	RM2671.78

Table 7: Cost for Daily Nicorette Gum Usage in the Maximum Dose Group

Activity		Frequency		
Daily Nicorette gum usage		Average 6 pieces per day		
Recurring cost				
Category	**Number**	**Cost**	**Time**	**Total Cost**
Nicorette gum (2mg)	30 days	RM1.75 / gum / day	Average 6 pieces per day	RM219.60
			Total cost	RM219.60
			Total cost per year	RM3832.50

Table 8: Comparison of Annual Costs for Smoking Cessation Programme Between the Usual and Maximum Dosage Groups

Activities	Usual dosage group	Maximum dosage group
Smoking counselling	RM449.94	RM899.88
Annual blood profile	RM127.95	RM127.95
Daily Nicorette gum	RM2671.78	RM3832.50
Total yearly cost	**RM 3249.67**	**RM 4860.33**

This study demonstrated that the maximum dosage of Nicorette gum (4mg) was more costly than the usual dosage (2mg), with annual per-patient costs of RM 4,860.33 and RM 3,249.67, respectively. These costs are considerably higher than those reported in Universiti Sains Malaysia (USM), where the annual cost per client was approximately RM 414.75 (Ibrahim et al., 2016). The discrepancy is largely attributable to differences in costing methods: the USM study excluded annual blood tests and other clinical investigations, while our analysis incorporated staff time, consumables, and laboratory procedures. Thus, the present study provides a more comprehensive estimation of the financial requirements for operating a structured smoking cessation programme in a tertiary educational setting.

The difference in costs between the two regimens reflects both the higher unit price of 4mg gum and the more frequent follow-up visits required for patients on higher doses. International evidence suggests that higher doses may lead to better abstinence outcomes, particularly among smokers with higher nicotine dependence. Kornitzer et al. (1987) reported abstinence rates of 32.2% with 4mg gum compared to 22.3% with 2mg at one year, while Garvey et al. (2000) found no significant difference overall, though higher-dependence subgroups benefitted more from 4mg gum. These mixed findings highlight the need for future cost-effectiveness analyses to determine whether the additional costs of higher dosages translate into meaningful long-term health and economic benefits.

Our results also align with international studies showing variation in programme costs. For example, annual smoking cessation costs were estimated at RM 889 in China (Qin et al., 2022) and RM 1,506 in Japan (Nakamura et al., 2013), both lower than the UMS programme. Exchange rate fluctuations and differences in healthcare delivery models partly explain these discrepancies. Notably, Sweden has demonstrated that high-intensity interventions may be more cost-effective in the long run than low-intensity approaches (Feldman et al., 2019). Similarly, USM reported counselling as the most cost-effective component of cessation programmes, with a success rate of 29.1% (Ibrahim et al., 2016), underscoring the importance of integrating behavioural support with pharmacotherapy.

The UMS programme incorporates evidence-based practices recommended in international guidelines, including provider-led counselling and pharmacological therapy (Fiore et al., 2008; Adsit et al., 2020). Research consistently supports combining NRT with structured behavioural support to improve quit rates, particularly in institutional settings (Tsoh et al., 1997; Reid et al., 2016). Our study adds to this body of evidence by quantifying the financial inputs required to sustain such interventions in a Malaysian university healthcare setting.

Limitations of this study include the small sample size (20 patients), single-site analysis, and one-year observation period, which may limit generalizability. Additionally, regional variations in drug pricing and service delivery may affect cost estimates elsewhere. Despite

these limitations, the findings provide a valuable baseline for planning and budgeting smoking cessation services in similar tertiary institutions.

The findings highlight the need for sustainable funding models to support university-based smoking cessation services. Policymakers and institutional decision-makers must balance affordability with effectiveness, considering whether to expand coverage using lower-cost regimens or to prioritize higher-cost, higher-dose regimens for patients with greater nicotine dependence. Incorporating routine cost analyses into programme planning can guide more efficient resource allocation and contribute to the long-term sustainability of smoking cessation initiatives.

CONCLUSION

This study demonstrates that operating a structured smoking cessation programme requires substantial financial resources, with the maximum Nicorette dosage (4mg) incurring higher costs than the usual dosage (2mg). By detailing the cost components, the findings provide important evidence for healthcare planners and policymakers in allocating budgets and justifying investments in university-based cessation services. Sustainable funding models are essential to balance affordability with treatment effectiveness, ensuring that programmes remain viable and accessible to those in need. Future research should extend this work through comprehensive cost-effectiveness analyses that compare different nicotine replacement regimens, incorporate long-term health outcomes, and evaluate scalability across diverse healthcare and educational settings. Such evidence will be critical for guiding policy and sustaining the impact of smoking cessation initiatives in Malaysia and beyond.

Ethical Considerations

All data collected were handled with strict confidentiality. No identifiable patient information, including names or any details that could potentially reveal the identity of the participants, was recorded or disclosed. All data were used solely for academic and research purposes. The study adhered to ethical research principles, including respect for privacy, protection of sensitive information, and compliance with relevant research ethics standards and institutional guidelines.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the analysis and reporting of this study.

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REVIEW ARTICLE Open Access

A NARRATIVE REVIEW OF TELEHEALTH SERVICE SUCCESS AND SUSTAINABILITY IN RURAL HEALTHCARE SETTINGS

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Abstract

Telehealth services have emerged as a promising solution to address healthcare disparities, improving access to care, reducing costs, and enhancing patient outcomes. This review explores the potential of telehealth in improving healthcare access, as well as the factors leading to its success and sustainability. Examining the promise and constraints of telemedicine adoption provides insights into the broader possibility and implications of telehealth technologies. A narrative review analysed 12 English-language literatures (2019-2023) from PubMed, Science Direct, Scopus, ProQuest, and Emerald Insight, focusing on telehealth data, regulations, success factors, and rural access. Telehealth offers significant benefits, particularly in improving access to healthcare for rural and underserved populations, reducing travel time and costs, and enhancing patient engagement. It also aids in early disease detection and management, leading to better patient outcomes and reducing unnecessary hospital admissions. However, challenges remain, especially in technological infrastructure, where inadequate internet connectivity in rural areas hampers effective implementation. Patient satisfaction depends on convenience, efficiency, privacy, and communication, all of which can be compromised by technical issues. Six critical factors for telehealth success include vision, ownership, adaptability, economics, efficiency, and equipment, which must be addressed for sustainable adoption, particularly in rural settings. Despite the potential of telehealth services to revolutionize healthcare access, challenges such as funding limitations, infrastructure barriers, and concerns about the quality of telemedicine encounters persist. For telehealth services to be successful and sustainable in the long run, several issues must be resolved. Strategies include enhancing infrastructure, ensuring adherence to regulations and guidelines, and fostering awareness and acceptance among healthcare professionals and patients. The results highlight the necessity of ongoing investigation, assessment, and strategic planning to fully realize the promise of telehealth services, particularly concerning cancer treatment and other crucial areas of healthcare.

Keywords: Telehealth, Healthcare Access, Rural Health, Health Technology, Sustainability in Healthcare

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INTRODUCTION

The integration of information and communication technology with health services has given rise to the concept of telehealth, which encompasses a broad range of remote healthcare services, including non-clinical applications such as education, administrative support, and health system management. Telemedicine, a subset of telehealth, specifically refers to the remote provision of clinical services, including diagnosis, treatment, and patient monitoring, through telecommunication technologies (Salmanizadeh F et al, 2022), Telehealth has become a critical solution for addressing healthcare disparities. This is especially true in rural and suburban areas where establishing communication infrastructure is more feasible than deploying a large number of healthcare providers (Maroju et al., 2023). Despite efforts by both government and private sectors, the lack of primary healthcare facilities in rural areas persists, with 90% of secondary and tertiary healthcare services located outside these regions, which are home to 68% of the population. The application of digital pathology for routine diagnoses in India highlights the potential of telehealth, although its broader implementation is often hindered by practical, technological, and financial challenges.

One of the major obstacles to telehealth, particularly telemedicine services in rural settings, is the need for improved internet infrastructure. Initiatives aimed at enhancing connectivity, such as laying optic fiber and linking smaller healthcare providers to larger institutions, are vital for the long-term success of telehealth (Graves et al., 2021). Additionally, a review of current telemedicine practices and adjustments to regulatory frameworks are necessary to ensure that remote clinical services remain effective and sustainable. Training healthcare professionals in the effective use of telemedicine is another crucial factor in enhancing rural healthcare delivery.

The high levels of patient satisfaction with telehealth services, including both telemedicine and non-clinical support, underscore its potential as a model for rural healthcare delivery. However, further research with larger and more diverse samples is necessary to generalize the findings to broader populations. Key factors that contribute to the success and sustainability of telehealth include vision, ownership, adaptability, economics, efficiency, and equipment (Gajarawala & Pelkowski, 2021). Strategic planning and strong leadership are essential to effectively implement these services.

Telemedicine has proven particularly beneficial in expanding healthcare access in remote areas by facilitating real-time clinical consultations, telemonitoring, and virtual follow-ups. Despite its potential to revolutionize healthcare access for rural populations, the limited availability of funding has hindered widespread implementation, particularly in rural and remote areas. Addressing this issue requires ensuring that appropriate technology infrastructure supports telehealth implementation and management, as disruptions in the telehealth experience can impact patient care and outcomes (Orlando et al., 2019). Telehealth plays a crucial role in healthcare system efficiency by reducing unnecessary hospital admissions and facilitating

timely specialist consultations, while telemedicine specifically improves patient diagnosis and treatment through remote interactions with healthcare providers (Tsou et al., 2021).

Moreover, patient satisfaction with telehealth services**,** including telemedicine consultations, is linked to factors such as convenience, efficiency, communication, privacy, and comfort. Barriers such as poor internet connectivity may lead to inadequate audio and visual quality, potentially causing diagnostic inaccuracies and care delays. A study in Portugal by (Maria et al., 2022) highlighted barriers for telemedicine-based teleconsultations including poor internet quality which affects image quality and the lack of synchronization between audio and video during online sessions can hinder the effectiveness of teleconsultation, causing disruptions and reducing the clarity during medical information exchanges. Addressing these barriers is vital to the success of teleconsultation. Participation from the patient's side will be less if the barriers remain.

This review aims to examine the criteria and factors that contribute to the success and sustainability of telehealth and telemedicine, emphasizing the importance of optimal planning, implementation, and long-term viability of these digital health solutions.

METHODS

This narrative review followed a systematic approach to ensure transparency in article selection and synthesis. A comprehensive literature search was conducted across five major databases—PubMed, ScienceDirect, Scopus, ProQuest, and Emerald Insight—to identify relevant studies on telehealth service success and sustainability published between 2019 and 2023. The search was restricted to English-language peer-reviewed articles. The following keywords and Boolean operators were used:

- ("Telehealth" OR "Telemedicine") AND ("Success factors" OR "Sustainability") AND ("Rural healthcare" OR "Remote healthcare")
- ("Digital health services" OR "E-health") AND ("Implementation challenges" OR "Health disparities")

The selection process followed a structured approach to enhance transparency and reproducibility. The initial database search retrieved 320 articles, and after removing 40 duplicates, 280 unique articles remained. Title and abstract screening was performed independently by all authors, leading to the exclusion of 200 articles that did not meet the eligibility criteria. Full-text screening of the remaining 80 articles was conducted based on relevance, methodological rigor, and adherence to the study focus, resulting in the exclusion of 68 articles for insufficient emphasis on telehealth success or sustainability. Finally, 12 high-quality studies were selected for inclusion in this narrative review (Figure 1).

The review adopted clear eligibility criteria to ensure relevance and consistency. Studies were included if they examined success factors and sustainability of telehealth or telemedicine services, focused on rural and underserved healthcare settings, and discussed challenges, infrastructure requirements, or policy considerations related to telehealth. Empirical studies, systematic reviews, and policy analyses were considered, while studies focusing solely on technological aspects without healthcare implementation insights, non-peer-reviewed sources, conference abstracts, and opinion papers were excluded.

To maintain consistency and reliability in data extraction, a standardized data extraction form was used to collect information on study characteristics (authors, year, country, study

design), telehealth interventions (type of service, technology used), success factors and sustainability indicators (infrastructure, policy, financial viability), and challenges and barriers (internet access, regulatory issues, user acceptance). The extracted data were thematically synthesized into key domains, including technological, economic, regulatory, and user-related factors, to provide a structured and comprehensive analysis of the findings. This methodological approach enhances reproducibility, transparency, and reliability, ensuring that the review systematically captures critical factors influencing telehealth service success and sustainability in rural healthcare settings.

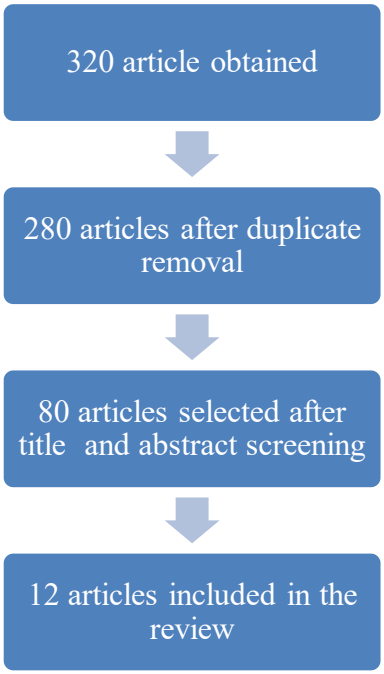

Figure 1: Flowchart

RESULTS AND DISCUSSION

Telehealth services have significantly improved healthcare access in underserved and remote areas, particularly in regions like India where many communities lack sufficient medical professionals. This improvement in access is crucial in areas where traditional healthcare infrastructure is either limited or non-existent. The use of telehealth has led to reduced travel costs, increased patient engagement, and enhanced healthcare efficiency. The main challenges identified include funding limitations, inadequate technological infrastructure, concerns over telemedicine encounter quality, and regulatory hurdles.

One of the major challenges is the financial burden associated with implementing and sustaining telehealth services. The high cost of setting up digital platforms, maintaining secure data storage, and training healthcare professionals often limits telehealth adoption, particularly in low-resource settings. To address this, public-private partnerships (PPPs) could provide a sustainable funding model by engaging both government and private entities in cost-sharing initiatives. Additionally, integrating telehealth reimbursement policies into national healthcare

systems and expanding insurance coverage for telemedicine services could ensure long-term financial sustainability. Governments could also incentivize telehealth adoption through tax breaks and subsidies for healthcare providers implementing telehealth solutions in underserved areas.

Another key barrier is technological infrastructure, particularly poor internet connectivity and inadequate digital literacy among both patients and healthcare providers. In many rural areas, limited broadband access and low-quality internet services affect the reliability and quality of telehealth consultations, often leading to misdiagnoses and care delays. A feasible solution is to expand internet infrastructure through national broadband initiatives or satellite-based internet solutions that provide stable connections to remote areas. Additionally, mobile-based telehealth applications with offline functionality could serve as an alternative for low-connectivity regions, allowing patients and providers to access telehealth services even with intermittent internet availability.

The quality of telemedicine encounters remains a concern, as low-resolution images, poor audio quality, and lack of physical interaction may compromise diagnostic accuracy and patient trust. One practical solution is the adoption of AI-powered diagnostic tools to enhance remote consultations. AI-assisted image recognition and real-time clinical decision support systems could help mitigate errors and improve the effectiveness of virtual consultations. Furthermore, standardized telemedicine training programs for healthcare providers would ensure they are proficient in delivering high-quality remote care while improving patient-provider communication techniques to enhance patient engagement.

Regulatory and legal challenges also pose barriers to telehealth sustainability. Unclear policies on licensing, cross-border telemedicine consultations, and data security continue to hinder seamless implementation. A potential solution is the harmonization of telehealth regulations at the national and regional levels, ensuring clear guidelines on licensing, data protection, and telemedicine service scope. Establishing centralized telehealth governance bodies could streamline regulatory processes and ensure compliance with ethical and legal requirements.

Another critical barrier is resistance from both healthcare providers and patients due to concerns over privacy, trust, and workflow integration. Many healthcare workers express scepticism regarding increased workloads, documentation requirements, and the risk of depersonalized care in telehealth services. Addressing these concerns requires the integration of telehealth platforms into existing hospital electronic medical record (EMR) systems, minimizing administrative burden and enhancing workflow efficiency. Additionally, educational campaigns and community engagement programs could increase public awareness and acceptance of telehealth, addressing patient reluctance.

While the review highlights these challenges, a multifaceted approach combining technological investment, financial incentives, regulatory reforms, and user acceptance strategies is necessary to fully realize the potential of telehealth services. The feasibility of these solutions depends on government commitment, cross-sector collaboration, and ongoing

innovation in telehealth technologies. Future research should focus on pilot programs evaluating the implementation of these solutions to assess their real-world effectiveness and scalability, particularly in rural and resource-limited settings.

Benefits of Telehealth

The use of contemporary communication and information technologies in telehealth offers expert-based healthcare to understaffed remote locations, providing cutting-edge emergency treatment, and contributing to early detection, better cure, prevention, and rehabilitation, particularly in managing diseases like cancer. Orlando et al (2019) highlighted the telehealth's potential to decrease the incidence of cancer in the nation is emphasized by raising national awareness of cancer and its care. For example, telehealth platforms can be used to launch awareness campaigns targeting specific populations that might be at higher risk due to environmental, genetic, or lifestyle factors. For instance, a campaign focusing on lung cancer awareness in areas with high pollution or smoking rates might use targeted messages through telehealth apps to encourage users to understand their risk factors and participate in preventive screenings. It has also been linked to changes in service use patterns, including increased local hospital admissions and reduced unnecessary patient transfers, which have translated into improved patient outcomes (Tsou et al., 2021). Furthermore, the regular use of telehealth workstations was associated with increased confidence among users and was perceived to enhance medical treatment (Valentin et al., 2022)

Barriers of Telehealth

However, telehealth encounters challenges such as patient and medical professional reluctance. Some patients may prefer physical visits, while healthcare professionals may be skeptical about visual quality during teleconsultations and telediagnostics. According to Maria et al. (2022), while patients held views on the value of face-to-face consultations, physicians emphasized on comfort in asking questions during face-to-face interactions. Legal and ethical issues, particularly regarding the application of laws in cross-border teleconsultations, continue to be a concern. Telehealth platforms are usually highly encrypted and follow regulations, but it is not entirely hack-proof which leads to concerns about the privacy and security of telehealth systems hinder broader acceptance (Gajarawala & Pelkowski 2021). Also, it is found that, there are concerns from physicians in terms of increased workloads especially regarding administrative tasks related to teleconsultation which includes scheduling, documentation and other administrative responsibilities (Maria et al., 2022).

Addressing these challenges is crucial for the success and sustainability of telehealth services. Improving visual quality in tele-radiology, telepathology, and tele dermatology to meet international standards can prevent incorrect interpretation and misdiagnosis. Integrating telehealth into daily tasks, expanding education and awareness efforts, and addressing reluctance and scepticism about telemedicine are essential.

For telehealth to reach its maximum potential, it is important to not only understand its limitations and challenges, but also to identify the criteria or factors that contribute to its success (Gajarawala & Pelkowski 2021).

Factors influencing success and sustainability:

1. The **vision** in defining the purpose of the service has to be clear and focused. As such, a well-defined and clear vision will not only help to develop a focused planning, but also makes the implementation of the program much smoother and eventually gains a good outcome.

2. **Ownership** in developing the service needs to be purposeful and empowered by all stakeholders. The involvement of patients or targeted populations, the clinicians or service providers and managers of the telehealth service will be crucial in developing a telehealth program that responds to the real need of the local health service and further improves the overall healthcare deliverance.

3. **Adaptability** of the telehealth service to the real needs of the local health service, considering the local limitations and restrictions before establishing a suitable model. For example, in rural populations, telehealth developers should consider the simplicity of interface or using a platform that has a wider or better accessibility to gain better acceptance by the local populations.

4. **Economics** aspect of the telehealth service in terms of time saving and cost effectiveness provided by telehealth as compared to conventional face to face service. For example, setting up an online platform is more cost effective as compared to setting up a new clinic in the rural area. The online platform can also serve as a communicative point between the outreach point and the referral centre to refine and speed up the referral process.

5. **Efficiency** related to the development and sustainability of the telehealth service is another important aspect to look into during the development of the telehealth system. The manpower or skills needed in developing the program framework as well as to manage and sustain the program in the long run plays a vital role in ensuring a successful outcome for the program.

6. **Equipment** needed for the establishment of the telehealth services is also very crucial in determining the successfulness of the program. Substandard equipment might result in poor internet connection and subsequently affect the quality of image and audio during a telehealth session thus leading to incomplete or failure telehealth sessions.

CONCLUSION

This review of telehealth literature from 2019 to 2023 highlights its potential to improve healthcare access for rural and underserved populations, demonstrating benefits such as enhanced patient engagement, reduced travel costs, and improved health outcomes. However, challenges persist, primarily due to inadequate technological infrastructure in rural areas, impacting the effectiveness and satisfaction associated with telehealth services.

Key success factors for telehealth include strategic vision, adaptability, economic viability, and technological adequacy. Addressing infrastructure deficiencies, regulatory compliance, and fostering acceptance among healthcare providers and patients are crucial for overcoming barriers and realizing telehealth's full potential.

Continued research and strategic implementation are essential to optimize telehealth services, ensuring they meet the needs of diverse populations and effectively manage healthcare challenges in rural settings. The success of telehealth depends on a balanced approach that integrates technological advancements with user-centric designs and inclusive health policies.

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THE GLOBAL PLAYBOOK FOR TOBACCO CONTROL POLICY: CHALLENGES, STRATEGIES, AND A CASE STUDY FROM MALAYSIA

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Abstract

Tobacco use remains a leading cause of preventable death globally, disproportionately affecting low- and middle-income countries (LMICs). Despite the implementation of the WHO MPOWER strategy, significant challenges persist, including the high prevalence of smoking among lower socioeconomic groups and the rapid emergence of e-cigarettes, particularly among youth. This narrative review explores the contemporary challenges in tobacco control, outlines effective strategies, and analyzes Malaysia's policy alignment with global recommendations to guide future interventions. A literature search was conducted in May 2025 across the Scopus, PubMed, and Cochrane Central databases. The search focused on articles published in English within the last 15 years, using keywords related to the challenges (e.g., "policy resistance," "enforcement problems") and strategies (e.g., "taxation," "cessation programme") of tobacco and e-cigarette control policy. All study designs were considered, while editorials and presentations were excluded. The review identifies two primary areas. First, key challenges to tobacco control include significant socioeconomic disparities in nicotine dependence, aggressive marketing targeting vulnerable populations, regulatory gaps concerning synthetic nicotine and novel products, and industry interference through legal challenges and manipulation of international trade policies. Second, effective strategies are categorized across three levels: macro (comprehensive taxation, product regulation), meso (community-based initiatives, pictorial health warnings), and micro (individual-level interventions like incentive programs and pharmacological support). Effective tobacco control demands a multi-layered, equitable approach that integrates robust policy with community and individual support. By enacting the Control of Smoking Products for Public Health Act, Malaysia has taken a positive step, but further action is crucial. Key future priorities include: 1) enhancing and harmonizing fiscal and legal measures through international collaboration to prevent industry forum-shopping; 2) sustaining investment in public education to reduce initiation and normalize cessation; and 3) advancing targeted research on cessation supports, especially for LMICs.

Keywords: Tobacco control, WHO FCTC, MPOWER, nicotine regulation, synthetic

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INTRODUCTION

One of the leading causes of preventable deaths in the world is related to tobacco use and it has contributed to approximately 100 million deaths worldwide (WHO, 2017). The economic cost of smoking surpasses the productivity loss due to smoking-attributable diseases/deaths (SADs) and the impact also resulted in suffering for the families of those who succumbed due to SADs (Drope et al., 2018).

World Health Organization has introduced the MPOWER strategy in 2003 as measure to tackle the dire situation posted by tobacco use globally, in which it combines tobacco control policies to reduce prevalence of active smokers while preventing second-hand (SHS) and third-hand smokers (THS) from harmful effects of smoking (WHO,2003; Kaleta et al., 2009). This strategy composed of six critical and most effective strategies for tackling global tobacco epidemic, specifically: monitoring tobacco use and prevention policies, protecting people from tobacco smoke, offering assistance to quit smoking, educating the public about the dangers of tobacco use, enforcing bans on tobacco advertising, promotion, and sponsorship, and raising taxes on tobacco products.

Despite significant global progress in tobacco control, tobacco use remains a critical threat to the health and well-being of an estimated 1.3 billion people worldwide, 80% of whom reside in low- and middle-income countries (LMICs) (WHO, 2021b). The South-East Asian Region is the most heavily burdened, with the highest percentage of tobacco users at 26.5% (PAHO, 2024). In Malaysia, recent data from the National Health and Morbidity Survey (NHMS) 2023 and the Global Adult Tobacco Survey 2023 show a smoking prevalence of 19.0% (Ministry of Health Malaysia, 2024) and 19.5% (WHO, 2024), respectively. The burden is most concentrated among the Bottom 40% (B40) household income category (Prevalence: 20.3%) and working adults aged 35-44 (Prevalence: 25%) (Ministry of Health Malaysia, 2024), indicating that the major impact of tobacco smoking in Malaysia falls upon lower-income and working-class groups

Compounding this issue is the rising popularity of electronic cigarettes (e-cigarettes), whose widespread availability and insufficient regulation undermine public health messaging, increase youth initiation, and inhibit successful smoking cessation (Starr et al., 2023). Globally, e-cigarette prevalence is reported at 10.72%, with the highest usage among young adults aged 18-24 (Martins et al., 2022; Albadrani et al, 2024). A similar trend is observed in Malaysia, where the e-cigarette prevalence is 5.0%, and the highest concentration of users is among adolescents and young adults aged 15-24, as reported in the NHMS 2023 (Ministry of Health Malaysia, 2024). The rising use of e-cigarettes among this younger demographic poses a significant new threat on top of the nation's unresolved burden of traditional tobacco smoking.

This narrative review explores global challenges in tobacco control regulation and synthesizes successful strategies to guide future interventions for advancing global public health.

The review provides a focused analysis of Malaysia's policy framework, examining its alignment with international recommendations to reduce smoking prevalence in the nation.

METHODS

Literature Search

We searched Scopus, PubMed and Cochrane Central in May 2025 using the following search strategy:

i) **Challenges of Tobacco Policy Control:** ("tobacco control" OR "tobacco policy" OR "smoking regulation" OR "nicotine regulation" OR “smoking policy”) OR ("electronic cigarette" OR "e-cigarette" OR vaping OR "heated tobacco" OR "nicotine delivery system") AND (challenges OR barriers OR obstacles OR "policy resistance" OR "implementation issues" OR "enforcement problems")
ii) **Strategies for Tobacco Control Policy**: ("tobacco control" OR "tobacco policy" OR "smoking regulation" OR "nicotine regulation" OR “smoking policy”) OR ("electronic cigarette" OR "e-cigarette" OR vaping OR "heated tobacco" OR "nicotine delivery system") AND ("policy strategy" OR "public health intervention" OR "legislation" OR "marketing restrictions" OR "taxation" OR "cessation programme")

Eligibility Criteria

The criteria of the included articles were 1) study design: all types of study design (Meta-analysis, systematic review, cross-sectional, cohort, case-control and interventional articles), 2) articles written in English. 3) Articles published in the past 15 years. Exclusion criteria included papers that were published as editorial comments and presentations.

RESULTS

The findings of this review are organised into two main subsections: *Challenges of Tobacco Control Policy and Strategies for Tobacco Control Policy*. This structure is intended to present the key issues and responses identified across the literature.

The first subsection, *Challenges of Tobacco Control Policy*, highlights several critical barriers that continue to hinder the effectiveness of global tobacco control efforts. Foremost among these are socioeconomic disparities in tobacco use and nicotine dependence, with lower-income and marginalised populations disproportionately affected. The review also identifies the persistent influence of targeted advertising, particularly campaigns directed at youth and other vulnerable groups, as a significant contributor to tobacco initiation and sustained use. Furthermore, regulatory shortcomings—particularly in relation to synthetic nicotine and novel products such as e-cigarettes —are shown to undermine national control measures. These challenges are further exacerbated by fragmented international trade policies and industry interference, which collectively enable tobacco companies to resist or circumvent public health regulations.

Challenges of Tobacco Control Policy

Social and Cultural Challenges

Increased nicotine use and dependence were notably significant among individuals with lower education and income and the changes over time in these nicotine outcomes were greater

among those with lower socioeconomic status relative to those with greater income and education (Grant et al., 2020). Low socioeconomic status interacts with an array of other factors to influence behavior of smoking, such as race / ethnicity, cultural characteristics, social marginalization (e.g. lesbian, gay, bisexual and transgender communities, people with mental illness and substance use disorders), stress and lack of community empowerment (Brady, 2020).

Policy and Regulatory Issues

Most of current regulation for tobacco control are still dependent on how the laws define the products covered by the regulations and synthetic nicotine products regulation differ from one country to another. Review by WHO Study Group on Tobacco Product Regulation (2023) found that among the 211 jurisdictions to control of products containing synthetic nicotine, only 52 jurisdictions have clear coverage of certain products, meanwhile the remaining either have broad coverage, unclear coverage or no coverage.
Tobacco companies are well versed that some tobacco control laws do not cover synthetic nicotine products and thus sought to take advantage of such regulatory gaps (WHO, 2023). Laws that apply only to "tobacco products" or "tobacco-derived" products are specifically referring to conventional tobacco products and its may not be broad enough to cover synthetic nicotine products, as synthetic nicotine is not derived from tobacco plants.

Nevertheless, non-health government agencies, particularly in lower and middle-income countries (LMICs) often disregard the commitment signed under WHO Framework Convention on Tobacco Control (WHO FCTC) and support the tobacco industry (Lencucha et al., 2015; Lenchucha et al., 2020; Patay et al., 2022a). Such practice is commonly explained by industry interference and government agency mandates to prioritize economic, trade industry and agriculture interests (FCTC Secretariat, 2018; Jongenelis, 2022).

Emerging Nicotine Products and Marketing Strategies

Cigarette manufacturers have been documented to manipulate product design, such as appearance, flavour and smoke characteristics to enhance their appeal and consumer acceptance. WHO Study Group on Tobacco Product Regulation (2023) revealed that several additives were added to improve sensory attributes of Tobacco and Nicotine products, leading to higher nicotine blood levels or maintenance of nicotine dependence. Menthol and synthetic cooling agents were found to reduce aversive sensory responses to both tobacco cigarettes and e-cigarettes. In the same report, evidence of menthol resulting in deeper inhalation of cigarette smoke and higher blood cotinine levels were found in study of rodents. Similarity of the effects of synthetic coolants to those of menthol is biological plausible, as both share an underlying mechanism, despite synthetic coolants and menthol differ in potency, with stronger effects of synthetic coolants on coolness and pleasant respiratory sensations.

In the same report by WHO, flavour additives with sweet properties, particularly in e-cigarettes have shown consistent reduction of perception of bitterness. Other perceptions of harness, contribution of olfactory and gustatory effects and increase smoothness were however inconclusive. However, the use of fruit-flavoured e-cigarettes among adolescents were associated with increased levels of most inhalation behavior, including puff duration and count.

Since 2015, Next Generation Labs (NGL) began marketing synthetic nicotine in the United States of America (USA) under the trademark of Tobacco Free Nicotine (TFN) for

consumer products. NGL further filed application for USA and worldwide patent with the title "Proccess for the preparation of (RS)-nicotine" and was assigned in 2017. The process describes a synthetic pathway that ethyl nicotinate as the starting material. Ethyl nicotinate is derived from nicotinic acid (niacin), a synthetic chemical produced from petrochemical sources and it reacts with N-vinyl-2pyrrolidinone to form myosmine, a tobacco alkaloid. Myosmine is then converted to nornicotine, which is then results in racemic (50:50) nicotine mixture of S- and R-nicotine after methylation process. The two forms of synthetic nicotine are currently in marketed products and synthetic S-nicotine is chemically identical to tobacco-derived S-nicotine, with its toxicological, metabolic and pharmacological properties were believed to be identical, especially when manufacturer claimed the purity added are more than 99%.

A recent systematic review and meta-analysis have presented that e-cigarettes were associated with less quiting in adult populations when regularly used as consumer products (Kalkoran and Glantz, 2016). Increasing number of studies have revealed potential harms of e-cigarettes, which include variety of known inhalation toxins (Strongin, 2019; Zhao et al., 2020), e-liquids with potential harm from explosions and poisoning (Tzortzi et al., 2020) and potential gateway to combustible cigarette and other substance use among youth (Chan et al., 2021).

Despite its harmful effects, review on perception of harmful and additives effects of e-cigarettes among adolescent have shown that adolescent perceived e-cigarettes as less harmful than tobacco cigarettes (Aly et al., 2022). As a result, prevalence of e-cigarettes has been reported at 10.72% by Martins et al. (2022) and Albradani et al., 2024) and the highest percentage of users are between 18 - 24 years old. This finding correlates with the rise of e-cigarettes users from 1.5% up to 27.5%, specifically among high school students during 2011 - 2019 (Cullen et al., 2019), leading to use of e-cigarettes among adolescent and young adults currently been recognized as a global public health challenge. Malaysia is also experiencing similar phenomenon with the majority e-cigarette smoker aged between 15 - 24 years old with the prevalence of 9.7% (Ministry of Health Malaysia, 2024).

Promoting the initiation of youth into tobacco use through surrogate advertisements and dubious marketing tactics affects cessation of tobacco use indirectly (Aghi et al., 2022). Many companies diverted their products portfolio to e-cigarettes as synthetic nicotine products are not well regulated in many nations. Many companies market synthetic nicotine products by suggesting their product are “safer” than products containing tobacco-derived nicotine, both implicitly or explicitly (WHO, 2023). Examples include claims that synthetic nicotine contains fewer impurities than tobacco-derived nicotine, other advantages over products with tobacco-derived nicotine (more satisfaction, better taste experience and more environmentally friendly) and effective aids for smoking cessation or equivalent to approved nicotine replacement therapy (WHO, 2023).

Electronic nicotine products (ENPs), or more commonly known as e-cigarettes), electronic nicotine delivery systems (ENDS) or vaping products were first invented by a Chinese pharmacist in year 2003 and it is currently widely available after 20 years across the world (Kaisar et al., 2016). The rapid expansion has been facilitated by aggressive marketing as a smoking cessation aid or a healthier alternative to combustible cigarettes (Franck et al., 2014), due to its ability to deliver nicotine in isolation without exposure to other harmful chemicals generated from burning of tobacco (Balfour et al.,2021).

Economic Interest, International Trade and Legal Challenges

Evidence shows small island developing states and LMICs are targeted by the tobacco industry due to vulnerabilities such as limited economic and regulatory capacities, geographic isolation, and dependence on policies from larger economies. Tobacco companies increasingly use international trade and investment agreements, including WTO mechanisms, to challenge existing tobacco control policies and deter future legislation. Legal disputes often arise from claims that tobacco control policies infringe upon trademark rights or international trade agreements, undermining national regulatory efforts (Crosbie and Glantz, 2014; Mitchell and Sheargold, 2014; Savell et al.., 2014). Strengthening international collaborations and clearly defining public health exemptions in trade agreements could mitigate these legal challenges..

Tobacco industry is increasingly manipulating the problem of tobacco smuggling for policy gain in ways that seriously threaten progress in tobacco control. Tobacco companies only prioritize their sale to distributor and whether the cigarettes are then sold through legal or illegal channels make little difference. The illegal channels has multiple advantages for tobacco companies and evidence has shown that tobacco companies' historical involvement in cigarette smuggling and increasing evidence of ongoing complicity, such as overproducing or oversupplying markets with products that eventually leaks into illicit channels. Such trades undermine the control efforts and contributes to the availability of cheaper and unregulated products. Tobacco companies have been actively and effectively hijacked the Illicit Trade Protocol (ITP) within the FCTC by using the threat of illicit trade to counter tobacco control policies through arguments, misleadingly claimed that tobacco control policies drive increases in illicit trade (Crosbie and Glantz, 2014; Mitchell and Sheargold, 2014).

The role of harmful commodity industries in using the rhetoric of individual responsibility is often documented in the public health and tobacco control literature (Friedman et al., 2015; Hoek, 2015; McKenzie and Collin, 2017; Magnussion, 2015; WHO, 2019). In the casual ideas that is frequently used to explain substance use, blame is commonly shifted on the raw material provider - manufacturer - seller - consumer axis, and the consumer is argued to be culprit of the issue. Such idea is commonly used to oppose regulatory measures, calling such policies "an assault on freedom and choice" and the government as "nanny state" (Chau et al., 2019; MacKenzie et al., 2018; Oliveira da Silva et al., 2019).

Strategies for Tobacco Control Policy

This second subsection, Strategies of Tobacco Control Policy, synthesizes a range of emerging and established approaches aimed at addressing the previously mentioned challenges. The review emphasizes the significance of integrated, multi-tiered strategies that function across macro- (policy and taxation), meso- (community-based initiatives), and micro- (individual-level interventions) levels. Identified effective measures include comprehensive taxation, plain packaging laws, advertising restrictions, and public awareness campaigns. The review also highlights the importance of equity-centered policies that address social determinants of health and ensure equitable access to cessation support. Innovative approaches such as digital cessation platforms, targeted outreach programs, and school-based prevention initiatives are recognized for their potential scalability and adaptability across various settings. Furthermore, the review underscores the necessity of international collaboration to harmonize standards, close regulatory loopholes, and counteract the legal and commercial pressures exerted by the tobacco industry.

According to Tracy et al. (2023), tobacco control strategies can broadly be organized into three categories: (1) prohibition, (2) contraction, and (3) harm minimization. Prohibition strategies are aimed to completely eliminate the sale of all tobacco products from the marketplace, and are almost impossible to achieve, mostly due to existing experience that has shown they are unworkable. Contraction strategies such as interventions attempt to scale down the overall size of the tobacco marketplace. Examples of contraction strategies are efforts targeting the demand of tobacco products such as taxation, advertising bans, flavour bans, consumer education about product harms and efforts to increase smoking cessation for users who want to stop using tobacco. Harm minimization strategy's major goal is to reduce the harm caused by use of tobacco by shifting consumers toward lower risk tobacco products.

Effective enforcement of tobacco related regulation will require similar targeted strategies to reduce supply of nicotine-contained products and focus on alternatives of tobacco products or e-cigarettes meanwhile incentivization reduces the demand of nicotine-contained products, a similar concept for spectrum of e-cigarette regulation and incentivization explained by Campus et al. (2021). Sustained demand and uncontrolled supply of nicotine-contained products remained as the driving force for both legal and illicit pathways which will reduce the effectiveness of tobacco enforcement activities as a part of tobacco control.

Macro-level Policies: Economic Measures and Product Marketing Regulation

Commercial determinant of health, particularly referring to the regulation of tobacco industry is an important approach in governance for LMICs (Patay et al., 2022b) and it aligns with raising taxes of tobacco strategy under WHO's MPOWER policy package.
Existing evidence (Jha et al., 2012) revealed increase in price of tobacco products effectively reduce consumption in five countries in Asia. This association of tobacco product prices / taxes are statistically significant and negative towards tobacco products consumption, enabling tax / price measure to be effective in controlling tobacco product consumption. Jawad et al. (2018) reported that 10% price increase would reduce demand by 8.3% for cigars, 6.4% for roll your owns, 5.7% for bidis and 2.1% for smokeless tobacco among adults. Similar findings were also reported in terms of e-cigarettes by recent systematic reviews (Yan et al., 2023; Chugh et al., 2023) in which reduction of affordability are effective policies in reduction of use.

In another systematic review conducted by Nazar et al., 2021 in the region of South East Asia, the effect of tobacco price and taxation on consumption were inconsistent as they may be influenced by per capita income growth of the country (He et al., 2018; Word Health Organization, 2019b). In the same report, the key finding from the review is majority of studies estimated that less affluent group were more price sensitive as compared to the affluent group, which supports the use of raising tax or price of tobacco products for reduction of smoking consumption relevant in LMIC nation.

For innovative tobacco products such as e-cigarettes and vape, there are limited evidence found for the effectiveness of taxation in reduction of adolescent e-cigarettes use in a recent systematic review by Yan et al. (2023). Other restrictions in terms of age restrictions, indoor vaping restrictions and tobacco product directives were not shown to be associated with reduction of e-cigarettes use.

Therefore, another important recommendations in terms of nicotine use control is to address the regulatory gap for synthetic nicotine products (as compared to products containing nicotine derived from tobacco) and consider amending the tobacco control laws to ensure that

they include synthetic nicotine products (WHO, 2023). Another element that was advised by WHO (2023) is to enforce standards for the purity of synthetic nicotine in products and regulators should consider implement product standards to ban the mixing of tobacco-derived nicotine with synthetic nicotine in marketed products. Systematic review by Yan et al. (2023) reported limiting access to flavours for minors is one of the effective policies in reduction of e-cigarettes use. This finding is aligned with WHO Study Group on Tobacco Product Regulation policy recommendation, where ban of ingredient that facilitates inhalation to reduce the attractiveness of any tobacco and e-cigarette products.

Exposing tobacco industry misconduct is an important first step of disrupting tobacco industry interference in misguiding policy making and public perception (Gilmore et al., 2015). Uniform labelling rules should be applied to any products containing nicotine and consideration should be made for restriction of marketing practices for promotion of synthetic nicotine as generally "tasteless and odourless", "pure" or "healthier" than tobacco- derived nicotine, unless new scientific evidence is available to support such claims is provided.

There is also a need to formulate tobacco control policies tailored according to age groups and the vulnerable age group is the youth, as there is a need for early prevention that is cost-effective and a lesser burden to the disease both clinically and economically (Ranabhat et al., 2019). This is of urgent importance as global prevalence of e-cigarettes is rising with the highest prevalence of users are among the age group of 18 - 24 years old (Martins et al., 2022; Albadrani et al., 2024).

Meso-level Policies: Community-level Initiative and Accessibility Intervention

Institutional structure plays substantial role in achieving policy coherence for tobacco control (Lencucha and Thow, 2019). Previous evidence from tobacco control initiatives had shown impact of intervention at institutional levels, including schools (Coppo et al., 2014; Thomas et al. , 2013) and general workplaces (Cahill and Lancaster, 2014; Tan and Glantz, 2012). Specialist settings also showed relative effect of reduction of active smoking as reported by Frazer et al. (2016), in which healthcare facilities (RR 0.75), higher education institution (0.72) and correctional facilities (RR 0.99) but evidence presented were of low quality and therefore more robust studies are necessary to increase the strength of estimate of effect observed.

Several studies (Hamzah et al, 2021; Majumdar et al., 2017; Brewer et al., 2016; Alaouie et al, 2015; Rahman et al., 2015) reported pictorial health warnings (PHW) are useful in provision of warning on the health risks associated with smoking. One randomized clinical trial evaluating PHW effectiveness in attempt to quit smoking in United States (Brewer et al., 2016) found that smokers who packs had PHW were more likely than those who packs had text-only warning to attempt to quit smoking in a 4-week trial (OR 1.29, 95% CI 1.09 - 1.54) and it did not differ across any demographic groups.

In the context of Malaysia, authoritative parenting style practiced among Malaysian parents may influence the attitude in understanding of PHW as sensitive matters such as negative habits (such as smoking) are not discussed openly (Hamzah et al., 2021). Therefore, it resulted in fear and reluctance to seek PHW understanding from parents. In the same population, the attempt to seek further understanding of new PHW was not observed. Such observation revealed the importance of inculcate habit among the public of making efforts to understand any health-related information by using narrative that understanding health information may have potential benefit for their own health and their loved ones, encourage

culture and best practice in seeking health information through reliable sources and encouraging parents or caregivers to be more open-minded to critical questions from their children.

Higher understanding of message delivered through PHW can be achieved if the 'form' of PHW (wordings, size, graphic, elements, placement and context of PHW's, usage of pictures and the potential adverse outcome) were suited according to the targeted population (Scollo et al, 2019). In Malaysia, despite PHW being fully coloured and printed in the principal language, some of the PHWs was still not fully understood. This emphasized the importance of formulating relatable and clear messages accustomed to the population to avoid confusion among the community.

Another concept worth exploring is whistleblowing practices policy among public. Whistleblowing can be a viable solution based on evidence in disclosing violations or illegal acts, unethical/immoral or other actions to be made in secret against violations. Timely information can be shared, and prompt reaction can be ensured by the authorities in charge. More precise law enforcement in an accountable and transparent manner can be achieved with the assistance of entire community (Asyary et al., 2021).

Compassion club model – exist around the world providing mediation, cannabis, opioids and other drugs through volunteer and nonprofit mechanism to provide supplies of drugs focused on helping the users who need access and providing safe supplier (Gartner et al., 2018). Sanctioned compassion clubs seek to provide low-barrier access to a safe supply of drugs in the context of peer support, and social supports such as mental health and addiction services. Compassion club model for nicotine and tobacco could provide access to a safe supply, education on the risks of the most harmful tobacco products and help in smoking cessation or switching to less harmful options. They can act as gatekeepers to prevent youth initiation. This mode of distribution will allow tobacco to be widely available without being sold as a normal commercial product. This can assist in gaining control of the illicit market and reducing public harm by carefully and rigidly regulating the expanding legal market. The not-for-profit model could make it less appealing for large retailers and corporations to participate in the tobacco industry.

Specific awareness drives on "Benefits of Quitting" through sustained funding for mass communication is also necessary to constantly remind the public on the benefits of quitting smoking. Engagement of nurses, counselors, social and ancillary medical workers, instead of only doctors is needed to increase the coverage of service accessibility, enabling both smokers and non-smokers to obtain the necessary information and services from legit sources (Aghi et al., 2022).

Increasing distance of tobacco vending retailers and eliminating designated smoking areas abolish surrogate advertisement are important policy related to the environment conditioning to promote smoking cessation by reducing access (Aghi et al., 2022). Such policy is another strategy that is worth investing to de-normalize smoking in the existing environment. Four different type of smoke-free implementation approach can be explored by phases to increase the priority from de-normalization of smoking to progressive expansion to include outdoor and child-related areas (Mlinaric et al., 2020).

Micro-level Policies: Individual-focused Interventions

Contingency, incentive and online smoking cessation approaches were found to be most effective in promoting short-term verified abstinence among rural, regional and remote smokers in high income countries (Trigg et al., 2023). Notley et al., (2025) reported incentive were effective for smoking cessation in mixed populations in the intervention group (incentives) as compared to no incentives with high certainty evidence from 39 randomized controlled trial and 43 other studies. Findings from the same meta-analysis in mixed populations suggests that incentives have significant impact on sustained smoking cessation, even after completion of programme, refuting previous reviews of incentive-based intervention of smoking cessation may be time limited.

Some examples of strategies focusing on incentivisation as proposed by Aghi et al., (2022) is by generating political and bureaucratic will for outcome and quality-oriented tobacco cessation delivery to all tobacco users with ease of access and preferably at minimal to no cost. The approach to motivation to quit tobacco through all possible channels is necessary and must be set within a specific timeline with adequate support for the successful quitters not to relapse. Those unable to quit within the stipulated timeline should be explicitly supported through families, educational institutions, and organizations to which they are affiliated. Incentivisation may be held back until successful quitting achieved.

Deposit-based incentives (White et al., 2020; Halpern et al., 2018) were reported to be effective for long term smoking cessation when compared between deposit-based and incentives intervention in Thailand and United States. This finding imply that despite the challenge to recruit people who smoke into deposit-based programme, those who willingly sign up appear to be strongly committed to the process and are able to achieve high quit rates equivalent to those offered voucher or cash-based incentive trials.

Mandatory licensing for tobacco users is another example that can be considered (Aghi et al., 2022). This allows improved tracking of tobacco users and their preference on the type of tobacco products, which are influential in design of future cessation delivery programme according to product preference. This approach will also ease enforcement team in detection and identification of tobacco sale transaction. Incentivisation may be considered for those who discard card permanently. All medical and health facilities should also introduce systems approach in handling of tobacco cessation clients (TCC). Screen, treat, follow up plus high visibility of the TCC set up in the premises and the displays that inform the tobacco users optimally on the benefits of quitting and how to reach out to TCC.

Strategies based on pharmacological approach for tobacco cessation delivery has been studied and it has shown to have significant relative effect on smoking cessation at 6 months, particularly varenicline (OR2.33, 95%CI: 2.02 - 2.68) and cytisine (OR 2.21, 95% CI: 1.66 - 2.97) as reported by Lindson et al. (2023). Hence, the accessibility of pharmacological therapy is compulsory to support smokers intent to quit. The effect estimate for pharmacological approach studies is however limited when compared between socioeconomic level as contextual factors affecting subpopulations may possibly moderate the efficacy of individual-level smoking cessation intervention (Theodoulou et al., 2025). Therefore, increase in research on tobacco cessation RCT with more focus on efficacy among different socioeconomic status are still necessary in future, especially among LMICs (Kumar et al., 2021).

Despite emerging e-cigarettes use among youth and adolescent population, there are limited evidence to support any prevention or cessation intervention effective for e-cigarettes at the time of writing based on current evidence (Butler et al., 2025; Barnes et al., 2023).

DISCUSSION

The review synthesizes critical challenges and strategies in tobacco control policy, providing a comprehensive exploration of both established and emerging issues. Significant socioeconomic disparities in nicotine dependence and demonstrates how targeted advertising, particularly towards youth and vulnerable populations, perpetuates tobacco use. In the Malaysian community, similar socioeconomic group (lower income household) were found to be the major contributor of current smoking as reported in both NHMS and GATS. The sociocultural norms of offering cigarette to one another is considered as a sign of friendship also serves an impediment to smoking cessation policy (Chean et al., 2019). Emergence of e-cigarettes and its marketing appeal to youth are seen in Malaysia with its evidence reflected in the rising prevalence of e-cigarette users among the 15 - 24 years old population in Malaysia reported in NHMS 2023.

Regulatory gaps, especially concerning synthetic nicotine and novel nicotine products, present substantial barriers to effective tobacco control, further complicated by inconsistent international trade regulations and aggressive industry lobbying. One the major challenges faced by Malaysia is the availability of illicit tobacco products where illegal cigarettes incidence are more than 50% as compared to the estimated total industry cigarette (Nielsen IQ, 2025). Availability of illicit tobacco products combined with the emergency of e-cigarettes which are not well regulated until 2024 are seen to limit effectiveness of policy targeting local tobacco and e-cigarette industry. However, the high incidence of illicit cigarettes in Malaysia, which shares similarities with evidence reported by Crosbie and Glantz (2014) and Mitchell and Sheargold (2014), warrants further investigation to determine whether this phenomenon is attributable to manipulation by the tobacco industry or stems from inadequate regulatory control and enforcement over production and imports.

Key insights emphasize the necessity of integrating robust, multifaceted policy measures tailored to diverse demographic and geographic contexts are discussed in the Strategies for Holistic Tobacco Control Policy Subsection. Macro-level strategies, such as comprehensive taxation and international regulatory frameworks, must align with meso-level community initiatives and micro-level interventions focused on individual behavior change. Importantly, policies must consider socioeconomic equity to prevent exacerbating health disparities. The importance of sustained public education and carefully regulated marketing practices. Enhanced public awareness initiatives, transparent communication regarding product harms, and tightly regulated advertising practices can collectively reduce tobacco initiation and promote cessation.

Malaysia has taken a proactive step to enhance its tobacco control policy by transitioning from the older Control of Tobacco Product Regulations (under the Food Act 1983) to the comprehensive Control of Smoking Products for Public Health Act 2024 (Act 852). Enacted on February 2, 2024, with a phased implementation beginning October 1, 2024, this new legislation plays a pivotal role in regulating all smoking products, including tobacco, smoking substances, substitute products, and related devices. The Act establishes a multifaceted regulatory framework covering the entire supply chain, from manufacturing to consumption. This approach aligns with established evidence favouring holistic and stringent

regulations that are sufficiently robust to address challenges from both conventional and emerging smoking products. However, as the Act's implementation is still in its early stages, its full impact is yet to be observed.

The WHO recommends that tobacco excise tax should account for at least 70% of the final retail price. However, Malaysia's current taxation policy—which includes 46% of excise duty, a 10% Sales and Service Tax (SST), and import duty—falls significantly short of this benchmark. As of 2025, the total tax burden on tobacco products is approximately 56% of the retail price (Campaign for Tobacco-Free Kids, 2025). A key factor is the stagnant excise duty, which has not been increased since 2014 (Southeast Asia Tobacco Control Alliance, n.d.). This policy inaction is reflected in Malaysia's low score of 2.5 (out of 5) on the 2022 Cigarette Tax Scorecard, which was attributed to the insufficient tax share and the failure to make cigarettes less affordable over time (Drope et al., 2024). Thus, urgent action on Malaysia's tobacco tax policy is essential to align with international public health standards and address the severe domestic consequences of inaction.

Nonetheless, this review underscores the urgent need for international collaboration to counteract the tobacco industry's legal challenges and exploitative market practices. Harmonizing legal frameworks across the region, guided by WHO FCTC recommendations, is a necessary step to prevent the industry from "forum-shopping" for more lenient jurisdictions, especially in the Southeast Asia Region. Looking ahead, more nuanced research on pharmacological interventions is essential to refine cessation strategies, particularly for the socioeconomically diverse populations within low- and middle-income countries, ensuring policies have a broader and more equitable impact.

This narrative review has several limitations. First, its reliance on currently available literature results in limited generalisability to low- and middle-income countries (LMICs), where quantitative studies on the effectiveness of pharmacological interventions are scarce. Second, tobacco control is a rapidly evolving field; consequently, this review represents a snapshot in time and may not capture the very latest developments in international trade policy or litigation strategies. Finally, due to the profound influence of unique social, cultural, economic, and literacy contexts on policy implementation in each nation, this review does not provide universal effect size estimations for the strategies discussed.

CONCLUSION

Tobacco control initiatives through WHO FCTC have come a long way since its inception in 2003 that focuses mainly on tobacco - related products. The huge global success shown by the programme introduced new challenges in terms of the social, cultural, policy making, new synthetic nicotine products, marketing and advertising, and international trade and legal issues. This review reaffirms that effective tobacco control requires a strategically layered approach, one that addresses macro-level taxation and international regulation, supports community-centered programs, and equips individuals with evidence-based cessation tools. The persistence of socioeconomic inequities, industry-driven marketing, and regulatory loopholes, particularly regarding synthetic and other novel nicotine products, demonstrates that single-track interventions are inadequate. Consequently, policies must incorporate equity safeguards at every level of action to prevent the exacerbation of existing health disparities.

By enacting the comprehensive Control of Smoking Products for Public Health Act, Malaysia has taken a bold step forward, setting a new benchmark in the region for regulating

both traditional and emerging smoking products. Looking ahead, three priorities are essential to build on this momentum. First, governments should enhance and harmonize fiscal and legal measures such as excise taxes and cross-border advertising restrictions through coordinated international agreements that prevent industry forum-shopping. Second, sustained investment in public education and transparent risk communication is critical to reducing initiation rates and normalizing cessation, particularly among youth and marginalized groups. Finally, targeted research especially in low- and middle-income settings should refine behavioral and pharmacological cessation supports while monitoring the evolving landscape of synthetic nicotine. By integrating these elements, policymakers can establish resilient, adaptable frameworks that not only reduce tobacco use but also advance global health equity.

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REVIEW ARTICLE Open Access

A REVIEW OF HEALTH INFORMATION SYSTEMS IN MALAYSIAN PUBLIC HOSPITALS: CURRENT PRACTICE, BENEFITS, AND BARRIERS

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Abstract

Hospital Information System (HIS) is one of the important pillars in current healthcare system practice worldwide. The study initiated after a review revealed a scarcity of applications and studies on HIS in Malaysia's public hospital setting. This scoping review aims to explore the current practice, benefits, and barriers associated with Health Information Systems (HIS) in Malaysian public hospitals. Utilizing the PRISMA guidelines, relevant literature was sourced from the SCOPUS database, focusing on publications from 2012 to 2022. A total of nine studies were selected for analysis. The review reveals that, despite being introduced early, the implementation and utilization of HIS in Malaysian public hospitals remain limited and slow. HIS offers substantial benefits, including improved clinical documentation, administrative efficiency, and enhanced quality and coordination of care. However, several barriers hinder its successful implementation, categorized into five main areas: financial, organizational, behavioral, technological, and support-related. Addressing these challenges is essential for realizing the full potential of HIS in improving patient care and hospital efficiency. This review serves as a baseline for identifying critical issues and guiding future improvements in Malaysia's public healthcare sector.

Keywords: Health Information System, Public Hospitals, Malaysia, Barriers, Benefits

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INTRODUCTION

A hospital Information System (HIS) is defined as integrated electronic systems that collect, store, retrieve and display overall patients' data and information such as the history of patients' information, results of laboratory tests, diagnoses, billing and other related hospital procedures which are used in several departments within hospitals (Ismail & Abdullah, 2012). In the year 2001 Ministry of Health claimed Hospital Selayang as the first in the world that provide a comprehensive ICT paperless system with THIS (Ministry of Health Malaysia, 2009). Although the system used in Selayang Hospital was adopted and adapted from the system provider in the United States, implementation of the system as comprehensive as at the Selayang Hospital has never been done before in the United States. This is due to the complex nature of the health services system in the US where the facilities are in a hospital (Hassan, 2012).

HIS has several components, for example, Clinical Information System (CIS), Financial Information System (FIS), Laboratory Information System (LIS), Nursing Information System (NIS), Pharmacy Information System (PIS), Picture Archiving Communication System (PACS) and Radiology Information System (RIS) (Biomedical Informatics Ltd., 2006). According to Biomedical Informatic Ltd. (2006), the HIS could have two or more HIS components whereby these components are linked to one another. Each component has different characteristics, based on its usage, department and users (Ismail et al., 2015).

In Malaysia, the implementation of Hospital Information System (HIS) in Malaysian Public Hospitals are divided into three categories, known as Total Hospital Information System (THIS), Intermediate Hospital Information System (IHIS) and Basic Hospital Information System (BHIS). This implementation is based on the hospital size and number of beds (Nurul Izzatty Ismail, 2015). The forms of integrated information systems that are installed are different among the HIS's hospitals. The THIS, IHIS and BHIS have different components of information systems installed in their hospitals (Hassan, 2012). The different classification of HIS is determined by different components of the Information System (IS) being implemented in the hospitals. THIS's hospitals are also known as paperless hospitals because they have completed HIS components. While IHIS and BHIS use the hybrid system, which maintains both electronic and manual systems. This is because both IHIS and BHIS's hospitals adopted only several forms of IS (Ismail et al., 2015).

The integration is so deep and extensive that it is not only between software applications but also between applications and modalities or equipment especially in the radiology, laboratory, intensive care and operating theatres where the system is interfaced directly into the equipment and whatever data or image produced by such equipment will go directly on-line into the system. Patient's medical records, guidelines and clinical protocols are instantly available and can be assessed in one integrated workstation at any place and at any time in the hospital, provided that the user has proper authority to access the information (Hospital Selayang, 2022).

The importance of HIS concerning administrative and financial aspects, the healthcare workers are primarily interested in the impact on improving the quality of care. HIS will improve the quality and efficiency of healthcare institutions, from small practices to large

centres. One study suggested that electronic healthcare records have the potential to decrease medical errors by providing improved access to necessary information, better communication, and integration of care between different providers and visits, and more efficient documentation and monitoring. However, overall improvements in patient outcomes associated with healthcare informatics are still not yet well documented. In particular, the effect of the implementation of HIS on inpatient adverse events, inpatient mortality, and the readmission rate for specific conditions has yet to be explored (Lovis & Debande, 2015).

HIS provide a common source of information about a patient's health history, and doctors' schedule timing. The system has to keep data in a secure place and control who can reach the data in certain circumstances. HIS also enables healthcare organizations to collect, store, manage, analyze, and optimize patient treatment histories and other key data. These systems also enable healthcare providers to easily get information about macro environments such as community health trends. HIS can benefit a healthcare organization in several ways. To realize these benefits, however, the organization must put the proper technological infrastructure in place. This includes both fundamental software and hardware requirements. Effective implementation of HIS requires a secure wireless network, which connects all associated devices and enables information to be accessed and shared from anywhere within the organization. It's also critical to have convenient workstations from which providers, nurses, technicians, and administrators can access records. These may include desktops, laptops, and/or tablets (Abdollah Salleh, 2021) Ohio University, 2020).

HIS is one of the important pillars in current healthcare system practice worldwide. The study initiated after a review revealed a scarcity of applications and studies on HIS in Malaysia's public hospital setting. The issues highlighted in this analysis serve as a baseline for identifying core issues and barriers to future improvement in Malaysian public hospitals. The review aims to identify the current practice of HIS in public hospitals in Malaysia based on current literature, to identify the overall benefits of the HIS system in terms of organization level (staff workload) and the patient (satisfaction and service delivery) and to identify barriers to the implementation of HIS in hospitals in Malaysia based on the review literature.

METHODS

Study Protocol

PRISMA guidelines for scoping review were used to conduct this review. The procedure for data collection and analysis and eligibility requirements were determined in advance.

Search Strategies

SCOPUS databases were used to identify eligible studies. The search was limited to articles written in English. All related articles will be synthesized to gather relevant information: the current practice of Health Information Systems in both public and private hospitals in Malaysia, their benefits and barriers. An extensive search using the following search terms was conducted on SCOPUS databases between January 2012 and December 2022 to locate relevant articles: Health information system" OR "Hospital information system" OR "information system" AND "public hospital" OR "government hospital" OR "private hospital" AND practices OR benefit OR advantage OR interest OR challenge OR barrier AND Malaysia. Free full-text articles were downloaded, and duplicates were removed. All remaining references were then imported into Mendeley software to continue for screening and data extraction processes.

Selection of Studies

The electronic searches of the mentioned database yielded a total of 18 articles. All retrieved studies were subjected to a preliminary screening based on titles, abstracts, and publication years. Fourteen articles were sought for retrieval, but only one could be downloaded. Another three articles were eliminated because they did not meet the inclusion and exclusion criteria (n=3) or were qualitative studies (n=1). As a result, ten articles were included in this review because they met the criteria. Figure 1 depicts the PRISMA flow diagram of the articles selected for analysis.

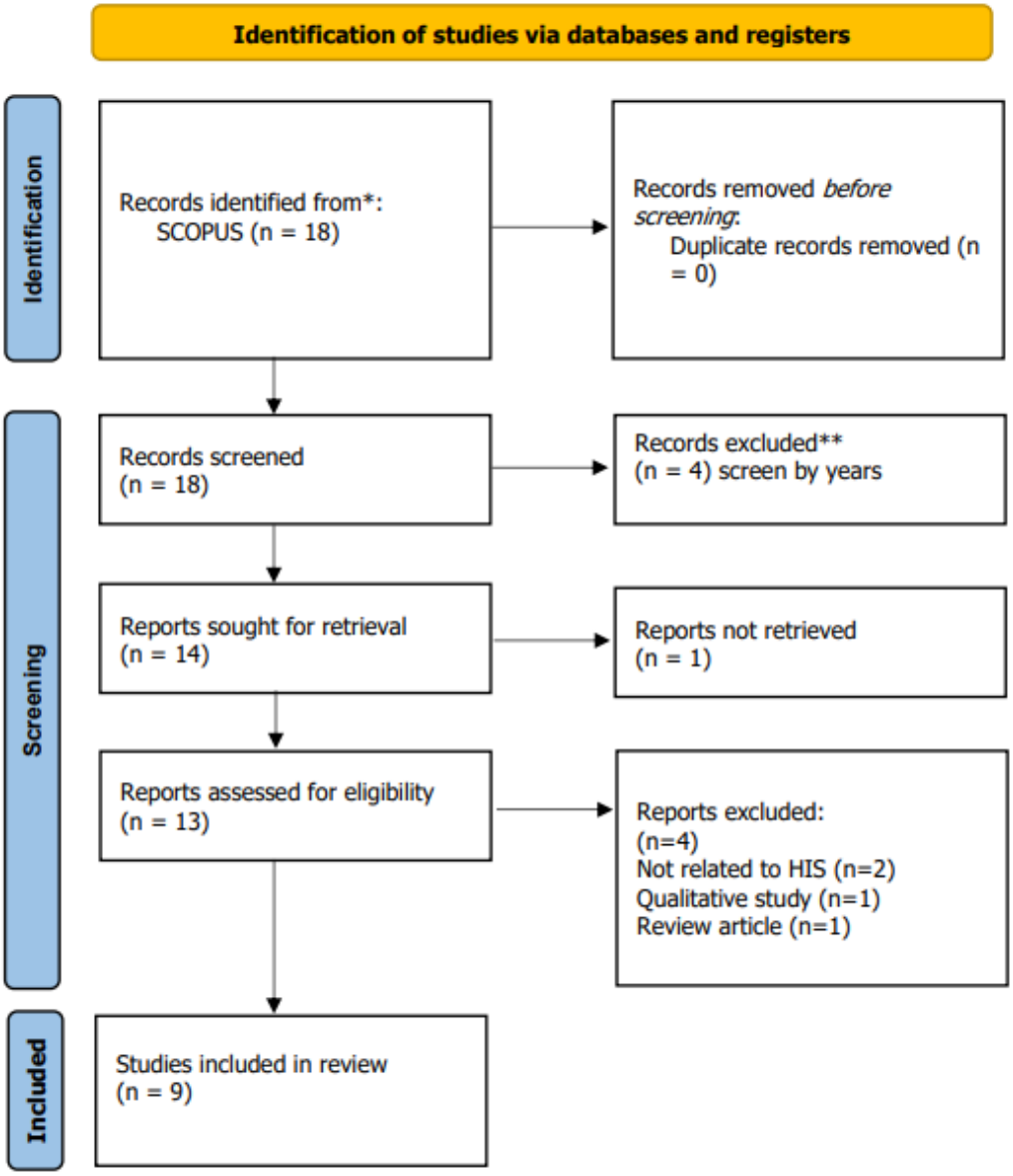

Figure 1: PRISMA flow diagram

Data Extraction and Analysis

The relevant findings were retrieved from the publication included in the study and assessed according to the following research questions:

1. What is the current practice of Health Information Systems in both public and private hospitals in Malaysia based on available works of literature?
2. What are the benefits of implementing a Health Information System in both public and private hospitals in Malaysia?
3. What are the major barriers or challenges in implementing HIS in both public and private hospitals in Malaysia?

The findings were tallied and organized under the following headings: context, practice or applications, benefits and lastly, barriers in the implementation of the Health Information System. Table 1 in the result section contains the research findings from the works of literature retrieved.

RESULTS

In total, we identified nine literature sources for inclusion in this scoping review. Overall, our findings indicate a languid pace of research on this topic in Malaysia. The majority of the publications published are from public hospitals. There are few articles describing HIS at private hospitals, and the only one discovered in the review is qualitative research. Recent studies focus on the benefits of adopting and integrating a Health Information System (HIS) in the practice environment and barriers to implementing and effectively using various technological systems. Only one source focus on factors determining the effective use of Electronic Health Records (EHR). A summary of articles related to the current use of HIS is presented in Table 1.

Table 1: Summary of Benefits and Barriers of Health Information System

Author	Context	Practice/ Application	Benefits	Barriers
(Salleh et al., 2021)	Government hospital	Electronic Health Records	• The paper described on factors determining the effective use of EHR among users in government hospitals. The EHR performance is influenced most by its system quality.	**NA**
(Osman et al., 2021)	Government hospital	Bluetooth Low Energy (BLE) based Real-time Location System implementation in the Emergency and Trauma department with HIS integration	• The mean ATC (waiting) time has significantly dropped from 46.67 minutes to 37 minutes when RTLS us introduced in the ETD workflow	**NA**

Author	Context	Practice/ Application	Benefits	Barriers
(Abd Razak et al., 2020)	Government Hospital	Basic Hospital Information System (BHIS), Intermediate Hospital Information System (IHIS), Total Hospital Information System	**NA**	• The four major challenges in the HIS implementation are support, human, technology and infrastructure, and software limitation. • HIS integration is still one of the key issues for HIS's success. • To ensure the successful integration of the system, organizations need the necessary financial and technological resources.
Lokhman M.T., Abdul Rasam A.R., Mohd Noor A.M. (2012)	Government hospital	Developing a GIS-based information analysis and system that allows patients to obtain information about necessary treatment in a hospital based on specialist services given	• Mapping helps patients to find the nearest hospital more easier • It could analyze the shortest distance to the hospital from the patients' location	**NA**

Author	Context	Practice/ Application	Benefits	Barriers
(Che Pa & Jasin, 2018)	Government hospital	proposes a guideline in ensuring a success implementation of IS in Malaysian government hospitals	• manage hospital's medical information related to patient care • manage administrative and financial information	**Human factors** • Resistance to change • Priority • Preference • Impression **Software limitations** • System's complexity • Wrong workflow • System Integration • Redundancy • Efficiency **Technology** • Compatibility • Availability • Network stability support • Technical • Peer influence • Enforcement • Monitoring

Author	Context	Practice/ Application	Benefits	Barriers
(Ahmadi et al., 2017)	Government hospital	proposed the initial theoretical framework based on the combined Technology Organization Environment (TOE), institutional theory, and Human Organization Technology (HOT) fit model.	• access patient's treatment records efficiently • better service to patients. • Improves work efficiency • successful integration of systems will allow data sharing across department/hospitals	• relative advantage • compatibility • security concern • hospital size • mimetic pressure-competitors • vendor support • perceived technical competence of IS staff • employees' IS knowledge
(Ahmadi et al., 2015)	Government hospital	Integrates the established Technology-Organization-Environment (TOE) framework with the recently developed Human-Organization-Technology (HOT) fit model to uncover factors influencing the hospital's choice to implement a HIS	• better service • top management support • work efficiency improves	• relative advantage • compatibility • complexity • centralization & formalization • IS infrastructure • Top management support • Business competition • Vendor support • Government policy

Author	Context	Practice/ Application	Benefits	Barriers
(Humaidi et al., 2014)	Government hospital	Based on the expanded Health Belief Model, investigate the information security awareness elements influencing user compliance behavior toward Health Information System (HIS) security policies.	**NA**	• susceptible to threat. • Lack of knowledge on information security threat • employees not aware of information security policies implemented by organization
Abdullah Z.S. (2012)	Government hospital	to assist in minimizing problems and/or potential concerns encountered by hospital information system (IS) implementers	**NA**	• Lack of support from top management & project management can affect IS implementation success • Lack of openness among employees could restrict system enhancement • Qualitative and single-site studies dominate many prior researches on implementation studies.

Table 2: Type of HIS implemented in Public Hospitals in Malaysia and its component.

Type of HIS	Name of Hospitals	Component of HIS used	Number of beds
THIS (large size)	Hospital Sultan Haji Ahmad Shah, Hospital Pandan Hospital Putrajaya, Hospital Selayang, Hospital Sedang, , Hospital Sg. Buloh, Hospital Sungai Petani, Hospital Ampang, Hospital Sultanah Zahirah, Hospital Alor Setar, and Hospital Bintulu	PMS, CAIS, LIS, PIS, RIS, PACS, AIS, FIS, SIS, PIS	> 400 beds
IHIS (medium size)	Hospital Lahad Datu and Hospital Keningau	PMS, CIAIS, LIS, PIS	> 200 beds
BHIS (small size)	Hospital Tunku Ja'afar , Hospital Kuala Penyu, Hospital Kuala Batas, Hospital Pitas, Hospital Kunak, and Hospital Setiu, Hospital Port Dickson	PMS and CAIS	< 200 beds

PMS: Patient Management System, CAIS: Clinical Access Information System, LIS: Laboratory Information System, PIS: Pharmacy Information System, RIS: Radiology Information System, PACS: Picture Archiving and Communication System, AIS: Administration Information System, FIS: Financial Information System, SIS: System Inventory System, PIS: Personal Information System

Source: Abd Razak et al., 2020

Table 3: Categories of Barrier of Health Information System

References	Categories	Factors
(Che Pa & Jasin, 2018) **(Ahmadi et al., 2015)**	Financial barrier	• Limited financial resources • High operation and maintenance cost
(Ahmadi et al., 2017) **(Ahmadi et al., 2015)** **(Abdullah, 2012)**	Organization	• Hospital size • Mimetic pressure from competitor • Centralization & formalization • Business competition • Government policy • Minimal evidence base • Top management support
(Che Pa & Jasin, 2018) **(Ahmadi et al., 2015)** **(Humaidi et al., 2014)** **(Abd Razak et al., 2020)**	Behavioural	• Low acceptance level – hesitancy to change • Lack of user skill • Priority • Preference • Impression • Knowledge • Lack of awareness of security policies
(Che Pa & Jasin, 2018)	Technology	• Interoperability of implemented system • Failure in data adjustment • Wrong work flow

(Ahmadi et al., 2017) **(Humaidi et al., 2014)** **(Abd Razak et al., 2020)**		• Complex system • Redundancy • Efficiency • System integration • Data security
(Che Pa & Jasin, 2018) **(Ahmadi et al., 2017)** **(Ahmadi et al., 2015)** **(Abdullah, 2012)** **(Abd Razak et al., 2020)**	Support	• Lack of facilities (computer, laptop) for user • Enforcement • Monitoring • Peer influence • Vendor support

DISCUSSION

The subheadings below are used to describe in great detail the implementation of Health Information Systems in Malaysian public and private hospitals. However, due to the scarcity of published reports and articles from private hospitals, the focus of the discussion will be on Health Information Systems in public hospitals.

The Current Practice of Health Information Systems in Malaysia

The Hospital Information System (HIS) is a coordinated electronic framework that collects, stores, restores and displays patient data and information. The data include patient history, clinical test results, treatments, billing, and other related information so that it can be used and analyzed for the benefit of patients and the government (Che Pa & Jasin, 2018; Hertin & Al-Sanjary, 2018; Osman et al., 2021).

According to the articles gathered for this review, Health Information Systems (HIS) have been implemented in Malaysian healthcare organizations for quite some time. The Malaysian HIS initiative began in 1997 with the Telemedicine flagship, which aims to provide better healthcare services to society (Abd Razak et al., 2020). The need for HIS implementation in Malaysia was critical at the time because public hospitals served a larger number of patients, resulting in longer wait times for services. HIS was introduced as part of the Lifetime Health Plan (LHP) project, which focused on digitalizing the healthcare sector (Ahmadi et al., 2015).

Nonetheless, the implementation of HIS has not yet been fully implemented in all public hospitals for various reasons, which will be covered in the following section. There are 139 hospitals with 18 referral and tertiary hospitals in Malaysia at the moment. The HIS in Malaysia currently being implemented in Malaysia is according to hospital size, which is categorized into the number of beds available, specialties and budgets. Basic Hospital Information System (BHIS) is for small size hospitals, Intermediate Hospital Information System (IHIS) is for medium size hospitals, and lastly, Total Hospital Information System (THIS) is designed for larger hospitals size (Abd Razak et al., 2020). For the record, Hospital Selayang was the first paperless hospital that ran THIS in Malaysia in 1997, followed by Hospital Putrajaya in 2000 (Salleh et al., 2021). Hospital Selayang has implemented Electronic Medical Records (EMR), which aims to improve the provision of health services by focusing on patients' management and information system at the organizational level. The following Table 2 shows examples of public hospitals in Malaysia implementing HIS and its component.

Various components of HIS were designed and developed to improve the overall service provided in hospitals in Malaysia ever since the HIS was first introduced. Some components of HIS include Patient Management System (PMS), Clinical Access Information System (CAIS), Laboratory Information System (LIS), Pharmacy Information System (PIS), Radiology Information System (RIS), Picture Archiving and Communication System (PACS), Administration Information System (AIS), Financial Information System (FIS), System Inventory System (SIS), Personal Information System (PIS) and many more.

In addition to the components of the HIS implemented in Malaysian hospitals, this review identified additional applications that enhance the efficacy of HIS. For instance, a GIS-based information system enables patients to access pertinent data regarding hospital services and treatments (Lokhman et al., 2012). Preliminary studies on the use of Bluetooth Low Energy (BLE) based on a Real-time Location System (RTLS) with the integration of HIS in the emergency department have shown a significant reduction in patient waiting time (Osman et al., 2021).

According to the study, only 15.2% of Malaysian hospitals are system-based, and less than 10% of 139 public hospitals are classified as HIS (Abd Razak et al., 2020; Ahmadi et al., 2017; Hertin & Al-Sanjary, 2018). According to a separate study, only 18 public hospitals in Malaysia currently use HIS (Wai et al., 2022). Consequently, this demonstrates the slow implementation and acceptance of HIS in Malaysian hospitals. In Malaysian hospitals, the reformation of HIS is influenced by a number of factors, including human, technological, infrastructure, software, and support issues (Wai et al., 2022). These concerns will be discussed in detail in the subsequent section.

The Benefits of Health Information Systems Implementation in Malaysia

The benefits of HIS can be viewed in three aspects: organization, staff and patients. In an organization, the main advantages of HIS are keeping up the privacy of patients' information, enhancing healthcare value and boosting productivity, including managing administrative and financial information and the hospital's medical information related to patient care. The study's findings that HIS significantly improves the value of healthcare and increases efficiency are consistent with previous research (Buntin et al., 2011; Chaudhry et al., 2006; E. Youssef, 2014; Fernández-Alemán et al., 2013; Nguyen et al., 2014). Therefore, information systems' efficient and effective use can help organizations improve their people management efforts. Concurrently, investing in organization-related information systems would enhance the quality of decision-making and increase organizational competitiveness.

Meanwhile, in staff, the results reveal that HIS reduces duplicating work, decreases the end user time in archiving patients and administrative information, and improves staff communication. HIS frequently come with features that let medical professionals secure access to patient data and manage electronic health records (EHRs) and picture archiving and communication systems (PACSs) locally and remotely via mobile devices (Mosa et al., 2012). One study found that patient care via mobile devices improved communication between doctors and nurses in inpatient wards (Ozdalga et al., 2012). More than 80% of respondents in the medical school healthcare providers and students poll said they used mobile devices to interact with colleagues regarding patient care via e-mail, phone, and text messages (Wallace et al., 2012). Texting was described as a more efficient mode of communication than phone calls or in-person meetings. Doctors can also access patients' treatment records efficiently, giving better service to patients and improving work efficiency. Similarly seen in international studies which support the generic benefits of HIS, including quick access to information and information control (Altarawneh & Al-Shqairat, 2010; Delorme & Arcand, 2010; Lina, 2019). Successful

integration of systems also will allow data sharing across departments or hospitals, which is supported by (Ahmadi et al., 2017).

The main benefits of HIS to patients are reducing waiting time, treating patients more proficiently, refining their presence and making procedures shorter. HIS could also enhance patient safety and quality of care in other countries (Carayon, 2010; Chaudhry et al., 2006; Karsh, 2004; Kaye et al., 2015). Meanwhile, a study in Johor utilized the Geographical Information System (GIS) data to improve HIS usage. It helps patients by identifying the fastest route to the hospital from their location and assisting patients in obtaining information about essential treatment in a hospital based on specialist services provided (Lokhman et al., 2012).

Above all, HIS performance is influenced most by its system quality. As highlighted in one study by (Salleh et al., 2021) on factors determining the effective use of EHR among users in government hospitals, knowledge quality improved user performance. The systems used to access patient information, results, and reports can also generate and disseminate new medical knowledge for effective problem resolution and decision-making by varied care providers. In addition, system compatibility was also the most substantial system quality component. The systems' structure and content that suit the providers' working styles will reduce workload by minimizing data input and documentation and eventually increase task productivity. A cross-sectional survey conducted in southern Taiwan hospitals indicated that ease of use and HIS efficiency positively influenced job satisfaction and care professionals' work performance (Chang et al., 2012). Similarly, an online survey of 219 California residents revealed that system quality, information quality, and service quality metrics positively influenced physicians' work (Tsai et al., 2020).

The Barriers in the Implementation of Health Information Systems in Malaysia

Despite the great concern and apparent interest in adopting and implementing health information systems, significant hindrances were identified from the review of the included papers. In Malaysia, seven articles describe the barrier to implementing health information systems successfully in local settings. The main obstacle can be categorized into the financial, organizational, behavioral, technology, and support, as described in Table 3. Generally, in the financial barrier, the main factor involved is the high cost of implementation of HIS throughout the country as only limited number of hospitals are implementing HIS. In addition, the failures approach as the system needed a high operation and maintenance cost as some software needs regular updates and servicing (Che Pa & Jasin, 2018). A study was done in Saudi Arabian hospitals that discussed a similar issue, claiming that other than lack of funding and expensive implementation and maintenance costs, minimal focus was given to such cost-benefit studies to be done in understanding the benefits of the HIS systems (Khalifa, 2013).

The organization plays a crucial role in implementing and transforming the health information system in the health system. The organization's barriers are focused on how the organization plays a role in supporting the usage or continuation of the system in the applied environment. The top management in the organization may develop an idea of unimportance to use the HIS because of the small hospital size or increased pressure to apply the system despite

lacking adaptability due to competitors causing inadequacy and incapability of the system in both situations (Ahmadi et al., 2015). Also, limited policies to support the implementation and integration of HIS with centralization of the decision-making hinder the conducive environmental practice of related systems (Abdullah, 2012) (Ahmadi et al., 2017). Similar findings were found in another study from the hospital setting in Iran and scoping review from European countries where a lack of organizational commitment impacts the success of HIS implementation (Keshvari et al., 2018) (Stamatian et al., 2013).

On the other hand, the human factor plays an essential role in the success of HIS implementation in a hospital system. A computerized information system requires skilled personnel for its effective operation, while a deficiency of skilled workforce can become a significant issue (Che Pa & Jasin, 2018). Inadequate training and short courses to enhance the knowledge of the program and basic computer science creates a domino effect from the ignorance of the healthcare worker, leading to hesitancy to change and different priorities and preferences in using the system. Despite recognizing the value of learning information systems, a lack of knowledge of the system initiates poor awareness of data security and application, causing lack of productivity in healthcare services. With this, the worker may have a negative perception in accepting the system and demotivate themselves and their ability to use the system (Ahmadi et al., 2017; Humaidi et al., 2014). In the meantime, from the physician's perspective, they found that inadequate awareness of the healthcare provider about the benefits of HIS creates a significant gap in success (Malekzadeh et al., 2018).

Failure of the vendor or commercial provider to supply the hospital with a properly usable system is another technological barrier (Abd Razak et al., 2020). The lack of interoperability of implemented system and failure in data adjustment significantly impact the negligence of HIS implementation. Instead of supporting the daily working system, functionality with no specified or inapplicable workflow to the respective teams with wrong workflow and complex system for the user holds the plan's efficiency (Humaidi et al., 2014). Other than that, the deficiency of the integrated system, for example, in sharing patient data between treating departments, causes redundancy and ineffectiveness, which may affect the data sharing for treatment and service to a patient. Understanding ownership of the system is also crucial as some departments who claim the system is theirs may not be willing and confident to share the data due to issues of confidentiality and security of the data (Ahmadi et al., 2017; Che Pa & Jasin, 2018). Nevertheless, inadequate planning for implementing and using HIS creates a similar issue (Malekzadeh et al., 2018).

Despite the implementation of HIS, poor enforcement and monitoring contributed to the failure of HIS performance. Comprehensive enforcement from multiple levels involving top management, middle manager, and immediate supervisors are needed to ensure the sustainability of the implemented system. Regular monitoring is also a principle task as it helps to identify any failure from the beginning, and prevention activities can be applied to ensure smoothness of the progress towards application (Che Pa & Jasin, 2018). The vendor with technical expertise is definite in guaranteeing the progress of implementation. The unavailability of a fast and knowledgeable team to help and support any critical issues that arise

and to solve in a short duration of time impacts the continuation of the process (Ahmadi et al., 2017). Moreover, the lack of facilities for the user and peer influence, with fewer coworkers using the system, caused an absence of motivation to involve and support the implementation (Che Pa & Jasin, 2018). For example, the partial rollout of THIS in Hospital Sultanah Aminah Johor faced delays due to insufficient IT staff training and outdated infrastructure (Hassan, 2012). Conversely, Hospital Selayang successfully implemented THIS due to strong top-down support and adequate investment in system integration (Salleh et al., 2021). While in some countries, another transparent barrier related to infrastructure support is poor internet availability, driving poor real-time access in the system, causing HIS to be impossible to be carried out (Anwar & Shamim, 2011).

Recommendation

Throughout time, strengthening health information systems has become a need and necessary implementation to fulfil universal health care. Improving system quality is one of the critical features in determining the success of HIS implementation. For instance, knowledge quality had the greatest positive effect on effectiveness and the most significant positive impact on performance. Housemen can benefit from past patient care for similar problems supplied by doctors with more experience. Through collaboration with experienced doctors, specialists may also be able to improve their medical practices. Different specialists with different specialities will record each clinical procedure in EHRs, which will be shared and improved by other responsible doctors. Besides that, system compatibility is another critical aspect that needs to be focused on during system adoption.

The system should suit care providers' clinical tasks to reduce their workloads from minimal data entry and documentation work, increasing task productivity. Another essential aspect of HIS reformation in Malaysian public hospitals is strong and committed leadership and governance. We have witnessed shifting leadership inside Malaysia's Ministry of Health, and the priority has shifted each time. If the government is dedicated to and prioritizes the adoption of HIS in public hospitals, more funding will undoubtedly be allocated to improve HIS in Malaysia, including workforce and infrastructure. Top management commitment and technology support are crucial in enforcing and integrating HIS in daily practice in the healthcare system. More focus and support should be given to enhancing the highlighted barrier from the review as a permanent solution to the HIS implementation issue in Malaysia.

Compared to countries like Singapore and Thailand, where national HIS strategies have seen higher adoption rates through centralized policy and infrastructure investment, Malaysia's adoption has been slower and more fragmented. Singapore's National Electronic Health Record (NEHR) and Thailand's Health Data Center demonstrate stronger interoperability and centralized governance models, which Malaysia could emulate. This review underscores the need to align HIS implementation with Malaysia's National Digital Health Blueprint 2021–2025, which emphasizes integrated, patient-centric digital health ecosystems. Future initiatives should also align with the Twelfth Malaysia Plan, particularly strategies under Pillar 2: Strengthening Healthcare Systems.

As for the limitation of this study, we conclude that less interest was given in publishing for this topic, causing a minimal number of papers to be included. This review was limited by the small number of eligible studies (n=9) found through SCOPUS. Attempts to expand the database search were constrained by limited open-access availability. Thus, findings should be interpreted with caution due to potential selection bias.

CONCLUSION

Based on this review, despite the earlier introduction of HIS in Malaysian hospitals, the use of HIS in public hospitals remains low and is progressing slowly. However, this review supports the HIS potential to improve patient care and clinical documentation, such as improved documentation quality, higher administration efficiency, and improved quality, safety, and care coordination. On the contrary, five main barriers – financial, organization, behavioural, technology & support; caused the failure to implement HIS successfully in Malaysia.

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REVIEW ARTICLE Open Access

NAVIGATING THE DIGITAL HEALTH RECORD: BARRIERS TO ELECTRONIC MEDICAL RECORDS IMPLEMENTATION IN SOUTHEAST ASIA: A NARRATIVE REVIEW

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Abstract

Traditional paper-based medical records face multiple limitations, including poor standardization and inefficiency in data retrieval. Electronic Medical Records (EMRs) offer solutions to these limitations and are key to healthcare digitalization. However, EMRs implementation remains inconsistent across Southeast Asia due to varied systemic and contextual barriers. A narrative review was conducted using three databases (PubMed, Scopus, and ScienceDirect) to identify peer-reviewed articles published between 2008 and 2023. Search terms included "Electronic Medical Records," "EMR," and "Southeast Asia." Inclusion criteria focused on studies describing the implementation challenges of EMRs in Malaysia, Indonesia, Vietnam, and Thailand. A total of 22 relevant articles were included. No formal quality appraisal was conducted due to the narrative nature of the review. Several barriers to implementation EMRs were identified such as high initial investment costs, limited IT infrastructure, lack of skilled personnel, resistance to technology adoption, data security concerns, and fragmented governance. While some countries, such as Malaysia and Vietnam, have national frameworks in place, challenges persist in rural access, interoperability, and policy enforcement. Despite growing interest and partial progress in EMRs adoption, Southeast Asian countries face systemic and logistical challenges that hinder full implementation. Coordinated regional strategies, greater investment in capacity building, and strong governance are essential for sustainable digital health transformation in the region.

Keywords: Electronic Medical Records, Information Technology, Barrier

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INTRODUCTION

The global transition toward digital health systems has been driven by the need to enhance the quality, accessibility, and efficiency of healthcare services. The use of Electronic Medical Records (EMRs) is a key part of this change, which are recognized by the World Health Organization (WHO) as a foundational tool for achieving universal health coverage, strengthening health systems, and supporting evidence-based decision-making (World Health Organization, 2016). In high-income countries, EMRs have been demonstrated to make clinical workflows more efficient, improve patient safety, cut down on medical mistakes, and help health data operate together across different levels of care (Janssen et al., 2021).

In contrast, many low- and middle-income countries (LMICs), including those in Southeast Asia, still rely heavily on paper-based systems. These systems are often fragmented, lack standardization, are prone to data loss, and hinder timely access to patient information (Honavar, 2020). EMRs are defined as computerized platforms that collect, store, and display patient data. It offer a solution to these challenges and are increasingly viewed as essential components of healthcare modernization (Zhang & Zhang, 2016).

EMRs can improve healthcare delivery by enhancing diagnostic accuracy, reducing redundant testing, improving continuity of care, and ensuring secure access to patient records (Janssen et al., 2021). Despite these benefits, the implementation of EMRs across Southeast Asia remains inconsistent. Countries such as Malaysia and Thailand have taken steps toward national health information systems (Mohan & Yaacob, 2004; Yingyong et al., 2022), but common obstacles persist. These include high implementation costs, insufficient infrastructure, limited digital literacy among healthcare workers, poor interoperability, and growing concerns about data security and privacy (Ismail & Abdullah, 2011; Kusumasari et al., 2018; Mohd Nor et al., 2019).

Given the complexity of health systems across Southeast Asia, addressing country-specific and cross-cutting barriers to EMR implementation is vital for informing policy development and guiding future investments. This narrative review aims to explore the challenges faced by Malaysia, Indonesia, Vietnam, and Thailand as LMICs in adopting EMRs, and to identify lessons that can guide regional strategies for strengthening digital health capacity.

METHODS

This review adopted a narrative approach to explore the challenges associated with the implementation of Electronic Medical Records (EMRs) in Southeast Asian countries that focused specifically on four countries in Southeast Asia: Malaysia, Indonesia, Vietnam, and Thailand. These countries were chosen due to the availability of published studies and their varying levels of progress in digital health infrastructure for low- and middle-income countries (LMICs). A narrative review was selected due to its flexibility in synthesizing evidence from diverse sources, allowing for a broader exploration of contextual and thematic barriers to EMR adoption.

To identify relevant literature, a comprehensive search was conducted using three online databases: PubMed, ScienceDirect, and Scopus. The search was limited to articles published between 2008 and 2023 and written in English. The following keywords and Boolean combinations were used: “Electronic Medical Records”, “EMR”, “Southeast Asia”, “EMR implementation challenges”, and “digital health in Southeast Asia”. Reference lists of relevant papers were also manually screened to capture additional studies. Studies were included if they discussed on:

i. EMR implementation status,
ii. Barriers or challenges to adoption, or
iii. Contextual insights into legal, technical, human resource, or user-related issues.

Articles were excluded if they focused solely on electronic health records (EHRs) in non-clinical settings, discussed unrelated digital health topics, or did not provide country-specific findings.

In total, 22 articles were selected after screening titles, abstracts, and full texts as in Figure 1. These included peer-reviewed original research articles, policy papers, and case studies. Although a formal critical appraisal of the included studies was not conducted, the selection process emphasized relevance, credibility of sources, and regional diversity. Key findings were then extracted and synthesized according to recurring themes and contextual challenges reported by healthcare professionals and policymakers.

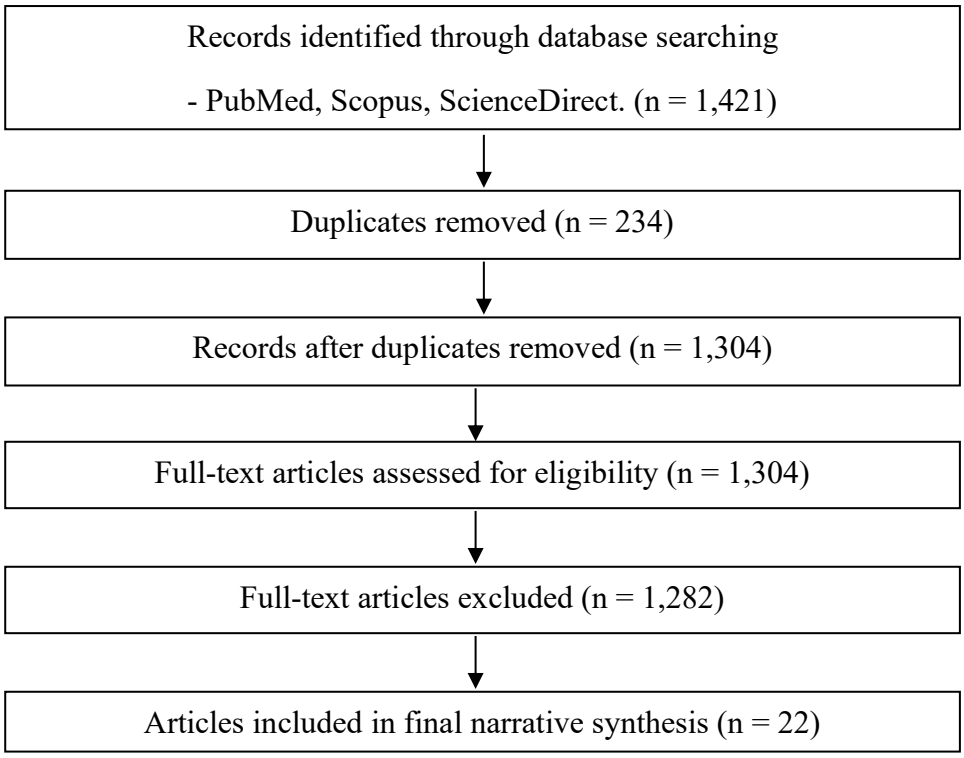

Figure 1: Flow chart

RESULTS

The results of this review were derived from 22 articles and reports that explored EMR implementation challenges in Malaysia, Indonesia, Vietnam, and Thailand as in table 1. The findings are synthesized into six recurring themes: (1) Infrastructure limitations, (2) Funding constraints, (3) Human resource and training gaps, (4) Data security and privacy concerns, (5) Legal and policy environment, and (6) User acceptance and system usability.

Infrastructure Limitations

Across all four countries, inadequate digital infrastructure was a critical barrier, particularly in rural and remote areas. In Indonesia and Vietnam, limited access to reliable internet and hardware such as lack of clinical-room computers, Local Area Network (LAN) or servers significantly hindered EMR use in primary care settings (Afrizal et al., 2019; Nguyen et al., 2011). Thailand and Malaysia, while more advanced in digital capacity, also faced challenges in integrating EMRs across fragmented hospital systems (Mohd Nor et al., 2019; Ngamsuriyaroj et al., 2011).

Funding Constraints

The high cost of EMR design, deployment, and maintenance was commonly cited. Malaysia, despite its early adoption of digital health strategies, struggled to sustain funding across all public facilities (Mohan & Yaacob 2004; Mohd Nor et al., 2019). Similarly, Indonesian studies noted disparities between urban and rural investment, with eastern provinces often underserved (Tilaar & Sewu, 2023).

Human Resource & Training Gaps

A lack of IT support personnel and clinical training emerged as another shared issue. In Indonesia and Vietnam, health workers often lacked computer literacy, and dedicated IT staff were either absent or underutilized (Anh et al., 2023; Kusumasari et al., 2018). Even in Malaysia, frontline staff reported difficulties using EMR templates, particularly without regular system support (Shaharul et al., 2023).

Data Security & Privacy Concerns

Fear of data breaches and uncertainty around data protection laws were prominent, especially among healthcare providers. Malaysian physicians expressed concern over the misuse of EMRs, despite the presence of the Personal Data Protection Act 2010 (Ismail & Abdullah, 2011). Indonesian and Vietnamese respondents also highlighted a lack of clarity on data access, encryption standards, and patient consent (Anh et al., 2023; Mathai et al., 2017).

Legal and Policy Environment

Malaysia and Thailand have introduced EMRs related frameworks, but governance inconsistencies persist. In Vietnam, the absence of a standardized national patient ID system complicates record sharing across hospitals (Tran et al., 2022). Indonesian policy mandates EMR use in primary health care yet fails to require the presence of IT support at facility level (Tilaar & Sewu, 2023).

User Acceptance & System Usability

Many healthcare workers resisted EMR adoption due to unfamiliarity with digital platforms, fear of change, or perceptions of increased workload. In Malaysia and Thailand, usability issues such as non-intuitive interfaces, poor system layout, and difficulty navigating patient dashboards led to user frustration and burnout (Chotchaisuwatana et al., 2011; Shaharul et al., 2023).

Table 1: Summary of Articles Regarding Challenges in Implementing Electronic Health Records.

Theme	Description	Examples & Country Highlights	References
Infrastructure Limitations	Inadequate digital infrastructure, especially in rural/remote areas.	Indonesia & Vietnam: Limited internet access, lack of clinical-room computers. Malaysia & Thailand: Integration issues across fragmented hospital systems.	Afrizal et al., 2019; Mohd Nor et al., 2019; Ngamsuriyaroj et al., 2011; Nguyen et al., 2011
Funding Constraints	High costs for EMR design, deployment, and maintenance; uneven investment.	Malaysia: Difficulty sustaining funding despite early adoption. Indonesia: Urban–rural funding disparity, eastern provinces underserved.	Mohan & Yaacob, 2004; Mohd Nor et al., 2019; Tilaar & Sewu, 2023
Human Resource & Training Gaps	Lack of IT support staff and insufficient user training.	Indonesia & Vietnam: Low computer literacy, few IT staff. Malaysia: Difficulty using EMR templates without support.	Anh et al., 2023; Kusumasari et al., 2018; Shaharul et al., 2023
Data Security & Privacy Concerns	Fear of breaches, unclear laws, low awareness of data rights.	Malaysia: Concerns persist despite Personal Data Protection Act 2010. Indonesia & Vietnam: Unclear encryption standards, weak consent processes.	Anh et al., 2023; Ismail & Abdullah, 2011; Mathai et al., 2017

Legal & Policy Environment	Fragmented governance and policy gaps hinder adoption.	Malaysia & Thailand: EMR frameworks exist but inconsistent. Vietnam: No standardized patient ID system. Indonesia: EMR mandated in PHC, but no IT staff requirement.	Tilaar & Sewu, 2023; Tran et al., 2022
User Acceptance & System Usability	Resistance to change, perceived workload increase, interface issues.	Malaysia & Thailand: Poor interface design, difficult navigation, burnout risk.	Chotchaisuwatana et al., 2011; Shaharul et al., 2023

DISCUSSION

This narrative review examined the barriers to implementing Electronic Medical Records (EMRs) in low- and middle-income countries (LMICS): Malaysia, Indonesia, Vietnam, and Thailand. While each country is at a different stage of digital health transformation, this review highlights both shared challenges and context-specific nuances that have shaped EMR adoption in the region. One of the most common barriers across all four countries is insufficient infrastructure, particularly in rural or remote areas. Indonesia and Vietnam, for instance, face significant gaps in reliable internet connectivity and basic hardware availability in primary care settings (Afrizal et al., 2019; Anh et al., 2023). Even in Malaysia and Thailand where national health IT strategies have been rolled out on issues of system integration and rural inclusion remain. These infrastructure limitations not only affect system performance but also contribute to delays in implementation and data entry.

Financial constraints were another consistent theme. The initial costs of developing, deploying, and maintaining EMR systems remain high, especially for low-resource settings. Malaysia's early Telemedicine Blueprint (Mohan & Yaacob, 2004) created a strong foundation, but sustaining funding across all healthcare levels has proven difficult (Mohd Nor et al., 2019). In contrast, Indonesia's progress has been uneven due to large geographical disparities and limited budget allocations in less-developed provinces (Tilaar & Sewu, 2023).

The lack of trained personnel and ongoing support systems also emerged as a core barrier. In Indonesia and Vietnam, many healthcare workers are not expert in using computers, and the absence of dedicated IT staff places additional pressure on already strained clinical teams (Gesulga et al., 2017; Kusumasari et al., 2018). Even in Malaysia, users report frustration with EMR templates, unclear workflows, and insufficient training, which can lead to reduced system use and increased burnout (Shaharul et al., 2023).

Additionally, concerns about data privacy and security were commonly reported. Malaysian physicians, for instance, remain apprehensive despite the enforcement of the Personal Data Protection Act 2010 (Ismail & Abdullah, 2011). Vietnam's emerging use of blockchain-based systems offers promise but raises questions about centralized data risks and patient consent procedures (Anh et al., 2023). This remarks the need for harmonized legal frameworks and digital ethics training across the region.

The policy environment also varies greatly. Malaysia and Thailand have national-level digital health strategies, whereas Vietnam and Indonesia are still consolidating fragmented policies and piloting various EMR systems (Ngamsuriyaroj et al., 2011; Tran et al., 2022). The lack of a universal patient ID in Vietnam affects record portability and interoperability.

The user acceptance remains a persistent issue. Many clinicians view EMRs as time-consuming or difficult to navigate. In Thailand, for example, cases of miscoding diagnoses due to poor system design have been documented, affecting clinical accuracy (Chotchaisuwatana et al., 2011). It is important to design EMR systems that are compatible with clinical workflows and involve healthcare workers in their development.

Despite these challenges, several lessons and opportunities emerge. First, successful adoption depends on inclusive system design that considers both urban and rural realities. Second, sustained training and technical support must be built into EMR programs, especially

for first-line staff. Third, regional collaboration, including shared standards, templates, and policy frameworks, could accelerate progress across the ASEAN region.

The findings highlight the need for implementation strategies that align national policies with local practice. A one-size-fits-all model will not work in Southeast Asia but by learning from each other's experiences, countries in the region can move closer to an integrated, secure, and patient-centred digital health future. To make EMRs truly work for the region, the first step is getting the basics right such as stable internet, reliable electricity, and enough computers in clinics, especially in rural and remote areas. Rolling out in phases, starting with smaller pilot sites, can help identify and fix problems before a nationwide launch. Funding also needs to be long-term and realistic covering not just the initial setup, but also training, technical support, upgrades, and cybersecurity. At the same time, systems should speak the same "digital language" across facilities by using common standards, open APIs, and a shared patient identifier. This prevents the frustration of isolated, non-compatible platforms.

The problem cannot be resolved by technology alone. People need to feel confident using the system. That means having trained IT staff available in health facilities, regular refresher training for clinicians, and "super users" among the users who can guide others on the job. The EMR itself should be designed with the user in mind that easy to navigate, not overloaded with unnecessary clicks, and able to work offline when needed. Data security and privacy must be more than just words in a policy, and they should be everyday practice through proper access controls, encryption, and regular security drills.

The progress should be tracked in simple, meaningful ways such as how complete and timely patient records are, how often the system is up and running, and how satisfied users feel with it. Lessons learned should be shared widely, both within countries and across the region. An ASEAN-led group could help pool resources, set shared standards, and bring down costs. Research should assess if EMRs enhance care, reduce costs, and function effectively in rural areas to support evidence-based decisions.

This review looked only at Malaysia, Indonesia, Vietnam, and Thailand, so the findings may not reflect experiences in other Southeast Asian countries especially high-income settings like Singapore, which already has a well-established EMR system. We focused on English-language, peer-reviewed articles, so important local-language or grey literature may have been missed. The studies we included were very different from each other in terms of setting, system type, and outcomes measured, which made direct comparisons difficult and meant we could not do a formal pooled analysis. Our search was up to 2023, so more recent changes in policy or technology may not be captured, and there is always the chance that studies showing no results or challenges were less likely to be published.

CONCLUSION

The move toward Electronic Medical Records (EMRs) is an essential step in modernising healthcare across Southeast Asia, yet progress remains uneven. In Malaysia, Indonesia, Vietnam, and Thailand, common challenges such as patchy internet in rural areas, limited funding, lack of trained IT staff, privacy concerns, and fragmented policies that cause slow adoption. While each country's situation is different, the shared struggles of weak infrastructure, low user confidence, and system usability issues show that these are not isolated problems, but regional ones. EMR adoption is not just about installing new software, it is about changing the way health systems work. This requires steady investment, stronger laws, and ongoing support for

the people using these systems every day. Working together as a region with sharing lessons, setting common standards, and closing the digital gap between cities and rural areas may help turn EMRs from a promising idea into a practical reality. When implemented properly, this leads to improved health records and faster, more coordinated care for millions.

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REVIEW ARTICLE Open Access

DETERMINANTS OF MEDICAL DOCTORS LEAVING MALAYSIA'S PUBLIC HEALTHCARE SECTOR: A NARRATIVE REVIEW

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Abstract

The exodus of medical doctors from Malaysia's public healthcare sector has become a pressing concern, with an average of 3.5 doctors resigning daily between 2019 and 2023. This narrative review explores the determinants of medical doctors leaving Malaysia's public healthcare workforce, based upon literatures published from the past 2 decades. Literature search was conducted across five databases. From the 25 identified articles, five main themes were synthesized: "Career Advancement & Job Security", "Professional Recognition & Work-Life Harmony", "Workplace Culture, Environment & Support", "Staff Welfare" and "Staff Emoluments". Contributing key factors include limited opportunities for career progression, job insecurity among contract doctors, attractive private sector offers with significant salary disparities between public and private sectors, poor workplace conditions with heavy workload, inadequate emotional and psychological support. Additionally, bureaucratic inertia with lack of autonomy, and burden in balancing clinical and administrative responsibilities have strained medical professionals. In addressing these challenges to retain medical doctors in the public healthcare workforce, it is pertinent to improve career advancement opportunities, enhancing workplace support systems and culture while reducing workload, and also addressing salary disparities. Thusly ensuring the Malaysian public healthcare workforce being more resilient and sustainable, assuring provision of quality healthcare services to the population.

Keywords: Medical Doctor Retention, Public Healthcare Workforce, Healthcare Brain Drain

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INTRODUCTION

The exodus of medical doctors from Malaysia's public healthcare sector has become an increasingly pressing concern, with 6,417 medical officers leaving public service between 2019 and 2023. This averages to 3.5 medical doctors resigning from the public healthcare sector each day (CodeBlue, 2024). As over 70% of the Malaysian population relied on public healthcare services for their medical needs, this exodus has significantly impacted the country's healthcare service delivery (Hajar Umira Md Zaki, 2024).

The factors driving this trend are multifaceted, with studies highlighting burnout due to excessive workloads with working hours up to 84 hours per week, inadequate compensation relative to the private sector (Danish Raja Reza, 2024), lack of career progression opportunities with poor work-life balance (Tarrence Tan & Ragananthini Vethasalam, 2023), job insecurity and dissatisfaction with the introduction of contract medical officer (K. Parkaran, 2024), playing contributory roles towards medical doctors' decisions to leave the public sector. Furthermore, COVID-19 pandemic has further exacerbated these challenges, predisposing more than half of Malaysian healthcare workers experiencing burnout symptoms during this testing period (Nurhanis Syazni Roslan et al., 2021).

This narrative review aims to explore the various determinants associated with medical doctors quitting the public healthcare workforce in Malaysia. It draws upon literatures published for the past 20 years from 1999 to 2024, highlighting that the issue being a long-discussed topic in the Malaysian healthcare system with new challenges to be addressed.

While previous studies examined individual factors contributing towards medical doctors quitting public healthcare workforce in Malaysia, this narrative review synthesized these contributory factors into a comprehensive list of themes. This provides insights to inform policy decisions and strategies to improve retention among medical professionals in the public sector. Thereby ensuring the sustainability of Malaysia's public healthcare system whilst assuring equity among our healthcare workers for their effort in delivering quality healthcare services for the community.

METHODS

Literature search through 5 databases namely PubMed, Scopus, Google Scholar, ProQuest and ScienceDirect had been conducted to identify articles which fulfilled the inclusion criteria (1) published between January 1999 and December 2024 (2) focused specifically on Malaysian medical doctors in public healthcare settings (3) addressed factors influencing retention, attrition, and / or career decisions; with exclusion criteria (1) studies focused solely on nursing or allied healthcare professionals (2) articles examining only student or trainee populations and (3) studies addressing only clinical practice issues without workforce implications.
Search terms and Boolean operators employed during literature search include:

i. ("medical doctor*" OR “physician*” OR “clinician*”) AND
ii. (“Malaysia”) AND
iii. ("public" OR "private" OR “hospital*” OR “clinic*”) AND
iv. (“career” OR “promotion” OR “job security” OR “job opportunity*” OR “recognition” OR “prestige” OR “culture” OR “environment” OR “support” OR “burnout” OR “welfare” OR “compensation” OR “salary” OR “emolument*” OR “allowance*” OR “pension*” OR “workload”) AND
v. (“retention” OR “turnover” OR "intention to leave" OR "job satisfaction")

Through the 25 identified articles, data set was condensed and underwent thematic analysis via inductive approach, which codes and themes subsequently emerged. After all-text familiarization, initial coding was conducted independently by six researchers (CRWA, ATSF, RR, MAB, CD, AA) to identify recurring factors. Codes were then collated into subthemes through a constant comparative manner. These subthemes underwent refinement via team discussions until consensus was reached on five main themes, which was then reviewed by two supervisors (ARR, MAS).

RESULTS AND DISCUSSION

The main themes emerged include “Career Advancement & Job Security”, “Professional Recognition & Work-Life Harmony”, “Workplace Culture, Environment & Support”, “Staff Welfare” and “Staff Emoluments” as summarized in the Table 1.

Theme 1: Career Advancement & Job Security

Career Progression Pathways

Career growth and recognition are essential for motivating, retaining and boosting productivity among medical doctors. Grooming talents of employees is also crucial part to improve service provision. A lack of development opportunities strongly correlates with turnover intentions.

In the public healthcare sector, many doctors were demotivated by their inability to work in preferred departments and limited postgraduate seats offered. This further promote their transitions from the public to the private sector (Dulajis et al., 2022). Furthermore, dissatisfaction with the promotional processes in public sector, with training and career development opportunities in the private healthcare sector had accentuated medical doctors migration from public to private healthcare sector (Andrew Sija, 2022; Faiz Daud et al., 2022; M. Aidalina & Ismail Aniza, 2015).

Job Stability

Since introduction of the contract employment system for Malaysian medical doctors in 2016, the Ministry of Health had reported 3,046 contract medical officers having resigned between 2021 and 2023 (Nor Ain Mohamed Radhi & Qistina Sallehuddin, 2024). This could be explained by the intrinsic and extrinsic factors affecting the job satisfaction and dissatisfaction among them.

Intrinsic factors like job insecurity due to contract job appointment causes doubts about contract renewal and career advancement, exacerbating emotional fatigue and reduces job satisfaction. Extrinsic factors like salary disparities, insufficient support services and employee

benefits fosters feeling of unfairness among the contract counterpart, fuelling discontent among them. These factors synergistically impact their job satisfaction, inadvertently resulted in increasing resignations and absenteeism (Razak & Ali, 2023).

Rural Posting Support System

Economic inequalities had been frequently cited to have discouraged medical doctors from working in rural areas, thusly financial incentives should be emphasised to retain those employed in district healthcare facilities nationwide (Faiz Daud et al., 2022). Moreover, increased workloads, challenging geographical access, facility and resource inadequacy also contributes to their reluctance to work in rural area.

Support system such as mentorship initiatives, peer support groups, and ongoing educational opportunities, all played important roles in improving their job satisfactions thusly enhancing the retention level among those posted to rural medical postings (Putri et al., 2020)

Theme 2: Professional Recognition & Work-Life Harmony

Private Sector Career Prestige

Since 1991, the Malaysian government's Privatisation Master Plan had substantially increased private healthcare facilities leading to increased demand for medical doctors in the private sector (Latifa M Hameed & Fadilah Mat Nor, 2014). This pull factor being complemented by push factors such as job dissatisfaction among public healthcare doctors related to low salary and unsatisfactory work environment had impacted their migration dynamics into private healthcare facilities (Faiz Daud et al., 2022; M. Aidalina & Ismail Aniza, 2015).

Furthermore, lack of appreciation and acknowledgement at public healthcare facilities contributed to their migration to the private sector (M. Aidalina & Ismail Aniza, 2015). Thus justifying that employee recognition and acknowledgment strongly predicted employee retention among Malaysia's private healthcare centres (Andrew Sija, 2022).

Work-Life Balance & Economic Stability

Work-life balance is highly associated with job satisfaction, predicting employees' retention in an organization. Permanent post medical doctors were better in balancing work-life demands as compared to contract counterpart, contributing to their retention in the public sector (Muhamad Khalil Bin Omar & Azzarina Zakaria, 2016). Furthermore, lower wages among medical officers had contributed to them quitting the public healthcare services (M. Aidalina & Ismail Aniza, 2015).

Thus, long-term actions are needed to rectify negative impact towards public healthcare services due to medical doctors venturing into the private healthcare sectors (Norehan Jinah et al., 2023). For instance, implementation of Full Paying Patient services in 2007 had significantly reduces the rate of medical specialists' resignation from the public healthcare sector (Muhammad Nur Amir AR & Sharifa Ezat WP, 2020).

Theme 3: Workplace Culture, Environment & Support

Organizational Culture

Post pandemic, bureaucratic inertia and double role playing by medical doctors who are overtasked with clinical services and administrative works, had caused detrimental effect to the public healthcare workforce. Hence resulting in job dissatisfaction and strained professional relationships, causing uptick of resignation from the public healthcare sector (Azrul Mohd Khalib, 2024; Mohd Ramlan et al., 2014; Muhammad Nur Amir AR & Sharifa Ezat WP, 2020).

The lack of autonomy over local policy planning and implementation, diminished job control and organizational culture of vertical administrative order had caused unease and dissatisfaction among medical doctors, predisposing them to quit the public healthcare sectors (Faiz Daud et al., 2022; Muhammad Nur Amir AR & Sharifa Ezat WP, 2020).

Workplace Condition

Ill workplace hygiene, poorly maintained assets, crowded working spaces in public healthcare facilities are among factors that most medical doctors are dissatisfied with (Mohd Ramlan et al., 2014; Rossilah Jamil, 2022). These dissatisfactions increases the risk of them quitting the public healthcare services.

Workplace violence negatively impacts employees' physical and psychological well-being with post-traumatic stress disorders. Majority of the public sector's medical community had experienced workplace violence with most reporting having experienced psychological violence, and some endured physical violence and sexual harassment. These have led to increased absenteeism among medical doctors and further influenced their decision to leave the public healthcare field (Lim et al., 2022).

Emotional & Psychological Wellbeing

Feelings of depersonalization and emotional exhaustion detract medical doctors from job satisfaction (Anisa Muhammad Nur & Herman Shah Anuar, 2020), enhancing risks of resignation from the public healthcare services (Rusli Ahmad et al., 2019). Thusly they should be encouraged to seek help when needed (Mohd Ikhwan Azmi et al., 2022), as a supportive workplace culture that encourages open communication and provides mental health support can enhance emotional well-being among doctors. This improve job satisfaction and retention in the public healthcare services (Julia C Prentice et al., 2020).

Theme 4: Staff Welfare

Impact of Excessive Workload

Heavy workloads, long working hours and insufficient staffing in the public healthcare sector significantly contributed to medical doctors' job dissatisfaction (Rusli Ahmad et al., 2019). This indirectly led to high level of burnout and mental ill health, leading them to a breaking point and eventually resigning from the public healthcare workforce (Marzo et al., 2022; The Star, 2023).

Due to concerns of career jeopardization and colleague's negative perception, medical professionals feared seeking mental support, underutilizing available supporting resources,

predisposing them to emotional burnout, depression and even anxiety (Norehan Jinah et al., 2023).

Impact of Inadequate Rest Periods

Due to the demanding working nature and insufficient recuperation time, these had contributed to burnout among medical doctors, indirectly affecting their work-life balance, with most reported having spent limited amount of family time thereby inflicting sense of guilt as parents (Ifrah Harun et al., 2022). This leads to job dissatisfaction with increased rates of quit intentions among them, amidst efforts to address and improve job satisfaction and also reducing staff turnover intentions (Dousin et al., 2022; Roslan JMG et al., 2014).

Theme 5: Staff Emoluments

Salary Disparities & Retirement Benefits

Salary influence employee retention, mediated by job satisfaction and is a crucial factor in turnover intention among medical doctors in the public healthcare workforce (Roslan JMG et al., 2014; Yang et al., 2021). This is evident when medical specialists engage in dual practice, being a precursor of quitting public practice in favor for a lucrative return at the private sector (Malindawati Mohd Fadzil et al., 2022).

Despite salary and benefits disparities exist between contract and permanent medical doctors in the public healthcare system, both shared similar level and amount of workload. These inequitable disparities could contribute to turnover intention among contract doctors from the public healthcare system (Norehan Jinah et al., 2023). Also, most permanent post doctors cited dissatisfaction with the current salary, allowances, and pension benefits, associating them with their intention to quit (Muhammad Nur Amir AR & Sharifa Ezat WP, 2020). Despite so, retirement benefits had contributed to their retention in the public healthcare workforce (Andrew Sija, 2022).

Allowance Benefits

Work-related allowances can impact job satisfaction and turnover intention among doctors in public healthcare facilities (Harun, 2020). Inadequate allowances may lead to insufficient compensation contributing towards demotivation and dissatisfaction, leading to their resignation from the public sector (S Sararaks & R Jamaluddin RAM, 1999).

Thusly non-salary benefits of permanent post offering and a transparent performance-based bonus system should be addressed for better job satisfaction, improving their retention in the public healthcare workforce (M. Aidalina & Ismail Aniza, 2015; Norehan Jinah et al., 2023)

Table 1: Thematic Summary Table

Themes	Sub-Themes	Determinant Factors
Career Advancement & Job Security	Career Progression Pathways	• Limited career opportunity advancements • Dissatisfaction with promotional processes in the public sector
	Job Stability	• Intrinsic and extrinsic factors affecting the job security among contract medical doctors
	Rural Posting Support System	• Economic inequalities • Limited manpower, challenging geographical access, facility and resource inadequacy
Professional Recognition & Work-Life Harmony	Private Sector Career Prestige	• Job dissatisfaction and lack of acknowledgement among public healthcare doctors regarding low salary and unsatisfactory work environment • Increased demand of doctors and employee recognition in the private sector
	Work-Life Balance & Economic Stability	• Imbalance between work-life demands • Low wages offered
Workplace Culture, Environment & Support	Organizational Culture	• Bureaucratic inertia • Double role playing by medical doctors • Vertical administration lacking employee autonomy
	Workplace Condition	• Public services facilities were not properly maintained • Small, crowded wards and clinic working spaces in public healthcare facilities • Workplace violence harms healthcare employees' physical and psychological well-being

	Emotional & Psychological Wellbeing	• Feelings of depersonalization and emotional exhaustion contributing to burnout and psychological distress
Staff Welfare	Impact of Excessive Workload	• High level of burnout and mental health issues among public healthcare medical doctors due to heavy workloads, long working hours and insufficient staffing • Stigma of seeking mental health assistance among medical professionals
	Impact of Inadequate Rest Periods	• Insufficient time for rest and recuperation contributed to burnout and job dissatisfaction • Sense of guilt among parents for not spending adequate family time
Staff Emoluments	Salary Disparities & Retirement Benefits	• Inadequacy between the public sector salaries and the private sector offerings • Salary and benefits disparities between contract and permanent medical doctors in the public healthcare system • Dissatisfaction with salary, allowances, and pension benefits by the public sector
	Allowance Benefits	• Inadequate allowances may lead to insufficient compensation for the demanding nature of healthcare services rendered

Strengths and Limitations

Through this article, various determinants which led to medical doctors leaving the Malaysia's public healthcare workforce had been explored, compiled and illustrated in a clear manner for policy makers to review and make considerations for policy amendments, thereby improving the public healthcare system to retain medical doctors.

However, as this article only focuses on the context of medical doctors working in the public healthcare sector, it does not portray the general condition and situation of the Malaysian public healthcare workforce, and does not exhibit in full, the current working conditions of the private healthcare sector which may have played its role in affecting medical doctors quitting the public healthcare workforce.

CONCLUSION

The emigration of medical doctors from Malaysia's public healthcare sector poses significant implications for the country's healthcare system. This narrative review has identified five key determinants contributing to this trend which includes (1) Career Advancement & Job Security (2) Professional Recognition and Work-Life Harmony (3) Workplace Culture, Environment & Support (4) Staff Welfare (5) Staff Emoluments.

By addressing these factors, Malaysia can progress towards establishing a more resilient and sustainable public healthcare workforce, ensuring continuous provision of high-quality healthcare services to its population. Future research should concentrate on assessing the efficacy of retention strategies and investigating innovative approaches to healthcare workforce management within the Malaysian context.

Conflicts of Interests

The authors have no conflicts of interest to declare.

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Data Availability Statements

No datasets were generated or analyzed during the current study. This article is a narrative review based primarily on previously published literature.

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Conceptualization: All authors; Data curation: All authors; Formal Analysis: All authors; Methodology: All authors; Resources: All authors; Supervision: ARR; Writing-Original Draft: All authors; Writing-Review and Editing: All authors. All authors read and approved the final manuscript.

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REVIEW ARTICLE Open Access

CHALLENGES OF DENGUE CONTROL AND PREVENTION WORLDWIDE: A SYSTEMATIC REVIEW

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Abstract

Dengue fever is a mosquito-borne disease representing significant public health challenges worldwide. Management of dengue prevention and control faces numerous challenges, including rapid urbanization, climate change, and socioeconomic inequalities. This systematic review aims to determine the challenges of the dengue control and prevention strategies. This review conducted a comprehensive search of articles published from 2013 to 2024, utilizing databases such as Scopus, ScienceDirect, and PubMed. The Preferred Reporting Items for Systematic Reviews (PRISMA) are used to improve transparency and completeness of reporting, and the Joanna Briggs Institute (JBI) is used for critical appraisal. The findings from the risk of bias assessment revealed moderate to high quality across the studies, with scores ranging from 5 to 9 out of 10. The populations studied included community members, health officers, healthcare workers, caregivers, and health surveillance experts representing diverse geographic locations like Malaysia, Thailand, the Dominican Republic, and Brazil. The types of studies included were qualitative, with one case report. Major challenges identified include weak community participation, inconsistent stakeholder coordination, socioeconomic constraints, and environmental factors affecting vector control sustainability. Integrated strategies combining traditional and innovative approaches, with strong community involvement and inter-sectoral collaboration, are essential for sustainable dengue control. In conclusion, the management of dengue needs integrated strategies that combine traditional methods with innovative approaches. In addition, it is crucial to involve the community and coordinate with stakeholders to enhance the effectiveness of dengue control measures by adapting to the local context. Future research should focus on developing sustainable and community-driven interventions, as well as enhancing inter-sectoral collaboration to address the multifaceted challenges of dengue prevention and control.

Keywords: Dengue fever, Challenges, Dengue control, Dengue prevention

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INTRODUCTION

Dengue fever, a viral disease transmitted by mosquitoes, has become a significant public health concern in tropical and subtropical regions globally. It is a viral infection that causes acute fever, severe headache, and muscle and joint pains (WHO, 2023). Approximately 400 million individuals each year, resulting in considerable morbidity and economic burden (Ho et al., 2023). Dengue fever is caused by the dengue virus (DENV), consisting of four serotypes, which are dengue virus 1 through dengue virus 4, making its spread complex and challenging to control (Bäck & Lundkvist, 2013).

The global prevalence of dengue has significantly risen due to urbanization, increased international travel, inadequate mosquito control, and climate change. These factors have led to the expansion of breeding seasons and geographic range of Aedes mosquitoes, particularly Aedes aegypti and Aedes albopictus (Abdullah et al., 2022). The adaptability of these vectors to urban environments poses additional challenges for control efforts (Gubler, 2011). Seasonal epidemics frequently occur, with the monsoon rains creating favorable breeding conditions for mosquitoes, thereby exacerbating the situation (Gui et al., 2022).

The burden of disease in the Western Pacific Region accounts for 75% of the global burden. The incidence of dengue cases in this region increased steadily from 0.20 million in 2011 to over 0.45 million in 2015 and further to 0.68 million in 2019. The Western Pacific Region experienced a 50% decrease in dengue deaths from 0.32% in 2008 to 0.16% in 2014, attributed to improved case management (Saeed & Asif, 2020). The decrease in reported dengue cases in 2020 can be attributed to reduced surveillance efforts during the COVID-19 pandemic due to a lack of resources and a decrease in the accessibility of healthcare services (Md Iderus et al., 2023). In Malaysia, dengue outbreaks have been recorded since 1902, with 123,133 cases reported in 2023 an 86.3% increase from 2022 (iDengue, 2024). In epidemiological week 6 of 2024, there were 22,058 reported dengue cases, representing a 68.5% rise from the 13,094 cases reported during the same period in 2023. There were 10 dengue-related deaths reported by week 6 of 2024, an increase from 9 deaths during the same period in 2023 (WHO Western Pacific Region, 2024).

Vector control strategies for dengue prevention and control consist of source reduction, larvaciding, space spraying, targeted outdoor residual spraying, health promotion, and law enforcement. The current control and prevention measures in Malaysia effectively reduce the morbidity and mortality of dengue cases (Ismail et al., 2022). The goal of vector control is to decrease the density of vectors to a level that prevents transmission, targeting both the larval and adult stages of the Aedes mosquito (Talbot et al., 2021).

New innovative approaches in dengue control include the release of Wolbachia-infected mosquitoes (Vektor et al., 2016). The Sterile Insect Technique (SIT) is a biological method that involves utilizing ionizing radiation, specifically gamma rays emitted by cobalt-60 and cesium-137 radioisotopes, or X-rays, to sterilize male mosquitoes (Nazni et al., 2021). The Institute of Medical Research (IMR) Malaysia has introduced a new approach called targeted outdoor residual spray (ORS) by applying a low dose of pyrethroid to outer surfaces where mosquitoes are believed to hide or rest in dengue hotspot areas or regions with frequent dengue outbreaks (Saadatian-Elahi et al., 2021).

Vector control strategies, such as source reduction, larviciding, fogging, and health promotion, remain the core of dengue prevention efforts (Ismail et al., 2022). However, sustaining these efforts is challenged by community fatigue, inconsistent stakeholder collaboration, and environmental adaptability of mosquito vectors. Therefore, this review aims to identify and synthesize the main challenges in the management of dengue control and prevention worldwide using a systematic approach.

METHODS

Design

This study adopts systematic review as its research design, with the Preferred Reporting Items for Systematic Reviews (PRISMA) statement guidelines utilized to improve transparency and completeness of reporting in systematic reviews (M.J., McKenzie, J.E., Bossuyt, 2021). Then, guidelines for evaluating the quality of studies were using The Joanna Briggs Institute (JBI) critical appraisal for case reports (Moola et al., 2015) and qualitative study (Lockwood et al., 2015).

Data Sources and Search Strategies

The search strategy only aims to identify published articles. The databases searched include Scopus, ScienceDirect, and PubMed. This is followed by a search using all identified keywords in the titles and abstracts, along with the index terms used to describe each article. Studies are limited to those published in English from 2013 to 2024. Keywords in this study are adjusted to the Medical Subject Heading (MeSH) and use a combination of Boolean operators (AND and OR), namely “challenges” AND “dengue control” OR “dengue prevention.”

Three reviewers independently assess the titles and abstracts of all studies to determine their relevance according to predefined inclusion criteria. Studies that pass the initial screening proceed to full-text review. Each reviewer independently evaluates the full text to determine whether to include or exclude it based on the study's relevance and quality. In cases where there is disagreement between the two reviewers regarding the inclusion or exclusion of a study, a third reviewer is usually brought in to resolve the conflict. This process ensures comprehensive consideration of all potential studies and minimizes bias risk. The disagreements can be resolved through discussion or by a third reviewer making the final decision.

The articles included in this systematic review meet specific criteria. Firstly, the study should focus on challenges associated with dengue prevention and control. Secondly, the articles considered articles published from 2013 until 2024. The timeline was selected to include the most recent evidence published since the previous systematic review conducted over 6 years ago. This time frame allows for incorporating recent research that may offer further insights or updated results. Lastly, only articles published in the English language are included.

Quality Assessment

Studies will then be assessed for their quality before any information retrieval. Any disagreements that arise between the reviewers will be resolved through discussion. All selected articles will be judged for their quality based on The Joanna Briggs Institute (JBI) critical appraisal for case reports study (Moola et al., 2015) and qualitative study(Lockwood et al., 2015). The three reviewers conducted the quality assessment independently, resolving any discrepancies in quality rating through discussion.

This tool has a checklist of ten questions covering the reviewer or a team of reviewers who systematically review each question in the JBI tool pertinent to the study design. Responses generally involve a yes, no, unclear, or not applicable option, enabling the appraiser to determine the extent of bias in the study. Each criterion that received a 'yes' score was given one point, while other responses score zero. The scores for each study were then calculated and summed. An evaluation method is used to assess studies conducted by researchers. Each study was critically appraised using the JBI checklist. Articles achieving ≥50% of the total score were included. The qualitative studies scored between 8 and 9 out of 10, and the case report scored 5 out of 8, indicating moderate to high quality (Lockwood et al., 2015; Moola et al., 2015).

Data Extraction

Three reviewers will independently assess all studies. Data extracted included author, year, country, participants, objectives, database source, and major findings. Themes were identified through meta-aggregation, and results were synthesized narratively.

Synthesis of Result

Study themes found in each article results were tabulated. The themes and subthemes found in the studies were then discussed in the discussions section.

RESULTS

The literature review was performed following PRISMA guidelines to select eligible articles (M.J., McKenzie, J.E., Bossuyt, 2021). The search strategy resulted in 1461 citations, with 84 from Scopus, 302 from ScienceDirect, and 1075 from PubMed. These citations were obtained through electronic database searches and were limited to articles published in English. Out of these, 660 were duplicates. Furthermore, 23 relevant articles were identified, and the full texts were retrieved and analysed. 17 studies were excluded, and 6 studies met the review inclusion criteria as in (Figure 1).

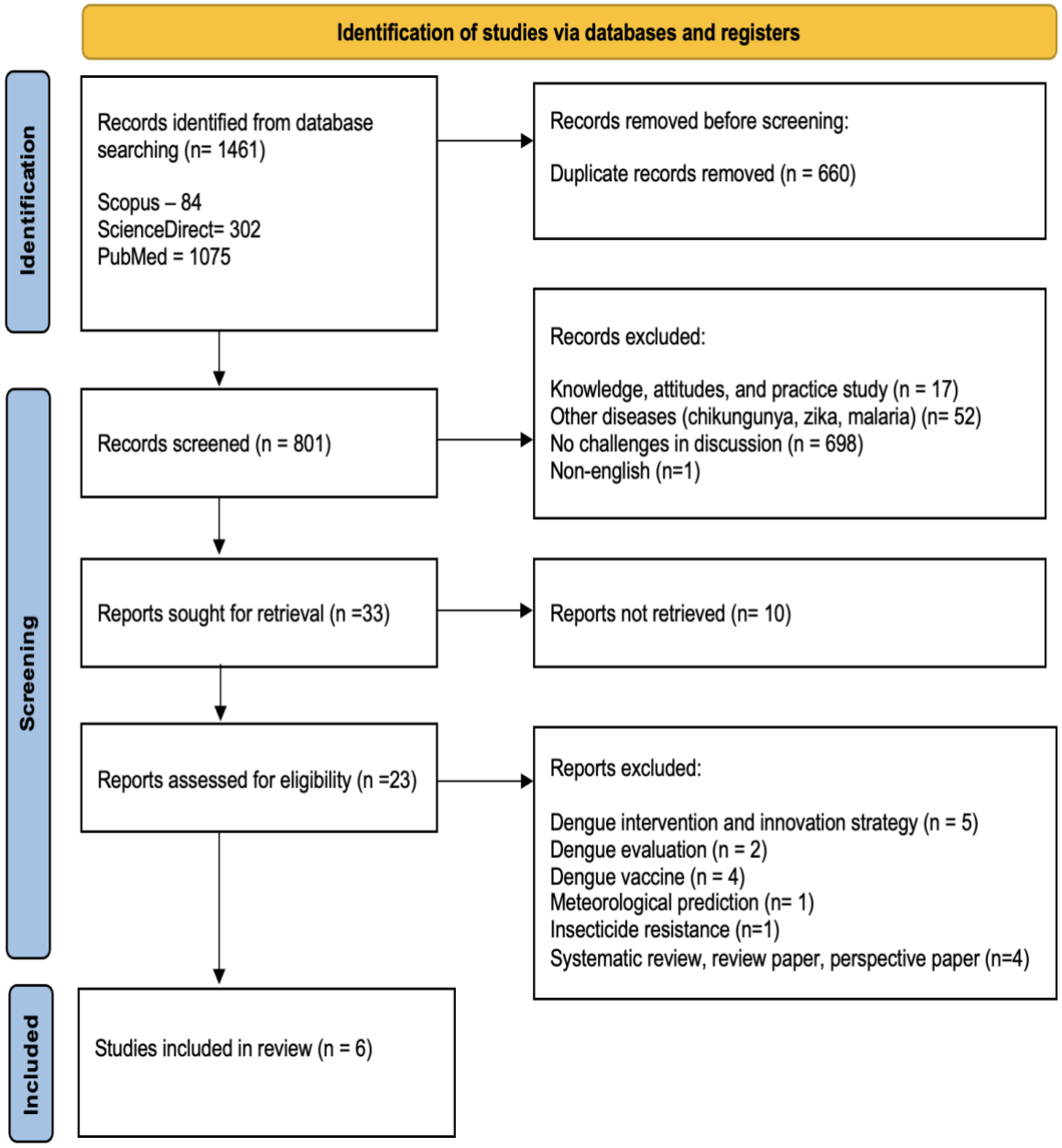

Figure 1: PRISMA 2020 flow diagram for new systematic reviews, which included searches of databases and registers only.

After searching three electronic databases, a total of 6 articles were identified that satisfied the inclusion criteria for this systematic review. More details regarding this systematic review, such as the author's name, year of publication, study design, number of participants, objectives, and a summary of the results, can be found in (Table 1).

Table 2: Summary of included literature

Author, Year, Country	Study Design	Participants	Database Source	Objective	Key Findings	Themes
Samsudin et al. (2024), Malaysia	Qualitative	42 participants	Scopus	Explore local community behaviors and stakeholder challenges	Limited community engagement and poor coordination between agencies	Community behavior, Stakeholder challenge
Srichan et al. (2018), Thailand	Qualitative	10 district health officers	ScienceDirect	Explore challenges of fogging operations	Resistance to fogging and low public cooperation	Community engagement, Public cooperation
Veras-Estévez & Chapman (2017), Dominican Republic	Qualitative	19 healthcare workers	PubMed	Identify perceived challenges among healthcare workers	Low socioeconomic support, poor awareness	Community engagement, Socioeconomic factor
Viennet et al. (2016), Singapore, Taiwan, US, Australia	Case report	–	PubMed	Review challenges and public health responses in high-income countries	Urbanization and imported cases pose ongoing risks	Environmental factor, Demographic factor
Frank et al. (2017), Peru	Qualitative	18 caregivers	Scopus	Explore caregiver experiences and perceptions	Misunderstanding of dengue symptoms and transmission	Community behavior, Stakeholder challenge
Angelo et al. (2020), Brazil	Qualitative	17 surveillance experts	ScienceDirect	Explore strengths and weaknesses of Brazilian surveillance	Incomplete reporting and lack of private sector data	Stakeholder challenge

Five qualitative research studies were conducted using the Joanna Briggs Institute (JBI) checklist, as shown in (Table 2). The assessment of each study is based on ten criteria, with a "+" indicating that the criterion is met and a "-" indicating that it is not (Angelo et al., 2020; Samsudin et al., 2024; Srichan et al., 2018) achieved a score of 8 out of 10. The omission of criteria 6 and 7 suggests potential deficiencies in areas such as locating the researcher culturally or theoretically and the researcher's influence or the clarity of conclusions. The two articles, (Frank et al., 2017; Veras-Estévez & Chapman, 2017) achieved a score of 9 out of 10, indicating that they fulfilled almost all criteria, with only locating the researcher's cultural or theoretical issue.

Table 2: JBI critical appraisal checklist for qualitative research

No	Author	1	2	3	4	5	6	7	8	9	10	Score
1	(Samsudin et al., 2024)	+	+	+	+	+	-	-	+	+	+	8
2	(Srichan et al., 2018)	+	+	+	+	+	-	-	+	+	+	8
3	(Veras-Estévez & Chapman, 2017)	+	+	+	+	+	-	+	+	+	+	9
4	(Frank et al., 2017)	+	+	+	+	+	-	+	+	+	+	9
5	(Angelo et al., 2020)	+	+	+	+	+	-	-	+	+	+	8

The JBI checklist for case reports was used to evaluate a single case report (Viennet et al., 2016) across eight criteria as in Table 3. This article achieved a score of 5 out of 8, suggesting that it fulfilled most of the criteria but had notable deficiencies in three aspects, possibly due to unclear diagnostic tests or assessment methods, unclear post-intervention clinical condition and insufficient to identify or describe adverse events (harms) or unanticipated events.

Table 3: JBI critical appraisal checklist for case report

No	Author	1	2	3	4	5	6	7	8	Score
1	(Viennet et al., 2016)	+	+	+	-	+	-	-	+	5

Summary of Main Themes

Although Viennet et al. (2016) is a case report, it was included because it provides valuable contextual evidence from high-income countries where dengue control strategies differ, enriching the comparative understanding of global dengue challenges. Across the six studies, four dominant themes emerged:
(1) weak community participation and behavioral barriers
(2) limited stakeholder coordination and resource constraints
(3) socioeconomic inequalities affecting prevention uptake
(4) environmental and climatic factors sustaining vector habitats.
These interlinked challenges emphasize the need for integrated and community-driven dengue control strategies.

DISCUSSION

The Challenges of Dengue Control and Prevention

Community behaviour

The battle against dengue fever continues to be a pressing global public health issue. Controlling this disease relies heavily on community awareness and proactive measures. Residents in different regions vary in their awareness and engagement in dengue prevention activities. Districts with lower incidence rates tend to have robust community networks crucial for effective dengue control (Angelo et al., 2020; Samsudin et al., 2024; Srichan et al., 2018). Nevertheless, despite the extensive efforts in health education, a significant number of community members still struggle to effectively implement preventive strategies (Veras-Estévez & Chapman, 2017).

Community participation plays a crucial role in determining the effectiveness of dengue management. One common challenge is the lack of community involvement, which is made worse by public weariness and doubt about current prevention efforts (Viennet et al., 2016). Many believe the lack of cooperation stems from a mindset where community members rely on the government or health centres to take charge (Frank et al., 2017).

There were significant challenges to overcome, as many residents were hesitant and uncooperative. They were reluctant to allow spraying inside their homes due to concerns about chemical exposure and disruptions (Srichan et al., 2018). To effectively control dengue, the entire community must come together and act, as the choices made by one household can have far-reaching consequences for the entire neighbourhood. Nevertheless, communities frequently suffer from a lack of collaborative spirit and collective action, which undermines their community-wide prevention efforts (Veras-Estévez & Chapman, 2017).

Stakeholder challenge

Regarding resources, the sustainable prevention and control of dengue can be challenging due to limited financial and material resources. This limitation significantly impacts the effectiveness and efficiency of education campaigns and other preventive initiatives (20–22). In addition, the inconsistent public health responses and infrastructure resulting from budget cuts present additional obstacles in sustaining efficient vector control and surveillance programs (Viennet et al., 2016).

Efforts to coordinate and enforce dengue prevention measures among various authorities have consistently encountered challenges, affecting the overall effectiveness of response efforts. Efficient collaboration between agencies is essential for a cohesive approach to dengue control, but the process is often hindered by jurisdictional constraints. The lack of coordination can result in fragmented efforts and inefficiencies in implementing prevention strategies, ultimately impeding the speed and effectiveness of responding to dengue outbreaks (Samsudin et al., 2024).

Education and public awareness play a crucial role in addressing the issue of dengue. Unfortunately, valuable educational materials are occasionally subjected to vandalism and theft, which hampers the efforts to disseminate knowledge (Samsudin et al., 2024). Caretakers'

understanding of dengue fever emphasizes an adequate understanding of its symptoms and modes of transmission. However, there are still noteworthy misunderstandings, especially regarding the biting habits of mosquitoes. The confusion between the behaviours of mosquitoes that transmit dengue (primarily Aedes aegypti and Aedes albopictus) and those that spread other diseases like malaria (typically carried by Anopheles mosquitoes) can complicate prevention efforts. This can lead to misunderstandings among parents (Frank et al., 2017).

Several factors contribute to the challenges in addressing dengue outbreaks. These factors include delays in reporting cases, lack of effective communication between hospitals and public health offices, and logistical issues in designated areas for spraying (Samsudin et al., 2024). The study highlighted significant challenges, including the insufficient reporting of cases, particularly from the private sector, and a shortage of human and technological resources that impede the notification process and data analysis. One problem that arises in data collection and reporting is the failure to integrate private healthcare data, which leads to inefficiencies in data collection and processing (Angelo et al., 2020).

Sociodemographic factor

Low socioeconomic status presents significant challenges for many community members in affording and sustaining effective dengue prevention measures such as mosquito nets or repellents. Due to economic constraints, individuals often prioritize basic needs over preventive health measures, potentially increasing their susceptibility to dengue (Veras-Estévez & Chapman, 2017). There is a need for targeted protection measures for children and rural community members, who are perceived as highly susceptible to dengue. Focused efforts to protect these vulnerable groups are crucial for reducing the impact of the disease within these populations (Frank et al., 2017).

On the other hand, high-income countries conveniently located near or connected to dengue-endemic areas face the ongoing challenge of imported cases through travellers. This constant virus introduction adds complexity to managing local transmission. Additionally, as population densities soar and urbanization occurs rapidly, more man-made breeding sites for mosquitoes can be created due to inadequate infrastructure. This is particularly concerning in locations such as Singapore and parts of Florida, where urban sprawl and favourable mosquito breeding conditions converge (Viennet et al., 2016).

Environmental factor

The presence of competent mosquito vectors, specifically Aedes aegypti and Aedes albopictus, is crucial. Controlling the spread of the virus is challenging due to its abundance and ability to thrive in urban and suburban areas. This adaptability poses significant challenges in controlling the spread of the virus, as these mosquitoes find suitable breeding grounds in a wide range of settings, making eradication efforts complex and demanding sustained coordinated public health strategies (Viennet et al., 2016).

The impact of weather patterns on mosquito populations and virus transmission is substantial. Fluctuations in rainfall, temperature, and humidity can significantly influence mosquito breeding sites and their population dynamics. Adapting mosquito control measures to these ever-changing environmental conditions remains a significant challenge. This variability requires flexible and responsive control strategies that can adjust to rapid changes in weather

patterns to effectively manage mosquito populations and curb the spread of viruses they carry (Viennet et al., 2016).

The Recommendations for Dengue Control and Prevention

The control and prevention of dengue require a comprehensive approach involving multi-agency and multi-strategies, such as vector control, community engagement, healthcare strengthening, and research advancements. Integrated vector management to reduce mosquito key breeding sites by combining multiple control efforts. It includes environmental management in managing solid waste and ensuring proper water storage practices. Then, chemical control is done using larvicides and adulticides such as temephos, malathion, aqua resigen, and Bacillus thuringiensis israelensis (Bti). Employ biological control, like larvivorous fish and coepepods, to control mosquito larvae. The upscale biological intervention combines conventional and innovative methods, such as Wolbachia-infected mosquitoes and the Sterile Insect Technique (SIT), to reduce mosquito populations for the recurrence outbreak locality or dengue hotspot area.

Strengthen dengue surveillance systems with mandatory reporting and real-time data sharing. Integrating private healthcare data into public health surveillance to notify dengue cases within 24 hours can enhance outbreak detection and response accuracy and efficiency. Dengue control can be implemented in a timely manner to help mitigate the transmission. In addition, utilising the Geographical Information System (GIS) to map and visualize dengue cases can help identify hotspots and monitor disease spread. GIS can aid in spatial analysis and risk prediction by machine learning for accurate forecasting.

Enhance community participation by raising awareness about dengue prevention through educational initiatives and promoting proactive community behaviours. The way to increase the effectiveness of dengue control is by giving accurate information and education about the safety of fogging. Thus, it can help to prevent misconceptions about mosquito control measures and to foster greater cooperation. The acceptance of the community fogging inside their house can reduce the mosquito density, especially in outbreak areas. Incorporating community-based participatory research (CBPR) methods can help tailor educational initiatives to the specific needs and behaviours of the community. This approach ensures that the materials are relevant and culturally appropriate. It also needs to encourage the use of protective clothing, repellents, and insecticide-treated materials during the Aedes biting time via health promotion activity on television, radio, and social media.

Next, collaborate with the school health unit to develop and implement school-based dengue intervention programs that use participatory and customized training materials to promote sustainable behavioural change among students. Developing customized training materials for school-based interventions can significantly improve knowledge and practice regarding dengue prevention. Techniques include using PowerPoint presentations, animated videos, colouring activities, games, and dengue zero field trips to learn how to identify the Aedes key breeding site. Moreover, interactive tools such as board games can make learning about dengue prevention fun and engaging. For example, the "Goodbye-to-Dengue Game" and “Aedes Larvae Ladder” can help to increase knowledge and self-efficacy among school children and adolescents.

Utilising digital platforms and social media for health education can enhance outreach to a wider audience and improve information accessibility. Utilising apps, interactive websites,

and social media campaigns can effectively distribute dengue prevention information. Health education materials should be visually appealing and easy to understand. Using colourful graphics, infographics, and engaging narratives can capture attention and improve the retention of information. The community leader plays a vital role in educating residents about dengue's dangers, its transmission, and preventive measures. This involves organizing awareness campaigns and informational sessions to disseminate accurate information. By building trust within the community, leaders can encourage greater participation in dengue prevention activities. Their influence can lead to higher compliance with recommended practices and more effective community engagement.

Strength

The strength of this study was that it utilized extensive database searches, including Scopus, ScienceDirect, and PubMed, adhering to PRISMA guidelines for systematic reviews and enhancing the review's transparency and completeness. The inclusion of a critical appraisal using the Joanna Briggs Institute (JBI) guidelines ensured a rigorous evaluation of the quality of the included studies, thereby strengthening the reliability of the review findings.

This review was guided by a well-defined research question aimed at identifying challenges in managing dengue control and prevention, which helps address specific issues effectively. Moreover, the review offers a broader perspective on the challenges faced across different demographic and geographic scopes by selecting studies that involve different populations and settings (community workers, public health providers, and volunteers in endemic areas). The novel value of this systematic review lies in its comprehensive and updated synthesis of evidence from 2013 to 2024, addressing gaps in previous research.

Besides that, the focus on qualitative studies allows for a deeper understanding of the community, socioeconomic, and systemic challenges in dengue prevention, providing rich, context-specific insights. Multiple reviewers performed the data extraction and quality assessment independently, reducing the risk of bias in the review process.

Limitation

This review only evaluated articles published in English from 2013 to 2024 and did not consider studies in other languages. Book chapters and grey literature are not included, which could offer valuable insights into dengue prevention and control strategies. The systematic review follows PRISMA guidelines and utilizes JBI critical appraisal tools. However, it is important to consider the potential impact of biases and methodological limitations in the included studies on the outcomes. Some studies did not receive high appraisal scores, suggesting that there may be differences in study quality that could impact the strength of the conclusions made.

CONCLUSION

This systematic review focuses on the challenge of various factors that impact dengue control and prevention efforts. Effective management of dengue requires a coordinated approach that integrates traditional strategies with innovative solutions. The findings highlight the importance of global collaboration in improving vector control, public health education, and disease surveillance to effectively address the increasing dengue issue.

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REVIEW ARTICLE Open Access

MATERNAL CHALLENGES AND STRATEGIES IN COMBATING CHILD MALNUTRITION IN RURAL COMMUNITIES: A NARRATIVE REVIEW

Kamal Lazi[1], Woon Fui Chee[1*]

Abstract

Child malnutrition remains a persistent global problem despite numerous nutrition initiatives, especially in rural and underserved settings. Many interventions overlook the central role of mothers whose ability to ensure adequate child nutrition is constrained by limited health literacy, socio-cultural norms, and economic barriers. This narrative review examines the influence of maternal health literacy, socio-cultural norms, economic constraints, and support networks on child malnutrition in underserved communities. This narrative review synthesized evidence from studies published between 2020 and 2024 retrieved from PubMed, Scopus, Web of Science, and Google Scholar to identify maternal barriers and facilitators influencing child nutrition in rural contexts. Mothers play a pivotal role in child health, yet factors like limited autonomy, financial hardships, and inadequate support systems hinder their ability to combat malnutrition. Research indicates that low maternal health literacy is associated with poorer nutrition outcomes, emphasizing the need for targeted education programs. Economic barriers limit access to diverse and nutritious foods, while socio-cultural norms shape caregiving practices, either facilitating or restricting maternal efforts. Effective interventions should incorporate community-driven support, economic empowerment, and culturally tailored education to strengthen maternal capacity and improve child nutrition outcomes.

Keywords: Maternal health literacy, Child malnutrition, Socio-cultural factors, Economic barriers, Social support networks, Rural communities

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INTRODUCTION

Child malnutrition remains a global health concern, with 148.1 million under-five children stunted, 45 million wasted, and 37 million overweight in 2023 (WHO, 2023a) . Early nutrition interventions are essential for child development and long-term health (Kirolos et al., 2022). Global strategies, such as the WHO Global Nutrition Targets 2025 and Sustainable Developmental Goals (SDG) 2.2, aim to combat child malnutrition, yet many countries remain off track in meeting these targets (Arndt et al., 2024; WHO, 2023b). Despite numerous initiatives, many programs fall short due to inadequate focus on the critical role of caregivers especially mothers who face challenges related to food access, education, and socio-economic barriers. Therefore, addressing mothers' challenges is crucial for ensuring sustainable progress in reducing child malnutrition.

Mothers, as primary caregivers, play a crucial role in shaping child health and well-being. However, their ability to fulfil this role is influenced by complex socio-economic and cultural factors. Traditional views of motherhood often overlook the diverse experiences and challenges faced by mothers, particularly those in marginalized communities (Keefe et al., 2017). In many contexts, mothers bear the primary responsibility for determining their child's health and nutritional outcomes (Matare et al., 2015). This central role is further reinforced by the sociobiological explanations that have historically presented mothering as the natural priority and inevitable destiny for women (Stringer, 2020). Mothers are expected to nurture their children and support their development, yet diverse backgrounds and challenges often complicate these idealised expectations (Keefe et al., 2017). Nonetheless, the role of mothers as the primary caregivers remains a crucial critical factor in child development, with significant implications for policy and practice (Stringer, 2020). Understanding this complexity is essential for effectively supporting mothers and improving child nutrition, particularly among marginalised populations.

In public health, the critical role of mothers in shaping child nutrition is well established (Likhar & Patil, 2022; A. Saleh et al., 2021; Soharwardi & Ahmad, 2020). As primary caregivers, mothers have a profound influence on the dietary habits, food preferences, and overall health of their children, particularly during the early years of life. Adequate nutrition during this formative period is essential, as malnutrition can have long-term consequences on physical growth, cognitive development, and lifelong health (WHO, 2024). However, mothers' capacity to ensure optimal nutrition for her children is shaped by external factors beyond individual choice, including economic stability, access to education, and healthcare infrastructure (Ickes et al., 2015, 2018). In many rural settings, these barriers are exacerbated by persistent inequalities, further hindering maternal efforts in combating malnutrition.

This narrative review examines the facilitators and barriers affecting mothers' roles in addressing child malnutrition in rural communities, with a focus on the socio-cultural, economic, educational, and healthcare dimensions. By shedding light on both supportive and restrictive influences, this review presents a balanced perspective on the challenges and opportunities that mothers encounter. Ultimately, this review advocates for a holistic, community-driven approach to addressing the factors that shape maternal influence in alleviating child malnutrition, particularly in underserved communities where resources are scarce and the stakes are high.

METHODS

This narrative review examines maternal barriers and facilitators in addressing child malnutrition in rural communities. Relevant studies were selected from PubMed, Scopus, Google Scholar, and Web of Science using key search terms such as "child nutrition," "child malnutrition," "rural communities," and "barriers to nutrition." Search combinations included phrases like ("maternal barriers" OR "mother's role") AND ("child malnutrition" OR "undernutrition") AND ("rural communities" OR "low-resource settings").

Studies published between 2020 and 2024 were prioritised to capture recent findings, while older foundational studies were included where necessary. The selection process considered peer-reviewed journal articles, qualitative and quantitative studies relevant to maternal roles in child nutrition. Studies were included based on relevance to rural settings, appropriate study design such as cross-sectional, cohort, or mixed-methods, and adequate sample size. Articles not published in English, non-peer-reviewed sources, and grey literature were excluded. The review focused on socio-economic, cultural, and structural influences in rural settings. This approach ensures a comprehensive understanding of the key challenges and opportunities in improving child malnutrition through maternal interventions.

RESULTS AND DISCUSSION

Key Determinants of Maternal Roles Addressing Child Malnutrition

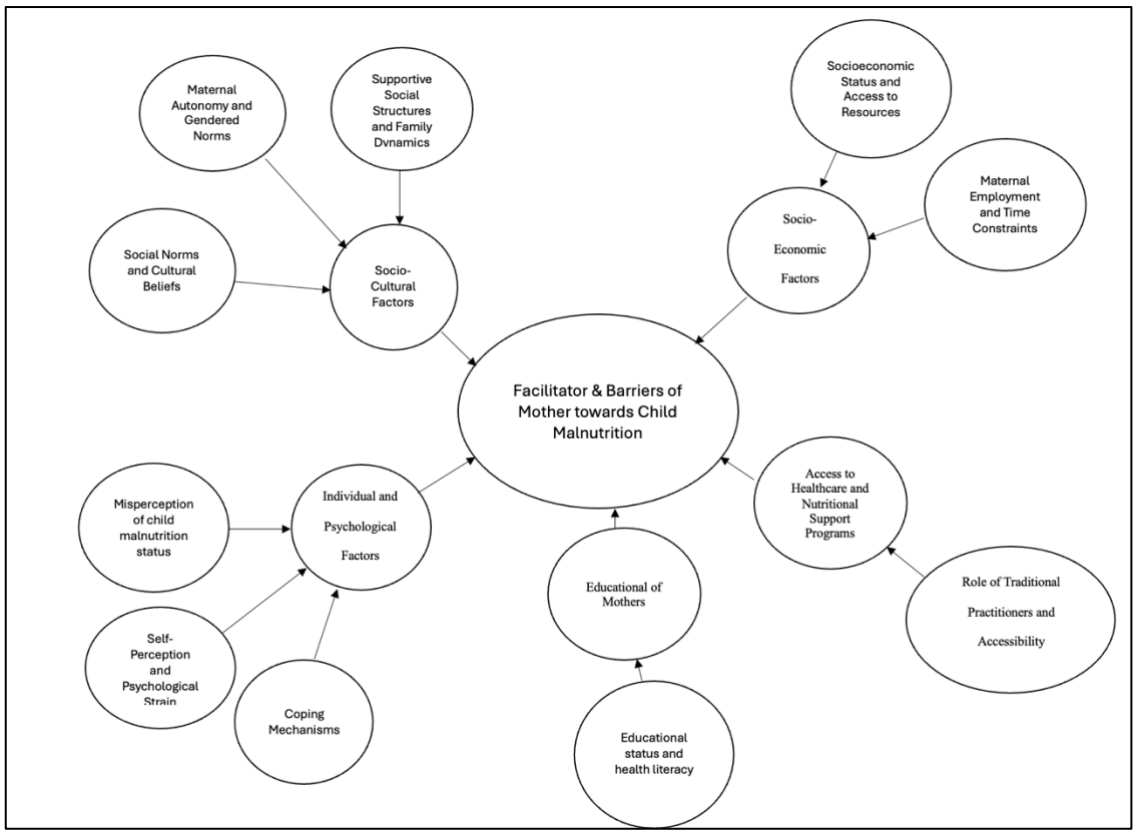

Figure 1: Framework of Maternal Barriers and Facilitators in Addressing Child Malnutrition in Rural Communities.

Socio-Cultural Factors

Supportive Social Structures and Family Dynamics

Socio-cultural factors play a crucial role in shaping maternal ability to address child malnutrition. Supportive family and community networks provide practical assistance, emotional support, and shared knowledge that benefit child nutrition (Burchinal et al., 1996; Gill et al., 2023; Nkwo et al., 2021) . Elders, particularly grandmothers and community leaders, significantly influence child-feeding practices and health-seeking behaviours (Capitani et al., 2023). Their guidance can reinforce traditional practices and impact parental decision-making on nutrition (Burtscher & Burza, 2015). Research indicates that maternal participation in women's support groups promote the adoption of balanced diets and effective feeding strategies (Ayine et al., 2021). These networks alleviate caregiving burdens and encourage positive nutritional habits in children.

Conversely, mothers who lack stable, long-term support from family or social networks often face greater challenges. Limited social support, unstable relationships, or the absence of a co-parent can contribute to maternal stress and reducing their capacity to provide adequate nutrition for their children (Kerr et al., 1978). Single mothers, in particular, may struggle with meal planning and food preparation, while those with strong support systems tend to experience better mental health and provide more balanced diets (Balaji et al., 2007). In South Africa, younger mothers face the added challenge of balancing traditional feeding norms, such as preparing indigenous porridges and observing breastfeeding taboos, with modern practices that favour convenience foods and formula feeding. This cultural tension often leads to inconsistent feeding patterns and lower adherence to exclusive breastfeeding recommendations (Chakona, 2020). Without adequate support, maternal well-being suffers, making it more difficult to meet their child's nutritional needs.

Maternal Autonomy and Gendered Norms

Maternal autonomy, which refers to a mother's ability to make independent decisions regarding household resources, food distribution, healthcare access, and child-rearing, is a key determinant of child nutrition in underserved communities. In patriarchal societies, male control over finances and food allocation can restrict mothers' ability to provide nutritious meals to their children. (Esterik, 1999). Restrictive gender norms further limit maternal autonomy, often leading to poorer child health and nutrition outcomes. (Miedema et al., 2018). Studies have shown that in households where mothers possess greater autonomy, children tend to have better nutritional outcomes and overall health. Smith et al. (2003) found that women who actively participated in household financial and food procurement decisions were more likely to provide diverse and nutrient-rich diets for their children, resulting in lower rates of stunting and wasting (Smith et al., 2003). Similarly, Shroff et al. (2011) reported that higher maternal autonomy was associated with a greater likelihood of engagement in health-seeking behaviors, such as routine check-ups and vaccinations, thereby supporting child growth and development (Shroff et al., 2011). However, Paul and Saha (2022) found that maternal autonomy had no significant association with children's stunting and wasting (Paul & Saha, 2022). Comparing findings across studies is challenging due to diverse socio-cultural contexts, which can influence both maternal autonomy and child health outcomes. While maternal autonomy holds potential for improving child nutrition, variations across different settings highlight the need for further research.

Social Norms and Cultural Beliefs

Social and cultural norms shape mothers' attitudes and child feeding practices, especially in traditional societies. In Indonesia, for example, cultural beliefs significantly impact the provision of complementary foods for breastfeeding infants. Cultural norms such as the influential role of grandmothers in decisions about when to introduce complementary feeding before six months, hesitancy to provide animal-source foods or seafood early because of fears about allergies or choking, and customary views on a child's 'readiness' for more textured foods are part of the local practices. A study by Saleh et al. (2023) found that mothers with a good understanding of local cultural practices tended to provide more appropriate complementary feeding (Saleh et al., 2023). Conversely, in Benin, socio-cultural beliefs have led to dietary restrictions that limit nutritional diversity. Lokossou et al. (2021) documented the avoidance of nutrient-rich foods such as catfish, crabs, pork, eggs, and certain fruits among pregnant and breastfeeding women. These restrictions stemmed from beliefs that such foods could cause childbirth complications, infant illness, or behavioural problems in children. As a result, many households relied heavily on maize-based porridge and vegetables, producing monotonous diets with low intake of animal protein and fruits, which heightens the risk of malnutrition (Lokossou et al., 2021). These taboos prevent mothers from introducing diverse and nutrient-rich foods to their children, increasing the risk of nutrient deficiencies. These beliefs can either support or hinder a mother's ability to meet her child's dietary needs, impacting not only the food choices but also maternal acceptance of nutrition education and intervention programs.

Inclusive approaches that engage fathers, grandmothers, and other influential family members can foster a more supportive environment for mothers to adopt recommended feeding practices. However, generational shift can create tensions. In South Africa, younger mothers often resist indigenous knowledge, reflecting evolving attitudes toward breastfeeding and complementary feeding (Chakona, 2020). Similarly in Pakistan, cultural norms dictate that elders, especially mothers-in-law and grandmothers, decide what young children should eat, and younger mothers are expected to obey without question. Baloch et al. (2020) found that nutritious foods such as milk, eggs, and apples are commonly avoided because they are believed to cause gastric problems or sore throats, while traditional foods like *Landhi* (dried meat) and heavily spiced dishes are preferred for cultural and taste reasons. These practices, reinforced by patriarchal household structures, restrict mothers' autonomy and contribute to poor dietary diversity and child malnutrition (Baloch et al., 2020). While some cultural beliefs support child health, others hinder optimal nutrition and contribute to deficiencies, highlighting the importance of culturally sensitive nutrition interventions.

Individual and Psychological Factors

Self-Perception and Psychological Strain

The psychological well-being and self-perception of mothers play a crucial role in determining child nutrition outcomes, particularly in cases involving malnutrition. Mothers experiencing psychological distress and stigma often struggle to provide adequate care, exacerbating child malnutrition. Self-stigma and societal blame can lower their self-esteem, reducing their likelihood of seeking health services. A study by Putri et al. (2024) found that self-stigma among mothers of malnourished children led to reluctance in engaging with healthcare providers and particpating in community health programs, further worsening the nutritional challenges faced by their children (Putri et al., 2024). When mothers feel unsupported or judged by their community, they may withdraw from social networks and essential resources, deepening the

cycle of malnutrition. Negative perceptions and judgment from community members, along with the absence of compassionate communication from health workers, further intensify feelings of shame among mothers.

Maternal mental health is closely linked to child nutrition, as poor mental health can hinder a mother's ability to provide adequate care, including proper feeding and hygiene practices. In a study conducted in Bangladesh, Khan (2022) found that maternal common mental disorders (CMD), such as depression and anxiety, were associated with poorer feeding practices and an increased prevalence of wasting and underweight in children (Khan, 2022). Mothers experiencing CMD may struggle tomaintain consistent feeding routines, making it difficult for them to meet their children's nutritional needs. Psychological distress in parents can also affect child growth and development. Studies by Susiloretni et al. (2020, 2021) demonstrated that stress experienced by both mothers and fathers has a direct impact on linear growth in children, increasing the likelihood of stunting. Addressing parental mental health is crucial for improving child nutrition, as stress and mental health challenges can hinder effective childcare, impacting long-term growth and development.

Misperception of child malnutrition status

Mothers' perceptions of child malnutrition play a pivotal role in determining child nutrition outcomes, as these perceptions guide feeding practices, health-seeking behaviours, and overall childcare approaches. A substantial portion of mothers misjudge their children's nutritional status, leading to potentially harmful feeding practices. A study by Sarker et al. (2024) found that 46% of mothers had perceptions that did not align with anthropometric measurements of their children's nutritional status. Within this group, 37% underestimated and 9% overestimated their child's nutrition levels (Sarker et al., 2024). These misperceptions can lead to feeding practices that are either insufficient or excessive, both of which pose health risks for children. Inappropriate feeding practices driven by misperceptions can have long-term consequences on child health. When mothers misjudge their child's nutritional needs, they may resort to dietary adjustments that fail to meet the child's actual requirements (Noor et al., 2022). Overfeeding, often resulting from a perception that the child is underweight, can increase the risk of obesity, while underfeeding may lead to deficiencies in essential nutrients. Educating mothers on accurate nutritional assessment is key to promoting balanced feeding practices and preventing both undernutrition and overnutrition.

Coping Mechanisms

Mothers play an essential role in shaping the nutritional outcomes of their children, especially when faced with challenges such as food insecurity, economic constraints, and health issues. The coping mechanisms employed by mothers can significantly influence child nutrition, with adaptive strategies often promoting better nutritional outcomes and maladaptive strategies potentially compromising them. Adaptive coping strategies are positive approaches that mothers use to secure and maintain their children's nutrition, often through creativity and resourcefulness. During the COVID-19 pandemic, for example, mothers turned to preparing home-cooked meals and seeking financial or food assistance to ensure their children received balanced diets. These methods helped to alleviate the impact of food insecurity and maintained children's access to essential nutrients, despite financial or logistical limitations (Vantono et al., 2022). In Rwanda, mothers have demonstrated further adaptive strategies through breastfeeding and complementary feeding practices. Ahishakiye et al. (2021) found that mothers prioritised improving their own diets to enhance breastmilk production, invested time in preparing

children's food in advance, and diversified their livelihoods to maintain food stability (Ahishakiye et al., 2021).

While adaptive coping strategies have positive effects, maladaptive coping mechanisms can undermine child nutrition. Emotional feeding is one such practice where mothers use food to manage their children's emotions, which can lead to maladaptive eating behaviors. A study found that emotional feeding is often influenced by coping styles like preoccupied coping, which may negatively impact nutritional outcomes and foster unhealthy eating habits (Goldstein et al., 2017). Furthermore, a study by Dellenmark-Blom et al. (2019) revealed that avoidance and distancing from eating challenges are associated with lower eating quality of life (Dellenmark-Blom et al., 2019). This avoidance-based approach may prevent children from developing healthy eating behaviors. Stress can also lead mothers to coping behaviors that, while protective in the short term, may disrupt the consistency needed for a malnourished child's healthy development. (Kerr et al., 1978). The resilience displayed by mothers in such challenging circumstances is a testament to their strength, yet these coping strategies often underscore an urgent need for supportive interventions.

Socio-Economic Factors

Socioeconomic Status and Access to Resources

Economic factors are fundamental in shaping a mother's ability to provide adequate nutrition. Financial stability enable access to diverse, nutrient-rich foods, while poverty and financial dependency remain major barriers. Economic challenges significantly affect child nutrition, particularly in rural area, where limited resources and socioeconomic disparities often restrict access to healthy food. Mothers in low-income households often face a difficult choice between food quantity and quality, prioritising basic sustenance over nutritional diversity (Black et al., 2013). Families with lower socioeconomic status are more likely to experience food insecurity, which directly compromises the nutritional outcomes of children. In Pakistan, for example, households facing economic challenges often experience significant food insecurity, increasing parental stress and negatively affecting child nutrition (Ahmed et al., 2024). Similar patterns are observed in Latin America and the Caribbean, where lower wealth indices predict a double burden of malnutrition – overweight mothers coexisting with stunted children (Otten & Seferidi, 2022). Addressing these socioeconomic challenges requires targeted interventions, such as microfinance programs, food subsidies, and community nutrition education, to improve access to nutritious food and break the cycle of malnutrition.

Maternal Employment and Time Constraints

In many developing countries, increasing maternal workforce participation, coupled with inadequate childcare support, creates significant time constraints that can impact child nutrition. In India, for instance, as more mothers enter the workforce, they often face higher non-food expenditures, leading them to rely on ready-to-eat market foods, which are convenient but tend to be less nutritious (Chaturvedi et al., 2016). These time constraints can result in reduced meal preparation at home and increased reliance on processed foods, which may contribute to poorer nutritional outcomes for children. Meanwhile, in Brazil, Amaral (2018) noted that maternal employment can enhance household income and improve access to a wider variety of foods. However, without a balanced approach to nutrition, increased financial resources can also lead to higher consumption of calorie-dense, processed foods, contributing to overweight and obesity among children (Amaral, 2018). This highlights the complex relationship between

maternal employment and child nutrition, where economic improvements can have both positive and negative dietary effects. For mothers in low-income settings, the challenge of balancing work and caregiving is even greater. Employment demands can limit the time available for meal preparation and attentive child feeding, making it difficult to adhere to public health nutrition guidelines. Although these mothers strive to prioritise their family's health, limited resources and time constraints often lead them to neglect their own well-being, which, in turn, may affect their ability to provide optimal nutrition for their children (Wittels et al., 2022).

Educational of Mothers

Educational Status and Health Literacy

Educational attainment and health literacy profoundly affect a mother's approach to child nutrition. Mothers with higher education levels tend to achieve better child health outcomes, as they are more knowledgeable about diet diversity, portion control, and food hygiene (Akseer et al., 2023). Access to education equips mothers with the ability to make informed dietary choices, positively influencing their children's nutritional status. A study conducted in Indonesia found that mothers with higher education levels and those who were employed were more likely to correctly perceive their children's nutritional status, suggesting that education and exposure to broader social contexts improve maternal awareness of child nutrition (Neli et al., 2021). The role of maternal education is particularly significant in rural areas, where healthcare resources and access to nutritional information are often limited. In Punjab, Pakistan, a study conducted by Shahid et al. (2020) revealed that 91.8% of malnourished children were born to mothers with low nutritional awareness, underscoring the importance of maternal education in preventing malnutrition (Shahid et al., 2020). Furthermore, low literacy remains a formidable barrier especially for mothers in rural areas. In regions with limited educational access, mothers often rely on traditional practices that may not align with modern dietary recommendations (Hoddinott et al., 2012). Mothers with limited health literacy often relied on informal sources such as family, friends, and social media for nutritional advice. However, these sources may not always provide accurate or evidence-based information. A study by Rudin et al. (2024) found that mothers with low health literacy often perceived informal sources as more credible than professional healthcare providers, leading to potential misinformation and poor feeding practices. Misconceptions about nutrition can lead to either underfeeding or overfeeding, both of which negatively impact child health. Despite this, many parents continue to face significant challenges in health literacy, which impairs their ability to make informed health decisions for their children. Morrison et al. (2019) highlighted that poor health literacy is associated with inadequate nutrition knowledge and practices, leading to higher malnutrition and other health issues among children. Parents with low health literacy may struggle to interpret food labels, understand portion sizes, or assess the nutritional content of foods, increasing the likelihood of unhealthy feeding patterns (Morrison et al., 2019). Addressing these health literacy challenges is essential to prevent malnutrition and related health issues in children, especially in communities where parents have limited education or access to reliable health information.

Access to Healthcare and Nutritional Support Programs

Role of Traditional Practitioners and Accessibility

Traditional practitioners play a significant role in shaping maternal behaviours related to child nutrition, particularly in communities where cultural beliefs strongly influence dietary practices. As custodians of traditional knowledge, these practitioners pass down both beneficial and harmful nutritional practices. In Indonesia, long-standing cultural beliefs shape maternal and infant feeding practices, often reinforced by traditional practitioners and family elders. Astuti et al. (2024) documented that many mothers avoid milk, red meat, seafood, eggs, and chicken during pregnancy due to fears that these foods cause hypertension, miscarriage, allergies, or affect the baby's appearance, beliefs commonly advised by older relatives and traditional birth attendants. Similar restrictions apply to children, with eggs and seafood often withheld for fear of allergies. Prelacteal feeding, for example newborn is given honey, sugar, coffee, rice water, or plain water, believed to bring good fortune, cleanse the infant's body, or promote growth.

Traditional birth attendants and senior family members play a central role in transmitting and reinforcing these beliefs, often outweighing health workers' advice. These traditional practices, though culturally significant, contribute to nutritional inadequacy and increase the risk of stunting (Astuti et al., 2024). Similarly, in Kenya, traditional birth attendants and family elders remain the main sources of infant feeding guidance, shaping practices in ways that often diverge from modern health recommendations. Among the Maasai community, Mugo (2008) found that prelacteal feeding, offering infants traditional fluids before breastfeeding, was widely practised, exclusive breastfeeding was rare, and nearly all mothers introduced complementary foods before one month of age in line with ancestral customs.

Advice from elders outweighed that from health clinics, illustrating how traditional knowledge systems continue to dominate maternal nutrition decisions in rural settings (Mugo, 2008). Meanwhile, in Turkey, societal pressure and maternal anxiety contribute to early complementary feeding, which may not always align with current nutrition recommendations. Ertem and Ergün (2013) found that many mothers discard colostrum because it is believed to be "dirty" or harmful. During this waiting period, infants are often given sugar water or herbal mixtures as prelacteal feeds to cleanse the stomach and bring blessings. Feeding decisions are typically controlled by grandmothers or mothers-in-law, and mothers who follow medical advice rather than traditional norms may be criticised.

Sons are often breastfed longer than daughters due to cultural expectations of male strength. These beliefs, reinforced by social pressure and maternal anxiety about milk sufficiency, result in deviation from national nutrition recommendations and practices (Ertem & Ergün, 2013). However, some traditional practices can also play a protective role. Kristo et al. (2021) observed that in low-income Turkish families, strong intergenerational support systems and customary food habits contribute to healthier diets among preschool children. Extended family networks encourage the preparation of home-cooked traditional dishes using fresh ingredients supplied by rural relatives, while eating out and processed snacks are discouraged. Mothers, supported by grandmothers and older women, prioritise vegetables, legumes, and soups over calorie-dense convenience foods. These traditional household structures and food-sharing practices help preserve balanced dietary patterns and reduce obesity risk even among children from low socioeconomic backgrounds. (Kristo et al., 2021).

This dual impact underscores the need for a nuanced approach; while some traditions promote child well-being, others may contribute to malnutrition or unhealthy feeding patterns.

Resistance to modern nutritional interventions remains a challenge. Traditional practitioners, deeply rooted in cultural beliefs, may be hesitant to adopt scientifically backed nutrition recommendations. This reluctance can hinder efforts to introduce improved child nutrition practices through public health initiatives (Sivaramakrishnan & Patel, 1993). Therefore, integrating traditional knowledge with modern nutritional science, rather than dismissing it entirely, may be a more effective strategy for sustainable behaviour change.

Access to healthcare and nutritional support is vital for improving maternal and child nutrition. Consistent access to maternal counselling and child growth monitoring play an important role in empowering mothers with evidence-based dietary knowledge and enhances mothers' ability to make informed nutritional choices (Torlesse et al., 2021). However, in remote and underserved areas, limited healthcare access often forces mothers to rely on traditional healers rather than trained medical professionals (Burtscher & Burza, 2015). Cultural familiarity, affordability, and trust in traditional healers contribute to their continued influence in these settings. To bridge this gap, community-based interventions such as mobile health units and community health worker programs can provide culturally appropriate nutrition education while respecting traditional values, which could improve maternal knowledge and child health outcomes in underserved communities.

Strength And Limitation

This review offers a comprehensive and multidimensional understanding of the sociocultural, psychological, and economic determinants that shape maternal practices and child nutrition outcomes, especially in underserved and low-resource settings. One of its key strengths is the integration of diverse global studies across different cultural contexts. The inclusion of both qualitative and quantitative evidence enhances the robustness of the review, while the focus on maternal autonomy, mental health, health literacy, and coping strategies adds a critical depth to the discussion. However, the review also presents several limitations. First, there is an inherent heterogeneity in the studies reviewed, making it difficult to generalize findings across contexts. Variations in study design, measurement tools, and cultural norms limit the ability to draw consistent conclusions, particularly regarding maternal autonomy and its impact on child malnutrition. Additionally, while the review highlights the influence of traditional practices and beliefs, it does not fully explore the mechanisms through which these practices can be transformed or integrated with modern nutritional knowledge. A further limitation lies in the underrepresentation of paternal roles and systemic policy influences, which are crucial to creating sustainable improvements in maternal and child nutrition.

Recommendations

Based on the review findings, a set of targeted, culturally sensitive, and evidence-based interventions are recommended to improve child nutrition outcomes. First, maternal mental health and autonomy should be central components of nutrition programs, recognising the interplay between psychological well-being, decision-making power, and caregiving practices. Integrating mental health support into maternal and child health services could address barriers related to stress, stigma, and health-seeking behaviour. Second, health literacy campaigns must be tailored to address misinformation and low literacy levels, especially in rural areas. These efforts should be accompanied by accessible, community-based nutrition education, delivered in local languages, and supported by trusted community figures such as grandmothers, fathers, and traditional practitioners. To promote sustainable impact, nutrition-sensitive policies should also incorporate childcare support for working mothers and expand financial inclusion

strategies like microfinance. Finally, partnerships between modern healthcare providers and traditional practitioners can foster culturally respectful interventions that bridge knowledge gaps without alienating local beliefs. This dual approach may enhance program acceptance and adherence, ultimately supporting healthier outcomes for both mothers and children.

CONCLUSION

Mothers play a crucial role in shaping child nutrition, with their influence affected by socio-cultural, economic, educational, and healthcare factors. Supportive families, financial stability, education, and healthcare access empower mothers to make informed nutritional choices, while socio-economic constraints, restrictive cultural norms, and low health literacy present significant challenges. Implementing family oriented, culturally sensitive, and gender-inclusive interventions can enhance maternal influence, fostering sustainable improvements in child nutrition and well-being, particularly in underserved communities.

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Conflicts of Interest

The authors declare no conflict of interest.

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REVIEW ARTICLE Open Access

ADDRESSING NON-COMMUNICABLE DISEASES IN MEN IN MALAYSIA: PROBLEMS AND CHALLENGES FROM PERSPECTIVE OF FAMILY HEALTH

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Abstract

Non-communicable diseases (NCDs) are becoming a serious issue for Malaysian men, affecting not just their health, but also the lives of their families. Many men delay seeking help because of social stigma and traditional views about masculinity, often making problems worse. Lifestyle factors like poor diet, lack of physical activity, and smoking further increase the risks. The aim of this review is to highlight how NCDs affect men in Malaysia, especially how these diseases impact families emotionally, financially, and through caregiving. By examining these connections, this review hopes to show why we need health policies and support systems that consider men's unique challenges. Promoting more male-friendly healthcare, raising awareness, and encouraging family and community involvement could help more men act early, making families and communities healthier in the long run.

Keywords: Men's health, non-communicable diseases, NCDs, masculinity.

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INTRODUCTION

Issues relating to men's health have increasingly become a central focus for public health, owing to distinct physical, mental, and lifestyle risk factors that impact men in unique and often profound ways. Non-communicable diseases (NCDs) are among the most critical concerns worldwide and pose a particularly severe threat to men. Globally, men experience premature mortality at a higher rate compared to women, especially before the age of 70. According to World Health Organization (WHO) estimates, approximately 52% of all deaths arising from NCDs occur among men (Ministry of Health, 2019; PAHO, n.d.). Cardiovascular diseases (CVDs) remain the leading cause of death for men, accounting for 35.6% of mortality. This is an alarming persistence since 2000 that remained largely unchanged until 2016 (Zhang et al., 2021). These statistics illustrate a landscape where NCDs contribute to increased morbidity, mortality, and diminished quality of life for both individuals and communities.

Within Malaysia, the situation mirrors global trends but is contributed by local factors. NCDs have reached epidemic proportions, representing a major public health concern, and have substantially contributed to premature morbidity and mortality among men. Findings from the National Health and Morbidity Survey (NHMS) 2015 emphasize this reality where 16.7% of Malaysian men reported diabetes, 30.8% hypertension, and a striking 43.5% hypercholesterolemia. Alarmingly, more than half of these cases remained undiagnosed (7.6% for diabetes, 12.2% for hypertension, and 8.5% for hypercholesterolemia), revealing significant gaps in early detection and management (Ministry of Health, 2019). These gaps are also highlighted by subsequent data: in 2019, 4 in 10 adults in Malaysia had hypercholesterolemia, 3 in 10 had hypertension, and 1 in 5 lived with diabetes mellitus. Despite increasing public health interventions, by 2023, 1 in 3 adults still faced hypertension, 1 in 6 had diabetes mellitus, and 1 in 3 lived with hypercholesterolemia, showing persistent and ongoing challenges for cardiovascular disease management (Institute for Public Health, 2024).

Beyond these statistics, there is a clear gender disparity in health outcomes. Men in Malaysia live, on average, five to six years less than women and are twice as likely to die prematurely between the ages of 15 and 65 (Ministry of Health, 2019). This significant gap in life expectancy and premature death highlights the need for more deeper analysis of the burden and determinants of NCDs among men versus women. Factors contributing to this disparity include increased rates of smoking, hazardous occupational exposures, reluctance to seek medical care promptly, and culturally embedded behaviors related to diet, alcohol consumption, and physical inactivity (Hossin, 2021; Uwimana et al., 2023; Zhang et al., 2021).

Men's health is not only an individual matter but profoundly influences the wider family unit and broader community. This is especially evident in societies like Malaysia where men are frequently heads of household and primary breadwinners. Their ability to provide emotional, physical, and financial support is directly tied to their health status. When men are affected by chronic illness or experience premature death, family stability can be disrupted. This disruption manifests in emotional distress and financial strain, as both partners and children may struggle with increased caregiving responsibilities, anxiety about future wellbeing, and the potential for economic hardship (Grau Grau et al., 2022; Ningrum & Mas'udah, 2021).

NCDs such as heart disease, diabetes, cancer, and chronic respiratory illnesses exert an impact on Malaysian men, reinforcing these challenges at the family level (Ministry of Health, 2019). Men's vulnerability to CVD is driven by both biological predisposition and behavioral patterns, such as higher rates of smoking, excessive alcohol intake, and poor dietary habits

(Zhang et al., 2021). Occupational risks and delays in seeking medical attention also exacerbate disease progression and worsen outcomes (Hossin, 2021; Uwimana et al., 2023). Cultural pressures—expectations of stoicism, reluctance to seek help for mental health, and limited discourse around men's wellbeing—further impede timely intervention and self-care (Abdullah et al., 2022; Uwimana et al., 2023).

The economic burden borne by families affected by NCDs is substantial. In Malaysia, chronic conditions among men commonly lead to reduced work capacity and instability in household income (MInistry of Health Malaysia, 2022). Ongoing expenses for medical care and medications stretch household resources and disrupt both immediate and long-term financial plans, often rendering families vulnerable. The financial pressure is not unique to Malaysia; regional evidence from India and Saudi Arabia highlights similar patterns. (Behera & Pradhan, 2021) found that Indian families with a member affected by NCDs spent annual healthcare costs totaling INR 13,170 (approximately MYR 618.99), more than twice that of unaffected families. Costs for diabetic care in Saudi Arabia reached SAR 932 (approximately MYR 1,043.84), with hypertension and hypothyroidism care also incurring substantial out-of-pocket expenses (Almalki et al., 2022). Within Malaysia, out-of-pocket spending is especially high among low-income families, where rising medication prices and limited health coverage intensify financial hardship (Isamail et al., 2024; MInistry of Health Malaysia, 2022).

Faced with increasing pressures, families frequently make difficult choices such as delaying medical care, reallocating household resources, or adopting coping strategies such as borrowing money or liquidating property to pay for treatments. While these actions may provide temporary relief, they often lead to further emotional and financial stress leading to increased overall vulnerability of the family (Abdul Gani, 2025). Children may experience chronic anxiety regarding their father's health and future, while spouses carry the dual burdens of caregiving and managing household stability, sometimes undertaking additional employment to keep pace with expenses. Research also shows that wives of men with chronic illnesses face elevated levels of depression, anxiety, and relationship stress, as uncertainty about the future and high caregiving demands persist (Umrigar & Mhaske, 2022). Emotional strain and societal expectations often lead caregivers to neglect their own well-being, and the psychological toll of caregiving can even impact patient outcomes. Studies show that elevated caregiver stress is associated with increased mortality for care recipients, emphasizing the vital role of psychological support and family-focused interventions (Zhao et al., 2021).

Despite increasing recognition of these burdens, current health strategies often focus on the individual, overlooking the broader family consequences and support needs. To effectively address NCDs in men, interventions and educational efforts must be tailored to reflect men lived realities, promoting healthier habits, earlier health-seeking, and supportive societal norms.

This narrative review seeks to identify and critically examine the unique challenges posed by NCDs among Malaysian men, focusing on their family-level impacts—financial, emotional, and caregiving. By illuminating the interconnectedness of men's health and family wellbeing, the review advocates for comprehensive, gender-sensitive public health strategies that strengthen support systems and foster resilient, healthier communities.

METHODS

This narrative review identifies and analyzes literatures on non-communicable diseases (NCDs) in men and their impact on family health. A wide range of studies were selected to ensure comprehensive insights and input. Searches were conducted across major databases, including PubMed, Scopus, Google Scholar, and Web of Science, known for their extensive collections of peer-reviewed articles and reliable reports. Key search terms were selected to align with the study objectives, including "men's health," "non-communicable diseases," "family health," "caregiving burden," "economic impact," and "Malaysia." The searches utilized Boolean combinations such as ("men's health" OR "male health") AND ("non-communicable diseases" OR "NCDs") AND ("family health" OR "caregiving burden" OR "economic impact") AND "Malaysia" to systematically identify relevant studies in each database. This strategy ensured comprehensive coverage, capturing both international research and, importantly, literature specifically relevant to the Malaysian context.

The inclusion criteria adopted in searching for articles includes studies published between 2020 until October 2025 to ensure relevance to recent findings. However, earlier articles were also included when they provided essential context or foundational information. This strategy ensured the review captured both current perspectives and key insights into the topic. Government reports such as those from the National Health and Morbidity Survey (NHMS), National Men's Health Plan of Action Malaysia 2019-2023 and other relevant guidelines which offer valuable data and statistics specific to population health trends and challenges were also included. Publications from global health organizations, like the World Health Organization (WHO) and similar bodies, were also included. By combining these varied resources, the review aimed to present a well-rounded and credible exploration of NCDs in men. Another inclusion criteria for literature selection in this review are studies on adult man (18 years and older) as it aligns with the aims and focus of this review.

Studies focus on women, children, or pediatric NCDs were excluded, as they fall outside the scope of this research. Another exclusion criteria is non-English publications without accessible translations were not included to ensure consistency and accessibility in the analysis.

RESULTS AND DISCUSSION

NCDs such as cardiovascular diseases, diabetes, cancer, and chronic respiratory conditions affects men globally, significantly contributing to morbidity and mortality. Factors like unhealthy lifestyles, occupational risks, and cultural norms discouraging early healthcare-seeking behaviors accounts for the irregular distribution of disease to men more when compared to women. In Malaysia, the rising prevalence of NCDs among men not only strains families but also the healthcare systems, as men's illnesses often lead to financial instability, increased caregiving responsibilities, and emotional stress. However, health policies often overlooked these family effects, focusing solely on individual treatment. This review aims to highlight the challenges of NCDs in men and their broader impact on family health.

Factors Associated with NCDs in Men

Epidemiological Trend of NCDs among Men

NCDs affecting men are a major concern due to their contribution to morbidity and mortality, with significant effects on families and society. Cardiovascular diseases, diabetes, cancer,

chronic respiratory conditions, and mental health disorders are leading health issues for men globally. NCDs and injuries together account for 86% of all male deaths worldwide (WHO, 2018). Among all NCD-related deaths, cardiovascular diseases rank highest, causing approximately 17.9 million deaths annually, followed by cancers (9.3 million deaths), chronic respiratory diseases (4.1 million deaths), and diabetes including diabetes-related kidney disease (2 million deaths) (WHO, 2023).

In the Americas, NCDs contributed to 5.8 million deaths in 2019, comprising 3 million men and 2.8 million women. The overall global death rate from NCDs is estimated at 411.5 per 100,000 population, with men exhibiting a notably higher rate (482.6 deaths per 100,000) than women (351.6 deaths per 100,000)(Pan American Health Organization, 2021). This epidemiological pattern signifies a clear gender gap: men experience significantly greater NCD-related mortality. Notably, men are 75% more likely to die from ischemic heart diseases than women, and 36% of male deaths are considered preventable compared to 19% for females (PAHO, n.d.; Pan American Health Organization, 2021).

Regional insights further emphasize hypertension, depression, gastrointestinal disorders, and diabetes as common NCDs among men. For instance, in India, hypertension (31.6%), depression (24.4%), gastrointestinal disorders (18.7%), and diabetes (11.93%) were prevalent among male patients (Sharma et al., 2023) . These findings underscore the urgent need for gender-responsive strategies and heightened attention to the impact of NCDs on men.

Transition to the Malaysian Context

In Malaysia, the burden of non-communicable diseases (NCDs) in men is pronounced and reflects global trends. Recent findings from the NHMS 2023 show that 15% of Malaysian men have diabetes, 29% have hypertension, and about 30% have hypercholesterolaemia. Over half of adults are overweight or obese, while 19%—predominantly men—are smokers (Institute for Public Health, 2024). NCDs account for 72% of all premature deaths, impacting working-age men most significantly(Ministry of Health Malaysia, 2024).
The high prevalence is compounded by behavioral risks such as smoking, unhealthy diets, low physical activity, and occupational hazards. Additionally, cultural expectations and delayed health-seeking behaviors contribute to late diagnosis and poorer outcomes (Abdullah et al., 2022; Ministry of Health, 2019; Uwimana et al., 2023). Addressing these issues requires gender-sensitive, locally relevant strategies that focus on prevention, early detection, and tailored public health interventions.

Men's Risk Factors

The rising prevalence of non-communicable diseases (NCDs) among men is strongly influenced by specific risk factors and behaviors which differ in magnitude and pattern from those seen in women. Gender plays an important role, with men often facing distinctive societal roles, behavioral influences, and biological predispositions that elevate their NCD risk (Ministry of Health, 2019).

Major modifiable risk factors include unhealthy diets, tobacco use, excessive alcohol consumption, and physical inactivity. Notably, men tend to fare worse than women across all these domains (Ministry of Health, 2019). In Malaysia, national data underscore persistently high-risk factor prevalence among men. The National Men's Health Plan of Action 2018–2023 reports that 46.6% of men are overweight or obese, 41.4% smoke, and fewer than 6% meet fruit

and vegetable intake recommendations where all significantly worse than rates compared to women (Ministry of Health, 2019). Notably, males are 26.7 times more likely to smoke and 5.1 times more likely to consume alcohol than women (Cheah Yk, 2014), with approximately 4.8 million male smokers identified in the NHMS 2019 (Wiki Impact, 2021).For example, research in Canada showed that over 60% of men reported unhealthy diets, and nearly 70% had poor eating habits, often linked to socioeconomic status and household composition (Kasabwala et al., 2020). In Malaysia, similar challenges were found with nearly half (48.9%) of men do not achieve the WHO-recommended 150 minutes of moderate exercise per week, reflecting significant gaps in physical activity (Kasabwala et al., 2020).

These high-risk behaviors are significantly influenced by cultural perceptions of masculinity, linking smoking and alcohol use to toughness and risk-taking, which creates barriers to health promotion efforts (Wiki Impact, 2021). Geographic and socioeconomic disparities further complicate prevention efforts, with higher smoking rates observed in states such as Kedah, Sabah, and Terengganu, often correlating with lower education and income levels (Cheah Yk, 2014; Wiki Impact, 2021). These risk behaviors are not only present but also deeply embedded in social and cultural expectations. For example, smoking rates among men are substantially higher, partly influenced by notions of masculinity associated with toughness, risk-taking, and emotional restraint. Men are more likely to start smoking at a younger age and typically consume more cigarettes and inhale more deeply compared to women. This pattern reflects both peer influence and social identity, though more research is needed to clarify the impact of inhalation depth on health risk (Flandorfer et al., 2021).

Similarly, alcohol consumption among men is shaped by cultural norms, serving as a means of social bonding, stress relief, and coping with life challenges like fatherhood or employment pressures (Dimova et al., 2022). These shared habits contribute to increased NCD risk profiles for men.

Turning to the Malaysian context, the NHMS 2023 reports that 2.5% of adults suffer from four major NCDs which are diabetes, hypertension, high cholesterol, and obesity, while 2.3 million adults live with at least three such conditions (Institute for Public Health, 2024). This clustering of NCDs greatly increases the risk of severe cardiovascular outcomes, including heart disease and stroke, especially among men (Institute for Public Health, 2024). Key contributors to these burdens include cardiovascular diseases, colorectal cancer, and lung cancer, which are intimately associated with risk factors such as hypertension, diabetes, dyslipidemia, smoking, poor diet, excessive alcohol, and insufficient physical activity (Ministry of Health, 2019). These lifestyle and behavioral patterns, paired together with lower rates of healthcare utilization and delayed health-seeking, contributes to high NCD prevalence among Malaysian men.

In summary, the combination of behavioral, social, and biological factors underscores why men remain particularly vulnerable to NCDs in Malaysia. Recognizing and targeting these modifiable risk factors through early intervention, education, and gender-specific strategies are essential for reducing the NCD burden and improving population health outcomes.

Socioeconomic Factors

In Malaysia, the prevalence of NCDs among men is heavily influenced by socioeconomic, cultural, and behavioral factors, which directly and indirectly impact health outcomes. Local studies show that variables such as job type, education level, income, and access to healthcare

play a significant role in determining how men manage NCD risk (Ithnin et al., 2021). For instance, low socioeconomic status is linked to increased mortality, with health-related behaviors accounting for less than one-fourth of these associations (Khalatbari-Soltani et al., 2020).

Furthermore, urban men often possess more health knowledge but may struggle to adopt healthy practices, whereas rural men tend to have better health attitudes but face challenges due to limited resources (Ithnin et al., 2021). These urban–rural differences underline the need for tailored interventions that target the specific circumstances of each group.

Additionally, health-seeking behavior in Malaysian men is shaped by factors such as income, education, employment status, and access to healthcare. Higher income and private insurance increase the likelihood of seeking timely treatment, while better education improves health literacy and proactivity. Conversely, lack of paid sick leave or limited healthcare resources can deter men from seeking care when needed (Abdullah et al., 2022; Ithnin et al., 2021). Both studies highlight that socioeconomic barriers persist in both urban and rural settings, emphasizing the need for comprehensive and equity-focused public health strategies.

Cultural and Societal Factors

Cultural and social influences significantly affect men's healthcare usage, often resulting in lower healthcare utilization compared to women. Social expectations around masculinity frequently lead men to avoid preventive care and delay seeking help for health issues (Grau Grau et al., 2022). Men may feel pressured to appear strong and self-reliant, which can cause them to neglect early signs of illness and postpone medical visits for serious conditions such as heart attacks or strokes.

In traditional context of masculinity, as highlighted by (Mokua et al., 2024), men may feel discouraged from seeking healthcare and addressing symptoms, perceiving such conditions as minor or believing it's a "real man's" responsibility to manage health independently. These behaviors are further reinforced by societal expectations, education, and personal attitudes towards health (Ministry of Health, 2019). Societal perceptions of masculinity such as associating risk-taking with strength directly contributes to unhealthy behaviors, including smoking, substance use, and risky sexual practices (Courtenay, 2000).

For behavioral factors, men adopt risk-taking habits such as poor diet, tobacco smoking, and excessive alcohol consumption, all of which elevate their likelihood of developing NCDs (Kasabwala et al., 2020; Ministry of Health, 2019). Men who view health problems as non-serious, or believe they can handle them independently, are less likely to seek medical care leading to lower healthcare utilization and poorer outcomes (Abdullah et al., 2022).

Societal expectations of men as providers and role models also create unique stresses, sometimes preventing men from accessing essential services, including sexual health (Young et al., 2024). Collectively, cultural, social, and behavioral factors underlie many of the disparities observed in NCD prevalence and men’s health-seeking behavior in Malaysia. It is important to recognize that these influences including socioeconomic, cultural, and behavioral factors differ from those affecting women and require tailored intervention strategies for effective NCD management in men. A gender-sensitive approach is needed, accounting for societal pressures and unique male health attributes, to guide public health policies and interventions. Factors associated with NCDs in men are summarized in Table 1.

Table 1: Summary Factors Associated with NCDs in Men

FACTORS	DETAILS	FINDINGS	AUTHOR
Men's Risk Factor	High-risk behaviors: poor diet, physical inactivity, tobacco use, alcohol	High prevalence of overweight/obesity (46.6%), smoking (41.4%), <6% meet fruit/veg guidelines. Poor diet, inactivity, and smoking together drive higher rates of CVD, diabetes, and cancer among Malaysian men.	(Ministry of Health, 2019; Wiki Impact, 2021)
	Socio-demographic & state disparities in risk behaviors	Men in certain states (Kedah, Sabah, Terengganu) show higher smoking prevalence; risk behaviors more common among men with lower income/education levels	(Cheah Yk, 2014; Wiki Impact, 2021)
	Physical inactivity	48.9% of men do not meet recommended activity levels; inactivity and poor diet remain major modifiable contributors to NCD development among men.	(Kasabwala et al., 2020)
Socioeconomic factor	Income, education, employment, healthcare access, urban/rural difference	Low socioeconomic status (SES), education, job type, access, and resources are linked to poor health behaviors and less preventive care; rural men face resource challenges, urban men have more knowledge but less action.	(Ithnin et al., 2021; Khalatbari-Soltani et al., 2020)
	Healthcare utilization & private insurance	Men with higher income, private insurance, and education are more likely to seek care and proactively manage NCD risk, while those with lower SES face more barriers and delayed care.	(Abdullah et al., 2022; Ithnin et al., 2021)
	Occupation	Lack of paid sick leave and limited healthcare access discourage some men from seeking timely medical care.	Abdullah et al., 2022

Cultural and societal factor	Masculinity, social/cultural norms, role as provider, health beliefs	Masculinity discourages preventive care, favors risk-taking and unhealthy behaviors (smoking, alcohol, substance use, risky sex). Men are less likely to seek care, viewing health issues as manageable or non-serious, and are hindered by "provider" pressures.	(Abdullah et al., 2022; Courtenay, 2000; Grau Grau et al., 2022; Mokua et al., 2024; Wiki Impact, 2021; Young et al., 2024)

Impact and Challenges

Impact towards Family Health

Men's health within the family context has vital implications especially in economic stability, emotional wellbeing, and caregiving dynamics. In Malaysia, when men with NCDs, their illness can impose significant out-of-pocket expenditure (OOPE) for healthcare affecting the family financial status. For example, most outpatient visits (61.5%) are paid for by OOPE, with only 18.2% covered by insurance (Institute for Public Health, 2024). This reliance places a heavy financial strain on households, forcing some families to compromise on other essential needs, such as education or housing.

For families with limited income, these expenses can be catastrophic. Coping mechanisms such as using personal savings, relying on family support, or borrowing money reflects the immense financial stress father or husband's illness can cause, sometimes pushing families into poverty (Mehak & Rajesh, 2023; Okoronkwo et al., 2016). Disrupted financial status undermines family security and long-term planning, while insufficient financial protection intensifies household vulnerability to hardship.

Beyond economics, men's health struggles often increase the burden on family members who must provide care for a husband or father with chronic disease. This includes not only managing medications, hospital appointments, and finances, but also dealing with the ongoing stress of the patient's ill health. Caregivers frequently spouses or adult children—report higher rates of anxiety, depression, isolation, and family conflict as the demands of care grow (Kang et al., 2020; Li et al., 2021; Mirhosseini et al., 2021; Umrigar & Mhaske, 2022). Over time, these stresses risk eroding family bonds and weakening overall emotional resilience.

Caregivers may become overburdened or burn out in the absence of sufficient support, such as financial aid, mental health services, or respite care. While some safety nets exist such as Malaysian tax relief up to RM6,000 for families managing disability or long-term illness by LHDN (LHDN, 2025), a stronger caregiver and patient support is urgently needed to protect families. Ultimately, addressing NCD burden in Malaysian men requires policies and programs that reflect the central role of men in family life and actively bolster the entire support system that cares for them.

Impact on Healthcare System

One of the core challenges for men's health in Malaysia is the limited availability of gender-sensitive healthcare services. Most healthcare systems utilize a generalized, "one-size-fits-all" approach, which fails to address the unique needs, risk factors, and health-seeking behaviors of men. For instance, screening programs, counseling, and outreach campaigns often do not tailor interventions or environments specifically for male patients, which reduces uptake and effectiveness. In contrast, research from Kelantan shows that men value primary care that is male-friendly, emphasizes comfort, and respects their preferences which such service model can enhance engagement and outcomes (Ab Aziz et al., 2022).

Stigma and cultural norms continue to discourage men from seeking timely healthcare. Men are less likely to access health services, as this conflicts with expectations of masculinity centered on toughness, self-reliance, and invulnerability (Leone et al., 2021). As a result, symptoms are often ignored until conditions become worsened, leading to late-stage diagnosis,

advanced disease, poorer prognosis, and increased system costs (Husted et al., 2022). Men reluctant to seek support for mental health or preventive care due to fear of stigma or being judged are more likely to present with advanced physical or psychological concerns (Abdullah et al., 2022; Eggenberger et al., 2021). This tendency amplifies NCD burden and increases overall pressure on healthcare resources, as treatable diseases progress unnecessarily.

Policy and system gaps further impede progress in addressing this NCDs among men. Many interventions remain gender-neutral, which fail to acknowledge men's unique occupational hazards, mental health challenges, and dominant NCD risk factors such as smoking, diet, and inactivity (Institute for Public Health, 2024; Ministry of Health, 2019; Sivanantham et al., 2021). Public health strategy must move beyond generic goals and integrate research and practice that are gender-responsive and context-specific.

Studies show that gender-focused health approaches not only improve men's engagement with services but can also enhance overall health outcomes and reduce long-term costs (Abualhaija, 2022; Seidler et al., 2024; Sunki Kim & Soyoung Yu, 2023). For example, activities like tailored communication, mental health education, and increasing male participation in reproductive health and self-care programs are critical for population-level NCD prevention (Narasimhan et al., 2021).

These gaps highlight the urgent need for coordinated gender-sensitive reforms in men's healthcare. Addressing the limitations of a generalized approach, combating stigma, and tackling social and behavioral barriers are essential prerequisites for improving men's health outcomes in Malaysia.

Proposed Strategies for Intervention of NCDs in Men

Improving the health of Malaysian men and reducing non-communicable diseases (NCDs) requires interventions that reflect the realities of men's risk profiles and societal roles. Gender-sensitive design in healthcare is important in developing male-friendly clinics with targeted screenings, extended service hours, approachable staff, and comfortable environments can improve men's engagement. Such approaches reduce barriers to care and align service delivery with men's preferences, as supported by the National Men's Health Plan of Action and recent primary care studies in Malaysia (Ab Aziz et al., 2022; Ministry of Health, 2019).

Addressing stigma is equally crucial for changing how men interact with the healthcare system. Stigma rooted in traditional masculine ideals discourages men from seeking help, especially for mental health or preventive care. Interventions must include public and workplace campaigns that normalize help-seeking, coupled with confidential and accessible counseling services (Eggenberger et al., 2021; Leone et al., 2021). These efforts support earlier care-seeking and improved long-term health behaviors among Malaysian men.

Evidence-based intervention design should respond directly to the most prevalent local risks for men, such as tobacco use, excessive alcohol consumption, unhealthy diets, physical inactivity, and occupational stressors. Programs must utilize digital tools, health education, workplace wellness initiatives, and community outreach to ensure relevance. Successful initiatives in Malaysia target common male behaviors and environments, supporting healthier choices and sustainable change (Institute for Public Health, 2024; Ministry of Health, 2019).

Effective NCD control also benefits from interdisciplinary and community collaboration. Engaging family members, workplaces, local leaders, and peer networks creates a holistic support system, reinforcing new norms and improving health literacy. Community-based and intersectoral approaches have been particularly effective in rural areas and high-risk groups, enhancing sustainability and reach (Oliffe et al., 2020).

Socioeconomic barriers remain a significant challenge, with men of lower income or from rural background facing greater obstacles to timely diagnosis and treatment. Policy solutions must include simplified healthcare navigation, direct subsidies, expanded insurance coverage, and outreach that specifically prioritizes vulnerable men. Concrete examples include reduced clinic fees, transportation support, and subsidized screenings for at-risk males (Bezzina et al., 2024; Bidmead et al., 2023; Chapman et al., 2020).

Finally, for long-term sustainability, policies and research must routinely integrate a men's health perspective. National frameworks should fund and monitor gender-sensitive mental and physical health initiatives, while supporting ongoing studies to refine and adapt interventions for Malaysian men. Scaling up these efforts is aligned with national policy, as many NCD complications and deaths among men are preventable with early, gender-targeted action (Ministry of Health, 2019; Seidler et al., 2024; Sunki Kim & Soyoung Yu, 2023).

By grounding intervention strategies in evidence, tailored delivery, and the realities faced by Malaysian men, the health system can achieve meaningful progress in reducing NCD burdens and supporting both men and their families.

CONCLUSION

NCDs poses significant health and economic challenges for men, impacting their well-being and family stability. Barriers such as stigma, societal norms, and limited access to tailored healthcare contributed to the delayed diagnoses and poor outcomes. Unhealthy lifestyles like poor diets, smoking, and inactivity worsen the burden. Addressing these issues requires targeted education, gender-sensitive services, mental health support, and preventive programs. Community engagement, technology, and inter-sectoral collaboration are also key to reducing stigma and promoting healthier behaviors among men thus reducing NCDs. These strategies can improve outcomes and ease the economic strain on households and healthcare systems.

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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REVIEW ARTICLE Open Access

RISING TEMPERATURES, RISING CHALLENGES: A NARRATIVE REVIEW ON STRENGTHENING CHILD GROWTH MONITORING SYSTEMS AMID CLIMATE VULNERABILITY

Edwin de Cruz[1], Khalid Mokti[1*], Azman Atil[1]

Abstract

Climate change presents an unprecedented challenge to child growth monitoring systems, with vulnerable populations disproportionately affected by malnutrition, health system disruptions, and displacement. This narrative review synthesizes evidence on the impacts of climate change on child health and explores adaptive strategies, including digital health innovations, community-based interventions, and policy responses. Case studies from climate-vulnerable regions highlight the importance of integrating growth monitoring into broader climate resilience frameworks. Recommendations include strengthening multi-sectoral collaborations, prioritizing equity in funding, and fostering community engagement to ensure sustainability. This review underscores the urgency of action to protect child health amid a changing climate.

Keywords: Child growth monitoring, Climate change, Malnutrition, Digital health, Health system strengthening.

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INTRODUCTION

Child growth monitoring, encompassing the regular measurement and tracking of children's physical growth parameters such as weight, height, and head circumference, serves as a cornerstone of public health by evaluating nutritional status and identifying developmental concerns (Yap et al., 2018). Despite its universal importance, implementation challenges persist globally. In Indonesia, only 15.3% of community health posts accurately measured body weight (Kusumawati et al., 2021), while research reveals that nearly 97% of children experience growth faltering over one-month periods during infancy (Leroy et al., 2025). Furthermore, only about one-third of all countries are currently on track to halve childhood stunting by 2030 (World Health Organization, 2023), underscoring the urgent need for enhanced monitoring systems worldwide.

These pre-existing challenges are now compounded by the escalating global threat of climate change, which imposes severe burdens on child health and existing healthcare systems. Climate change is projected to cause an additional 14.5 million deaths and $12.5 trillion in economic losses by 2050, with healthcare systems facing a predicted $1.1 trillion additional burden (World Economic Forum, 2025). Environmental and occupational risk factors already account for 18.9% of global deaths and 14.4% of all disability-adjusted life years (DALYs). The urgency is underscored by 2024 becoming the first year to exceed 1.5°C above pre-industrial levels, reaching 1.55°C (World Meteorological Organization, 2025), with human-induced warming accelerating at an unprecedented rate of 0.27°C per decade (Forster et al., 2025).

For children, climate change creates cascading health impacts through multiple pathways. Extreme weather events cause displacement and psychological trauma, while disrupted food systems exacerbate malnutrition during critical developmental periods (Hadley et al., 2023; Rylander et al., 2013). Climate-induced changes in disease vector patterns increase infectious disease risks, while water shortages and poor sanitation amplify infection susceptibility (Torres-Fernández et al., 2024; Patz & Khaliq, 2002). These interconnected challenges disproportionately affect vulnerable populations in regions such as Sub-Saharan Africa, South Asia, and Pacific Islands, where economic, environmental, and social vulnerabilities converge.

The intersection of climate change impacts with existing growth monitoring deficiencies creates a critical research gap. While robust child growth monitoring systems are essential for early detection and intervention, climate change threatens to overwhelm these already-strained systems precisely when they are most needed. This convergence demands innovative approaches that strengthen monitoring capabilities while building climate resilience.

This narrative review synthesizes evidence on climate change impacts on child health and examines strategies for strengthening child growth monitoring systems in vulnerable contexts, providing actionable recommendations for policymakers and public health professionals to address these interconnected challenges in an era of environmental uncertainty.

METHODS

This narrative review synthesizes existing evidence to examine the impacts of climate change on child growth monitoring systems and to identify strategies for strengthening these systems in vulnerable contexts. The aim is to integrate insights from diverse sources to provide actionable recommendations for policymakers and public health professionals.

A comprehensive literature search was conducted across PubMed, ScienceDirect, and Scopus using keywords such as "child growth monitoring," "climate change child health," "digital health solutions," and "policy adaptation for climate vulnerability," with Boolean operators to refine results. Gray literature from the World Health Organization (WHO) and UNICEF was also reviewed to incorporate policy perspectives and practical insights.

Inclusion criteria: English-language peer-reviewed articles, case studies, and reports published within the last 10 years that employed quantitative, qualitative, or mixed methodologies. Exclusion criteria: non-English publications, studies focusing exclusively on adult populations, and publications unrelated to public health or child growth monitoring.

Regions of emphasis included Sub-Saharan Africa, South Asia, and the Pacific Islands, selected for their heightened vulnerabilities due to economic, environmental, and social factors. A thematic synthesis approach was used to identify and organize key themes: challenges in climate-vulnerable contexts, technology-driven and community-based solutions, and policy integration within broader climate adaptation frameworks.

To structure this review around a clear, theory-driven model, we adopt the following framework, which illustrates how climate stressors interact with pre-existing health system weaknesses to impair child growth monitoring and lead to adverse health outcomes.

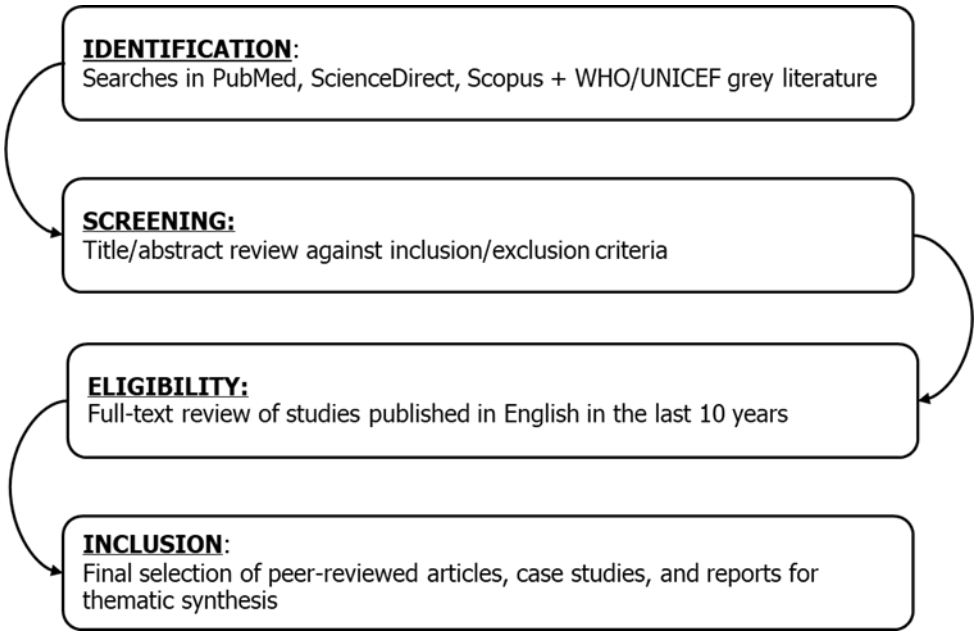

Figure 1: Narrative Review Process

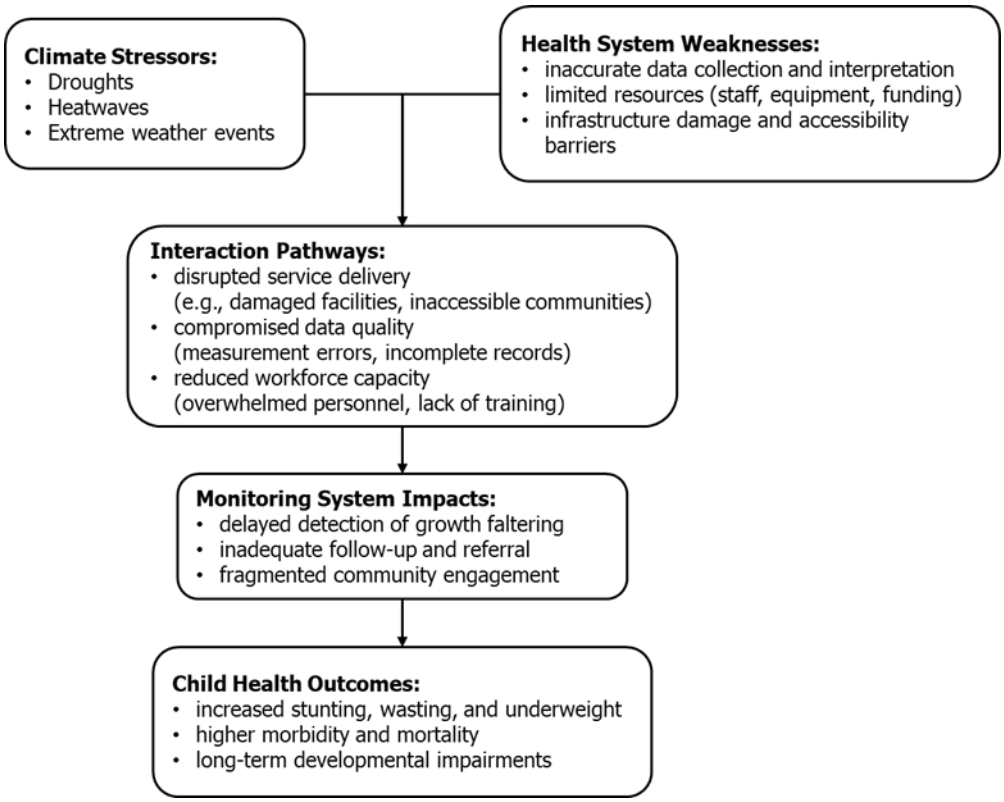

Figure 2: Conceptual framework for child growth monitoring under climate vulnerability.

RESULTS AND DISCUSSION

Synthesized Findings: Impacts and Adaptation Strategies

Climate change profoundly impacts child growth and development through three interconnected pathways: food insecurity, health system vulnerabilities, and climate-induced displacement. Food insecurity driven by crop failures, droughts, and extreme weather undermines nutritional status, leading to stunting, wasting, and underweight in children during critical early-life stages (Dimitrova, 2022; Ol, 2022). Certain groups such as boys, children of uneducated mothers, rural populations, and agricultural households are especially vulnerable due to limited coping mechanisms and resources (Dimitrova, 2022; Ol, 2022). Addressing these challenges requires comprehensive strategies such as household income support, targeted nutritional interventions, stress-tolerant crops, enhanced food markets, and social protection measures (Fanzo et al., 2024).

Health system vulnerabilities amplify climate-related impacts on growth monitoring by disrupting infrastructure and service delivery. Extreme weather events damage healthcare facilities, transportation, and communication networks, hindering child health assessments. For instance, the April 2014 floods in Honiara, Solomon Islands, destroyed infrastructure, caused a diarrhoeal outbreak, and led to ten paediatric fatalities (Natuzzi et al., 2016). Hurricanes such as Maria in 2017 further illustrate how power outages and delayed responses can result in catastrophic child health outcomes (Little & Wallace, 2020). Enhancing infrastructure resilience

and emergency preparedness through rapid environmental hazard assessments and resilient facility design is essential to maintain growth monitoring during crises (Ma et al., 2019).

Climate-induced displacement adds complexity by interrupting established monitoring systems and data continuity. Disasters force families to relocate, straining both origin and destination health services. In Bangladesh, climate-driven rural–urban migration has challenged the tracking of children's growth across settings (M.M. Ali et al, 2024), while Indonesia's economically driven migration further complicates monitoring efforts (Wahyuni et al., 2020). With projections of up to 200 million climate migrants by 2050 (Shultz et al., 2018), public health systems must integrate migration into monitoring strategies—leveraging technology, improving data collection, and fostering collaboration between affected regions (Chetto et al., 2024).

By addressing these three pathway, food insecurity, health system vulnerabilities, and displacement, policymakers and health professionals can develop holistic, climate-resilient child growth monitoring systems that safeguard vulnerable children against the multifaceted threats of a changing climate.

Digital Health Solutions

- Mobile applications for healthcare workers and parents to record and monitor growth data, enabling timely interventions and developmental assessments (Wahyudi & Sulaiman, 2024).
- Wearable devices providing continuous monitoring of vital signs and growth parameters for real-time insights into child health (Butt et al., 2024).
- Telemedicine platforms (e.g., India's Apollo Telemedicine Networking Foundation, Sehatvan mobile service) improving access to specialist paediatric care in rural and underserved areas (Chandrakar, 2024; Theodore, 2023).
- Remote patient monitoring systems allowing providers to track health indicators from a distance and tailor personalized care plans, especially for chronic conditions (Butt et al., 2024; Theodore, 2023).
- Challenges: poor internet connectivity, data privacy and security concerns; initiatives like India's Bharat Net project aim to enhance rural connectivity (Chandrakar, 2024).

Community-Based Health Initiatives

- Volunteer community health worker (CHW) models (e.g., Healthy Child Uganda) achieving reductions in diarrhoea prevalence, malaria cases, and a 53% decline in under-five mortality within 18 months (Campbell et al., 2024).
- Rural Climate Dialogues (Minnesota) engaging communities in collaborative planning to address climate-related health risks such as extreme weather and food insecurity (Myers et al., 2017).
- Climate Resilience through Community Resilience (Central Appalachia) integrating agricultural adaptation and water management to bolster food security and reduce

waterborne disease risks, indirectly supporting child growth monitoring (Campbell et al., 2024).

Capacity Building for Healthcare Workers

- mHealth platforms delivering scalable training and real-time support to HCWs in LMICs for disaster preparedness, extreme weather response, and public health emergencies (Mehmood et al., 2023).
- Nutrition education and resilience-building policies empowering HCWs to maintain effective growth monitoring under adverse conditions (Rifkin, 2023).
- Integration with international training efforts (e.g., AFHSC-GEIS collaborations on outbreak surveillance and laboratory strengthening) aligned to local priorities for sustainable capacity development (Myers et al., 2017).

Integrated, Multi-Sector Partnerships

- Public–private partnerships linking health, environmental, and education sectors to embed climate-smart agricultural practices into school feeding programs, addressing malnutrition and reducing vulnerability to climate shocks (Goncalves et al., 2024).
- Pacific Island community health programs that combine local agricultural practices with digital monitoring tools to improve both food security and child health outcomes through culturally sensitive approaches.

Policy and Global Strategies

Climate-Resilient Health System Frameworks

- Early warning systems for climate-driven health risks.
- Upgrades to healthcare infrastructure (e.g., flood- and heat-resistant clinic design).
- Improved water, sanitation, and hygiene (WASH) services.
- Community-based adaptation initiatives (Bikomeye et al., 2021; Walimah et al., 2024).

Integration into Public Health Policies

- Embedding child growth monitoring in national climate adaptation plans (Eidson et al., 2016).
- Developing child-focused vulnerability assessments to guide resource allocation (Arifuzzaman et al., 2020).
- Harmonizing protocols across national, state, and local health departments (Holmes et al., 2022).

Dynamic and Adaptive Management

- Incorporating climate modelling and continuous learning into health planning (Van Bavel et al., 2020).

- Prioritizing resilience in urban health systems, especially for marginalized communities (Hassan, 2024).
- Fostering multi-sectoral collaboration among health, environment, and education sectors (Nnaji et al., 2024).

Localized and Participatory Approaches

- Community engagement in health impact assessments (Van Bavel et al., 2020).
- Leveraging Indigenous knowledge networks for seasonal monitoring in Uganda's subsistence communities (Van Bavel et al., 2020).
- Mobile health platforms for refugee and disaster-prone settings to ensure service continuity.

Global Financing and Capacity Building

- Leveraging the Green Climate Fund and other climate finance for health infrastructure.
- Adapting national action plans (e.g., India's NAPCC) to include child monitoring systems.
- Strengthening workforce capacity through targeted training and technical assistance.

Research and Implementation Gap

Despite these frameworks and initiatives, explicit examples of climate-adapted child growth monitoring systems are scarce. This gap arises from:

- Insufficient Funding: Health-sector budgets rarely allocate dedicated resources for child monitoring within climate programs.
- Policy Disconnect: Climate adaptation policies often overlook child health priorities, while health policies may not integrate climate risks.
- Sectoral Silos: Limited collaboration between climate, health, and development agencies impedes cohesive strategy development.

Recommendations For Practise and Research

Short-Term Strategies

- Deploy digital health solutions with offline capability, including mobile health platforms and wearable monitoring devices, supported by targeted funding from governments and development agencies.
- Adapt existing healthcare facilities and deploy mobile clinics to ensure continuity of services during extreme weather events.
- Train community health workers in climate-resilient practices and provide them with resources for effective growth monitoring in diverse settings.

Long-Term Strategies

- Invest in climate-resilient healthcare infrastructure, including flood- and heat-resistant clinic design and robust supply chains for nutritional supplements and monitoring tools.
- Foster multi-sectoral partnerships between health, education, agriculture, and environment sectors to integrate climate-smart agricultural practices into nutrition and school feeding programs.
- Embed child growth monitoring within national climate adaptation plans and international health frameworks, allocating resources to prioritize vulnerable populations and address systemic inequities.

CONCLUSION

By addressing these barriers through dedicated funding streams, policy alignment, and cross-sector partnerships, global strategies can more effectively strengthen child growth monitoring under climate vulnerability.

Child growth monitoring systems must evolve to withstand the multifaceted threats posed by climate change, including food insecurity, extreme weather, and displacement which undermine infrastructure, overburden health services, and exacerbate inequities in vulnerable regions; this review demonstrates that resilience can be bolstered through targeted digital health innovations, community-based programs, capacity building, and policy integration within climate adaptation frameworks, thereby ensuring timely detection and intervention for at-risk children and guiding policymakers toward equitable, sustainable health system strengthening.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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BORNEO EPIDEMIOLOGY JOURNAL | BEJ

REVIEW ARTICLE Open Access

FROM FOREST TO FAST FOOD: NUTRITION AND LIFESTYLE TRANSITIONS IN SABAH

Edwin de Cruz[1], Khalid Mokti[1*], Azman Atil[1]

Abstract

Indigenous communities in Sabah, Malaysia, are undergoing a rapid nutrition transition, shifting from traditional, nutrient-dense diets to modern, processed food consumption. This transition, driven by factors like urbanization, economic shifts, and environmental degradation, is profoundly affecting health outcomes. Data from the National Health and Morbidity Survey (NHMS) reveals that overall obesity rates in Malaysia increased from 17.7% (in 2015) to 19.7% (in 2019), with indigenous groups experiencing a disproportionate burden of non-communicable diseases (NCDs). This paper synthesizes current research on dietary shifts, rising NCD prevalence, and socioeconomic determinants among Sabah's indigenous populations, focusing on the coexistence of undernutrition and rising obesity (the double burden of malnutrition). We argue that addressing these complex challenges requires urgent, culturally tailored public health interventions that promote traditional diets, enhance food security, and integrate indigenous knowledge with modern health strategies.

Keywords: Nutrition transition, Indigenous communities, Obesity, Non-communicable diseases (NCDs), Malaysia.

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INTRODUCTION

The health and nutritional status of indigenous communities globally are intimately tied to their environment and cultural practices (Pressler et al., 2022). Indigenous communities in Sabah, Malaysia, have historically maintained resilient, nutrient-dense diets based on subsistence activities such as gathering forest produce, cultivating rice, and fishing for wild-caught species (Ganesan et al., 2020). These traditional diets and physically demanding lifestyles were central to their community identity and physical health, historically offering protection against the chronic conditions now prevalent in industrialized nations (Pressler et al., 2022).

Unfortunately, rapid globalisation, urban migration, and the influence of modern market economies have initiated a swift and pervasive nutrition transition (Pressler et al., 2022). This shift involves the displacement of indigenous staples by heavily processed, energy-dense foods high in refined carbohydrates, sugar, salt, and unhealthy fats (Abang Brian et al., 2023; Pressler et al., 2022). This phenomenon mirrors broader changes occurring throughout Malaysia, leading to an alarming increase in lifestyle-related diseases.

This manuscript comprehensively synthesizes recent findings regarding the dietary and lifestyle transitions and resulting health outcomes among Sabah's indigenous populations. It specifically integrates local primary data on indigenous communities in Sabah (Ganesan et al., 2020; Rafiz Azuan et al., 2024) and Perak (Chew et al., 2022) with national epidemiological trends (Ministry of Health Malaysia, 2020).

The novelty of this paper lies in its integrated approach that:

i. Synthesises Disparate Data: It connects socio-economic and cultural observations (Ganesan et al., 2020; Chew et al., 2022) with recently identified dietary patterns among Sabah's children (Rafiz Azuan et al., 2024) and national NCD statistics (Ministry of Health Malaysia, 2020).
ii. Addresses the Double Burden: It critically examines the simultaneous existence of undernutrition (stunting) and rising obesity/NCDs within the same vulnerable groups, providing context often overlooked in national reports focusing solely on obesity (Ministry of Health Malaysia, 2020).
iii. Proposes Culturally Relevant Strategies: It grounds policy and intervention recommendations in traditional practices and community-led initiatives, moving beyond generalized public health advice.
iv. This analysis provides a targeted understanding necessary for developing effective, culturally relevant public health policies to mitigate the adverse effects of dietary transition.

METHODS

This article is based on a narrative review and synthesis of existing literature and national health data. The studies selected reflect the most current and relevant research concerning nutrition, lifestyle, and health outcomes among Malaysian indigenous and youth populations, contextualized by national epidemiological and global health data.

The synthesis involved analysing key findings from:

i. National Epidemiology: Data from the Malaysian National Health and Morbidity Survey 2019 (NHMS) (Ministry of Health Malaysia, 2020) and Malaysian population statistics (Department of Statistics Malaysia, 2021) to establish national NCD burden and demographic context.
ii. Global Health Context: Publications from the World Health Organization (WHO) (World Health Organization, 2021) and systematic global reviews (Ng et al., 2014; Pressler et al., 2022) to define terms and position the Malaysian situation within global trends of obesity and nutrition transition.
iii. Local and Regional Studies: Peer-reviewed articles focusing on the eating habits, environmental pressures, and health issues within indigenous communities in Sabah (Ganesan et al., 2020; Rafiz Azuan et al., 2024) and Perak (Chew et al., 2022), and among Malaysian youth (Abang Brian et al., 2023).

The findings of these selected papers were qualitatively compared and discussed to identify common themes, contradictions, and mechanisms driving the nutrition and lifestyle transitions.

RESULTS AND DISCUSSION

The Burden of Non-Communicable Diseases (NCDs)

The rise of NCDs is one of the most critical public health challenges in Malaysia. According to the NHMS 2019 (Ministry of Health Malaysia, 2020), the national burden is significant:

i. Obesity and Overweight: The combined prevalence of overweight and obesity (BMI ≥ 25kg/m2) among Malaysian adults reached 50.1% in 2019 (Ministry of Health Malaysia, 2020). The prevalence of obesity alone (BMI ≥ 30kg/m2) rose from 17.7% (2015) to 19.7% (2019) (Ministry of Health Malaysia, 2020). Globally, the prevalence of obesity has more than doubled since 1990 (World Health Organization, 2021).
ii. Diabetes: The prevalence of overall raised blood glucose (known and undiagnosed diabetes) among adults was 18.3% in 2019, an increase from 13.4% in 2015 (Ministry of Health Malaysia, 2020).
iii. Hypertension and Hypercholesterolaemia: The prevalence of hypertension remained high at 30.0% and raised blood cholesterol was 38.1% (Ministry of Health Malaysia, 2020). These NCDs are major risk factors for cardiovascular disease, the leading cause of death in Malaysia (Ministry of Health Malaysia, 2020).

The economic development and urban migration of rural families underpin this health burden. The urban population of Sabah reached 55.5% in 2021 (Department of Statistics Malaysia, 2021), a trend that accelerates the shift away from physically active, subsistence-based lifestyles towards sedentary work and reliance on convenient, processed foods.

Dietary Transition and the Double Burden

The shift in dietary habits among Sabah's indigenous populations is a classic case of nutrition transition (Pressler et al., 2022). This involves three distinct, and often simultaneous, challenges:

Loss of Traditional Diets

Traditional diets of Sabah's communities, exemplified by the Lundayeh, emphasized rice, wild meats, fish, and foraged vegetables (Ganesan et al., 2020). This pattern is being displaced by modern foods high in refined carbohydrates and sugars. For instance, one study in Sabah identified that children following a "Fish Dietary Pattern" had favourable outcomes (taller stature), while others followed a "White Rice Dietary Pattern" that was associated with higher weight and Body Mass Index (BMI) (Rafiz Azuan et al., 2024).

The Double Burden of Malnutrition

The most challenging aspect of this transition is the emergence of the double burden of malnutrition, where undernutrition (specifically stunting) coexists with rising overweight/obesity (Ministry of Health Malaysia, 2020) within the same vulnerable population.

- The national prevalence of stunting (Height for Age < -2SD) among children under five years old increased to 21.8% in 2019 (Ministry of Health Malaysia, 2020), a figure comparable to the global prevalence of 21.9% (World Health Organization, 2021).
- A recent study in Sabah found a high prevalence of stunting (~ 16.5%) alongside overweight / obesity (~ 21.4%) among low-income children (Rafiz Azuan et al., 2024).

This dual problem indicates that while energy intake is sufficient (or excessive) to cause obesity, the quality of diet is poor, leading to nutrient deficiencies and stunting (Ministry of Health Malaysia, 2020). Health practitioners working with the Orang Asli children in Perak noted that barriers such as poverty and food taboos contribute to this ongoing cycle of undernutrition (Chew et al., 2022).

The Role of Processed Foods and Youth

The shift towards "fast food" and convenience items is amplified among younger generations (Abang Brian et al., 2023). As a universal feature of modern diets, the increased consumption of sugar-sweetened beverages (SSBs) and instant snacks directly contributes to metabolic risk (Ministry of Health Malaysia, 2020). The NHMS 2019 found that 94.9% of Malaysian adults do not consume adequate fruits and vegetables (Ministry of Health Malaysia, 2020), pointing to a severe national deficiency in protective foods. Furthermore, 25% of Malaysian children (aged 5-17) are overweight or obese (Ministry of Health Malaysia, 2020).

Lifestyle and Environmental Factors

The rapid rise in NCDs is exacerbated by a parallel decline in physical activity. Traditional lifestyles including farming, fishing, and hunting are highly physically demanding (Ministry of Health Malaysia, 2020). These activities are being replaced by sedentary occupations, particularly following urban migration. NHMS 2019 reported that 25.1% of adults in Malaysia were physically inactive (Ministry of Health Malaysia, 2020), a significant decrease from the 33.5% in 2015 (Ministry of Health Malaysia, 2020).

Furthermore, environmental degradation is a significant pressure point for food security. Deforestation and agricultural expansion have reduced access to wild foods (Ganesan et al., 2020), forcing indigenous families to rely on imported, store-bought foods. This

commodification of traditional food systems (Pressler et al., 2022) increases vulnerability to food insecurity and displaces indigenous wisdom regarding food preparation and harvesting.

Limitations of the Study

The synthesis relies heavily on large-scale cross-sectional survey data (Ministry of Health Malaysia, 2020) and regional studies (Ganesan et al., 2020; Rafiz Azuan et al., 2024; Chew et al., 2022). While NHMS provides excellent national-level prevalence, it lacks the detailed longitudinal data to fully establish causality between dietary changes and NCD onset (Ministry of Health Malaysia, 2020). Furthermore, while the indigenous studies provide vital qualitative and localized context, their small-scale limits generalizability across all diverse indigenous groups in Sabah (Chew et al., 2022).

CONCLUSION

The transition from a forest-based diet to a market-based diet among indigenous communities in Sabah presents a critical public health emergency, defined by escalating NCD rates and the complex double burden of malnutrition (Ministry of Health Malaysia, 2020). This crisis is rooted in the interplay of economic development, rapid urbanization, changing consumption patterns, and environmental loss (Pressler et al., 2022; Ganesan et al., 2020).

Addressing these challenges requires a multi-pronged approach that prioritizes both economic resilience and cultural preservation. Interventions must be culturally sensitive and target key mechanisms:

i. Reclaiming Traditional Food Systems: Health campaigns should emphasize the nutritional and cultural value of traditional foods, complementing global evidence on the effectiveness of community-led nutrition programs (Pressler et al., 2022).
ii. Targeted Education: Nutrition education must be integrated into school curricula, allowing youth to appreciate the health benefits of their heritage foods while discouraging the consumption of highly processed, aggressively marketed foods (Abang Brian et al., 2023).
iii. Policy Support: State and federal support, such as incentivizing local production of traditional crops and creating targeted programs for high-risk, low-income groups, is essential to ensure healthy food choices are the most accessible and affordable (Chew et al., 2022).

By acknowledging the uniqueness of indigenous lifestyles and leveraging indigenous wisdom, public health initiatives can move beyond surface-level solutions to provide sustainable and effective health outcomes for these vulnerable populations.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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REVIEW ARTICLE Open Access

ADDRESSING THE DUAL BURDEN OF SEXUALLY TRANSMITTED INFECTIONS (STI) AND HIV/AIDS IN MALAYSIA: A NARRATIVE REVIEW

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Abstract

Malaysia has achieved notable success in HIV/AIDS prevention, including the elimination of mother-to-child transmission and widespread availability of antiretroviral therapy (ART). However, significant challenges persist in addressing the dual burden of sexually transmitted infections (STIs) and achieving the 95-95-95 HIV cascade targets. This narrative review aims to synthesize evidence on the barriers and facilitators of STI and HIV/AIDS prevention in Malaysia, emphasizing sociocultural and systemic factors within a family health context. A thematic synthesis was conducted using literature retrieved from databases including PubMed, ScienceDirect, and Scopus to explore constraints and innovative strategies. Key findings demonstrate that cultural norms and religious beliefs perpetuate stigma, hindering access to care and education, particularly for key populations such as men who have sex with men (MSM) and transgender individuals. Systemic issues, including pervasive healthcare worker bias, late HIV diagnoses (68% in 2023), and privacy concerns surrounding digital health tools, further constrain progress. Framing these issues within family health reveals profound financial, emotional, and intergenerational impacts. By addressing these deep-rooted cultural and systemic barriers through evidence-based, inclusive strategies, Malaysia can accelerate progress toward its 2030 goal of ending AIDS and reducing the STI burden.

Keywords: HIV Infections, Sexually Transmitted Infections, Stigma and Discrimination, Malaysia, Family Health.

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INTRODUCTION

The rise of human immunodeficiency virus (HIV) infections and sexually transmitted infections (STIs) remains a significant global public health concern. While global HIV incidence rates peaked in 1996 and have since declined, HIV prevalence rates have continued to accelerate since 2006 (Liang et al., 2024). Concurrently, the incidence of other STIs globally has been volatile, increasing again since 2015, resulting in an estimated 358 million new cases of the four most common curable STIs annually (Stewart et al., 2019). These infections demonstrate sizable disparities in prevalence across regions and populations, highlighting the need for context-specific prevention efforts.

Malaysia has made considerable progress in its HIV response. The HIV notification rate decreased from a peak of 28.5 per 100,000 population in 2002 to 9.6 per 100,000 in 2023. Notably, Malaysia achieved the elimination of mother-to-child transmission (EMTCT) of HIV and syphilis, becoming the first country in the WHO Western Pacific Region to be certified for elimination in 2018. Current initiatives include a Pre-Exposure Prophylaxis (PrEP) program and an HIV self-testing program. Despite these achievements, significant challenges persist, such as the rise of reported urethral discharge syndrome and laboratory-confirmed gonorrhoea among men older than 15 years since 2016, and difficulties in achieving the ambitious global 95-95-95 HIV cascade targets.

This persistent dual burden requires a comprehensive approach that moves beyond biomedical intervention. Current literature lacks a synthesis of the context-specific sociocultural barriers and systemic factors that drive these persistent gaps in care within Malaysia. Therefore, this narrative review aims to synthesize the evidence on the sociocultural barriers, systemic challenges, and innovative strategies influencing STI and HIV/AIDS prevention and control in Malaysia. Furthermore, this review applies a family health framework to highlight the profound impacts of these conditions on Malaysian families, providing context-specific insights to accelerate progress toward the national goal of ending AIDS by 2030.

METHODS

This narrative review adopts a thematic synthesis approach to explore the issues, constraints, and innovative strategies within STI and HIV/AIDS prevention and control programs, specifically focusing on Malaysia's unique sociocultural and systemic challenges. The methodology was designed to contextualize these challenges within global best practices and offer evidence-based insights for enhancing local program development and implementation.

Search Strategy and Selection

A comprehensive literature search was conducted across three major scientific databases: PubMed, ScienceDirect, and Scopus. The timeframe for the literature search spanned from 2014 to 2024 to capture recent trends and interventions while maintaining historical context.

Keywords were carefully selected to ensure relevance, including terms such as: "STIs," "HIV/AIDS," "prevention," "Malaysia," "95-95-95 targets," "health inequities," "cultural barriers," and "digital health".

i. Studies were included in the review if they:
   - Focused on STI or HIV/AIDS prevention and control programs in Malaysia or comparable sociocultural contexts.
   - Addressed themes such as cultural influences, barriers to healthcare access, innovative prevention strategies, or the integration of family health approaches.

ii. Studies were excluded if they were:
   - Unrelated to the STI or HIV/AIDS domain.
   - Lacked primary data or robust analysis.
   - Published in languages other than English.

Although a PRISMA flow chart was not utilized due to the nature of this narrative review, the search process yielded approximately 250 initial articles. Following screening based on title, abstract, and full-text eligibility, 41 high-quality and contextually relevant sources were retained and included for the final thematic synthesis.

Data Extraction and Thematic Synthesis

Data from the included studies including location, population characteristics, identified barriers, and intervention outcomes were systematically extracted. A thematic analysis was then conducted, grouping the findings into four primary domains: Sociocultural Barriers and Stigma, Systemic and Health Service Gaps, Innovative Strategies and Digital Health Challenges, and Impact on Family Health. Comparative insights were drawn from similar countries, such as Thailand and select African nations, to contextualize Malaysia's findings.

Ethical Considerations

Ethical considerations were minimal as the review relied exclusively on secondary data from published studies. However, attention was given to respecting diverse cultural perspectives and sensitivities in interpreting and presenting the findings.

RESULTS

The thematic synthesis identified four major domains that drive both the continued burden of STIs and HIV/AIDS and the constraints in achieving prevention targets in Malaysia.

Socio-Cultural Barriers and Stigma

Cultural norms and religious beliefs in Malaysia significantly influence public perceptions and responses to sexual health, thereby creating major barriers to open discussion and intervention. The resulting stigma surrounding STIs and HIV/AIDS is deeply rooted in this conservative cultural and religious context, ultimately limiting access to education and preventive measures.

Taboos surrounding sexuality and misconceptions perpetuate fear and discrimination, particularly for marginalized groups such as men who have sex with men (MSM) and transgender individuals. Studies among MSM in Malaysia indicate that the compounded effect of HIV stigma and homosexuality-related stigma critically hinders access to preventive services and testing (Khati et al., 2022). For sex workers, legal prohibition increases stigma and the difficulty in accessing health services openly, resulting in extraordinarily low prior

HIV and STI testing rates (e.g., only 20% tested in the past year in one study) (Wickersham et al., 2017).

Furthermore, comparative findings from similar Islamic communities, such as in Saudi Arabia, highlight how religious views on extramarital sex can lead to the belief that STIs are a punishment from God, which justifies stigmatization. This perspective often discourages medical intervention in favour of strengthening religious beliefs. This cultural sensitivity around sexuality consequently inhibits open discussions about sexual health and STI prevention in Malaysia (Alomair et al., 2023).

Societal taboos also lead to insufficient sexual health information and contraceptive access, often due to the misconception that providing resources encourages promiscuity (Loganathan et al., 2020). For instance, a study among students in Melaka found generally unsatisfactory knowledge levels regarding STIs, with HIV being the most well-known, while infections like gonorrhoea and chlamydia were less recognized. Critically, over 90% of these students were unaware that a person infected with an STI could be asymptomatic, underscoring a lack of awareness that increases transmission risk (Mansor et al., 2020).

Systemic and Health Service Gaps

Significant gaps remain in the HIV cascade despite national efforts. By the end of 2023, while 84% of people living with HIV (PLHIV) were diagnosed, only 68% were on treatment, indicating a substantial gap in linkage to care and treatment uptake. This uptake has stalled since 2019, likely due to disruptions during the COVID-19 pandemic. Timeliness of diagnosis is also a major concern, as 68% of patients were diagnosed at a late stage in 2023, emphasizing the need for increased awareness and earlier testing among high-risk groups.

High levels of stigma persist among healthcare workers (HCWs), which directly impacts testing and treatment rates. Specific HCW attitudes include: 89.9% perceiving risk and fear toward PLHIV, 77% exhibiting value-driven stigma, and 40.5% showing discriminatory attitudes. Concerns were also raised about breach of confidentiality by healthcare providers, which further discourages individuals from seeking treatment.

Low socioeconomic status and economic vulnerability are key barriers to accessing STI/HIV services, particularly for marginalized populations like transgender individuals and sex workers (Mujugira et al., 2021). Limited financial resources can restrict access to healthcare and necessary medications (Mendonça Gil et al., 2023). In rural areas, the scarcity of health services further exacerbates these inequities, compounding issues for low-income populations (Valentine et al., 2021).

Innovative Strategies & Digital Health Challenges

Malaysia has implemented several successful public health programs and piloted innovative interventions, though the adoption of new technology presents its own unique challenges related to confidentiality. Historically, harm reduction programs targeting people who inject drugs (PWID), such as Opioid Substitution Therapy (OST) and the Needle-Syringe Exchange Program (NSEP), successfully reduced HIV transmission among this key population. By the end of 2023, almost 100% of PWID were enrolled in OST programs, leading to a major shift where PWID are no longer the dominant group of newly diagnosed HIV cases (MOH Malaysia, 2024).

Digital health platforms, such as the JomPrEP initiative, have also shown promise by integrating mobile technology to deliver holistic HIV prevention services, including Pre-Exposure Prophylaxis (PrEP) and support for mental health, to MSM. There is high acceptance among Malaysian MSM to use these platforms, with a survey finding that over 90% of participants were open to receiving HIV prevention information and medication reminders through mobile apps (Shrestha et al., 2022). Despite this high acceptance, ethical concerns surrounding digital health are a major barrier to wider adoption. Participants expressed fear of third-party access to personal health information by friends, family, or government agencies. This is exacerbated by the criminalization of same-sex sexual behaviours and the high degree of social stigma in Malaysia, creating a challenging sociopolitical climate for mHealth interventions (Peng et al., 2022). Consequently, concerns about data security, equity of access, and informed consent must be carefully addressed for mobile health platforms to gain public trust (Khati et al., 2022).

Impact On Family Health

The presence of STIs and HIV/AIDS extends beyond individual health, creating significant, often overlooked impacts on family dynamics and management. STIs can lead to serious health consequences such as infertility, pregnancy complications, and cancers, which place emotional and financial burdens on the family unit (Bretz et al., 2023).

The associated morbidity and mortality substantially impact the quality of life for individuals and their families. However, Malaysia's Prevention of Mother-to-Child Transmission (PMTCT) program for HIV and syphilis, which provides free ARV prophylaxis and replacement feeds for HIV-exposed infants, serves as a strong example of an effective family-centred approach to care and prevention (MOH Malaysia, 2024). Conversely, the stigma associated with STDs, especially HIV/AIDS, results in social isolation and discrimination that extends to family members, straining relationships within the family and the broader community.

Furthermore, the need for ongoing chronic care places additional burdens on family resources and time management. This disproportionate impact on marginalized individuals can exacerbate existing social inequalities and complicate family management in vulnerable communities (Elendu et al., 2024).

DISCUSSION

This narrative review synthesized evidence to explore the persistent dual burden of STIs and HIV/AIDS in Malaysia, identifying a complex interplay of sociocultural, systemic, and technological factors that impede national targets. The key findings, synthesized in Table 1, confirm that while Malaysia’s success in eliminating mother-to-child transmission (EMTCT) and expanding antiretroviral therapy (ART) availability is laudable, the nation faces critical constraints in fully achieving the 95-95-95 cascade goals.

Table 1: Synthesis of Sociocultural and Systemic Challenges, Key Findings, and Policy Recommendations for STI/HIV/AIDS Prevention in Malaysia

Thematic Domain	Key Challenge / Gap	Supporting Data (Malaysia)	Policy Implication (Recommendation)
Socio-cultural Barriers & Stigma	Deeply entrenched stigma against key populations (MSM, transgender individuals) and PLHIV.	Compounded HIV/homosexuality stigma hinders testing. 40.5% of HCWs show discriminatory attitudes.	Mandatory, targeted HCW anti-stigma training focusing on confidentiality and bias reduction.
	Low knowledge of general STIs and transmission.	90% of students unaware that STIs can be asymptomatic. HIV is the most known STI, others are less recognized.	Comprehensive, culturally sensitive educational reform moving beyond HIV to all STIs.
Systemic & Health Service Gaps	Breakdown in the linkage-to-care cascade and late diagnosis.	Only 68% of PLHIV are on treatment (gap in linkage). 68% of new diagnoses were late-stage in 2023.	Integrate STI testing into existing HIV services (like PrEP) to normalize screening.
	Inequity in access (geographic / socioeconomic).	Scarcity of health services in rural areas; low socioeconomic status restricts access to medications.	Implement alternative testing methods (in-home, self-sampling) with robust linkage-to-care systems.
Innovative Strategies & Digital Health Challenges	Digital health adoption constrained by privacy and trust issues.	User fear of government/family access to mHealth data (e.g., JomPrEP). Criminalization of same-sex behaviors exacerbates fear.	Platforms must use anonymous user settings; address ethical and data security concerns to build public trust.
Impact on Family Health	STIs/HIV impose significant emotional, financial, and social burdens on the family unit.	Stigma extends to family members, causing isolation and strain. Morbidity affects family quality of life.	Build on the PMTCT success model by creating expanded family-centred care and support systems.

Interpretation of Key Findings

The review confirms that the most significant barrier remains deeply rooted stigma and discrimination, particularly towards key populations like MSM and transgender individuals (Mujugira et al., 2021). The finding that religious views often frame STIs as a form of punishment, observed in comparable communities, directly contributes to shame, knowledge gaps, and justifies discriminatory attitudes (Alomair et al., 2023). This stigma is institutionalized through structural factors, including high levels of bias and fear reported even among healthcare workers (Nor et al., 2024).

This institutionalized inequity leads to a breakdown in the care continuum: the stalled ART uptake since 2019 and the fact that 68% of new diagnoses are late stage underscore a systemic failure to link diagnosed individuals to care (MOH Malaysia, 2024). While successful harm reduction programs (e.g., OST) demonstrate Malaysia's capacity for effective public health implementation, the failure to maintain momentum in the treatment cascade highlights a fundamental disconnect between policy intent and ground-level execution, particularly within primary care facilities where HCW bias is prevalent (Nor et al., 2024).

Furthermore, technology cannot solve stigma alone. Innovative strategies, such as the *JomPrEP* app, offer solutions to bypass barriers (Shrestha et al., 2022). However, the synthesis reveals that these digital tools are constrained by the prevailing legal and social environment; the profound fear among users regarding the privacy and potential governmental access to health data highlights that technological solutions cannot succeed in isolation, as they must be embedded in a protective sociopolitical climate (Khati et al., 2022; Peng et al., 2022).

Family Health Imperative and Comparative Context

Framing the findings within the family health context reveals the necessity of inclusive strategies, as STIs and HIV/AIDS impose emotional, financial, and intergenerational burdens on families (Elendu et al., 2024). Malaysia's success with the PMTCT program serves as a powerful model, demonstrating that targeted, holistic interventions focusing on the affected family unit and not just the individual are both feasible and effective for preventing transmission and mitigating social strain (MOH Malaysia, 2024).

Comparison to Global Context: While Malaysian progress aligns with global best practices for vertical transmission (EMTCT), the challenges in addressing MSM stigma and access to care are mirrored in other contexts facing structural homophobia (Mujugira et al., 2021). The high rate of late diagnosis and low STI knowledge among students in Melaka (Mansor et al., 2020) suggests that interventions seen as successful elsewhere, such as school-based education programs, need culturally adapted implementation to overcome local taboos and knowledge gaps (Lambrinou et al., 2020).

Limitation

This review relied on a narrative synthesis of existing secondary data; consequently, the findings are limited by the variability and quality of the original primary studies. Although the systematic search targeted recent data (2014 – 2024), reliance on published literature means that the immediate impact of newer initiatives, such as the full scale-up of the national PrEP program and the HIV self-testing program (both started in 2023), may not be fully reflected. While comparative insights were drawn from similar sociocultural contexts, the unique legal and ethnic diversity of Malaysia means direct extrapolation of success factors from international examples remains challenging.

Recommendations

Based on the synthesis of cultural barriers, systemic challenges, and innovative opportunities identified, the following recommendations are proposed to accelerate progress toward the 2030 goal of ending AIDS and reducing STI burdens.

Community-Level and Educational Reform

Educational programs must move beyond focusing solely on HIV to provide comprehensive information on a wider range of STIs, including less-recognized infections like gonorrhoea and chlamydia Programs must emphasize the critical fact that STI-infected individuals can be asymptomatic, as over 90% of students in one study were unaware of this fact (Mansor et al., 2020).

System-Level and Healthcare Policy Strategies

Implementing mandatory, targeted training programs for healthcare workers (HCWs) to address value-driven stigma, discriminatory attitudes, and fear towards PLHIV is crucial, focusing on reinforcing patient confidentiality (Nor et al., 2024).

STI testing should be integrated into existing HIV prevention programs, such such as PrEP services, to normalize and routinize screening. This integration requires standardized guidelines, staff training, and adequate funding to overcome implementation challenges (Ong et al., 2021).

Collaboration between the medical fraternity and engineers is needed to develop and implement rapid point-of-care diagnostic tests for STIs, especially for gonorrhoea, chlamydia, and syphilis, to address detection disparities (Gottlieb et al., 2024). Developing machine-learning-based risk prediction tools could help identify high-risk individuals for targeted testing (Xu et al., 2022).

Family-Centred and Digital Health Frameworks

Building on the success of the PMTCT program, family-centred care and support systems should be improved by addressing barriers such as cost and lack of trust (Khumalo et al., 2023). Innovative programmatic approaches, including new STI communication and partner management strategies, can help strengthen family support systems (Gottlieb et al., 2024).

Digital health interventions (like JomPrEP) must gain public trust by carefully addressing ethical considerations around privacy, confidentiality, and data security (Khati et al., 2022). Key design strategies for platforms include providing anonymous user settings and ensuring efficient linkage to healthcare professionals for follow-up (Peng et al., 2022).

Strategies must be deployed to overcome the challenging sociopolitical climate created by the criminalization of same-sex sexual behaviours, which exacerbates stigma and limits the effectiveness of prevention tools (Peng et al., 2022).

CONCLUSION

Malaysia has achieved notable success in HIV/AIDS control, particularly through the elimination of mother-to-child transmission, expanded antiretroviral therapy, and the introduction of HIV self-testing and pre-exposure prophylaxis. Despite these gains, the persistently high burden of sexually transmitted infections (STIs) and gaps in the HIV testing-treatment cascade highlights the ongoing challenge of a dual epidemic in Malaysia.

This review underscores that sociocultural stigma, shaped by cultural and religious norms, remains a major barrier to timely testing, treatment uptake, and continuity of care, especially among key populations. Systemic constraints, including healthcare worker stigma, late diagnoses, and concerns around confidentiality, further limit progress. Nevertheless, promising opportunities exist through digital health innovations and family-centered prevention frameworks, which can improve access and acceptability when ethical and privacy safeguards are ensured.

In conclusion, sustained progress toward the 2030 goal of ending AIDS, as advocated by the World Health Organization, will require integrated, culturally sensitive, and stigma-informed strategies that address both HIV and STIs holistically.

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Conflicts of Interest

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REVIEW ARTICLE Open Access

BEYOND BARRIERS: ENHANCING ABORTION CARE IN SOUTHEAST ASIA

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Abstract

WHO estimates show that 45% of abortions globally are unsafe and responsible for up to 13 % of maternal deaths, a burden that is disproportionately high in regions with restrictive abortion law such as developing regions like Southeast Asia. Our scoping review explores the knowledge, attitudes, practices (KAP), barriers, and limitation related to abortion care in Southeast Asia from 2019 to 2023. This review was conducted following PRISMA-ScR guidelines. Articles published between 2019 and 2024 were identified using PubMed, ScienceDirect, Scopus, and Google Scholar. Inclusion criteria focused on studies from Southeast Asia addressing abortion care, including PAC, with qualitative, cross-sectional, cohort, or intervention designs. Data were synthesized descriptively by themes such as KAP, barriers, and policy implications. From 584 identified records, 11 studies met inclusion criteria. Findings revealed significant knowledge gaps among healthcare providers and the general population, influenced by cultural and religious stigmas. Support for abortion was higher in medically critical situations than for socio-economic reasons. Barriers included stigma, legal restrictions, and inadequate training. Findings emphasize the importance of addressing cultural and systemic barriers, enhancing provider training, and incorporating PAC into primary healthcare systems. Global practices, such as telemedicine in China and mid-level provider training in Ethiopia, provide valuable models for Southeast Asia. To improve PAC access and quality in Southeast Asia, culturally sensitive, decentralized, and collaborative approaches are essential. Governments, healthcare systems, and communities must work together to ensure equitable and inclusive reproductive health services.

Keywords: Abortion, Induced, Post-abortion Care, Health Knowledge, Attitudes, Practice, Reproductive Health Services, Asia, Southeastern

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INTRODUCTION

Abortion is a straightforward procedure with minimal risk when performed safely by trained provider (WHO, 2022). However, WHO estimates show that 45% of abortions globally are unsafe and responsible for up to 13 % of maternal deaths, a burden that is disproportionately high in regions with restrictive abortion law such as developing regions like Southeast Asia (WHO, 2022). Post-abortion care (PAC) is critical in reducing maternal morbidity and mortality in Southeast Asia, where unsafe abortion remains a significant public health issue (WHO, 2022, 2020). The World Health Organization (WHO) defines PAC as the provision of services after an abortion, including contraceptive service, counselling, management of complications, and referrals to additional healthcare services as needed (WHO, 2022).

In Southeast Asian countries like Malaysia, Thailand, and Indonesia, restrictive legal environments and limited access to comprehensive PAC increase the likelihood of unsafe abortion practices and complications (Jain et al., 2023). Despite recent policy shifts in some areas, healthcare systems often fall short in meeting PAC needs, especially in rural and marginalized communities where stigma and limited healthcare access persist (Philbin et al., 2020; Sanitya et al., 2020; WHO, 2020). The scarcity of reproductive health services in these regions has led to calls for task-shifting, empowering mid-level providers, such as nurses and midwives, to deliver PAC services to improve access and reduce health risks for women (Suchira et al., 2024; WHO, 2022).

To address these challenges this scoping review aims to systematically map the current evidence from 2019 to 2023 regarding knowledge, attitudes, and practices related to abortion care in Southeast Asia, including but not limited to post-abortion care (PAC). The review focuses on understanding key barriers to abortion services, examining healthcare providers' perspectives and knowledge about abortion care, and exploring interventions that may improve access to safe abortion practices. By addressing these broader objectives, the review seeks to provide insights that could inform more supportive and accessible reproductive health services across Southeast Asia.

METHODS

We undertook a scoping review rather than a systematic review, as we anticipated that studies on abortion care in Southeast Asia would vary widely in focus, and multiple themes would need to be addressed, including barriers, healthcare provider perspectives, and intervention impacts. This scoping review approach allowed for a broader mapping of the available evidence rather than a narrow synthesis of intervention-focused studies. The review was conducted using a framework developed for scoping reviews and follows the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines for reporting on scoping reviews (Tricco et al., 2018)

The review focuses on abortion care in Southeast Asia, covering articles published from 2019 to 2024 across various Southeast Asian countries, including Malaysia, Thailand, Singapore, Myanmar, Laos, Brunei, the Philippines, Cambodia, and Indonesia.

Eligibility Criteria

The inclusion criteria:

i. Studies published between 2019 and 2024
ii. Conducted within Southeast Asian countries (Malaysia, Thailand, Singapore, Myanmar, Laos, Brunei, the Philippines, Cambodia, and Indonesia)
iii. Focused to abortion care but not limited to post-abortion care (PAC).
iv. Designed as cross-sectional, cohort, qualitative, or intervention studies
v. Published in English language
vi. Published in open-access journals

Exclusion criteria*:*

i. Review papers (e.g., scoping, systematic, and narrative)
ii. Editorial articles, policies, books, reports, and board meeting materials
iii. Studies with incomplete data
iv. Case series and case studies
v. Meta- analysis articles.

Search Strategy

The literature search was conducted on October 25th, 2024, using four databases: PubMed, ScienceDirect, Scopus, and Google Scholar. Boolean operators and keywords were used to optimize search precision. For Scopus and PubMed, the search terms included: “safe abortion” OR "post-abortion care" OR "unsafe abortion" AND ("Southeast Asia" OR "Philippines" OR "Vietnam" OR "Indonesia" OR "Thailand" OR "Malaysia" OR "Laos" OR "Singapore" OR "Brunei" OR "Myanmar" OR “Cambodia”). For ScienceDirect and Google Scholar, the search terms were: ("safe abortion" OR "post-abortion care" OR "unsafe abortion") AND ("Southeast Asia").

Study Selection

The selection process followed the PRISMA flowchart for scoping reviews, including identification, screening, eligibility, and inclusion stages (Page et al., 2021). Two reviewers independently screened titles and abstracts, followed by full-text reviews to determine eligibility based on the inclusion and exclusion criteria.

Data Extraction

The data extraction process was conducted in two phases. In the first phase, demographic data were extracted, including author, year, country, population, sample size, study design and type (cross-sectional, cohort, etc.). In the second phase, information was collected on the research focus on the key findings related to post-abortion care which include knowledge, attitudes, practice, limitation and and barriers of abortion care in Southeast Asia Countries.

Data Synthesis

A descriptive synthesis approach was used to analyse and present the findings, organized by themes related to abortion care and PAC barriers, interventions, healthcare provider perspectives, and policy implications. As this is a scoping review, quality appraisal of individual studies was not conducted.

RESULTS

This scoping review maps evidence from 2019 to 2023 on knowledge, attitudes, and practices (KAP) related to abortion care in Southeast Asia, including post-abortion care (PAC). Using the PRISMA framework, 584 records were identified across databases such as ScienceDirect, Google Scholar, PubMed, and Scopus. After removing duplicates, 566 records were screened, 549 excluded, and 11 studies met the inclusion criteria (Page et al., 2021). The selection process is outlined in the PRISMA Framework (Figure 1).

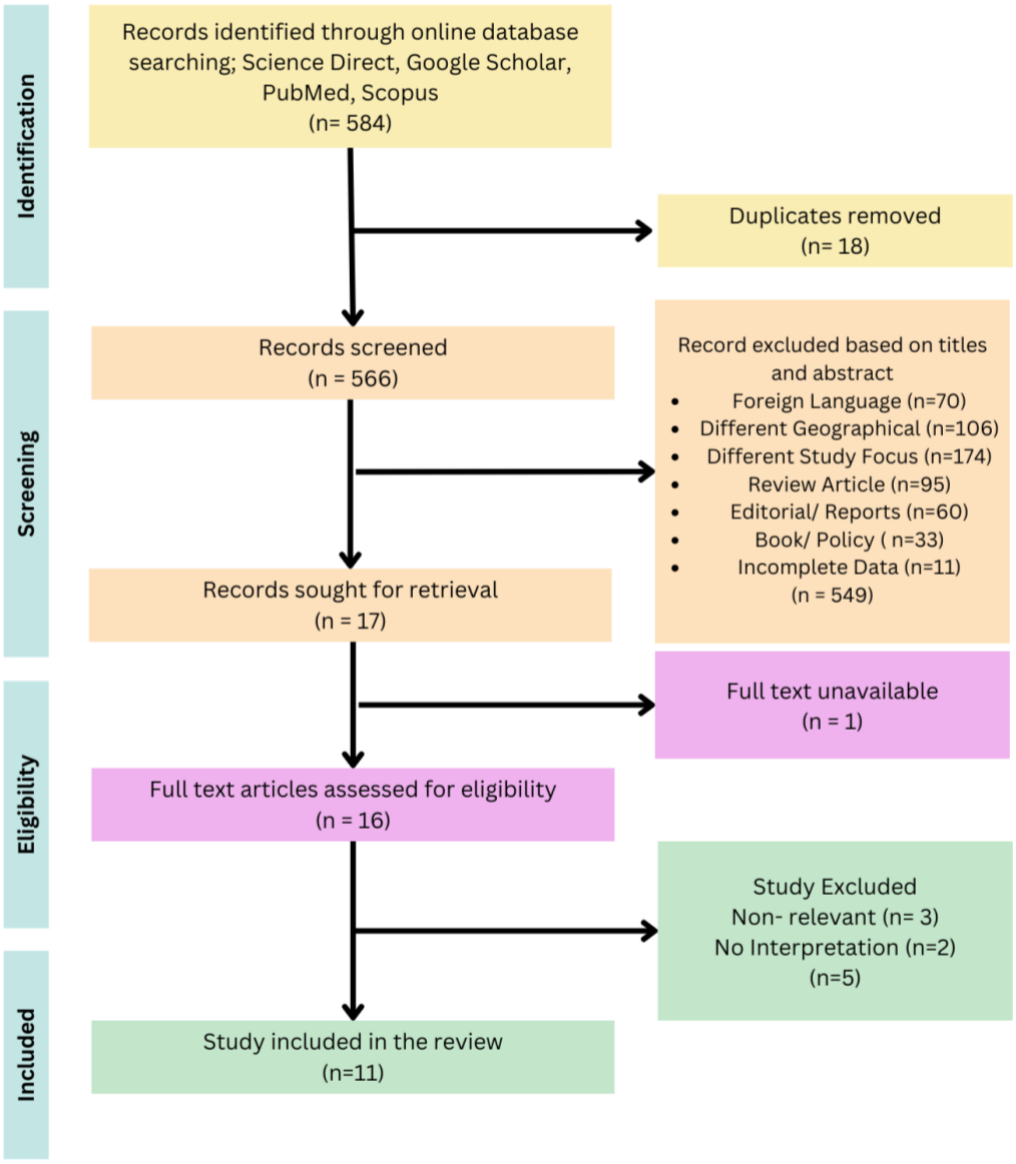

Figure 1: PRISMA Framework

Of the 11 studies, seven originated from Thailand, and one each from Indonesia, Lao PDR, Vietnam, and Myanmar. Sample sizes ranged from 12 to 926 participants, reflecting diverse objectives and study designs. Six studies focused on healthcare providers, while others examined adolescents, reproductive-age women, and healthcare facilities. Most employed a cross-sectional design, with two using interventional and quasi-experimental approaches.

Seven studies used the KAP framework, including one on knowledge improvement following intervention. Ngo et al. (2023) examined Mhealth application impact on knowledge in Vietnam, while Sanitya et al. (2020) evaluated post-training KAP improvements among Thailand healthcare workers. A qualitative study explored post-abortion experiences in Thai women, and Htun et al. (2019) studied contraceptive use attitudes in Myanmar. Philbin et al. (2020) assessed PAC readiness in Indonesian hospitals and public health clinics using signal function analysis. Table 1 provides detailed study characteristics.

Knowledge, Attitudes, and Practices Related to Abortion Care

Knowledge levels about abortion laws and services among healthcare providers and the general population varied significantly across Southeast Asia. In Thailand, 31.7% of pharmacy students demonstrated strong knowledge of abortion laws, while 45.6% of medical students had high knowledge scores, especially regarding legal contexts for abortion (Poolkumlung et al., 2023; Rongkapich et al., 2023). However, misconceptions were common; for instance, only 30% of participants could correctly identify legal gestational limits for second-trimester abortion (Poolkumlung et al., 2023). Similarly, in Laos, only 31.5% of adolescents were aware of induced abortion, highlighting significant knowledge gaps in the region (Vongxay et al., 2020).

Public understanding of abortion laws was very low and heavily influenced by cultural and religious beliefs. In Laos, 93% of adolescents held negative attitudes toward abortion, often associating it with sin or promiscuity, although 62.1% recognized the risks of unsafe abortion (Vongxay et al., 2020). In Myanmar, 62.6% of women reported negative attitudes toward emergency contraceptive pills, with cultural stigma being a primary factor affecting access and use (Htun et al., 2019). These findings show how societal norms shape public perceptions and influence access to reproductive health services.

Support for abortion was highest in medically critical situations. In Thailand, 95.6% of medical students supported abortion for nonviable feotal anomalies, and 93.2% agreed in cases of rape. However, support was much lower for socio-economic reasons, such as contraceptive failure (62.5%) or pregnancies among women under 15 years (66.4%) (Poolkumlung et al., 2023). Among nursing students, 97.3% agreed with abortion for maternal health reasons, showing a preference for cases considered medically necessary (Uaamnuichai et al., 2023).

Barriers on Abortion Care

The studies identified several barriers that hinder access to abortion and post-abortion care (PAC) services. Cultural and religious beliefs played a significant role, with strong stigmatization and moral opposition affecting access and discussions around abortion, particularly among non-Buddhist populations in Southeast Asia (Saengruang et al., 2021; Sinthuchai et al., 2022; Vongxay et al., 2020). Legal restrictions, such as limiting abortion procedures to specialists like Ob/Gyns, reduced PAC availability in lower-level facilities and rural areas, as observed in Indonesia and Thailand (Philbin et al., 2020; Poolkumlung et al., 2023). Knowledge gaps among healthcare providers, including limited understanding of abortion laws and safe procedures like medical abortion and manual vacuum aspiration (MVA),

further contributed to reduced service provision (Rongkapich et al., 2023; Sanitya et al., 2020). Additionally, misconceptions about emergency contraceptive pills (ECPs) and their usage created hesitancy among women in Myanmar, further complicating access to reproductive health services (Htun et al., 2019).Social stigma, lack of confidentiality, and inadequate gender-sensitive services were also prominent barriers that restricted mental health support for women post-abortion (Ngo et al., 2023; Prasertwong et al., 2021)

Service Limitations on Abortion Care

The studies presented several limitations that impacted the breadth and applicability of their findings. Many were conducted in single locations or among specific populations, such as university students, healthcare trainees, or urban residents, which limited the generalizability of the results to other regions or demographic groups (Poolkumlung et al., 2023; Sinthuchai et al., 2022; Uaamnuichai et al., 2023). The use of self-reported data was a frequent limitation, potentially introducing bias due to the sensitive and stigmatized nature of abortion-related topics (Htun et al., 2019; Prasertwong et al., 2021; Sanitya et al., 2020). Small sample sizes in some studies, such as those focusing on women with abortion histories, further restricted the robustness of the conclusions (Prasertwong et al., 2021). Cross-sectional designs employed in most studies limited the ability to capture changes in knowledge, attitudes, or practices over time (Saengruang et al., 2021; Vongxay et al., 2020). Finally, some studies lacked representation from rural or underserved populations, leaving critical gaps in understanding abortion care disparities (Htun et al., 2019; Philbin et al., 2020). The key findings, barrier and limitation is further explained in Table 2.

Table 3: Study Characteristics

No	Author (Year)	Population	Sample size	Country	Design	Type
1	Saengruang et al. (2021)	Medical Graduates	926	Thailand	Cross Sectional	Questionnaire-KAP study
2	Sinthuchai et al. (2022)	Registered Nurse	375	Thailand	Cross Sectional	Questionnaire - KAP Study
3	Sanitya et al. (2020)	healthcare worker	247	Thailand	Interventional	Pretest-Postest survey - KAP
4	Uaamnuichai et al. (2023)	Nursing Student	206	Thailand	Cross Sectional	Questionnaire - KAP Study
5	Ngo et al. (2023)	Female Sex Worker (FSWs)	251	Vietnam	Quasi Experimental	Pretest-Postest Mhealth
6	Vongxay et al. (2020)	Adolescent	800	Lao PDR	Cross Sectional	Questionnaire - KAP Study
7	Philbin et al. (2020)	Registered public health centres in Java, Indonesia	657	Indonesia	Cross Sectional	Signal Function Analysis
8	Rongkapich et al. (2023)	Pharmacy Students	104	Thailand	Cross Sectional	Questionnaire - KAP Study
9	Htun et al. (2019)	Reproductive age woman	238	Myanmar	Cross Sectional	Structured Interviews – contraceptive
10	Poolkumlung et al. (2023)	Medical Student	204	Thailand	Cross Sectional	Questionnaire-KAP study
11	Prasertwong et al. (2021)	Reproductive woman with abortion history	12	Thailand	Cross Sectional	Qualitative descriptive – Post abortion

Table 2: Key Findings, Barriers and Service Level Limitations.

No.	Author (Year)	Key Findings	Barrier	Limitation
1	Saengruang et al. (2021)	a) Strongest support for abortion in life-threatening, rape, and foetal impairment cases. b) Urban-trained graduates more supportive than rural-trained CPIRD graduates. c) Less support for abortion in non-marital and socioeconomic cases.	CPIRD's rural training focus limits support for non-critical abortion cases.	Limited to public sector-bound graduates, lacks private sector representation.
2	Sinthuchai et al. (2022)	a) Low abortion law knowledge (only 19% scored >80%). b) Majority held pro-life views, especially among Muslims. c) Willingness to provide abortion was higher among Buddhists than Muslims.	Religious beliefs and lack of legal update training limit abortion support.	Single location with limited department representation, reducing generalizability.
3	Sanitya et al. (2020)	a) Improved attitudes post-training, especially among non-doctors. b) Highest support for cases involving health risks, foetal anomalies, and rape/incest. c) Knowledge gaps remain on laws and safe methods.	Cultural opposition and resource limitations hinder access to safe abortion services.	Urban training bias and voluntary participation limit applicability.
4	Uaamnuichai et al. (2023)	a) High knowledge on abortion legislation among 37.4% of students. b) Strong support for abortion in cases of maternal/foetal health issues and sexual assault. c) Buddhist students showed more favorable attitudes.	Religious beliefs, especially among non-Buddhist students, influence abortion attitudes negatively.	Focus on one location limits generalizability to broader student populations.
5	Ngo et al. (2023)	a) Safe abortion knowledge improved (e.g., correct gestational age rose from 78.9% to 96.8%). b) Stigma concerns decreased from 36.5% to 27.8%. c) 80%+ satisfaction with app's privacy and support.	Initial stigma and complex medical language in the app affect accessibility.	Limited to female sex workers, lacks comparison with non-users.
6	Vongxay et al. (2020)	a) Low awareness of induced abortion (31.5%); 68.3% support safe access.	Strong cultural and religious beliefs create	Gender differences in knowledge, with females

		b) High negative attitudes (93%) with 71% viewing abortion as sinful. c) Majority (59%) desire more education on abortion and pregnancy.	stigma and hinder post-abortion care discussions.	more supportive and informed than males.
7	Philbin et al. (2020)	a) Only 46% of hospitals have full PAC services, with highest availability at referral hospitals. b) Expanding authorization to midwives/GPs could significantly increase PAC access. c) 88% of PAC patients treated with D&C in 2018.	Limited PAC capacity at lower-level facilities due to staffing and regulatory constraints.	Results may not generalize to regions outside Java.
8	Rongkapich et al. (2023)	a) Only 31.7% had good knowledge of abortion laws. b) High support for abortion in cases of foetal defects (97.1%) and sexual assault. c) Low support for abortion for socioeconomic reasons.	Limited abortion education in curriculum; cultural biases impact attitudes.	Single university sample with potential self-report bias.
9	Htun et al. (2019)	a) 11.3% ECP use, primarily due to contraceptive failure. b) 94.5% availability and 84.9% affordability reported. c) Higher usage linked to higher income and no pregnancy history.	Cultural and social misconceptions about ECP create hesitancy among women.	Limited to urban area, may not reflect rural settings.
10	Poolkumlung et al. (2023)	a) 45.6% had high knowledge on Thai abortion laws. b) Strong support for abortion in foetal anomalies (95.6%) and rape cases (93.2%). c) Less support for abortions due to socioeconomic factors.	Knowledge gaps on gestational limits could affect legal compliance.	Limited to one university's medical students, affecting broader applicability.
11	Prasertwong et al. (2021)	a) Long-term guilt and stigma post-abortion; religious rituals provided peace. b) Desired empathetic support and responsibility-sharing from men. c) Highlighted need for accessible mental and obstetric care.	Social stigma and lack of confidential, gender-sensitive services restrict access to mental health support.	Small sample size: stigma may limit full disclosure of experiences.

DISCUSSION

Knowledge and Attitudes

The results highlight significant gaps in knowledge and attitudes about abortion care in Southeast Asia, particularly among healthcare providers and the general population. For instance, only 31.7% of pharmacy students in Thailand demonstrated strong knowledge of abortion laws (Uaamnuichai et al., 2023). Misconceptions about gestational limits and safe abortion procedures were prevalent, reflecting insufficient training and awareness. Similarly, adolescents in Lao PDR exhibited limited awareness, with only 31.5% knowing about induced abortion, heavily influenced by cultural and religious stigmas (Vongxay et al., 2020). However, global practices show that targeted education and training initiatives can bridge these gaps. In the United States, evidence-based training programs for healthcare providers have significantly improved their knowledge and confidence in providing PAC and abortion care (Jung et al., 2023). Positive outcomes from targeted interventions were noted in Kenya and Vietnam, where education and training programs significantly improved knowledge and attitudes (Mutua et al., 2018; Ngo et al., 2023; Ngugi et al., 2021). These findings emphasize the importance of education in transforming attitudes and highlight the pervasive impact of societal norms on public and provider perceptions.

Barriers to Access

Barriers to accessing post-abortion care (PAC) in Southeast Asia are deeply rooted in cultural, legal, and systemic challenges. Stigma surrounding abortion remains a significant obstacle, particularly in Myanmar and Indonesia, where societal norms frame abortion as immoral and sinful, deterring women from seeking care (Htun et al., 2019; Philbin et al., 2020). Legal restrictions, such as limiting PAC procedures to specialists, further restrict access, particularly in rural areas (Owolabi et al., 2019). Knowledge gaps among healthcare providers exacerbate this issue. Social stigma and lack of confidentiality also deter women from seeking care, as evidenced in Uganda and Kenya, where fear of judgment often outweighed the need for medical attention (Kibira et al., 2023; Penfold et al., 2018). In Burkina Faso, integrating PAC into routine services and training providers improved access significantly, illustrating the importance of comprehensive training (Kiemtoré et al., 2016). Nepal's liberal abortion laws and community-based PAC initiatives have improved service accessibility, even in rural areas (Huber, 2019). These approaches demonstrate how policy reforms and decentralized healthcare systems can enhance PAC services.

Strengthening PAC Services

Global best practices offer valuable insights into improving PAC services in Southeast Asia. Ethiopia’s integration of PAC into primary healthcare systems, supported by training mid-level providers such as midwives, significantly improved rural access (Baker et al., 2024; Huber, 2019). Nepal's liberal abortion laws and community-based initiatives successfully increased access without alienating cultural norms (Huber, 2019). During the COVID-19 pandemic, China adopted telemedicine for PAC, enhancing accessibility and ensuring privacy for patients, a model that could benefit Southeast Asia (Wang & Yang, 2021). Incorporating post-abortion family planning counselling, as practiced in Kenya, effectively reduced the likelihood of repeat abortions and supported long-term reproductive health goals (Ngugi et al., 2021). These global examples illustrate that tailored, culturally sensitive interventions can address barriers and improve PAC delivery.

Study Strength and Limitation

This scoping review has several strengths. It provides an up-to-date overview of abortion care and post-abortion care (PAC) in Southeast Asia from 2019 to 2024, using a transparent search strategy across four major databases and following the PRISMA-ScR framework. By synthesising findings on knowledge, attitudes, practices, barriers and service limitations, the review highlights key themes relevant for policy and practice.

However, several limitations must be acknowledged. The evidence base is geographically imbalanced, with seven of eleven studies from Thailand; thus, Buddhist-majority contexts are over-represented, while Muslim-majority countries such as Indonesia, Malaysia and Brunei are under-represented. Most studies were also conducted in urban or tertiary settings among students, trainees or facility-based populations, limiting applicability to rural or marginalised groups. Although Timor-Leste is part of Southeast Asia, it was not explicitly included in the search terms, and no studies were identified from that country. In addition, the review was restricted to English-language, open-access publications, resulting in the exclusion of numerous non-English studies (n = 70) that may contain important context-specific findings. Finally, as a scoping review, no formal quality appraisal was undertaken, so individual study findings should be interpreted cautiously.

A Path Forward

An approach that is culturally sensitive and multifaceted is crucial for improving PAC in Southeast Asia. Decentralising services by empowering mid-level providers directly addresses shortages such as those in Indonesia, where only 46% of hospitals had full PAC services and care remained concentrated in referral facilities (Philbin et al., 2020). Evidence from Ethiopia and Burkina Faso shows that decentralisation is most effective when paired with structured training, supervision and regulatory oversight (Baker et al., 2024; Huber, 2019; Kiemtoré et al., 2016)

Telemedicine can also mitigate barriers identified in this review, including stigma, confidentiality concerns and geographical distance. China's experience demonstrates its feasibility for counselling and follow-up (Wang & Yang, 2021). With internet penetration exceeding 70–80% in Thailand, Malaysia and Vietnam, telemedicine could complement facility-based PAC where supported by appropriate regulation and data-protection measures.

Comprehensive provider training is needed to address the KAP gaps observed in Thailand, Lao PDR and Myanmar. Training should include safe methods, legal literacy and value-clarification components to reduce stigma (Saengruang et al., 2021; Sanitya et al., 2020; Sinthuchai et al., 2022). Evidence from Kenya supports the effectiveness of structured PAC and family planning counselling in improving provider confidence and reducing repeat abortions (Mutua et al., 2018; Ngugi et al., 2021)

Finally, community-level and faith-engaged strategies are essential to address deep-rooted stigma in Lao PDR and Myanmar (Vongxay et al., 2020; Htun et al., 2019) and the long-term emotional burden described by Thai women (Prasertwong et al., 2021). Engaging religious and community leaders may help normalise PAC, promote harm-reduction and support women's mental health (Ibrahim, 2015; Kibira et al., 2023).

Co-ordinated action across governments, health systems and communities is necessary for equitable PAC in Southeast Asia. Future research should move beyond documenting KAP and prioritise evaluating integrated interventions such as decentralisation and telemedicine that address the structural and social barriers identified in this review.

CONCLUSION

Post-abortion care in Southeast Asia encounters obstacles stemming from cultural, legal, and systemic difficulties. Global instances illustrate that context-sensitive strategies, including decentralization, telemedicine, and community involvement, may greatly enhance access and quality. By addressing knowledge deficiencies, mitigating stigma, and incorporating PAC into primary healthcare, Southeast Asia can develop equitable and culturally suitable PAC systems. Cooperative initiatives involving governments, healthcare providers, and communities are crucial for guaranteeing the accessibility of reproductive health rights and services for everyone.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this work.

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REVIEW ARTICLE Open Access

WILLINGNESS TO PAY FOR OUTPATIENT SERVICES: A NARRATIVE REVIEW

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Abstract

The concept of Willingness to Pay (WTP) in healthcare refers to the maximum amount an individual is willing to pay for a particular health service for outpatient (OP) services. WTP studies provide valuable insights into patients' preferences, perceived value of care, and ability to contribute financially to their healthcare. Hence, it assists in informed decision-making and policy formulation, potential strategies for cost-sharing, resource allocation, and service improvement, determine appropriate pricing strategies and identify potential barriers to the access. This narrative review aims to synthesize the current literature on WTP for OP services, exploring the factors that influence patients' WTP and the implications for healthcare policy and practice. Total of 13 articles reviewed across the global related to WTP for OP Services between 2014 and 2024. Prevalence of WTP for OP services varies across different countries and healthcare settings. Factors influencing WTP for OP services include sociodemographic factors, economic factors, health-related factors, health insurance coverage, type and quality of healthcare, accessibility, type of healthcare provider, and past experiences with healthcare services. WTP analysis helps identify and prioritize investments in service that tailored with patient needs to enhance the quality of care. This review highlights important lessons for healthcare financing and equity. If it reveals that by providing concrete data on the factors influencing WTP for OP services in the local setting, the research can drive evidence-based policy decisions

Keywords: Willingness to pay, Outpatient services.

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INTRODUCTION

The concept of Willingness to Pay (WTP) in healthcare refers to the maximum amount an individual is willing to pay for a particular health service or intervention (Abbas et al., 2019). In an era where healthcare systems worldwide grapple with mounting financial pressures and resource constraints, understanding the concept of WTP for OP services has become more crucial than ever. In the context of OP services, WTP studies provide valuable insights into patients' preferences, perceived value of care, and ability to contribute financially to their healthcare (Steigenberger et al., 2022). As healthcare systems evolve and face mounting pressures to balance quality, access, and cost-effectiveness.

Outpatient (OP) services encompass a wide range of medical care provided without hospital admission, from routine check-ups to complex diagnostic procedures and treatments such as consultations, scans, and minor procedures. These services form a significant portion of healthcare utilization and expenditure in many countries (Mohammadi et al., 2023). As healthcare systems evolve to meet the changing needs of populations, the importance of aligning these services with patient values and preferences cannot be overstated. As such, exploring WTP for OP services can shed light on potential strategies for cost-sharing, resource allocation, and service improvement (Tringale et al., 2022). It is here that WTP analysis emerges as a powerful tool, bridging the gap between economic theory and patient care.

WTP for OP services has become an increasingly important topic in healthcare economics and policy as health systems worldwide grapple with rising costs and the need for sustainable financing models. This narrative review aims to synthesize the current literature on WTP for OP services, exploring the factors that influence patients' WTP and the implications for healthcare policy and practice. It contributes to the field by exploring how WTP evidence can inform practical policy decisions, including the development of pricing strategies, identification of access barriers, prioritization of service improvements, and design of insurance schemes that align with population preferences and financial capacity. For middle-income countries in transition toward universal health coverage, WTP research offers critical insights for balancing affordability for patients with the financial sustainability of healthcare systems.

METHODS

In this narrative review, total of 13 articles reviewed across the global. Searches of published literature were conducted for articles related to Willingness to pay for Outpatient Services between 2014 and 2024, in the following databases which are PubMed, Semantic Scholar and Scopus. Key word search includes “Willingness to pay” and Outpatient service.

Papers were excluded based on the following criteria:

- Non-English
- study design: cross-sectional, prospective and retrospective study
- 10 years
- form of original article
- not a protocol, review, commentary or report
- content not related (e.g cost effectiveness, insurance scheme, hospital service)

.

RESULTS

The prevalence of WTP for OP services varies significantly across different countries and healthcare settings, reflecting diverse economic, cultural, and systemic factors. Studies reveal a wide range of WTP prevalence, from as low as 36.3% in the Netherlands (Martín-Fernández et al., 2021) to as high as 94.8% for specific service improvements in Bangladesh (Pavel et al., 2015). Moderate to high WTP levels were observed in countries like Indonesia (78.2%) (Astrilia et al., 2020), Saudi Arabia (73%) (Al Mustanyir et al., 2022), and Taiwan (68.5-76.2%) (Hsu et al., 2021), while lower percentages were seen in Greece (39.3%) (Mavrodi et al., 2021) and for certain services in Malaysia (Aizuddin & Junid, 2018) - 16.7% for private clinic treatments. Interestingly, WTP often varied within countries depending on the specific service or improvement being considered. Similarly, in Hungary, WTP was higher for specialist examinations (66.3%) than for planned hospitalizations (56.0%) (Baji et al., 2014). These findings give a fundamental insight on how complex and context-dependent nature of WTP for OP services.

Factors Influencing WTP for OP Services

Sociodemographic Factors

Age emerged as a significant factor in multiple studies, with varying effects across different contexts. In Greece, younger individuals were more likely to be willing to pay for health improvements, with the odds of WTP decreasing by 1.7% for each year increase in age (Mavrodi et al., 2021). Similarly, in Hungary, older respondents were less willing to pay for specialist examinations (Baji et al., 2014). However, a Danish study found that patients aged 65 years or older were almost twice as likely to be willing to pay for a GP consultation compared to younger patients (Kronborg et al., 2017). These contrasting findings suggest that the relationship between age and WTP may be context-dependent and influenced by factors such as retirement status, health needs, and cultural expectations.

Education level consistently showed a positive association with WTP across multiple studies. In Greece, individuals with higher education levels were more likely to be willing to pay for health improvements, with those having no or elementary education showing 72% lower odds of WTP compared to higher education graduates (Mavrodi et al., 2021). Similarly, in Saudi Arabia, higher education levels were associated with greater WTP, with undergraduate and postgraduate degree holders being 14.6% and 19.7% more likely to participate in WTP schemes, respectively (Al Mustanyir et al., 2022). This trend was also observed in Bangladesh, where higher education was associated with increased WTP for waiting time improvements (Pavel et al., 2015). This is evidence on how educated people will have better understand the importance of preventive care and early intervention, recognize the long-term benefits of investing in quality healthcare an able to critically evaluate health information and make informed decisions about their care.

Gender played a role in some studies, although its effect was not as consistent as age or education. In Saudi Arabia, males were found to be willing to pay more than females (Al Mustanyir et al., 2022). In Bangladesh, females had lower WTP for chance of recovery improvements (Pavel et al., 2015). This is probably due to men tend to have higher incomes than women, which can enable greater healthcare spending. These gender differences may reflect broader societal inequalities in income and decision-making power within households.

Marital status was identified as a factor in some studies. In Ethiopia, married participants were willing to pay 14.49 USD more than unmarried participants for medical care in private health care facilities (Belete & Walle, 2023). Similarly, in Saudi Arabia, married individuals were willing to pay more than single individuals (Al Mustanyir et al., 2022). This could be related to factors such as shared financial resources in married households or different health priorities among married individuals.

Economic Factors

Economic conditions play a pivotal role in shaping WTP prevalence. Countries with stronger economies and higher income levels generally exhibit higher WTP rates. Income consistently emerged as one of the most significant factors influencing WTP across all studies. In Indonesia, higher income was associated with greater WTP, with an adjusted prevalence ratio of 2.64 (Astrilia et al., 2020). The Saudi Arabian study found that employed individuals were willing to pay more than unemployed ones (Al Mustanyir et al., 2022). In Greece, individuals with household income less than €500 had 69% lower odds of being willing to pay compared to those with income more than €2000 (Mavrodi et al., 2021). This strong association between income and WTP highlights the importance of considering affordability and equity when implementing cost-sharing mechanisms in healthcare.

Employment status was another important economic factor. In South Africa, unemployed individuals had lower odds of WTP compared to students (Chiwire et al., 2021). The Ethiopian study found that participants who were still working were willing to pay 19.66 USD more than retired or unemployed participants (Belete & Walle, 2023). This trend likely stems from heightened ability to invest in healthcare services among populations in more affluent nations and the ability or WTP for healthcare services.

Health-Related Factors

Health status and experience with medical care were significant factors in several studies. In Saudi Arabia, individuals with chronic diseases were 19% more likely to participate in WTP schemes and willing to pay more (Al Mustanyir et al., 2022). The Ethiopian study found that participants with a history of medical illness were willing to pay 16.64 USD more than those without (Belete & Walle, 2023). Additionally, having a family or friend with a history of medical care increased WTP by 25.74 USD. These findings suggest that personal experience with health issues or familiarity with healthcare needs can increase the perceived value of health services.

Knowledge about medical care also played a role. In Ethiopia, participants with good knowledge about medical care were willing to pay 36.16 USD more than those with poor knowledge (Belete & Walle, 2023). This highlights the importance of health literacy and public education in shaping attitudes towards healthcare financing. Health insurance status had varying effects across different contexts. In Malaysia and Denmark, having health insurance was associated with higher WTP for both government and private clinic services (Aizuddin & Junid, 2018) (Kronborg et al., 2017). However, in Saudi Arabia, those with private health insurance were willing to pay less than those without it (Al Mustanyir et al., 2022). These contrasting findings may reflect differences in healthcare system structures and the perceived value of additional payments among insured individuals.

Service-Related Factors

The type and quality of healthcare services significantly influenced WTP. In Taiwan, patients showed higher WTP for improving medical service quality compared to implementing hierarchical medical care. The perceived quality of medical services, especially in terms of reliability and assurance, was strongly associated with higher WTP. Even within individual countries, WTP can fluctuate dramatically depending on the OP service under consideration. In Bangladesh, for example, WTP ranged from 61.5% to 94.8% across different aspects of healthcare quality. In Bangladesh, there was a preference for seeing the same doctor, with those who "never" see the same doctor having 19% higher odds of WTP for improvements in this area (Pavel et al., 2015). In China, there was a slight preference for senior healthcare practitioners. The type of healthcare provider and continuity of care were important in some contexts (Li et al., 2021).

Accessibility factors, such as distance to healthcare facilities and waiting times, also affected WTP. In Ethiopia, for every 1-km increase in distance from the healthcare facility, participants' WTP increased by 1.98 USD (Belete & Walle, 2023). In Bangladesh, patients living "very far" from hospitals were 39% more likely to pay for improvements in geographical proximity (Pavel et al., 2015). Long waiting times were also associated with higher WTP for improvements in several studies. In China, residents in more rural areas were willing to pay more for shorter traveling times compared to those in central municipalities (Li et al., 2021). This suggests that rural residents place a higher value on accessibility due to potentially longer travel distances. It's different than in Malaysia and one of the studies in Saudi, whereby those who from urban locality willing to pay more (Aizuddin & Junid, 2018) (Al Mustanyir et al., 2022), which may indicate the readily of service available and typically have better access to healthcare facilities, which may influence their WTP. They often have higher average income levels, which is consistently associated with increased WTP for healthcare services.

Past experiences with healthcare services, including informal payments, influenced WTP. In Hungary, those who had paid informally in the past 12 months were significantly more willing to pay formal fees (Baji et al., 2014). This suggests that past behaviors and expectations can shape attitudes towards future payments for healthcare services. Figure 1 summarizes the factors of WTP for OP services.

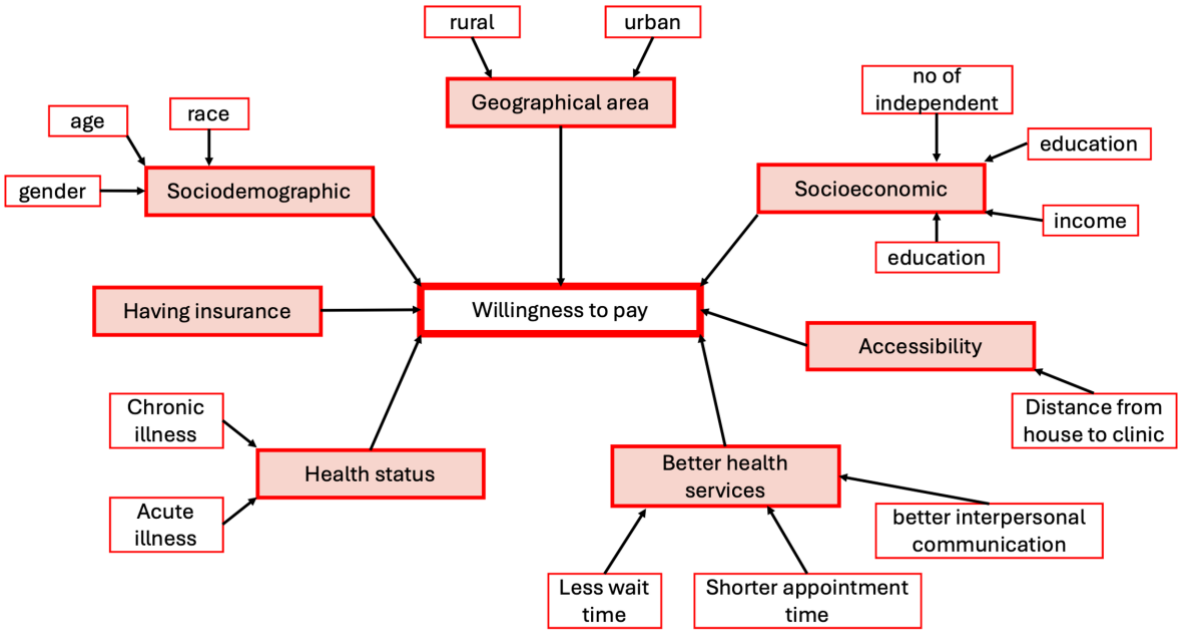

Figure 1: Factors of willing to pay summary

DISCUSSION

This review offers important lessons for healthcare financing and equity, especially for policymakers in middle-income countries such as Malaysia seeking sustainable health system solutions. It highlights key factors influencing WTP and may suggest practical policy directions. One of the strongest patterns observed is the influence of education on WTP, seen consistently across countries. People with higher education or better health literacy are more likely to pay for health insurance and use health services wisely. Lower health literacy is linked with much higher healthcare costs and higher spending on prescriptions (Tusoni et al., 2025) (Haun et al., 2015). These costs often result from inefficient use of services, such as frequent emergency visits and less use of preventive care. A statement by Health Minister in 2022 Malaysia, despite full subsidies, only around 10% of eligible people use the PeKa B40 scheme, possibly due to low insurance literacy. Policymakers should prioritise health literacy programmes, such as using plain language in insurance documents, simplifying benefits, and offering community education, especially for those with less education.

The varying effects of factors like age, gender and marital status across different contexts underscore the importance of conducting localized WTP studies. What holds true in one healthcare system or cultural context may not apply in another. For example, in Saudi Arabia, males were found to be willing to pay more than females, while in Bangladesh, females had lower WTP chance of recovery improvements (Pavel et al., 2015). This could tell us more about what it highlighted. Health consequences of such disparities may contribute to underdiagnosis and delayed treatment of conditions disproportionately affecting women, perpetuating cycles of poor health outcomes and economic disadvantage (Temitope et al., 2024). Hence the need for healthcare systems to develop tailored approaches that consider local norms, values, and economic conditions. By providing concrete data on the factors influencing WTP for OP services in specific settings, research can drive evidence-based policy decisions, ranging from restructuring healthcare financing to investing in targeted infrastructure and education programs (WHO, 2012).

Income also plays a major role in determining WTP, reflecting affordability challenges and raising important equity issues. In Southeast Asia, challenges to universal health coverage include unstable revenue sources, fragmented insurance, and low government health spending. Heavy out-of-pocket payments can discourage low-income groups from seeking care (Lim et al., 2023). Progressive financing models, like Malaysia's tax-based system, help reduce these gaps, but more is needed for long-term sustainability. Hybrid models combining public funding and income-based contributions, as seen in Australia and Singapore, may offer a way forward (Haseltine, 2013). Proposing National Social Health Insurance scheme is promising, but must cover informal workers, ensure legal protection, and use means-tested contributions to shield vulnerable groups from financial hardship (Moideen et al., 2025).

WTP studies provide crucial insights into patients' valuation of OP services, offering a foundation for developing pricing strategies and cost-sharing mechanisms. By understanding patients' WTP, healthcare providers can set user fees or copayments that balance revenue generation with affordability (Abbas et al., 2019; Donaldson, 1999). The level of the community can pay need to be considered before implementing modest cost-sharing mechanisms. It's a win-win situation where healthcare can have the revenue at the same time community get the service. By understanding patients' WTP, healthcare systems can develop more sustainable financing models that balance affordability for patients with the need to cover costs. This can help reduce the accumulation of bad debt for healthcare providers. However, it's important to note that WTP often falls below the actual cost of service provision, presenting challenges for sustainable financing (Liaropoulos & Goranitis, 2015). This discrepancy underscores the need for careful consideration when implementing cost-sharing to avoid creating access barriers, especially for vulnerable populations (Emerton, 2006).

As a service provider to the people, healthcare should be able to cater the need of the community. WTP analysis helps identify aspects of OP care that patients value most, guiding healthcare providers and policymakers in prioritizing service improvements (Jeetoo & Jaunky, 2022; Yao et al., 2025). For example, in Taiwan, patients showed higher WTP for improving medical service quality compared to implementing hierarchical medical care, hence the priorities can be be directed to improvement of services (Hsu et al., 2021). Another example given in Bangladesh. The strong preference for seeing the same doctor, with those who "never" see the same doctor having 19% higher odds of WTP for improvements in this area, therefore a policy or guideline enhancements and changes should be look upon (Pavel et al., 2015).

Analysing WTP can also help predict the demand for new OP services or interventions. Urban and rural needs differ. Urban residents want convenience, while rural populations value proximity and reduced travel time (Li et al., 2021). If a new service is introduced such as mobile clinic or telehealth services, there's a likelihood for the uptake of the service. This predictive capability is crucial for healthcare planners when considering innovations in service delivery models or treatment options. These insights can inform resource allocation decisions for the services, focusing on enhancements and innovations that align with patient preferences and potentially lead to improved satisfaction and outcomes (Fagbenle, 2025).

Several practical recommendations arise for general policymakers. First, establish clearly defined income-based exemption criteria with streamlined application processes to protect low-income households from financial barriers. Taiwan's catastrophic illness coverage and Hong Kong's comprehensive waiver mechanisms for vulnerable groups provide relevant models. Second, differentiate registration fees between socioeconomic groups while

maintaining universal access principles, as evidence shows willingness varies substantially by income quintile. Third, integrate WTP assessments into the reform planning to ensure proposed fee adjustments remain within community capacity. Fourth, strengthen public-private partnerships with transparent pricing regulations framework to prevent cost-shifting that disproportionately burdens vulnerable populations. Finally, invest in health literacy programs to enhance understanding of healthcare value and insurance mechanisms, as knowledge significantly influences WTP and appropriate utilization patterns.

CONCLUSION

WTP studies for OP services offer valuable insights that can significantly impact healthcare policy and practice. By emphasizing these insights, stakeholders can make informed decisions that enhance service delivery, improve patient satisfaction, and work towards ensuring the sustainability of healthcare systems. This multifaceted approach addresses immediate financial concerns while promoting long-term improvements in health outcomes and system efficiency.

As healthcare systems continue to evolve and face mounting pressures to balance quality, access, and cost-effectiveness, understanding WTP becomes increasingly crucial for informed decision-making and policy formulation. By considering the complex relationship of sociodemographic, economic, health-related, and service-related factors that influence WTP, healthcare systems can develop more equitable, accessible, and culturally appropriate OP services that meet the needs of diverse populations while ensuring finance security.

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Conceptualization: all authors; Data curation: all authors; Formal analysis: all authors.; Methodology: all authors; Resources: all authors; Supervision: ARR; Writing-original draft: all authors; Writing-review & editing: all authors. All authors read and approved of the final manuscript.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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Data Availability Statements

No datasets were generated or analyzed during the current study. This article is a narrative review based primarily on previously published literature.

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REVIEW ARTICLE Open Access

REPRODUCTIVE AGING AND MENOPAUSAL TRANSITION IN MALAYSIA: PUBLIC HEALTH AND POLICY STRATEGIES FOR ENHANCING WOMEN'S QUALITY OF LIFE

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Abstract

Reproductive aging and the menopausal transition represent significant public health challenges that affect millions of women globally and in Malaysia. By 2030, more than 1.2 billion women worldwide will be menopausal, yet healthcare systems remain insufficiently prepared to address the health, social, and economic implications. This narrative review synthesizes recent evidence (2020-2025) on the epidemiology, challenges, and strategies for improving women's quality of life during menopause, with a focus on Malaysia. Key findings show that the average age of menopause varies globally, ranging from the 47 years in South Asia to 51 years in high-income countries, with early menopause increasingly reported in low- and middle-income regions. Health consequences include osteoporosis, cardiovascular disease, metabolic syndrome, and mental health disorders, compounded by social stigma and inadequate workplace and healthcare support. Public health challenges in Malaysia include limited awareness, lack of provider training, and underfunded menopausal services. Strategies to address these issues involve education campaigns, integration of menopause into primary healthcare, workplace accommodations, lifestyle and preventive interventions, and digital health solutions such as mobile applications and telemedicine. International examples, including UK Menopause Taskforce and WHO's Health Aging framework, provide valuable lessons for Malaysia. However, digital health interventions face challenges related to access, affordability, and data privacy. This review emphasizes the need for culturally sensitive, evidence-based, and policy-driven approaches to strengthen menopausal health services in Malaysia. Future research should evaluate digital health tools, cross-cultural experiences, and long-term health outcomes to guide policy and practice.

Keywords: Menopause, reproductive aging, women's health, public health policy, digital health.

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INTRODUCTION

Menopause marks the permanent cessation of menstruation for 12 consecutive months and typically occurs between 45 and 55 years of age (Bharti & Choudhary, 2021). It represents a major biological milestone in women's lives, accompanied by hormonal decline, particularly reduced estrogen, which contributes to vasomotor symptoms, osteoporosis, cardiovascular disease, and psychological changes. Beyond its clinical implications, menopause has substantial social, economic, and public health consequences (Kalita et al., 2024; Srivastava & Sreelatha, 2024). By 2030, an estimated 1.2 billion women worldwide will be menopausal, spending nearly one-third of their lives in the postmenopausal stage (Namazi et al., 2019).

Despite its importance, menopausal health remains underprioritized in health systems. In Malaysia, demographic shifts toward population aging mean that women will increasingly live many years beyond menopause, heightening the burden of age-related diseases and healthcare needs (Abdullah et al., 2024) . However, current services for menopausal care remain fragmented, with limited provider training, lack of structured policies, and persistent stigma surrounding discussions of reproductive aging. These gaps result in untreated symptoms, reduced quality of life, and loss of productivity, particularly for working women.

From a policy perspective, reproductive aging intersects national goals on healthy aging, women's health, and non-communicable disease (NCD) prevention. Yet, few national frameworks explicitly integrate menopause into public health planning. Internationally, the UK Menopause Taskforce and WHO's Healthy Aging agenda highlight how structured policies and health system integration can address this gap (Hacking & Mander, 2022). For Malaysia, adapting such models to local sociocultural contexts offers an opportunity to advance women's health equity.

This narrative review aims to synthesize recent literature (2020-2025) on the epidemiology, public health challenges, and strategies related to menopause, with a focus on Malaysia. It emphasizes the novelty of integrating both policy analysis and digital health perspectives, highlighting opportunities for strengthening menopausal care through education, primary healthcare integrations, workplace policies, lifestyle interventions, and technology-enabled solutions.

METHODS

A literature search was conducted between January and March 2025 using PubMed, Scopus, and Google Scholar. Additional references were identified through citations tracking relevant articles. The search strategy included the following Medical Subject Headings (MeSH) and keywords: "menopause", "reproductive aging", "women's health", "public health policy", "digital health", and "Malaysia". Boolean operators (AND/OR) were used to combine terms, and filters were applied to restrict publications to the years 2020-2025 to ensure relevance and recency.

Inclusion and Exclusion Criteria

Studies were included if they:

i. Focused on menopause, reproductive aging, or women's health during the menopausal transition.
ii. Reported on epidemiology, public health challenges, interventions, policies, or digital health solutions
iii. Were published in peer-reviewed journals, official reports, or organizational frameworks (e.g., WHO, Ministry of Health Malaysia)
iv. Were written in English

Exclusion criteria included articles published before 2020, studies limited to clinical case reports without public health relevance, and non-peer-reviewed commentaries without empirical data.

Data Extraction and Synthesis

Key data extracted included epidemiological trends, health risks, social and workplace impacts, intervention strategies, and policy responses. Findings were synthesized thematically into subsections: (i) Epidemiology of Menopausal Transition, (ii) Public Health Challenges, (iii) Strategies to Enhance Women's Quality of Life, (iv) Policy Interventions, (v) Lifestyle and Preventive Approaches, and (vi) Digital Health and Technology.

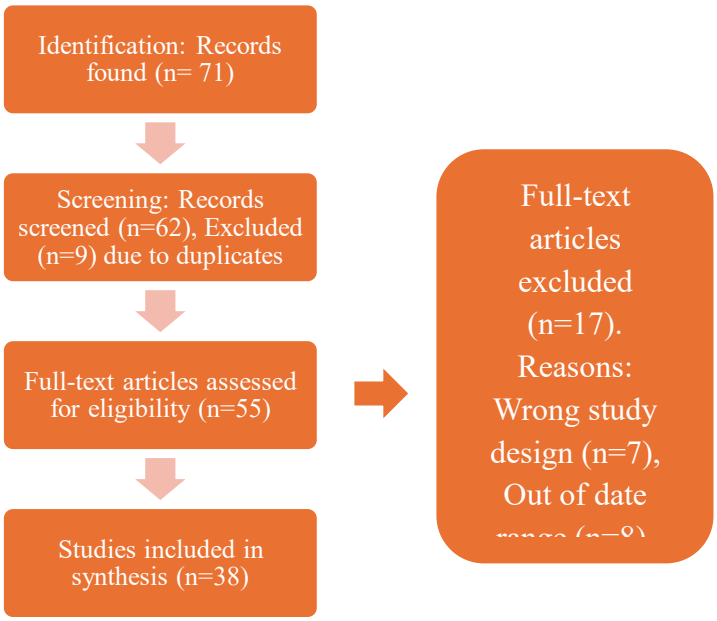

Figure 1: Flow diagram illustrating the selection of literature

RESULTS

Epidemiology of Menopausal Transition

Globally, the average age of natural menopauses ranges between 47 and 51 years, with notable variations across regions (Mishra et al., 2024). In high-income countries, menopause typically occurs at 50-51 years (Mishra et al., 2024), while in South and Southeast Asia the mean age is lower, around 46-48 years (Leone et al., 2023). Studies from India and Zambia report average onset at 47 years, with early menopause (before 45 years) affecting up to 10% of women (Mulenga, 2023; Satapathy et al., 2020; Singh & Kaunert, 2024). Early menopause is increasingly documented in low- and middle-income countries (LMICs), influenced by factors such as smoking, low physical activity, and socioeconomic disadvantages (Djalalinia et al., 2024).

In Malaysia, large-scale national data are limited, but smaller regional studies suggest a mean menopausal age of 50 years, aligning with global averages. With the projected increase in women aged ≥ 50 years, Malaysia faces a growing population of postmenopausal women who will spend up to one-third of their lives in this stage (Osman et al., 2023). This has significant implications for health systems, as menopause is linked to increased risks of osteoporosis, cardiovascular disease, and metabolic syndrome (Siusiuka et al., 2024).

Ethnic and cultural factors also shape experiences of menopause. Evidence suggests that Asian women often report fewer vasomotor symptoms than Western populations but experience higher rates of somatic symptoms, such as joint pain and fatigue (Khoudary, 2020). Immigrant and minority groups face additional challenges related to discrimination, chronic stress, and limited access to culturally appropriate care (Cortes & Marginean, 2022).

Public Health Challenges in Menopausal Transition

Menopause poses a multifaceted public health challenge. Symptom burden affects up to 80% of women, with hot flashes, sleep disturbance, and mood changes impacting quality of life and workplace productivity (Lancet, 2022). In Malaysia, stigma surrounding menopause contributes to silence at both family and community levels, limiting open discussions and healthcare-seeking behavior (Osman et al., 2023).

Healthcare system gaps include lack of provider training, minimal integration of menopause into primary care, and limited access to hormone replacement therapy (HRT) (Hirsch, 2021). Many general practitioners report low confidence in managing menopausal health, reflecting a lack of structured training programs. In rural areas, limited health infrastructure further restricts access (Barber & Charles, 2023).

Economic consequences are also significant. In high-income settings such as the U.S. and Europe, menopause-related productivity losses are estimated in the billions of dollars annually (Ahmed & Hardcastle, 2023). In Malaysia, no such national estimate exists, but anecdotal evidence suggests women face absenteeism, reduced productivity, and in some cases early retirement due to unmanaged symptoms.

Intersectional disparities further compound challenges. Women from lower socioeconomic backgrounds, those with disabilities, or those in informal employment sectors often lack access to healthcare and workplace accommodations (Frank et al., 2024; Zou et al.,

2021). Migrant women may rely on traditional remedies, reflecting cultural norms and healthcare access barriers (Ye et al., 2024).

Strategies For Enhancing Women's Quality of Life

Education and Awareness

Educational campaigns have proven effective in improving menopausal knowledge and reducing stigma. For example, interventions in South Asia showed improved symptom recognition and healthcare-seeking following structured education sessions (Keye et al., 2023). In Malaysia, public campaigns in reproductive health exist, but menopause remains underrepresented compared to maternal and adolescent health programs. Expanding awareness campaigns can empower women to manage symptoms proactively and seek care.

Healthcare Provider Training

Training healthcare providers is crucial. Evidence from the UK and Australia demonstrates that structured menopause training programs for general practitioners improve patient care and confidence in prescribing HRT (Hemachandra et al., 2023). Incorporating menopause into Malaysia's continuing medical education and family medicine curricula would strengthen primary care capacity.

Workplace Policies

Menopausal symptoms disrupt careers, particularly for women in mid-to-senior roles. Internationally, workplace accommodations such as flexible hours, access to cooling facilities, and health consultations have improved retention and productivity (Faubion & Shufelt, 2023). In Malaysia, workplace health policies remain focused on maternity and occupational safety with little attention to menopausal health. Policy integration could reduce absenteeism and support women's participation in the workforce (Hacking & Mander, 2022).

Policy Interventions

Policy frameworks are essential for mainstreaming menopausal care. International examples include the UK Menopause Taskforce (established 2022), which improved treatment access and raised national awareness, and WHO's Healthy Aging framework, which emphasizes integrating aging into primary healthcare systems (Hacking & Mander, 2022).

Malaysia's National Health Policy for Older Persons and Clinical Practice Guideline on Menopause (2022) provide initial foundations. However, implementation remains limited due to resource constraints, lack of funding, and competing health priorities (Abdullah et al., 2024). Strengthening these policies requires clearer financing mechanisms, integration of routine menopausal screening into primary healthcare, and community-based support services (Lee et al., 2025).

Cross-sectoral collaboration with NGOs, employers, and community organizations is also necessary. For example, the Senior Citizens Activity Centers (Pusat Aktiviti Warga Emas, PAWE) could incorporate menopause education and peer-support programs to reduce isolation and stigma among older women.

Lifestyle and Preventive Interventions

Lifestyle modification is a cornerstone of menopausal health. Evidence supports the Mediterranean diet and regular physical activity in reducing vasomotor symptoms and lowering risks of cardiovascular disease and osteoporosis (Vázquez-Lorente et al., 2025). Stress management interventions, including yoga and mindfulness, have also shown benefit (Boakye et al., 2022; Iqbal et al., 2024).

Community-based programs improve adherence by fostering peer support and social accountability. Social prescribing models, where healthcare providers link patients to community exercise or diet programs, have been effective in Europe and could be adapted in Malaysia (Kent-Marvick et al., 2023).

However, barriers remain. Women often struggle with adherence due to caregiving responsibilities, financial constraints, and lack of time. Focused interventions, supported by primary healthcare providers and local communities, are needed to improve long-term adoption.

Digital Health and Technology

Digital health solutions are emerging as promising tools for menopausal care. Mobile applications such as MenoSmile and Menopause Assistant Manager (MAMA) have shown benefits in symptom tracking, self-care education, and emotional support (Kim et al., 2024; Osman et al., 2023). Telemedicine also provides convenient access to consultations, particularly during the COVID-19 pandemic (Shin et al., 2024; Vollrath et al., 2024).

Yet, challenges are significant. Many women, especially in rural Malaysia, face limited internet connectivity, low digital literacy, affordability barriers (S. Z. S. Abdullah, 2022; Maung et al., 2020). Data privacy is another major concern, as most menopause apps lack robust security standards. Without regulation, users risk exposure to misinformation and misuse of sensitive health data (Sillence et al., 2023).

Equitable access requires integrating digital health into existing public healthcare frameworks, providing affordable or subsidized tools, and ensuring cultural and linguistic tailoring for Malaysian users. Regulations must also establish standards for safety, data privacy, and quality assurance (Baltzer & Bonancina, 2023).

DISCUSSION

Main Findings and Significance

Epidemiological evidence shows that while the average age of menopause in Malaysia aligns with global patterns which are around 50 years old of age (J. M. Abdullah et al., 2024), women now spend a larger proportion of their lives post-menopause due to increased life expectancy (Safwan et al., 2024). This demographic shift intensifies risks of osteoporosis, cardiovascular disease, and multimorbidity. Importantly, menopause affects not only health outcomes but also social and economic participation, particularly through workplace disruptions and reduced productivity(Faubion et al., 2024).

In Malaysia, major challenges include inadequate awareness, insufficient provider training, and fragmented integration of menopause into primary healthcare. Current policies, such as the National Health Policy for Older Persons and the Clinical Practice Guideline on Menopause (2022), offer a foundation but lack robust implementation and financing mechanisms (J. M. Abdullah et al., 2024). This situation mirrors trends in many LMICs, where menopause remains a neglected area of women's health compared to maternal and reproductive health (Wang et al., 2020).

Comparison with Global Best Practices

International examples provide lessons for Malaysia. The UK Menopause Taskforce, established in 2022, has raised national awareness, improved access to hormone replacement therapy, and influenced workplace policies (Hacking & Mander, 2022). Similarly, WHO's Healthy Aging framework emphasizes integrating aging into all levels of healthcare, including reproductive aging. These initiatives underscore the importance of multisectoral collaboration, funding, and sustained advocacy (Cortes & Marginean, 2022).

Malaysia has begun to adopt aging policies but lags in integrating menopause-specific initiatives. Unlike high-income countries, workplace accommodations for menopausal women are largely absent (Riach & Jack, 2021). Moreover, health services in Malaysia remain urban-centered, leaving rural and indigenous populations underserved. Incorporating culturally tailored education, decentralized health services, and affordable treatment options could close this gap (J. M. Abdullah et al., 2024).

Policy and Public Health Implications

Strengthening menopause care in Malaysia requires embedding it into broader health and social systems. Key implications include:

1. Integration into Primary Healthcare: Training general practitioners and family physicians to routinely screen for menopausal symptoms and provide evidence-based treatment, including safe use of HRT, would reduce unmet needs (Zeng et al., 2023).
2. Workplace Policies: Formal policies promoting flexible work arrangements, awareness training for managers, and occupational health services tailored to menopausal women could prevent productivity loss and early retirement (Safwan et al., 2024).
3. Community Engagement: Leveraging community health workers, NGOs, and programs such as Pusat Aktiviti Warga Emas (PAWE) to deliver education and peer support would normalize discussions and reduce stigma (Frank et al., 2024).
4. Digital Health Regulations: Establishing national standards for menopause-related mobile applications and telemedicine services would ensure quality, privacy, and accessibility, while subsidies could enhance uptake in rural areas (Sillence et al., 2023; Vollrath et al., 2024).
5. Financing Mechanisms: Dedicated budget lines within Malaysia's health financing system are necessary to fund menopausal health services, training, and digital health innovations (J. M. Abdullah et al., 2024).

Table 1: Public Health Challenges and Recommendations

Domain	Identified Challenge	Evidence-Based Recommendation	Key References
Primary Healthcare	Lack of provider training; fragmentation of services.	Mandate routine menopause screening in primary care; Train GPs in updated HRT guidelines.	J. M. Abdullah et al., 2024
Workplace	Reduced productivity; early retirement due to symptoms.	Implement flexible work arrangements; Occupational health policies specific to menopause.	Riach & Jack, 2021
Community	Stigma; low health literacy regarding aging.	Leverage community centers (e.g., PAWE) for peer support and education.	(Barber & Charles, 2023)
Financing	Lack of dedicated funding for menopausal services.	Create specific budget lines within national health financing for older women's health.	(J. M. Abdullah et al., 2024)

Digital Health Opportunities and Risks

Digital health solutions are promising but must be critically examined. Evidence suggests that mobile apps can improve symptom tracking and self-care, while telemedicine enhances access to consultations (Baltzer & Bonancina, 2023). However, digital divides persist, especially for women in rural and low-income settings. Without careful planning, digital health may exacerbate inequities rather than reduce them (Yoldemir, 2022). Data privacy and misinformation are additional concerns, as most apps alack robust regulatory oversight (Malik et al., 2024). For Malaysia, integrating digital health into the public healthcare system, ensuring linguistic and cultural adaptation, and providing subsidies for access are crucial steps.

Table 2: Digital Health Solutions: Opportunities versus Risks

Digital Solution	Potential Benefit	Associated Risk/Challenge	Mitigation Strategy	Key References
mHealth Apps	Apps like *Health & Her* have shown statistically significant reduction in symptoms through self-monitoring and behavioral change.	**Quality Control:** A 2023 review found many apps lack medical evidence or privacy protection (only 57% had educational content on bone health).	Establish national standards for app recommendation; promote apps reviewed by medical bodies.	Sillence et al., 2023
Telemedicine	"Impak Sihat" and similar	**The Digital Divide:** Poor	Hybrid models (nurse-assisted	(Yoldemir, 2022)

	telehealth initiatives can bridge the urban-rural gap and reduce travel costs for women in remote areas.	internet coverage in rural Malaysia (<70%) and lower digital literacy among older women (aged >60).	tele-consultation at rural clinics); simplified interfaces for elderly users.	
Online Support	Reduces psychological isolation; empowers women to advocate for themselves during doctor visits.	**Misinformation:** Risk of unregulated advice regarding herbal supplements or unsafe hormone use.	MOH-endorsed digital support groups or moderated forums.	(Hemachandra et al., 2023)

Research Gaps

Several gaps warrant further investigation. First, there is limited national-level epidemiological data on menopause in Malaysia, particularly stratified by ethnicity, socioeconomic status, and geographic region. Second, few studies evaluate the effectiveness of education campaigns, workplace policies, or digital health interventions in LMIC contexts. Third, the long-term safety and cultural acceptability of alternatives to HRT, such as phytoestrogens and cognitive-behavioral therapy, remain underexplored. Fourth, little is known about how intersectional factors such as disability, migration, and gender norms influence menopausal experiences in Malaysia.

Limitations of the review

As a narrative review, this article does not provide the systematic rigor of a meta-analysis. Although recent and relevant studies were prioritized (2020-2025), some earlier foundational studies were excluded, which may limit historical context. Nevertheless, the review synthesized diverse perspectives, integrating epidemiology, public health, policy, and digital health, to provide a comprehensive overview tailored to Malaysia.

Future Directions

Future research should address these gaps through large-scale epidemiological surveys, cross-cultural comparative studies, and evaluations of policy implementation. Digital health interventions should be tested in randomized trials, with particular attention to privacy, accessibility, and cost-effectiveness. Policy evaluations are also needed to measure the impact of integrating menopause into primary care and workplace structures. Importantly, participatory approaches that include women's voices in policy and program design can ensure culturally relevant and equitable solutions.

CONCLUSION

This review underscores the urgent need to prioritize menopausal health as a public health and policy concern in Malaysia. With increasing life expectancy, women are spending a substantial proportion of their lives in the postmenopausal stage, amplifying risks of chronic diseases, reduced quality of life, and economic consequences. Despite these challenges, menopause remains underrecognized in national health agendas, healthcare training, and workplace policies.

The findings highlight that effective strategies must be multifaceted: integrating menopause into primary healthcare, expanding provider training, supporting workplace accommodations, promoting lifestyle and preventive interventions, and leveraging digital health solutions. Lessons from international models, such as the UK Menopause Taskforce and WHO's Healthy Aging framework, demonstrate the value of structured policy interventions and multisectoral collaboration.

The novelty of this review lies in combining policy analysis with digital health perspectives, offering a forward-looking approach to menopausal care in Malaysia. Future research should focus on evaluating digital interventions, examining cross-cultural experiences, and assessing the long-term outcomes of policy and program implementation. By embedding menopausal health within broader public health strategies, Malaysia can advance women's health equity, promote healthy aging, and strengthen the contribution of women to society across the lifespan.

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Conflicts of Interest

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REVIEW ARTICLE Open Access

CLOSING THE IMMUNITY GAP: A NARRATIVE REVIEW ON IMPROVING HEALTHCARE WORKER PERTUSSIS VACCINATION IN MALAYSIA THROUGH LESSONS FROM THE GLOBAL EXPERIENCE

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Abstract

Pertussis remains a significant public health concern despite widespread vaccination programs, with healthcare workers (HCWs) increasingly recognised as both susceptible populations and potential sources of nosocomial transmission to vulnerable infants. While many high-income countries have established comprehensive HCW pertussis vaccination policies, Malaysia lacks formal national guidelines despite documented infant pertussis burden. This narrative review examines global healthcare worker pertussis vaccination policies and their applicability to Malaysia, evaluating evidence on nosocomial transmission, vaccination strategies, cost-effectiveness, and policy implementation. A narrative review was conducted in accordance with established guidelines for literature synthesis. Multiple databases, including PubMed, Scopus, and Web of Science, were searched for peer-reviewed literature on pertussis vaccination policies, nosocomial outbreaks, HCW immunisation strategies, and economic evaluations. Grey literature from government health agencies was included to capture policy documents. Healthcare workers demonstrate substantial pertussis susceptibility globally, with seroprevalence studies showing 48.3-51.7% lacking protective immunity. Documented nosocomial outbreaks indicate a significant risk of transmission to vulnerable infants. International policies vary considerably: Australia, the United Kingdom, and Canada mandate or strongly recommend Tdap vaccination for HCWs as part of occupational health programs, while Malaysia lacks specific HCW vaccination guidelines. Cost-effectiveness analyses show that HCW vaccination programs yield net savings of $17.84 per dollar spent when productivity losses are included. Substantial evidence supports the implementation of mandatory Tdap vaccination policies for Malaysian healthcare workers. Recommendations include establishing national HCW vaccination guidelines, providing free workplace vaccination programs, and implementing pre-employment vaccination requirements.

Keywords: Pertussis, Healthcare workers, Vaccination policy, Nosocomial transmission, Malaysia, Tdap vaccine, Occupational health

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INTRODUCTION

Pertussis, caused by the Gram-negative bacillus *Bordetella pertussis* (Gabutti et al., 2016), spreads through aerosolized droplets and remains a highly contagious respiratory infection despite the availability of vaccines for over 70 years (Domenech de Cellès et al., 2016). The disease can affect people of all ages; however, the burden is particularly severe among infants under six months, especially those who are unvaccinated or under-vaccinated (Mohamed et al., 2022). Globally, pertussis was estimated to cause approximately 19.5 million cases in 2019, with Southeast Asia experiencing one of the highest regional burdens (Nguyen et al., 2025). In 2014, pertussis was projected to have caused over 160,000 deaths in children under five, with Southeast Asia bearing the second-highest mortality burden (Yeung et al., 2017). The disease has re-emerged with heterogeneous patterns worldwide, with outbreaks reported in at least 42 countries by mid-2025 (Nguyen et al., 2025).

Recent data from Sarawak, Malaysia, revealed that among infants under 12 months admitted to hospital between 2015 and 2021, 18% of tested infants had PCR-confirmed pertussis, with an average annual incidence of 482 per 100,000 infants (Mohan et al., 2024). In a separate national surveillance study, 12.7% of hospitalized infants aged less than six months with symptoms consistent with pertussis had laboratory-confirmed infection, with the majority (89.3%) occurring in infants too young to be fully vaccinated or under-vaccinated for their age (Mohamed et al., 2022). In England, the UK Health Security Agency (UKHSA) reported 10,493 confirmed cases of pertussis between January and June 2024, with 10 infant deaths during

Current evidence indicates an epidemiological shift in pertussis, with increasing recognition of cases among adolescents and adults due to waning vaccine-induced immunity and improved diagnostic capabilities (Nguyen et al., 2025; MacIntyre et al., 2024). Adults and adolescents now serve as under-recognized reservoirs of infection, capable of transmitting pertussis to vulnerable infants who are too young to be fully immunized (Nguyen et al., 2025; Kardos et al., 2024). This transmission dynamic is particularly concerning in healthcare settings, where healthcare workers (HCWs) have been implicated in transmission chains affecting neonates and patients. The global resurgence of pertussis cases underscores the urgent need for enhanced vaccination strategies. Booster vaccinations for adolescents and adults, including HCWs, have gained attention as a measure to reduce transmission within the broader population and provide protection to those at highest risk (Nguyen et al., 2025; MacIntyre et al., 2024). However, implementing adult vaccination remains challenging due to low awareness of the risk of pertussis in adults, limited time or funding for vaccination programs, low prioritization by healthcare providers, misconceptions about the necessity of vaccination, and infrequent proactive recommendations from clinicians (Nguyen et al., 2025; Choi et al., 2022).

Despite the documented burden of pertussis and the recognized role of adults, particularly HCWs in disease transmission, gaps remain in understanding optimal vaccination strategies for HCWs in Malaysia. The objective of this narrative review is to examine pertussis vaccination policies for HCWs in various countries and conduct a comparative analysis with

the situation in Malaysia. Specifically, this review focuses on pertussis outbreaks in healthcare facilities, vaccination strategies and coverage among HCWs, and evidence on the cost-effectiveness of vaccinating HCWs against pertussis. By synthesizing global lessons and best practices, this review aims to inform policy recommendations to close the immunity gap and improve HCW pertussis vaccination in Malaysia.

METHODS

This narrative review followed established guidelines for synthesizing the literature and integrating qualitative evidence (Greenhalgh et al., 2018; Ferrari, 2015). We conducted a comprehensive literature search across three major databases (PubMed, Scopus, and ScienceDirect) for English-language articles published between 2000 and 2025. Our search strategy combined key terms across four domains: (1) disease-related terms ("pertussis," "Bordetella pertussis," "whooping cough"); (2) vaccination terms ("pertussis vaccine," "Tdap," "acellular pertussis vaccine"); (3) population-specific terms ("healthcare workers," "HCW," "hospital staff"); and (4) policy-related terms ("vaccination policy," "immunization guidelines," "outbreak management"). Boolean operators (AND, OR) were applied to construct comprehensive search strings (Bramer et al., 2017). The search was supplemented by backward and forward citation tracking and examination of grey literature from key health organizations, including the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), UK Health Security Agency (UKHSA), and the Malaysian Ministry of Health (Adams et al., 2016; Paez, 2017). Articles were selected based on relevance to HCW pertussis vaccination policies, outbreak evidence, barriers to vaccination, and implementation strategies, with priority given to peer-reviewed studies, clinical guidelines, and policy documents from high-income countries with established HCW vaccination programs.

Two independent reviewers screened titles, abstracts, and full texts using predefined inclusion criteria: studies addressing pertussis epidemiology, vaccine efficacy, outbreak management in healthcare settings, or vaccination policies, with particular focus on Southeast Asia and Malaysia. We excluded case reports, non-English publications without available translations, and studies that were not relevant to healthcare worker vaccination or pertussis control policies. Discrepancies were resolved through discussion or adjudication by a third reviewer. The search identified 1,432 articles; after duplicate removal, 992 remained. Title and abstract screening excluded 823 articles, and full-text review excluded an additional 99 articles. In total, 56 articles were included in the narrative synthesis. Data were synthesized thematically to examine pertussis transmission in healthcare settings, HCW vaccination coverage and effectiveness, barriers to implementation, and cost-effectiveness evidence (Baethge et al., 2019).

RESULTS

Nosocomial Pertussis: Outbreak Evidence and Healthcare Worker Susceptibility

The epidemiological landscape of pertussis has shifted dramatically in recent decades. While infants have historically been the primary affected demographic, adults—particularly healthcare workers and family caregivers—have emerged as critical sources of infection due to waning immunity and atypical clinical presentations (Cherry, 2012). This epidemiological shift has transformed healthcare facilities into potential outbreak epicenters, with documented nosocomial pertussis epidemics resulting in substantial morbidity among vulnerable patient

populations, significant operational disruption, and considerable financial burden for healthcare institutions (Calugar et al., 2006; Yasmin et al., 2014).

Multiple documented outbreaks demonstrate the profound impact of nosocomial pertussis transmission. A neonatal intensive care unit outbreak in Louisville, Kentucky, exposed 72 infant patients and 72 healthcare workers, requiring extensive antibiotic prophylaxis and resulting in four confirmed HCW cases with cough illness duration ranging from 11 to 25 days before identification (Bryant et al., 2006). An Arizona NICU outbreak involved 15 confirmed pertussis cases (5 infants and 10 healthcare professionals) (Yasmin et al., 2014). In a haematology-oncology unit, 10 of 117 employees (8.5%) developed pertussis after exposure to a single infected healthcare worker, although prompt isolation measures prevented patient-to-patient transmission (Boulay et al., 2006). A French hospital outbreak documented transmission from an infected HCW to colleagues who subsequently infected two immunosuppressed patients, highlighting the vulnerability of high-risk populations (Bassinet et al., 2004). These outbreaks consistently demonstrate that HCWs with prolonged unrecognized cough illness serve as primary transmission sources, with diagnostic delays averaging 11-25 days contributing to extensive exposure of vulnerable patient populations (Bryant et al., 2006; Pascual et al., 2006).

Seroprevalence studies reveal substantial susceptibility among healthcare workers worldwide. In Spain, de Juanes et al. (2004) found 51.7% seroprevalence among HCWs during routine health examinations at a Madrid university hospital, with similar findings (51.7%) reported by Urbiztondo et al. (2015) in Catalonia. Asian studies report comparable or lower rates: Higa et al. (2008) reported 43.8% IgG-PT antibody positivity among Japanese university hospital personnel, whereas Choi et al. (2018) reported 33.7% prevalence at a Korean institution. A systematic review of annual pertussis incidence among HCWs reported rates of 1.3% among resident physicians and 3.6% among emergency department staff—significantly higher than those for most other vaccine-preventable diseases targeted for HCW vaccination (Wright et al., 1999). These data collectively demonstrate that a substantial proportion of healthcare workers lack protective immunity against pertussis, creating ongoing risk for nosocomial transmission to vulnerable patients, including neonates, immunocompromised individuals, and those too young for complete vaccination.

Healthcare Worker Pertussis Vaccination Policies: International Comparison

HCWs are at increased risk of contracting vaccine-preventable diseases, including pertussis, due to occupational exposure to infected patients and may serve as potential sources of nosocomial transmission, particularly to vulnerable patients who are immunocompromised, too young for vaccination, or unable to mount adequate immune responses (Kretsinger et al., 2006). The tetanus, diphtheria, and acellular pertussis (Tdap) vaccine, licensed in 1991, is approved for adolescents and adults (aged 11–64 years in the U.S.) and has demonstrated 92% efficacy against culture- or PCR-confirmed pertussis within 2.5 years of vaccination (Kretsinger et al., 2006).

Globally, policies regarding HCW pertussis vaccination vary considerably. The Global Pertussis Initiative (GPI) and the International Consensus Group on Pertussis Immunisation recommend replacing routine tetanus-diphtheria (Td) boosters with Tdap for all adults, prioritising HCWs, parents, and childcare workers (Campins-Martí et al., 2001). In the United States, since February 2006, the CDC's Advisory Committee on Immunisation Practices (ACIP) designated HCWs as a priority group for Tdap vaccination, recommending a single dose for all

healthcare personnel with direct patient contact, regardless of interval since last tetanus-containing vaccine (Kretsinger et al., 2006). Whereas in the United Kingdom, the Joint Committee on Vaccination and Immunisation (JCVI) advised in 2016 that HCWs with direct contact with vulnerable patients (pregnant women and/or infants) are priority groups for immunisation. From July 2019, following an improvement in vaccine supply, occupational pertussis vaccination became available for HCWs who have not received a pertussis-containing vaccine in the last 5 years and have regular contact with pregnant women or young infants under 3 months of age (UK Health Security Agency [UKHSA], 2024). In Australia, the Australian Immunisation Handbook recommends that all healthcare workers receive the dTpa vaccine every 10 years, given the significant risk of transmitting pertussis to vulnerable patients and the waning of vaccine immunity (Australian Government Department of Health and Aged Care, 2023). This recommendation is incorporated into occupational health policies across Australian states and territories. In Canada, healthcare workers are recommended to receive Tdap vaccination as part of occupational health programs, with provincial policies varying in implementation details but uniformly aligned to protect vulnerable patient populations, particularly infants (Public Health Agency of Canada, 2018).

Malaysia's Pertussis Vaccination Programme and Policy Gaps

Malaysia incorporated pertussis vaccination into its National Immunization Programme (NIP) in 1976, protecting infants and children through doses administered at 2, 3, and 5 months of age, with a booster at 18 months In 2020, the vaccine formulation was updated from pentavalent Pentaxim to hexavalent Hexaxim, maintaining the acellular pertussis component while protecting against additional diseases (Aljunid et al., 2022). However, unlike several developed nations with comprehensive adult pertussis vaccination guidelines, Malaysia currently lacks official recommendations for adult immunization, particularly for high-risk groups such as HCWs. Malaysia's Ministry of Health has yet to implement a national vaccination policy for HCWs against pertussis despite documented disease burden and nosocomial transmission risks (Nguyen et al., 2025). A multi-country study demonstrated that pertussis remains under-recognized as a substantial disease burden among adults in Asia, including Malaysia. In Malaysia, Taiwan, and Thailand, approximately 5% of adult patients presenting with a cough lasting at least two weeks had serological evidence of pertussis infection.

In contrast, more than two-thirds lacked immunity (Koh et al., 2016). However, a 2021 study in Sabah and Sarawak found that 86.9% of HCWs were willing to receive the vaccine if officially recommended (Michal et al., 2021), suggesting high acceptability should a policy be introduced. This presents a significant opportunity for Malaysia to leverage existing HCW support to establish comprehensive vaccination guidelines aligned with international best practices.

Economic Burden and Cost-Effectiveness of Healthcare Worker Vaccination

The financial impact of nosocomial pertussis outbreaks is substantial, with documented costs ranging from $6,500 per case in neonatal units to $43,893 per case in general hospitals (Baggett et al., 2007; Yasmin et al., 2014). Major expenditures include post-exposure prophylaxis, workforce furloughs, contact tracing, diagnostic testing, and infection control measures, with single outbreaks exceeding $260,000 (Calugar et al., 2006; Leekha et al., 2009). Preventive HCW immunisation demonstrates strong cost-effectiveness. Economic modelling indicates that Tdap vaccination could reduce pertussis incidence by more than 46% annually, yielding net savings of $2.38 per dollar invested (Sandora et al., 2008). Hospitals that implement mandatory

vaccination policies report fewer outbreaks and lower containment costs than those that use voluntary programs (Zhang et al., 2011).

DISCUSSION

Barriers and Strategies for Healthcare Worker Pertussis Vaccination

Despite recommendations for Tdap (tetanus, diphtheria, and acellular pertussis) vaccination, HCW immunization rates remain suboptimal globally due to multiple interconnected barriers. At the individual level, vaccine hesitancy persists due to concerns about side effects, perceived low risk, and misconceptions about vaccine safety (Fortunato et al., 2015; Yaqub et al., 2014). Recent evidence indicates that low awareness of adult pertussis burden and insufficient recognition of HCWs' role in nosocomial transmission contribute to low prioritization (Kardos et al., 2024; MacIntyre et al., 2024). Unlike influenza, pertussis is not consistently recognized as an occupational hazard, which can lead to complacency, particularly among HCWs not working directly with neonates (Weber & Rutala, 1998; Sandora et al., 2008). (Weber & Rutala, 1998; Sandora et al., 2008). At the institutional level, logistical and financial barriers impede uptake. Many healthcare facilities do not provide free on-site vaccinations, forcing HCWs to seek immunization externally, which substantially reduces uptake (Maltezou et al., 2014; See, 2025). Time constraints, particularly among shift workers, further limit vaccination opportunities (MacIntyre et al., 2024). Additionally, poor surveillance and reporting of HCW vaccination coverage obscure gaps and prevent targeted interventions (Regan, 2025).

Successful intervention strategies fall into three key categories. **Access interventions** include providing free on-site vaccination during working hours, mobile vaccination teams visiting different departments, extended clinic hours for shift workers, and walk-in availability. **Educational and promotional strategies** comprise targeted education addressing misconceptions, leadership modelling through visible vaccination of institutional leaders, active offers during onboarding, and campaigns communicating disease risk and vaccine benefits (de Koning et al, 2024). **Systems-level approaches** involve standing orders authorizing vaccination without physician approval, provider reminder systems, departmental audit and feedback on vaccination rates, and routine surveillance with public reporting to identify low-coverage areas requiring intervention (Wennekes et al., 2024). Evidence consistently demonstrates that multicomponent interventions that combine elements from multiple categories achieve superior outcomes than single-strategy approaches (Clari et al., 2024).

Policy Implications and Recommendations for Malaysia

The evidence reviewed has direct implications for Malaysia's pertussis control strategy. Malaysia currently lacks a national policy on adult pertussis vaccination, including specific recommendations for HCWs, despite documented pertussis burden and high HCW willingness (86.9%) to be vaccinated if officially recommended (Michal et al., 2021). Based on international best practices and evidence from implementation science, we propose the following actionable recommendations. First, the Malaysian Ministry of Health should establish a national policy recommending Tdap vaccination for all HCWs, with priority for those in neonatal, paediatric, and maternity settings. The policy should specify a single Tdap dose for HCWs without prior adult pertussis vaccination and include Tdap in pre-employment health screening. Second, healthcare institutions should implement employer-funded, on-site vaccination programmes led by occupational health units. These should provide free vaccinations during routine

occupational health visits and at employee onboarding, establish mobile clinics that accommodate all shifts, and eliminate out-of-pocket costs for HCWs (Maltezou et al., 2014). Third, pertussis vaccination training should be integrated into mandatory Continuing Medical Education and Continuing Professional Development requirements, emphasizing HCWs' role in preventing nosocomial transmission and addressing safety misconceptions through peer-led educational sessions (Choi et al., 2022). Fourth, Malaysia should establish systematic monitoring by requiring healthcare facilities to report HCW Tdap vaccination coverage annually to the Ministry of Health, with a target of 80% within two years and a linkage to hospital accreditation standards (Regan, 2025). Fifth, implementation should leverage existing National Immunization Programme infrastructure for vaccine procurement and distribution and collaborate with ASEAN countries—particularly Thailand and Singapore—to share best practices and harmonize approaches (Nguyen et al., 2025). Finally, a phased implementation approach is recommended: pilot programmes in selected tertiary hospitals with high neonatal and paediatric caseloads; expansion to all tertiary and selected secondary hospitals; and nationwide coverage, with impact evaluation. This approach allows iterative learning, stakeholder engagement, and resource mobilization while demonstrating feasibility. Improving HCW pertussis vaccination in Malaysia has broader implications beyond direct protection. HCWs serve as role models for vaccination behaviour, their vaccination reduces healthcare system disruptions from outbreaks, and the infrastructure developed can be leveraged for other adult vaccines and high-risk groups (Choi et al., 2022). Establishing a successful HCW pertussis vaccination programme represents a strategic investment in strengthening Malaysia's broader adult immunization system.

Limitations and Future Research

This review has limitations, including the narrative (non-systematic) approach, limited country-specific policy data for middle-income settings, scarcity of cost-effectiveness analyses applicable to Malaysia, and potential underreporting of nosocomial pertussis cases in Malaysian facilities. Future research should establish HCW seroprevalence baselines, conduct Malaysia-specific cost-effectiveness analyses, implement and evaluate pilot vaccination programmes, strengthen nosocomial surveillance, and explore HCWs' perceptions to inform culturally appropriate interventions. Regional ASEAN collaboration could accelerate evidence generation and implementation.

CONCLUSION

This narrative review examined healthcare worker pertussis vaccination policies globally and revealed a critical gap in Malaysia's approach. While high-income countries have established comprehensive HCW vaccination policies that successfully reduced nosocomial outbreaks, Malaysia lacks formal national guidelines despite documented disease burden and high HCW willingness to be vaccinated. Three key findings emerge: healthcare workers face elevated occupational risk and serve as documented sources of outbreaks affecting vulnerable patients; low vaccination rates stem from limited awareness, complacency, inadequate workplace access, and the absence of monitoring systems; and multicomponent interventions combining on-site vaccination, targeted education, and surveillance achieve superior, cost-effective outcomes. Malaysia's opportunity is clear—with 86.9% of HCWs willing to accept Tdap if officially recommended, decisive policy action can protect vulnerable patients, strengthen the adult immunisation system, and position Malaysia as a regional leader in healthcare worker vaccination within ASEAN.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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BORNEO EPIDEMIOLOGY JOURNAL | BEJ

CASE REPORT Open Access

NEWBORN HEARING SCREENING IN BORNEO INTERIOR ZONE: PRIME CASE IN KENINGAU

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Abstract

Borneo Sabah being part of the country of Malaysia, is constituted by huge land area. Healthcare development in rural area of interior always lags behind the city area. Wise distribution of healthcare personnel and equipment are possible and should be looked in as an important step to escalate heath care accessibility of the under privileged folks. Neonatal hearing screening is not available in the interior of Sabah. This study describes the first case of newborn hearing screening conducted at Keningau Hospital, an interior zone of Northern Borneo, Malaysia. New service of high-risk neonatal hearing screening was launched and protocol of neonatal Otoacoustic Emission (OAE) screening was established.

Keywords: Neonatal hearing screening, Otoacoustic Emission, Deafness, Borneo Interior, Keningau

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INTRODUCTION

Borneo of Malaysia constitutes of Sabah and Sarawak. Since the inception of Malaysia, Northern Borneo has formally joined Malaya in 1963 to form a strong union and remain strong for the past 62 years. Sabah, being part of the island of a huge Borneo landscape, are rich with terrains of biodiversity and long mountainous ranges. Reserves land occupied half of its massive 7.32 million hectares in this land below the winds (Kodoh et al., 2009).

Interior of Sabah strives to develop at a pace much slower than bigger city of waterfront. Keningau district is in the deep interior of Sabah state. The only health facility in this domain is Keningau Hospital which is located 120 km away from the coastal city and separated by the Crooker range. Newborn here are not privileged to be screened for hearing loss as to what baby born in the city usually do. Baby with high risk of hearing loss needs to be referred to the state hospital for mere preliminary screening. Due to logistic hindrance, some mothers of newborn has opted to default referral and thus deprived their baby of possible earliest detection of hearing impairment as well as rehabilitation. We strive to break this logistic healthcare accessibility barrier by provision of prime in-house hearing screening facility. This paper aims to report the implementation of the first newborn hearing screening using Otoacoustic Emission (OAE) at Keningau Hospital.

METHODS

Neonatal hearing screening is inherently aimed at all newborns at our centre in postnatal ward. Babies who were admitted to neonatal intensive care unit are not considered. Existing screening team were formed from trained Assistant Medical Officer and Nurse in the centre. The selection of baby for our first case of screening was based entirely upon on the first parental consent obtained in the postnatal ward.

Our prime case of hearing screening was a baby girl 12 hours of life, born at term via spontaneous vaginal delivery in the labour room of Keningau Hospital. The birth weight was 3060 grams. The baby was noted to have APGAR score of 9 and 9 at 1 and 5 minutes after birth, respectively. Perinatal periods were uneventful. Prenatal history was unremarkable. There was no risk of hearing loss in the family history. Mother was a healthy 28-year-old lady with no comorbidities. On examination, the neonate was active and normal in appearance. No syndromic features were noticeable. Oral, nasal and aural examination were normal. The pinna and ear canals normal and intact on both sides.

Our screening began with transporting the neonate to an examination baby cot in the postnasal ward with the company of the mother. Consent was obtained after the intended procedure of hearing screening was explained thoroughly to the mother.

Baby was positioned supine on the examining baby cord in the postnatal ward at a chosen location of corner with less sound interference (Figure 1). The baby was calmed before conducting the screening assessment. We used the Grason Stadler GSI Corti OAE machine with Distorted Product Otoacoustic Emission (DPOAE) mode and tested the baby in a quiet corner of the postnatal ward.

Figure 1: OAE assessment of our prime case in postnatal ward on baby cot in open ward environment.

Grason Stadler GSI Corti OAE machines have been distributed to all state hospital by Ministry of Health for the purpose of nationwide neonatal hearing screening program. This basic model has preset module with single mode of DPOAE only and option of signal transduction two and four seconds during the screening. The machine has a test probe fitted with a silicon seal (Figure 2) that would be inserted into the ear canal of the baby to initiate the test.

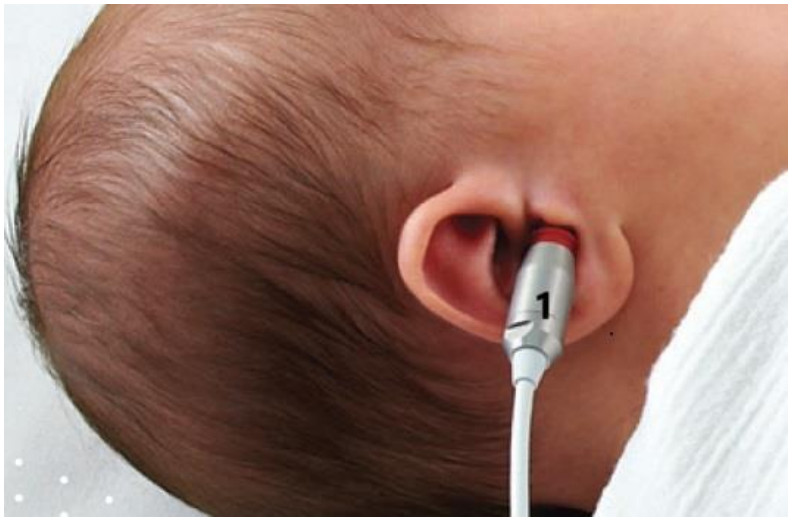

Figure 2: Site of test probe (1) of the OAE machine fitted with a red silicone soft seal with the outer ear canal.

RESULTS AND DISCUSSION

The left ear showed a 'REFER' result in the first test, but after calming the baby and repositioning the probe, the second test showed a 'PASS' (Table 1).

Table 1: Otoacoustic Emission test result

OAE Site	First Test	Second Test	Time Taken (Min)
Right Ear	PASS	-	5
Left Ear	REFER	PASS	10

Hearing screening for newborns is utmost important to prevent missed early detection of hearing loss that could hamper the speech development. The earlier the detection, the better the outcome of hearing rehabilitation that could make a significant different in speech development of the newborn.

Vital preparations were conducted to enable the establishment of neonatal hearing screening programme in the interior of Sabah. Firstly, a suitable machine is needed to perform such test. OAE test is the recommended evaluation tool for all neonatal hearing screening in our country (Ministry of Health, Malaysia, 2021) . An OAE machine (Grason Stadler GSI Corti) sourced from the state hospital was used in this launching of services. Intensive training sessions were conducted to ORL staff in the facility to ensure the proper conduct of the test and handling of the machines. Meetings dan workshop was conducted in line with this intention (Figure 3).

Figure 3: Workshop to strengthen and credential staff of interior hospital in neonatal hearing programme.

Selection of our baby for our first screening case was random as she was the only baby admitted to postnatal ward at the time of the official launching of our screening program. The result has shown that the OAE test is a fast and simple procedure that is not time consuming. The venue limitations of noisy ambience were unavoidable as the existing venue was not soundproof. Nonetheless, the machine was able to produce reliable test result in the background noise level below 55 decibel sound pressure level (dbSPL) (Kemp, D. T., 2002).

Time taken to conduct the left ear was prolonged due to repeated testing. The test generates two spectrums of result: PASS or REFER. REFER means the testing probe failed to detect any cochlear microphonic response, indicating possible positive in hearing loss of cochlear origin. Immediate redo testing is performed to verify the findings as false positive result in hearing loss could happen. Studies have shown that the REFER result rates drops with repetitive testing in the same setting (Joint Committee on Infant Hearing, 1994). Hence 3rd attempts of repetitive screening is not performed in the same setting should the 2nd result persistently show the result of REFER (Figure 4).

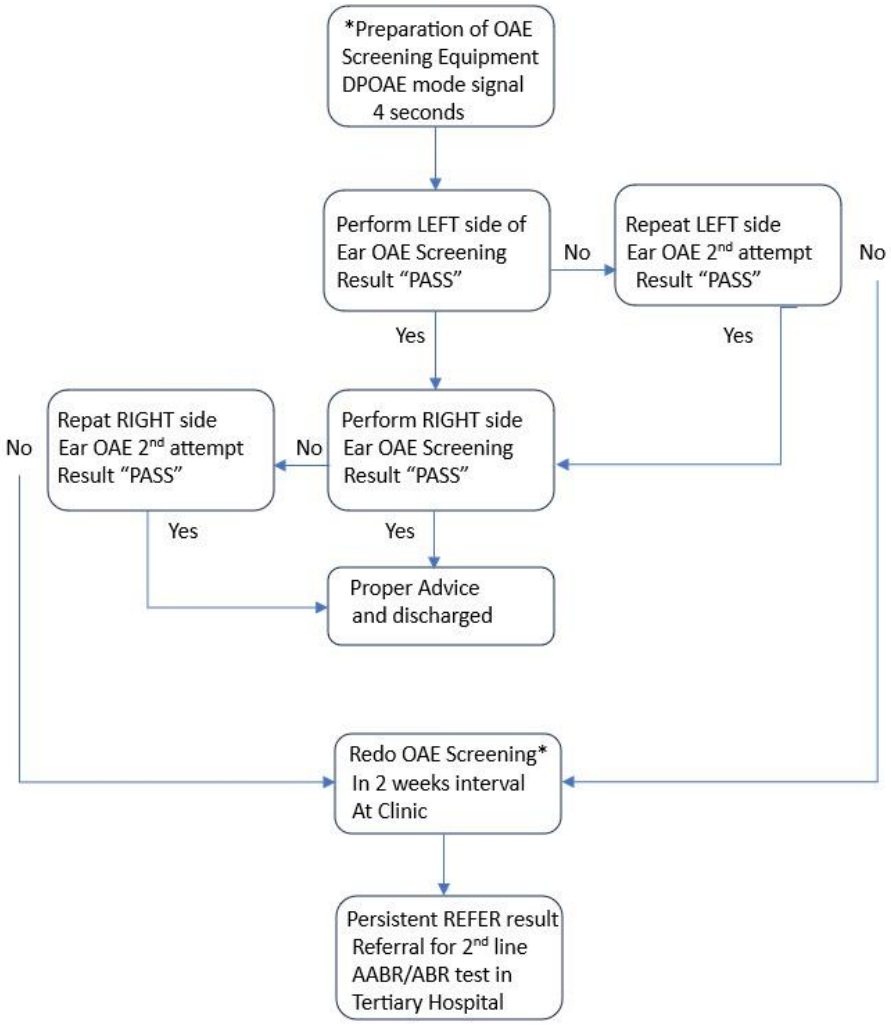

Figure 4: Flowchart of OAE Testing Protocol in Borneo Interior (AABR: Automatic auditory brainstem reflex).

The interior Keningau Hospital is a small healthcare facility that capable of providing 261 beds admission. The census over the last three years shows an average 4000 deliveries per annum. Moreover, figures have shown that almost one in 1000 newborn was born with one or both side of hearing loss (Joint Committee on Infant Hearing, 2007; Thompson, D. C et al., 2001). The availability of neonatal screening in the interior hospital obviates the need to refer the patients to state hospital. Shortest route to the state hospital in the city centre traverses the Crook Range Kimanis road which spans across 120 km distance and consumes three hours journey. Public transport shuttle and chartered taxis services are costly to many families.

Nonetheless, with the current sizing of the Otorhinolaryngology (ORL) unit and limited manpower as well as resources, the hearing screening test can only be considered for the high-risk group (Davis, A. et al., 1997). Future plan of development includes recruiting a permanent audiologist staff to serve the interior hospital, acquisition of more OAE test machines as well as assignment of more staff to the screening team. Universal screening will be the next agenda in line for Keningau Hospital.

Our first case of OAE screening for newborn has proven that the interior hospital has the capability to perform this audiological assessment by minimal staff with proper training of OAE tool. The launching of OAE screening in interior Borneo (Figure 5) was a laudable move in escalating health care provision to the interior and underprivileged folks. Although current neonatal screening is limited for high-risk group, future plan for universal screening expansion will surely benefit more newborns.

Figure 5: Prime case of hearing screening and official launching of the Neonatal Hearing Screening Programme in Keningau on 12th November 2024.

CONCLUSION

This meaningful project was undertaken by the initiation of a Head and Neck subspeciality trained surgeon in the field of laser, robotic and reconstructive surgery that has embarked on a journey to explore the establishment of an ORL unit in the interior of Sabah. The unorthodox order of this subspecialist placement has enabled the serendipitous initiation of a historical launching of prime hearing screening programme in Keningau district. Furthermore, OAE neonatal screening protocol for interior Keningau Hospital was established. The centre handles more than a handful of deliveries per day. With proper training, the time required for each hearing screening remains reasonable. Even with a limited number of trained personnel, the implementation of universal newborn hearing screening is feasible and holds promise for future service expansion.

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