

RESEARCH

Open Access



Factors influencing work performance and prospective mobile health applications among village health support groups: a formative study for i-MoMCARE development to enhance maternal, newborn, and child healthcare in Cambodia

Hendra Goh^{1†}, Chhavarath Dary^{2†}, Mengieng Ung¹, Sreymom Oy^{1†}, Yan Fang Lee¹, Sovatha Mam², Sophea Chhorn³, Chanthou Ny², Sveng Chea Ath Chhay⁴, Chhorlika Khim⁴, Dyna Khuon², Michiko Nagashima-Hayashi¹, Sovanthida Suy⁵, Rattana Kim⁴, Siyan Yi^{1,6,7*} and Vonthanak Saphonn^{2†}

Abstract

Background Village Health Support Groups (VHSGs) are pivotal in delivering maternal, newborn, and child health (MNCH) in underserved Cambodian regions. However, their work performance is influenced by multifaceted determinants, hampering capacity in service delivery. While mobile health applications (mHealth apps) offer a promising avenue to overcome some of these challenges, research on mHealth apps in Cambodia remains scarce. Therefore, this study aims to explore the sociocultural and environmental factors influencing VHSGs' work performance and assess the dynamic influencing their willingness to adopt mHealth apps.

Methods A qualitative study was conducted in Battambang province in May 2023. 38 stakeholders engaged in MNCH service planning and provision were interviewed. We collected data on the factors influencing VHSGs' work performance in delivering MNCH services and examined how these factors impact the potential adoption of mHealth apps. Data were analyzed according to reflexive thematic approach.

Results Findings demonstrated that work performance is influenced by factors spanning all five domains of the socio-ecological model. At the micro-level, intrinsic motivation, strong interpersonal relationships and adequate working knowledge were identified as key enablers. However, main challenges remained at the meso and macro-level, including manpower and resources shortages, limited community trust and the absence of a sustainable financial framework to support VHSGs operations. While stakeholders recognized the potential of mHealth

[†]Hendra Goh, Chhavarath Dary, Siyan Yi and Vonthanak Saphonn contributed equally.

*Correspondence:

Siyan Yi

siyan@nus.edu.sg

Full list of author information is available at the end of the article



apps as handy job aids to improve work performance, a digital divide exists due to uneven digital literacy, immense workload, and poor digital infrastructure, hampering intention to use.

Conclusion Our findings highlight the pressing need for a stepwise reevaluation of VHSGs employment model to address existing challenges in work performance. This three-pronged approach entails a gradual transition to remunerated positions, accreditation and opportunities for professional development, implemented in successive phases. Additionally, to further boost VHSGs' work performance through mHealth apps, strategies such as cultivating a digitally competent workforce and strengthening digital infrastructure can collectively reduce barriers to adoption and sustain long-term engagement.

Keywords Community health worker, Village health support group, Maternal and child, Work performance, Mobile health, Determinants

Background

In recent years, Cambodia has demonstrated commendable progress in enhancing maternal, newborn, and child health (MNCH) outcomes. This positive trajectory is evidenced through the implementation of various initiatives, such as expanding health facilities [1] and community-based interventions [2, 3] to collectively improve health coverage. While notable strides have been achieved, a recent national health survey revealed that challenges persist particularly in rural regions [4]. Issues such as low socio-economic status and geographic disparities among villagers contributed to the complexity of seeking MNCH services [5, 6]. Moreover, limited number of skilled birth attendants, insufficient pregnancy care, and poor village infrastructure further exacerbated the disproportionately high maternal and child deaths in the countryside [7, 8].

Against this backdrop, there has been a resurgence of focus on MNCH delivery in rural areas among policymakers and healthcare leaders. This renewed interest prompted a reevaluation of the integral role played by community health workers, also known as the Village Health Support Groups (VHSGs) in Cambodia [9]. Within the country, VHSGs play a pivotal role in delivering MNCH services such as antenatal care, postnatal care and child health services [10]. In addition, they wield a broader impact that extends to mitigating health inequities through promoting health service accessibility in hard-to-reach areas [11, 12]. This highlights their intermediary role as the primary point of contact with the healthcare system for community members, serving as a vital link between marginalized populations and essential health services [13, 14],

Despite the integral role in advancing MNCH delivery, previous studies underscored that VHSGs grapple with low intrinsic motivation and satisfaction at work [15]. Their work performance is further hampered by external factors such as inadequate training, resource constraints, and limited institutional support when brought to scale, impacting suboptimal community health outcomes [16, 17]. To address obstacles in work performance, the

convergence of technological innovation and health, particularly mobile health applications (mHealth apps), emerged as a promising solution. Over the years, mHealth apps have gained traction in low and middle-income countries (LMICs) where their role in supporting health service delivery was established [18]. As such, mHealth apps are often employed in these settings, including clinical support in decision-making, health information systems for data management, community health education outreach and facilitating coordination between healthcare providers and patients [19–21].

While several studies have explored the factors influencing VHSGs' work performance, the majority focus on the South Asian subcontinent [11, 12, 22, 23]. These findings may have limited applicability to Cambodia owing to its unique contextual factors, healthcare infrastructure, and sociocultural dynamics. More importantly, research on mHealth apps remains scarce in Cambodia. Identifying influencing factors that originate from the specific sociocultural and environmental context in which VHSGs operate is paramount before introducing digital health solutions (DHS) in the country. Therefore, this study aims to explore the factors influencing VHSGs' work performance in MNCH delivery and assess the dynamic influencing their inclination to adopt mHealth apps.

Methods

Study setting and design

This qualitative study was conducted in May 2023 in Battambang province as a formative assessment laying the groundwork for i-MoMCARE, a larger-scale community-based randomized controlled trial aimed at developing a digital intervention designed to improve VHSGs' work performance in delivering MNCH services in Cambodia [24]. In this study, we define work performance as the ability to deliver healthcare services without let or hindrance and achieve desired health outcomes within communities [25]. In addition, Battambang province is predominantly rural, making it an ideal location for the

study team to identify various factors influencing work performance and intention to adopt mHealth apps in a resource-constrained context.

Socioecological model was used to categorize findings into five dimensions: (1) individual, (2) interpersonal, (3) organizational, (4) community, and (5) health system. Recognizing the dynamic interplay between individuals and their sociocultural surroundings across all levels of the system, the model posits the interdependence of influencing factors within and across various health problems and behaviors [26]. To enhance rigor and transparency, the study methodology was anchored to the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (Supplementary File 1) [27].

Participants

We conducted in-depth interviews (IDI) and focus group discussions (FGD) with a sample of 38 stakeholders involved in MNCH service planning and provision. Participants were recruited according to three distinct levels of analysis: (1) macro-policy context where stakeholders bear the responsibility for crafting national health policies, coordinating or overseeing public health programs (e.g., directors from National Maternal and Child Health Center (NMCHC), and United Nations (UN) specialized agencies such as the World Health Organization (WHO) and United Nations Population Fund (UNFPA)); (2) meso-organizational context where stakeholders focus on supervising MNCH programs and policy implementation (e.g., officials from the provincial health department, operational districts, and health center directors); and (3) micro-program implementation context in which the stakeholders deliver MNCH services and have direct interactions with the populations they serve (e.g., health center staff and VHSGs). This level also includes program beneficiaries (e.g., pregnant women). Purposive recruitment based on the three levels of analysis allowed a diversity of viewpoints and experiences from a multi-stakeholder perspective [28].

Data collection

A combination of purposive sampling and snowballing techniques was used to identify individuals in relevant positions. Potential participants received an email or a phone call inviting them to participate in the study. Consented individuals took part in either IDI or FGD. The interviews were conducted in the health centers by interviewers trained in qualitative research (CD, MU, SO and DK). Distinct semi-structured topic guides were customized for different data collection methods and participant groups, drawing upon relevant literature and the expertise of the study team [29, 30]. These guides were pre-tested to ensure clarity and accuracy. Major topics

included facilitators, barriers and challenges at work with a specific focus on the influence of sociocultural and environmental contexts. In addition, the potential adoption of DHS was also explored. Field notes and memos were written in every interview to capture insights. The interviews lasted from 45 to 75 min.

Data analysis

All interviews were audio-recorded following consent. Trained bilingual research staff transcribed all interviews verbatim in Khmer and translated them into English (CD, MU, SO and DK). All transcripts were analyzed according to Braun and Clarke's six-phase reflexive thematic approach [31]. Two independent coders familiarized the transcripts and employed open coding to generate initial codes (YFL and MNH). This procedure allowed the subthemes to be derived from the transcripts instead of pre-existing ideas. The codes were then compared and grouped into potential themes during axial coding. The themes were reviewed in relation to the codes extracted and continuously refined until no new emergent themes were identified. Coding discrepancies between two coders were triangulated and resolved through iterative discussions with a third member of the team (HG). Where feasible, findings were interpreted using reflections drawn from field notes and memos to enhance reflexivity. The process of iterative coding was conducted using NVivo 12.

Results

Participant characteristics

A total of 19 healthcare providers participated in one-to-one IDIs, while 19 pregnant mothers engaged in three FGDs, with an average of six participants per group. All participants who were approached consented to participate in the study, and no dropouts were recorded throughout the data collection process. Table 1 presents the characteristics of healthcare providers, comprising three government officials, two representatives from UN specialized agencies, three health center directors, five health center staff, and six VHSGs. Most were female, with a mean age of 47.7 (± 10.9) years. While most healthcare providers completed tertiary education, all VHSGs had high school education and below. Interviewed pregnant mothers had a mean age of 28.1 (± 6.6) years, with all reporting education qualifications of high school and below. Nearly three-quarters of pregnant mothers reported having two children or fewer. Data saturation were reached after the 15th interview, with no new themes emerging from subsequent interviews. Additional seven interviews were conducted to ensure that point of information redundancy was achieved.

Table 1 Characteristics of participants

| Characteristic | Healthcare provider (n = 19) | Pregnant mother (n = 19) |
|--------------------------------|------------------------------|--------------------------|
| Age (years) | | |
| Mean \pm SD | 47.7 \pm 10.9 | 28.1 \pm 6.6 |
| Gender, n | | |
| Female | 14 | 19 |
| Male | 5 | |
| Education, n | | |
| Primary | 2 | 6 |
| Secondary/high school | 4 | 13 |
| Tertiary | 13 | |
| Profession, n | | |
| Government official | 3 | |
| UN specialized agency official | 2 | |
| Health center director | 3 | |
| Health center staff | 5 | |
| Village health support group | 6 | |
| Number of children, n | | |
| 1 child | | 6 |
| 2 children | | 8 |
| 3 children | | 4 |
| 4 or more | | 1 |

Multilevel facilitators affecting the performance of VHSGs

Table 2 presents the facilitators affecting work performance of VHSGs according to the socio-ecological model. At the individual level, micro-level participants felt that the performances of VHSGs were deeply rooted in a profound dedication to their role. This was evidenced through the sense of altruism embedded in their professional identity. As echoed by participants, the enduring commitment to volunteer was underscored by a genuine passion for “collective health improvement” despite modest remuneration, emphasizing intrinsic motivation for improving community health. On a more personal level, VHSGs themselves derived motivation from perceived personal benefits, such as the belief in generating “good karma”, with some viewing their work as a virtuous deed aimed at helping others. In addition, the elevation of social status was another notable motivator where acknowledgment and respect earned from community members contributed to a sense of fulfillment, reinforcing their belief in the meaningfulness of their work.

At the interpersonal level, facilitators could be broadly categorized under social relations. Good collegial relationships between VHSGs and health center staff were instrumental in fostering collective achievement as driven by their alignment around a shared goal. Teamwork among VHSGs also facilitated task completion by

promoting the delegation of responsibilities based on individual strengths and expertise. At the same time, it was important to acknowledge the supportive role of family members. Their positive reinforcement created an enabling environment for VHSGs to engage in their roles with a sense of harmony within their personal lives.

Meanwhile, participants from the macro and meso levels recognized the significance of organizational investment in the professional development of VHSGs. Albeit currently provided on an “irregular” basis, such initiatives were viewed as opportunities to enhance both the capacity and competency of VHSGs. Additionally, improving staff welfare was also noted to boost both staff motivation and retention. For instance, extending free medical services to VHSGs’ family members served as a form of compensation for their modest remuneration, fostering a sense of recognition and appreciation for their contributions. At the community level, engaging positive relationships with community members emerged as a salient theme. Cultivating meaningful interactions not only stimulated community participation, but also instilled a sense of trust in VHSGs, enhancing credibility in fulfilling their roles.

Lastly, facilitators at the health system level were notably centered around funding availability, with financial remuneration emerging as a major theme in retaining VHSGs. Participants from all levels emphasized the importance of providing VHSGs with regular financial support to appreciate their volunteering time and cover operation costs. This support system acted as a tangible acknowledgment of VHSGs’ dedication and encouraged their continued engagement in community health initiatives. On the other hand, stakeholders highlighted the potential of strengthening public–private partnerships to better support VHSGs. By leveraging the existing network of external organizations, these partnerships could help to improve the “quality of health service” by providing workers in the public health system with the necessary time and support to gradually assume full responsibility.

Multilevel barriers affecting the performance of VHSGs

Table 3 presents the barriers affecting work performance of VHSGs according to the socio-ecological model. A frequently cited barrier at the individual level was knowledge gaps. As emphasized by micro-level health center staff and pregnant mothers, instances where VHSGs lacked the knowledge to execute essential tasks underscored the deficiency in well-structured training programs to rectify these knowledge limitations. Besides, differences in motivation levels among VHSGs were also evident. Though the reasons for these variations still need to be clarified, disparate attitudes toward job

Table 2 Multilevel facilitators affecting the performance of VHSGs

| Domain | Theme | Subtheme | Illustrative quotes |
|----------------|--|---|---|
| Individual | Professional dedication towards the role | Desire to improve collective health | "If we don't help in the community, some people won't know about the benefit of vaccination or proper nutrition. Some families still think that vaccination makes their children sick, so they avoid getting vaccinated. When we advise them, and they listen, I feel happy and satisfied!" #VHSG 5 |
| | | Sense of altruism in professional identity | "I think they [VHSGs] are genuinely trying to help the people to become healthier without hoping for anything in return... since the money is so little." #PregnantMother 1 |
| | | Perceived generation of good karma through diligent professional contributions | "I think I'm doing a good deed by helping people. I hope to get good karma. I always guide people to do the right thing [such as getting healthcare services]. A lot of pregnant women follow my advice and go to get their medications regularly." #VHSG 3 |
| Interpersonal | Multifaceted social relations foster a sense of shared purpose | Elevated social status improves retention | "When I meet people, they smile at me and respect me. It makes me feel like the work I am doing is meaningful." #VHSG 1 |
| | | Partnerships between VHSGs and health center staff promote professional development | "They [HC Staff] also work very closely together with the VHSGs... and conduct joint visits to see the patient together. Regularly, they will check the book [that VHSGs have to log every time after seeing a patient] and go through the cases. It is good because it lets VHSGs know what they have done well and where to improve." #HC Director 2 |
| Organizational | Prioritizing VHSGs development and welfare | Good teamwork among VHSGs streamlined shared work responsibilities | "Because there are two of us, we would help each other. I could tell my colleague that I'm busy and that I would send her the name list. For example, each of us has to note down 40 names of the women who have to visit the health center. I could only record 20 or 30 names, while she would help me with the remaining ones. We help each other, so it's not that difficult." #VHSG 5 |
| | | Positive support from family members encourages participation | "I asked my husband first before becoming a VHSG. I need to ask for his permission to avoid making him angry. He said I can do whatever I want as long as I'm happy." #VHSG 1 |
| | | Availability of professional training to enhance capacity | "We try to support the health center by providing training, such as family planning, to build up the capacity of the VHSGs. But currently, it is [irregular]." #UN Specialized Agency Official 1 |
| Community | Good relationship with the community | Enriched compensation package despite modest remuneration | "When they [VHSGs] come to the clinic, we will treat them for free to thank them for their service. This is the least we can do because sometimes they are not paid to help us with our work." #HC Director 2 |
| | | Cultivating meaningful interaction promotes community cooperation | "They have a good interaction with the community, when we tell them that we [need] children to come for checkup or elderly to check their blood pressure or sugar level, they will bring them and people will come... since they trust the VHSGs." #HC Staff 1 "Almost everyone here knows the VHSGs. There are two of them [in this community]. They will always tell us what to do when our children are sick and people listen to them. I like them very much." #PregnantMother 7 |

Table 2 (continued)

| Domain | Theme | Subtheme | Illustrative quotes |
|---------------|--|---|---|
| Health system | Availability of funding for coordinating entity to support VHSGs | Appreciating staff dedication through financial remuneration | <p>"For encouragement, sometimes we [health center] provide them with financial support to cover their time and transportation costs. On top of remuneration from the health center, occasionally we will also get support from external organizations... This may [have left them] felt appreciated." #HC Director 1</p> <p>"We provide [remuneration to] them [VHSGs]. Though I don't know if they are satisfied with the payment, from what I see, their participation rate is quite good. Though we may increase it yearly to motivate them... to continue helping us out!" #HC Staff 3</p> |
| | | Reasonable remuneration improves staff retention | |
| | Recognizing the importance of public-private partnership | Strengthened collaboration with external organizations provides multiple layers of professional support | <p>"To improve the quality of the services in and out of health centers, we have increased the cooperation of services between health centers and external organizations. Through partnership, it ensures that our staff can be better supported. In a sense, multiple organizations can lend their support to the staff on different occasions." #UN Specialized Agency Official 1</p> |

*VHSG—Village Health Support Group, HC Staff—Health Center Staff, HC Director—Health Center Director

Table 3 Multilevel barriers affecting the performance of VHSGs

| Domain | Theme | Subtheme | Illustrative quotes |
|----------------|--|---|---|
| Individual | Personal knowledge and attitude influence the practice of job responsibilities | Insufficient training results in knowledge gaps to effectively perform the assigned duties | <p>"We have a few problems; a few cases are related to their knowledge being limited. Some did not know how to [spot] signs of child infections. Maybe because there was not enough training." #HC Staff 5</p> <p>"Once during house visit, a VHSG told me she was not very sure of how to manage my kid's diarrhea, so she referred us back to the health center." #Pregnant Mother 4</p> <p>"During health screening events, we have observed that some villages supported by specific VHSGs tend to have consistently low attendance rates. In some instances, they themselves did not attend the events. It is unclear whether they are genuinely motivated and possess the right attitude towards their jobs." #HC Staff 3</p> |
| Interpersonal | Challenges in balancing family responsibilities negatively impacts commitment | <p>Motivation disparities undermine commitment to their roles</p> <p>Competing domestic tasks affect frequency of commitment</p> | <p>"She's [my wife] not really happy about what I'm doing. It's not that I don't have enough time for household work. I make sure we have enough wood and water at home. I take care of the plants. However, I don't want to get blamed for spending a lot of time on volunteer work and not caring for the house. So, I volunteer lesser now." #VHSG 3</p> <p>"I've been a VHSG before my resignation; back then, I had to use my free time to do it. But now I cannot do it anymore because I need to help my husband with his work [to support the family]." #VHSG 5</p> |
| Organizational | Institutional resource gaps impede ability to deliver effective care | <p>Lack of essential equipment at health centers to properly serve the community</p> <p>Limited transportation during VHSGs outreach efforts affects work performance</p> | <p>"If there's anything to add, I would say they should add ultrasound equipment in the health center because, with that, everyone could get it here. With ultrasound equipment here, people won't have to worry about going to Battambang for it. Presently, even if the VHSG asked me to go to the health center, it is pointless if I cannot receive the service there." #Pregnant Mother 2</p> <p>"The whole village is quite big. It takes me about an afternoon to walk door-to-door. If I have to visit children and pregnant women, I have to walk from morning till evening. Sometimes, if I cannot finish in one day, I have to work the next morning, too. If I have a vehicle, it will be easier moving about the village." #VHSG 2</p> |
| Community | Distrust among the community on VHSG | <p>High workload experienced by VHSGs amidst limited manpower support resulted in suboptimal care provision</p> <p>Challenges in establishing credibility in the face of skepticism and hierarchy</p> | <p>"She's [another VHSG] not familiar with this work yet. She can't help me with my work, but that is understandable because we are simply understaffed. She's very busy with [the tasks she has] in the community. So, I need to complete all the tasks that are assigned to me alone. It is very tiring. Sometimes, I cannot finish the work." #VHSG 1</p> <p>"The people in the village are really hard to work with. I'm not exaggerating, but they aren't believing me; they are following another person's advice. The problem is that I'm not the village leader, so they won't listen. They even look down on how much impact I can make." #VHSG 6</p> |

Table 3 (continued)

| Domain | Theme | Subtheme | Illustrative quotes |
|---------------|--|---|--|
| Health system | Sustainability challenges within current health system | Lack of funding to integrate VHSGs into permanent position diminishes sustainability of commitment | <p><i>"They [VHSGs] are very important. But so far, we don't have sufficient financial support and the work hasn't progressed much. I think we can consider changing them as full-time staff, to engage them to work with us long-term. Not only can we sustain their engagement, but also encourage them to adopt new technologies." #Government Official 2</i></p> |
| | | The absence of longstanding partners and low government ownership pose challenges in sustaining initiatives | <p><i>"We used to have partner organizations to help us, like this one organization that had been very supportive of [VHSGs' efforts in] MNCH these past few years. But now the project has ended, and we no longer have any partners to help us. Previously, they helped to provide training for staff and VHSGs." #Government Official 3</i></p> |

*VHSG—Village Health Support Group, HC Staff—Health Center Staff, HC Director—Health Center Director

commitment challenged the consistent execution of their responsibilities.

Within households, the findings highlighted the substantial impact of family responsibilities on the commitment to volunteering. One VHSG articulated that, despite previous involvement, “economic pressures” compelled a decrease in volunteer activities. Simultaneously, another VHSG echoed the challenges of striking a “balance between volunteer work and domestic duties.” To prevent domestic discontent arising from perceived neglect of family responsibilities, some individuals opted for a reduction or complete abstention from volunteering.

Resource deficiencies stood out as a predominant challenge at the organizational level. A recurring barrier was the lack of essential equipment within health centers, particularly affecting micro-level service recipients, such as pregnant mothers. For instance, the absence of ultrasound machines at public health centers compelled patients to seek services elsewhere. Poorly resourced public health centers created dissatisfaction among patients and rendered VHSG efforts futile. A pregnant mother highlighted the “pointlessness” of visiting a health center when she found herself unable to access the requisite care. Additionally, the high workload of VHSGs amidst limited manpower support further undermined their efforts. The consequence was evident in suboptimal care provision and the fatigue experienced by VHSGs due to the overwhelming responsibility of completing tasks alone.

Another noteworthy barrier was the presence of distrust in the community. The challenge lay in establishing credibility and a prevailing social hierarchy. As articulated by VHSGs, some community members proved “resistant to believe” in their guidance. The lack of recognized authority further compounded skepticism, as VHSGs might not hold formal positions within the village. Consequently, villagers favored advice from other “influential” community members, undermining the impact of VHSGs.

Finally, participants also discussed sustainability challenges within the current health system. The lack of funding to integrate VHSGs into permanent positions was a crucial factor contributing to this challenge. This sentiment was mostly perceived by macro-level participants whereby the vital contribution of VHSGs was acknowledged, but insufficient financial support compromised long-term commitment and diminished intention to adopt novel technologies at work. Likewise, the absence of longstanding partners was also noted. As mentioned by a government official, the historical presence of partner organizations has been instrumental in providing essential support for health center staff and VHSGs.

However, the cessation of such collaborative efforts created a gap in vital support, underscoring a need for more ownership and reduced dependence on external partners.

Factors affecting the potential adoption of mHealth apps

Factors that potentially influence the adoption of mHealth apps are presented in Table 4. They are grouped into seven broad domains: (1) skills and knowledge; (2) memory, attention, and decision process; (3) environmental context and resources; (4) reinforcement; (5) intention; (6) belief about consequences, and (7) goals. In general, participants exhibited a positive receptivity toward adopting mHealth apps, contingent upon fulfilling “hardware conditions”. These essential conditions encompassed the accessibility of suitable devices and comprehensive digital training, ensuring that users were equipped to integrate DHS into their professional practices. Furthermore, participants emphasized the perceived utility of mHealth apps as a catalyst for adoption. Many viewed the integration of mHealth apps as a valuable asset that could enhance their work performance. In doing so, they articulated the need to “stay abreast” amidst technological advancements in this era. More significantly, government officials from the macro-level understood the “transformative potential” of mHealth apps in facilitating healthcare delivery, particularly in remote regions. This perception of utility exhibited a broader recognition that these applications were integral components in healthcare practices and, ultimately, improving coverage quality.

On the flip side, the adoption of mHealth was confronted by several challenges, with self-efficacy emerging as a prevalent hurdle. Notably, older micro-level end users often expressed reservations about their capacity to learn new technologies, attributing their “cognitive limitations” as a significant hindrance. Some VHSGs expressed additional barriers due to illiteracy, amplifying the challenge of navigating digital tools. In contrast, even among participants with the capability to operate mHealth apps, a notable resistance towards adoption might manifest due to concerns that integrating such technologies could inadvertently escalate their workload. This apprehension suggested a need to address concerns about the potential impact on workload dynamics. Environmental factors also played a role in impeding the uptake of technology. The absence of robust public infrastructure, such as Wi-Fi coverage and electricity, diminished the connectivity of DHS, rendering them “intermittently inaccessible”. This inconsistency not only disrupted user experience, but also stressed the vulnerability of DHS to the challenges posed by inadequate infrastructure. Moreover, even when DHS are technically ready for use, the implementation continuity relies

Table 4 Factors affecting the potential adoption of mHealth apps

| Domains | Opportunities | Challenges |
|--|---|---|
| Skills and knowledge | Familiarity with IT systems increases confidence to uptake the mHealth apps "We do have computers, and we record data on the computers, including blood tests and other health records. So, having a platform to monitor the VHSGs should not be too difficult to use since we are familiar with computers." #HC Staff 1 | Low digital literacy diminishes mHealth apps adoption but may be mitigated with rigorous training "All of [us] can use smartphones. But for computers, some of us know how to use them, while some don't. I feel we can improve it with training; it shouldn't be challenging." #HC Staff 3 Inherent illiteracy among VHSGs poses a challenge in utilizing the mHealth apps "Some VHSG were illiterate, so it will be a bit hard [if we want them to use a phone to record down health records]. We need to teach them from scratch! Like how to write and read." #VHSG 5 |
| Memory, attention and decision process | Competence in retaining information to anticipate application "The staff attended HIS [Healthcare Information Systems] training before. From what I [observed], most [of them] can retain the information and hopefully apply them when the IT [ecosystem] is ready." #HC Director 2 | Cognitive challenges due to advanced age and reduced memory capacity hamper the acquisition of new knowledge "There is training provided [on how to use digital devices], but I found it really hard to understand, so I gave up. I also wanted to learn, but I can no longer remember things well." #HC Staff 2 |
| Environmental context: and resources | Availability of mobile devices among staff "I am confident that all of our staff members in the hospital know how to operate smartphones because each service has their own group chat, such as telegram groups." #Government Official 1 | Technological impediments due to limited Wi-Fi coverage and inconsistent electricity supply "I contacted [the internet service provider], and they said the cable couldn't reach this place; the same goes for other companies... Also, I fear [when] the electricity is cut off, how are we going to access the app on our computer?" #HC Director 3 "I think [mHealth app] is a good initiative. But sometimes we experience blackouts. I can't even charge my phone, so I am not sure how they can use the app." #Pregnant Mother 11 Insufficiently trained expertise to maintain the IT ecosystem "Second, we do not have enough trained IT personnel; even when the system is ready for use, we do not have enough people trained in IT." #UN-Specialized Agency Official 2 Training deficiency at a macro scale led to a pervasive impact on low micro-level technological competence "Very limited IT-related training course provided by the Ministry or other related stakeholders. This resulted in staff not familiar with newer digital technologies." #Government Official 2 Concerns with a low prevalence of smartphone ownership "It's difficult. I don't own a smartphone; I am only using [basic feature phone]." #VHSG 4 |
| Reinforcement | Provision of work phones enhances motivation "If they could provide me with a smartphone, I would be willing to use it!" #VHSG 1 | Concerns over penalty for not adopting DHS "Will it look bad on me if I do not use [mHealth apps]? I think yes, right?" #VHSG 3 |
| Intention | Willingness to learn given adequate support "I will be able to use it if I get trained. It can't be perfect, but I think I can do it at some point. It's a technology era in which we must keep ourselves updated." #VHSG 3 | Resistance to adopting DHS "Most VHSG don't use it [mHealth apps]. Also, when you ask them to use not everyone can use it. Maybe they are not interested or simply don't want to use it." #HC Director 1 |
| Beliefs about consequences | Perceived utility of the mHealth apps "I think it's good because the system allows VHSG to perform data entry, and the health center side can verify and check them. When we get the information through phone calls, some information might be missing." #HC Staff 2 | Perceived increased burden due to digitalization of healthcare practices "Probably not [willing to learn] because right now, their workload is high. Using the mHealth apps might even add to their stress. They do not have the bandwidth to do it." #HC Staff 5 |

Table 4 (continued)

| Domains | Opportunities | Challenges |
|---------|---|------------|
| Goals | <p>Hope in the transformative power of DHS to enhance care in remote areas <i>"[I feel] the mHealth apps can help our women, especially women living in remote areas. [It can provide care virtually] immediately after delivery. Sometimes, after giving birth, they do not get back because of distance and lack of money. So, mHealth apps can help them." #Government Official 2</i></p> | |

*VHSG—Village Health Support Group, HC Staff—Health Center Staff, HC Director—Health Center Director

heavily on a pool of expertise to manage and improve the system. However, several macro-level officials acknowledged that the current landscape in the country lacks this requisite expertise, exacerbating the challenges associated with the successful maintenance of DHS.

Discussion

This study examined the multilevel determinants influencing the work performance of VHSGs in Cambodia and their perceptions of adopting mHealth apps at work. To be considered effective health workers, VHSGs must operate in ways that are responsive, equitable, and efficient to achieve optimal health outcomes for the communities they serve [15]. However, our findings indicated that the challenges affecting VHSGs' work performance stemmed from the interconnected nature within each layer of the socio-ecological model. Specifically, their work performance is shaped by the transactional social processes between VHSGs and surrounding environment. This is particularly relevant given the nature of their work, which requires them to navigate relationships at multiple levels—from direct engagement with patients and healthcare providers at the micro-level to interactions with community actors and policy frameworks at the macro-level.

Among the macro-level factors impacting the work performance of VHSGs is undoubtedly the prevailing funding framework. Under the current scheme, VHSGs operate on a voluntary basis. While our qualitative analysis identified personal motivation as pivotal elements influencing their intention to commit, the voluntary nature of work means that they may occasionally divert their attention to alternative income-generating activities aimed at supplementing their earnings. Such conflicting economic priorities, in turn, can lead to fluctuations in dedication as well as impacting motivation to embrace new initiatives at work, such as adopting DHS and expanded job scope [32].

While efforts to recognize their contributions through remuneration are increasing, the existing compensation structure often falls short in terms of adequacy. As a result, there are ongoing discussions regarding the formal integration of VHSGs into the health sector [33, 34]. One proposed approach is to formalize VHSGs as a distinct cadre within the healthcare system to ensure progressive employment practices [35]. This formalization may contribute towards fair remuneration and opportunities for professional development, especially as VHSGs increasingly take on enhanced responsibilities including tasks previously performed by other healthcare professionals [36]. However, literature cautions that abrupt integration of VHSGs into existing healthcare landscape may be met with resistance and financial challenges [35]. Therefore,

integrative measures that are both equitable and transparent are necessary to prevent mistrust among actors in the health system [37].

We propose a three-pronged stepwise reassessment of the employment model to facilitate the gradual integration of VHSGs into the health system. The initial step toward job reform could involve gradually transitioning VHSGs from voluntary roles to compensated, shift-based work. This approach may help them begin adapting to more structured employment arrangements, while also allowing policymakers to explore the feasibility of introducing full-time positions over time to foster job security [38, 39]. Once VHSGs demonstrate sustained engagement, the next step is working toward accreditation. This measure may elevate the social status of VHSGs by enhancing their credibility as esteemed members of the healthcare community. When VHSGs are perceived as more trustworthy, community engagement becomes easier as individuals are more inclined to follow their guidance—an outcome that was previously challenging to achieve [40]. Moreover, accreditation delineates a structured pathway promoting opportunities for career advancement that further reinforces their integration within the broader healthcare system [41, 42]. Once VHSGs have been established as credible, the last prong is to upskill them collectively. This step focuses on continuous learning such as structured training programs, advanced certifications, and skill enhancement initiatives tailored to meet evolving healthcare demands [43]. These ensure that VHSGs are equipped with advanced skills to function as a competent component of the health system. By implementing this phased approach, it provides the health system with the financial flexibility to adapt incrementally, allowing it to stabilize and sustainably support the inclusion of VHSGs over time.

Meanwhile at the micro-level, a key barrier affecting VHSG performance is their limited working knowledge. This knowledge gap often leaves VHSGs ill-equipped to manage complex MNCH issues [44]. While multiple reasons may contribute to a knowledge-deficient VHSG workforce, we contend that the absence of a standardized training pathway as the primary cause. Without a clear framework for capacity building, VHSGs struggle to acquire the necessary skills and knowledge to perform effectively [45]. This need reinforces the relevance of the final prong of our proposed approach, which offers a comprehensive solution to upskill the workforce and enhance overall competency. Additionally, it is noteworthy that VHSGs in our context were burdened by reduced health resources and manpower which hindered the ability to deliver care even when they possessed the necessary competencies at work [46]. As discussed in the results, the absence of medical equipment and under

staffing deterred VHSGs to deliver care, highlighting the broader challenge of resource limitations. While addressing resource gaps often require multistakeholder collaboration [47], mHealth solutions present a potential avenue to bridge certain aspects of care delivery, particularly in facilitating remote consultations and enhancing diagnostic support where equipment is lacking [48].

Before DHS can be realized in Cambodia, our findings stressed the need for a digitally ready workforce. While literature posited that negative attitudes towards mHealth apps may stem from the introduction of a new technology unfamiliar to VHSGs [49], we argue that the insufficiency of manpower, many of whom are also digitally illiterate, emerged as a more decisive factor impacting the acceptance of health technologies. As a result, this compromised their willingness to adopt DHS due to the perceived additional effort required to learn and utilize technology within such a stressful working environment [46]. Therefore, addressing workforce shortages are prerequisite to creating a conducive environment for the adoption of DHS. This again emphasizes the urgency of the first and second prong of our proposed approach as a foundational step. As the knock-off effects of employment reform may not only increase staff retention but also promote recruitment efforts, gradually alleviating manpower constraints. Additionally, a well-supported workforce is also more likely to utilize DHS, ensuring widespread adoption into the healthcare landscape [50, 51].

Finally, a robust digital infrastructure is fundamental in sustaining utilization of mHealth apps. A consistent electricity supply is particularly required to ensure the uninterrupted operation of DHS. While several health centers in our study relied on power generators during periods of electricity outages, its functionality was limited by the lack of funding for fuel. Therefore, we advocate for the exploration of alternative, sustainable power sources such as solar energy. Despite the initial investment required, this approach has the potential for long-term cost-effectiveness and reducing reliance on the national grid over time [52]. Regarding poor internet connectivity, particularly in villages within our study that lacked service coverage, the central government can leverage its regulatory authority to negotiate agreements with telecommunication companies. This strategic move would help ensure reliable internet access for healthcare facilities and VHSGs, facilitating the continued usage of DHS. Finally, a proactive approach to bolstering the tech support workforce is equally important. By ramping up the training and recruitment of IT professionals, the country can cultivate a pool of skilled workforce capable of ensuring the continuous maintenance and enhancement of digital healthcare systems [53]. Therefore, prioritizing

digital infrastructure before investing in DHS are recommended, as the effectiveness of the latter is dependent on well-functioning digital ecosystem [54].

Strengths and limitations

It is noteworthy that this study was part of the formative study to support the i-MoMCARE randomized controlled trial (RCT) [24], which aimed to develop and implement an mHealth app for VHSGs in the country. The findings from this qualitative study uncovered the real-world challenges VHSGs faced in delivering community-based MNCH services. These insights provide critical background that will guide the app development process. In the next phase, the identified facilitators and barriers—organized using the socio-ecological model—will be systematically reviewed by the research team to determine the most pressing needs of end users. This deliberative process will inform which app features should be developed to best support VHSGs in overcoming these challenges. By grounding the app's design in the lived experiences of its end users, it ensures that the resulting intervention is not only contextually appropriate, but also enhances the likelihood of effectiveness and uptake in the subsequent RCT.

However, this study should be viewed in light of a few limitations. It was conducted in a single province, Battambang, a province that is relatively well developed in terms of both health and digital infrastructure compared to other regions in Cambodia. As a result, the findings may not fully capture the challenges faced in more remote provinces, where limitations in connectivity, technology access, and healthcare infrastructure could affect the implementation and usability of DHS. This context may limit the generalizability of the results to settings with less robust infrastructure, where additional barriers to mHealth adoption may exist. Another limitation pertains to the sample composition. Despite efforts to ensure representation across various levels of analysis, the recruitment of additional participants was hindered by operational challenges. The demanding nature of their responsibilities, particularly among healthcare providers offering round-the-clock care, led many to be unable to participate.

Conclusion

Our study proposes a three-pronged approach to improve the current work performance of VHSGs through the lens of the socio-ecological model. Reassessing employment model may provide a structured pathway to address longstanding problems surrounding retention, social status, and competency development. This study also recognizes the potential of mHealth apps as a handy job aid for enhancing VHSGs work performance. Hence, cultivating a digitally

competent workforce is the first step to encourage mHealth apps acceptance and adoption. Once the workforce gains digital proficiency and confidence, the next priority is to strengthen digital infrastructure to ensure sustained usage. In turn, this may foster the development of a sustainable and resilient VHSGs workforce capable of meeting the evolving demands of the healthcare system.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12960-025-01002-6>.

Additional file 1.

Acknowledgements

We would like to thank the participants for their support in this study.

Author contributions

Conceptualization: SY and VS. Design: SY and VS. Drafted the original manuscript: HG and CD. Designed the data collection instruments: HG and MNH. Collected data: MU, SO, SM, SC, CN, SCAC, CK, DK, and SS. Carried out the initial analyses: HG and YFL. Critically reviewed the manuscript: HG and SY. All authors have read and agreed to the published version of the manuscript.

Funding

Funding for this project was provided by The Bill & Melinda Gates Foundation funds this study (INV-022514). The views expressed in this manuscript do not necessarily reflect the views of the funder.

Availability of data and materials

No datasets were generated or analyzed during the current study.

Declarations

Ethical approval and consent to participate

This study was approved by the Cambodian National Ethics Committee for Health Research (No. 386 NECHR) and the National University of Singapore Institutional Review Board (NUS-IRB-2022-535). During recruitment, all participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Informed consent was obtained prior to data collection, and confidentiality was strictly maintained by anonymizing all responses.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Saw Swee Hock School of Public Health, National University of Singapore and National University Health System, 12 Science Drive 2, Singapore 117549, Singapore. ²University of Health Sciences, Phnom Penh, Cambodia. ³Department of International Cooperation, Ministry of Health, Phnom Penh, Cambodia. ⁴National Maternal and Child Health Center, Phnom Penh, Cambodia. ⁵Directorate General for Health, Ministry of Health, Phnom Penh, Cambodia. ⁶KHANA Center for Population Health Research, Phnom Penh, Cambodia. ⁷College of Education and Health Sciences, Public Health Program, Touro University California, Vallejo, CA, USA.

Received: 26 February 2025 Accepted: 18 June 2025

Published online: 01 July 2025

References

- Vibol T. PM opens Techo Santepheap National Hospital today. *Khmer Times*. 2023.
- Sokunthea N. Baby health centre project expanded. *The Phnom Penh Post*. 2023.
- Raksmey H. KOICA push healthcare for mothers, newborns. *The Phnom Penh Post*. 2023.
- Statistics NlO. Cambodia Demographic and Health Survey 2021–22 (English) 2022.
- Bae SH, Pen M, Sinn C, Kol S, An B, Yang SJ, et al. Work hours and overtime of nurses working in Cambodian hospitals. *Int Nurs Rev*. 2022;69(2):150–8.
- Ir P, Jacobs B, Asante AD, Liverani M, Jan S, Chhim S, et al. Exploring the determinants of distress health financing in Cambodia. *Health Policy Plan*. 2019;34(Supplement_1):i26–37.
- Kobashi Y, Chou K, Slaiman N, Neun P, Hayashi Y, Tsubokura M, et al. Improving the rural-urban balance in Cambodia's health services. *Int J Health Policy Manag*. 2021;10(6):358–9.
- Hwang WJ, Park YM. Factors influencing the accessibility of maternal health service in Cambodia. *Int J Environ Res Public Health*. 2019. <https://doi.org/10.3390/ijerph16162909>.
- Punreay H. Ministry urges stakeholders to heed the work of local village health support groups. *Khmer Times*. 2023.
- Annear PL GJ, Ir P, Jacobs B, Men C, Nachtnebel M, Oum S, Robins A, Ros CE. The Kingdom of Cambodia health system review. In: Pacific ROftW, editor. Geneva: Asia Pacific Observatory on Public Health Systems and Policies; 2015.
- Dongre AR, Deshmukh PR, Garg BS. A community based approach to improve health care seeking for newborn danger signs in rural Wardha, India. *Indian J Pediatr*. 2009;76(1):45–50.
- Hafeez A, Mohamud BK, Shiekh MR, Shah SA, Jooma R. Lady health workers programme in Pakistan: challenges, achievements and the way forward. *J Pak Med Assoc*. 2011;61(3):210–5.
- Ahmed S, Chase LE, Wagnild J, Akhter N, Sturridge S, Clarke A, et al. Community health workers and health equity in low- and middle-income countries: systematic review and recommendations for policy and practice. *Int J Equity Health*. 2022;21(1):49.
- Gilmore B, McAuliffe E. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low- and middle-income countries: a systematic review. *BMC Public Health*. 2013;13:847.
- Kok MC, Broerse JEW, Theobald S, Ormel H, Dieleman M, Taegtmeyer M. Performance of community health workers: situating their intermediary position within complex adaptive health systems. *Hum Resour Health*. 2017;15(1):59.
- Ozano K, Simkhada P, Thann K, Khatri R. Improving local health through community health workers in Cambodia: challenges and solutions. *Hum Resour Health*. 2018;16(1):2.
- Betrian M, Umans D, Vanna M, Ol S, Adhikari B, Davoeng C, et al. Expanding the role of village malaria workers in Cambodia: implementation and evaluation of four health education packages. *PLoS ONE*. 2023;18(9):e0283405.
- Kachimanga C, Mulwafu M, Ndambo MK, Harare J, Murkherjee J, Kulinkina AV, et al. Experiences of community health workers on adopting mHealth in rural Malawi: a qualitative study. *Digit Health*. 2024;10:20552076241253994.
- Feroz AS, Khoja A, Saleem S. Equipping community health workers with digital tools for pandemic response in LMICs. *Arch Public Health*. 2021;79(1):1.
- Braun R, Catalani C, Wimbush J, Israelski D. Community health workers and mobile technology: a systematic review of the literature. *PLoS ONE*. 2013;8(6):e65772.
- Källander K, Tibenderana JK, Akpogheneta OJ, Strachan DL, Hill Z, ten Asbroek AH, et al. Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: a review. *J Med Internet Res*. 2013;15(1):e17.
- Wagner AL, Porth JM, Bettampadi D, Boulton ML. Have community health workers increased the delivery of maternal and child healthcare in India? *J Public Health*. 2018;40(2):e164–70.

23. Puett C, Coates J, Alderman H, Sadler K. Quality of care for severe acute malnutrition delivered by community health workers in southern Bangladesh. *Matern Child Nutr.* 2013;9(1):130–42.
24. Saing CH, Ung M, Suy S, Oy S, Dary C, Yam ELY, et al. I-MoMCARE: innovative mobile technology for maternal and child health care in Cambodia—study protocol of a cluster randomized controlled trial. *Trials.* 2023;24(1):692.
25. Krijgsheld M, Tummers LG, Scheepers FE. Job performance in healthcare: a systematic review. *BMC Health Serv Res.* 2022;22(1): 149.
26. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health Educ Q.* 1988;15(4):351–77.
27. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care.* 2007;19(6):349–57.
28. Yoon S, Goh H, Kwan YH, Thumboo J, Low LL. Identifying optimal indicators and purposes of population segmentation through engagement of key stakeholders: a qualitative study. *Health Res Policy Syst.* 2020;18(1): 26.
29. Abimbola O, Barbara M, Sarah B-Z, van den Nynke B. The roles of community health workers who provide maternal and newborn health services: case studies from Africa and Asia. *BMJ Glob Health.* 2019;4(4): e001388.
30. Akalewold TG, Olumuyiwa O, Sanni Y. Multilevel determinants of community health workers for an effective maternal and child health programme in sub-Saharan Africa: a systematic review. *BMJ Glob Health.* 2022;7(4): e008162.
31. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* 2006;3(2):77–101.
32. Karaferis D, Aletras V, Raikou M, Niakas D. Factors influencing motivation and work engagement of healthcare professionals. *Mater Sociomed.* 2022;34(3):216–24.
33. Zulu JM, Kinsman J, Michelo C, Hurtig AK. Integrating national community-based health worker programmes into health systems: a systematic review identifying lessons learned from low-and middle-income countries. *BMC Public Health.* 2014;14: 987.
34. Tulenko K, Møgedal S, Afzal MM, Frymus D, Oshin A, Pate M, et al. Community health workers for universal health-care coverage: from fragmentation to synergy. *Bull World Health Organ.* 2013;91(11):847–52.
35. Payne J, Razi S, Emery K, Quattrone W, Tardif-Douglin M. Integrating community health workers (CHWs) into health care organizations. *J Community Health.* 2017;42(5):983–90.
36. Zachariah R, Ford N, Phillips M, Lynch S, Massaquoi M, Janssens V, et al. Task shifting in HIV/AIDS: opportunities, challenges and proposed actions for sub-Saharan Africa. *Trans R Soc Trop Med Hyg.* 2009;103(6):549–58.
37. Strachan DL, Källander K, Ten Asbroek AHA, Kirkwood B, Meek SR, Benton L, et al. Interventions to improve motivation and retention of community health workers delivering integrated community case management (iCCM): stakeholder perceptions and priorities. *Am J Trop Med Hyg.* 2012;87(5 Suppl):111–9.
38. Yeager VA, Wisniewski JM, Amos K, Bialek R. Why do people work in public health? Exploring recruitment and retention among public health workers. *J Public Health Manag Pract.* 2016;22(6):559–66.
39. Kwon S, de Castro AB, Herting JR, Lee SJ, Johnson K, Bao S. Job satisfaction and job security as moderators in the relationships among job demands, musculoskeletal symptoms, and work performance. *Int Arch Occup Environ Health.* 2023;96(4):607–19.
40. Sripad P, McClair TL, Casseus A, Hossain S, Abuya T, Gottert A. Measuring client trust in community health workers: a multi-country validation study. *J Glob Health.* 2021;11:07009.
41. Bogh SB, Blom A, Raben DC, Braithwaite J, Thude B, Hollnagel E, et al. Hospital accreditation: staff experiences and perceptions. *Int J Health Care Qual Assur.* 2018;31(5):420–7.
42. Katoue MG, Somerville SG, Barake R, Scott M. The perceptions of healthcare professionals about accreditation and its impact on quality of healthcare in Kuwait: a qualitative study. *J Eval Clin Pract.* 2021;27(6):1310–20.
43. Smithwick J, Nance J, Covington-Kolb S, Rodriguez A, Young M. “Community health workers bring value and deserve to be valued too.” Key considerations in improving CHW career advancement opportunities. *Front Public Health.* 2023;11:1036481.
44. Scharff D, Enard KR, Tao D, Strand G, Yakubu R, Cope V. Community health worker impact on knowledge, antenatal care, and birth outcomes: a systematic review. *Matern Child Health J.* 2022;26(1):79–101.
45. Thio S, Tesema AG, Patel B, Vakaloloma U, Wilson C, Joshi R. ‘First of all, I need training’: a qualitative study evaluating the Fiji community health worker training program. *BMC Prim Care.* 2024;25(1):228.
46. Haq Z, Iqbal Z, Rahman A. Job stress among community health workers: a multi-method study from Pakistan. *Int J Ment Health Syst.* 2008;2(1):15.
47. Pereno A, Eriksson D. A multi-stakeholder perspective on sustainable healthcare: from 2030 onwards. *Futures.* 2020;122: 102605.
48. van Veen T, Binz S, Muminovic M, Chaudhry K, Rose K, Calo S, et al. Potential of mobile health technology to reduce health disparities in underserved communities. *West J Emerg Med.* 2019;20(5):799–802.
49. Addotey-Delove M, Scott RE, Mars M. Healthcare workers’ perspectives of mHealth adoption factors in the developing world: scoping review. *Int J Environ Res Public Health.* 2023. <https://doi.org/10.3390/ijerph20021244>.
50. Tegegne MD, Tilahun B, Mamuye A, Kerie H, Nurhussien F, Zemen E, et al. Digital literacy level and associated factors among health professionals in a referral and teaching hospital: an implication for future digital health systems implementation. *Front Public Health.* 2023;11:1130894.
51. White CH, Meier N, Swint C. The implementation of a stress management program for health care workers through a rural occupational health clinic. *Workplace Health Saf.* 2021;69(4):161–7.
52. Sharma L, Singh J, Dhiman R, Vargas Nunez DR, Ba AE, Joshi KJ, et al. Advancing solar energy for primary healthcare in developing nations: addressing current challenges and enabling progress through UNICEF and collaborative partnerships. *Cureus.* 2024;16(1): e51571.
53. Rippen H. Building support for health information technologies. *Stud Health Technol Inform.* 2003;92:103–8.
54. WHO Guidelines Approved by the Guidelines Review Committee. WHO guideline Recommendations on Digital Interventions for Health System Strengthening. Geneva: World Health Organization © World Health Organization 2019.; 2019.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.