BMC Infectious Diseases

RESEARCH

Open Access

Uncovering the obstacles: a comprehensive analysis of barriers to hand hygiene adherence among healthcare providers: a systematic review

Abel Afework[1*] and Aiggan Tamene[2,3]

Abstract

Background Hand hygiene is the most effective and feasible infection prevention and control measure within the healthcare facilities. Despite the ease and simplicity of the technique, the adherence rate among health professionals remains suboptimal. Hence, developing targeted interventions to improve adherence requires a clear understanding of these obstacles. Therefore, this systematic reviews of existing literature aims to fully understand the context specific barriers of hand hygiene to answer why barriers persisted despite the interventions to maintaining hand hygiene practices among healthcare providers.

Methods This systematic review was conducted to synthesize existing evidence according to the Joanna Briggs Institute (JBI) qualitative studies review methodology on qualitative studies publish between the year 2010 and 2024. The study is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline (PRISMA) and the protocol for the study was published on PROSPERO (CRD42024573753) before commencing the study.

Result The review included twenty eight studies that are conducted in different regions of the world representing six of the continents. The study identified four interconnected themes of barriers with many subthemes. Behavioural barriers and organizational barriers were the most highlighted themes within the review. Physical barriers were one of the significant themes, where unavailability and inconvenience of hand hygiene resources gain the most attention by study participants across the studies. The fourth theme was societal/interpersonal barriers characterized by negative social influence and unsupportive colleagues.

Conclusion The study highlights that the barriers to hand hygiene adherence among healthcare professionals are intertwined and complex, with the main interplaying among behavioural, societal/interpersonal, physical, and organizational barriers. The findings underscore that the intertwined nature of these barriers requires a multifaceted approach involving the relevant stakeholders to improve hand hygiene adherence among healthcare providers.

Keywords Barriers to hand hygiene, Hand hygiene adherence, Hand washing, Hand hygiene, Healthcare worker

*Correspondence:
Abel Afework
agziabel@gmail.com
[1]Center for Sustainable Development, Addis Ababa University, Addis Ababa, Ethiopia
[2]Center for Sustainability, University of Otago, Dunedin, New Zealand
[3]Department of Preventive and Social Medicine, University of Otago, Dunedin, New Zealand

Introduction

Hand hygiene is the most effective and feasible infection prevention and control measure within healthcare facilities. Hand hygiene can be achieved through different methods depending on various factors like the activity/procedure being performed or to be performed, the level of dirtiness of hand and time. Despite the ease and simplicity of the technique, the adherence rate among health professionals remains suboptimal, leaving health professionals and patients vulnerable to healthcare-acquired infections [1, 2].

Contaminated hands of health professionals are responsible for the transmission of most infections including drug-resistance microorganisms through direct and indirect contact [3]. Studies suggested that improving hand hygiene adherence alone can reduce up to 50% of the transmission of pathogens within the healthcare settings. A significant reduction of Healthcare Acquire Infections can be achieved with an approximately 60% hand hygiene adherence rate among healthcare workers within the facility. However, almost 61% of health professionals don't comply with the hand hygiene guidelines [4, 5]. Hand hygiene adherence rates significantly differ across the World Health Organization (WHO) five critical moments for hand hygiene [6, 7].

Hand hygiene adherence remains a major challenge within healthcare facilities. Adherence rates differ across different regions and facility types, with a higher noncompliance rate among healthcare workers in the primary healthcare units of least developed nations [8]. Studies conducted across various regions of the globe reported a hand hygiene adherence rate ranging from 21% in Ethiopia [9] to 84.3% in Australia [10]. This evidence is mirrored by the 2023 Joint Monitoring Program (JMP) Report, which reported the basic hand washing service coverage in Sub-Saharan African countries ranged from 22% in Sierra Leone to 57% in Ghana. In contrast, the basic hand hygiene service coverage among European and Northern American countries ranged from 86% in Serbia to 100% coverage in most nations [11]. Service unavailability indicates noncompliance among healthcare providers, with such unavailability serving as a barrier to adherence.

The WHO has developed and implemented a multimodal hand hygiene strategy to improve adherence within healthcare settings [12]. The multimodal programs succeeded initially, however, they were not able to be sustained due to a multitude of reasons [13]. The factors that influenced the effectiveness of these programs and contributed to the lag in achieving maximum results in hand hygiene compliance, including the absence/inconvenience of hand hygiene infrastructure, poor budget al.location, absence of hygiene supplies, absence of guidelines, poor awareness, attitudinal challenges, lack of time, poor monitoring and evaluation [7, 14–17].

According to WHO, despite the efforts and commitments made by researchers to identify the rate of compliance, challenges, and best interventions to improve hand hygiene compliance, there is still a need to critically understand factors that are responsible for the low adherence among healthcare providers [18]. Therefore, this systematic review and meta-synthesis is conducted to synthesize evidence based on the existing qualitative study findings to fully capture barriers to hand hygiene adherence among healthcare providers. In addition, most systematic review studies are conducted on quantitative studies and lack in-depth perspectives of individuals and organizations [9, 19, 20].

Methods and materials

Review typology

A systematic review was conducted to synthesize existing evidence according to the Joanna Briggs Institute (JBI) qualitative studies review methodology. The study is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline (PRISMA) (Supplementary 1 file). The protocol for the study was published on PROSPERO (CRD42024573753) before commencing the study.

Search strategy and data sources

Search engines like PubMed/MEDLINE, Google Scholar, African Journal Online (AJOL), HINARI, Science Direct, ProQuest and Directory of Open Access Journals was used to find relevant articles published in the English language that are published from 2010 to 2023 (Supplementary 2 file). The search strategy used KEY Terms using Boolean operators "AND" and "OR" as follows: ("Hand hygiene" OR "hand wash" OR "Hand Sanitizing" OR "Hand Antisepsis") AND ("Barrier" OR "Determinants" OR "Challenges" OR "Facilitators" OR "Factors affecting") AND ("Healthcare worker" OR "Health professionals" OR "Hospital workers" OR "Healthcare facility workers").

Eligibility criteria

Inclusion criteria

Study designs Only qualitative studies included.

Setting All research articles exploring barriers to hand hygiene adherence within healthcare facilities of any region of the world regardless of the facility tiers/size was included in this systematic review.

Time frame The studies included were studies published from 2000 to 2023.

Publication condition This review only included articles published in peer-reviewed journals.

Language Only articles published in English were considered.

Exclusion criteria

Quantitative studies, reviews, commentaries, letters to editors, interventional studies, as well as other opinion publications were excluded from the analysis.

Screening and data extraction

The screening and selection of articles was conducted using Zotero reference manager. Primarily AA and AT had made the data base search. Then both AA and AT screened all the articles based on title and abstract and those articles with full text were assessed using the eligibility criteria for inclusion or exclusion independently. Then both the authors checked all the articles again together and included the articles both agreed. Relevant data including authors' name (First author last name), year, country, study population, methodology and theoretical framework used were extracted from each article according to the JBI data extraction tool by AA and AT. Authors settled discrepancies through discussion at every stage of the screening and data extraction.

Data analysis

A thematic analysis approach was utilized and a narrative synthesis incorporating quotes from the included papers was presented. Therefore, the two reviewers independently gathered the qualitative data from the studies using a template and organized it into codes and subthemes. These subthemes were then grouped based on their similarities to create a cohesive set of themes. Through discussions with review members (AA and AT), the subthemes and themes was refined to ensure accurate representation of the data. Then finally narrative synthesis was used to support the data from the thematic analysis.

Quality appraisal

The study used the Joanna Briggs Institute (JBI) quality assessment tool for qualitative studies to assess the quality of the studies and risks of biases of the studies [21]. AA and AT independently appraised the quality of the studies and studies that had been agreed by the two reviewers were included in the study. The tool comprises 10 items/parameters which assess the quality of studies and the study team assigned 0 to items met by the study and 1 for unmet items. The risk of bias was categorized as low (total score, 0 to 2), moderate (total score, 3 or 4), or high (total score, 5 to 9). Finally, 20 studies with low risk of biases were included directly. Eight of the studies with moderate risk of bias were included in the study after reviewing the study setting and findings. The study team found that most of the studies were from the same nations' and the studies included very critical perspectives that are overlook/unexplored in other studies. Therefore, the study team decided not to exclude the perspectives of healthcare providers that would help to better synthesize the findings (Supplementary 3 file).

Result

Characteristics of included studies

The initial database search had found 108 studies that seemed relevant to the study based on key words. However, after going through rigorous screening based on the study objective and eligibility criteria only 28 studies were included in the study (Fig. 1).

The included studies were conducted in the six continents of the world, where 4 in Iran [22–25], 1 in Saudi Arabia [26], 1 in Vietnam [13], 1 in Korea [27], 3 in India [28–30], 3 in Nigeria [31–33], 1 in Malawi [34],1 in Benin [35], 1 in Guinea [36], 1 in Ethiopia [37], 1 in South Africa [38], 1 in Brazil [39], 1 in Turkey [40], 2 in Netherlands [41, 42], 1 in Germany [43], 1 in France [44], 2 in Canada [45, 46] and 2 in Australia [47, 48]. In this systematic review a total of 953 healthcare providers from different disciplines and tiers (Primary to Tertiary) of healthcare organization were included. Regarding sampling method, twenty one of the studies used purposive sampling [22–28, 30–32, 34–38, 41, 43, 45–47], two recruited participants on voluntary bases [13, 44], three used Convenience sampling [29, 39, 40] and two study used both purposive and convenience [33, 42] and one study used both purposive and snowball sampling techniques [48]. Twenty two of the studies used either Interviews [22–24, 26–29, 31–35, 38, 43, 45, 48] or Focus Group Discussions [13, 30, 39, 42, 46, 47] as a method of data collection, where six study used both methods for data collection [25, 36, 37, 40, 41, 44] (Table 1).

Findings

The study identified four main themes consisting of many categories and codes. The themes were behavioural barriers, societal/interpersonal barriers, physical barriers and organizational barriers (Table 2).

Behavioural barriers

The theme emerged from five categories including knowledge gap, cognitive barriers, attitudinal barriers, perceived barriers and automaticity and forgetfulness.

Knowledge gap

The health professionals included in one of the study indicated that poor knowledge of professionals regarding infections transmission cycle within the healthcare

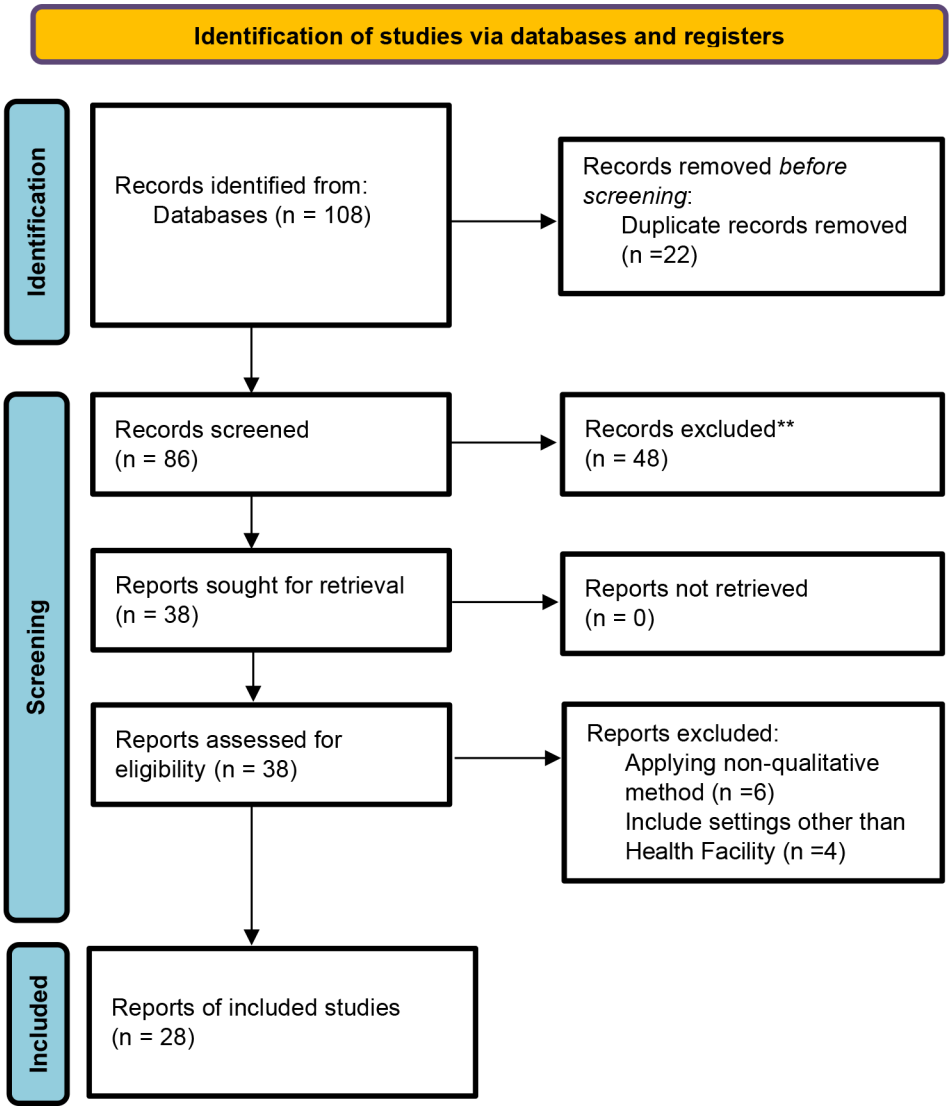

Fig. 1 PRISMA flowchart for the selection of eligible studies on Barriers to hand hygiene among healthcare workers studies conducted between 2010 and 2023

facilities contributed to low adherence [13, 28, 45]. In addition, the participants in nine of the studies identified that the healthcare providers' lower level of awareness regarding the importance and procedures for performing hand hygiene within the healthcare settings was one of the barriers for adherence [22–25, 31, 33, 34, 42, 46].

> *"Sometimes we do not take hand hygiene seriously because we do not know enough about the complications of poor hand hygiene practice." (Ahmadipour et al., 2022, p.4).*

Cognitive barriers

In two of the study included, the participants stated that some of them and their colleagues have a feeling of insusceptibility to infection due to their long years of work without acquiring any infection. This makes them to believe that they need not to be diligent to wash their hand [22, 23].

> *"...They think they are immune to all infections and keep saying nothing has happened to me during all these years; so why should I wash my hands frequently?" (Kaveh et al., 2022, p.46).*

Mistrust or undermining of the efficacy of hand hygiene was reported as a barrier for hand hygiene adherence among participants in five of the study [39–41, 44, 45].

> *"....okay, we're washing hands but unavoidably sometimes we're leaving it out. I don't believe that HH is related to these infections actually; sometimes*

Table 1 Description of studies conducted on barriers to hand hygiene among healthcare workers, published between 2000 and 2023

Author and year of publication	Study area	Study design	Study population	Sampling	Data collection technique	Data analysis	Theoretical framework	Risk of bias
Ataiyero et al., 2023	Nigeria	Qualitative	Nurse, Doctors (*N* = 45)	Purposive sampling	Interview	Thematic analysis	TDF	Low
Calcagni et al., 2021	France	Qualitative	Multiple professionals (*N* = 46)	Voluntary basis	Interview, focus group discussion	lexicographical and thematic content analyses	Not used	Low
Salmon et al., 2015	Vietnam	Qualitative	Nurse, Doctors (*N* = 130)	Voluntary basis	Focus group discussion	Thematic analysis	Not used	Moderate
Kaveh et al., 2022	Iran	Qualitative	Nurse (*N* = 15)	Purposive sampling	Interview	Content analysis	Not used	Moderate
Jang et al., 2010	Canada	Qualitative	Multiple professional (*N* = 153)	Purposive sampling	Focus group discussion	Thematic analysis	Not used	Moderate
Ahmadipour et al., 2022	Iran	Qualitative	Nurse, Anaesthesiologists, Physiotherapist (*N* = 25)	Purposive sampling	Interview	Content analysis	Not used	Moderate
Ghaffari et al., 2020	Iran	Qualitative	Nurse (*N* = 16)	Purposive sampling	Interview	Content analysis	TPB	Moderate
White et al., 2015	Australia	Qualitative	Nurse (*N* = 27)	Purposive sampling	Focus Group Discussion	Thematic content analysis	TPB	Moderate
Yehouenou et al., 2022	Benin	Qualitative	Nurse, surgeon, physician, cleaner (*N* = 23)	Purposive sampling	Interview	Thematic analysis	TDF	Low
McLaws et al., 2014	Iran	Qualitative	Nurse, Physician, Interns (*N* = 80)	Purposive sampling	Interview, Focus Group Discussion	Thematic analysis	Not used	Low
Erasmus et al., 2009	Netherlands	Qualitative	Nurse, Physician, Medical students (*N* = 65)	Purposive sampling	Interview, Focus Group Discussion	Systematic content analysis	TPB	Low
Singh et al., 2023	India	Qualitative	Nurse, Physician, Attendant, Physiotherapist (*N* = 50)	Purposive sampling	Interview	Content analysis	Not used	Low
Lescure et al., *2021*	Netherlands	Qualitative	Nurse, Nurse attendant (*N* = 31)	Purposive and convenience sampling	Focus Group Discussion	Thematic content analysis	Not used	Low
von Auer et al., 2024	Germany	Qualitative	Nurse, Physician, (*N* = 25)	Purposive sampling	Interview	Content analysis	TDF	Low
Kaur et al., 2014	Australia	Qualitative	Key academics, Medical students (*N* = 17)	Purposive and snowball sampling	Interview	Thematic analysis	Not used	Low
Ay et al., 2019	Turkey	Qualitative	Nurse, Physician, Resident, Cleaner (*N* = 25)	Convenience sampling	Interview, Focus Group Discussion	Thematic content analysis	TPB	Low
Jeong et al., 2015	Korea	Qualitative	Nurse, Physician, Resident, (*N* = 33)	Purposive sampling	Interview	Content analysis	RAA	Low
Iswarya et al., 2022	India	Qualitative	Medical students (*N* = 11)	Convenience sampling	Interview,	Thematic Analysis	Not used	Low
Alshagrawi et al., 2024	Saudi Arabia	Qualitative	Doctors, Anesthesiologists, Nurses (*N* = 49)	Purposive sampling	Interview	Content analysis	Not used	Low
Chioma et al., 2023	Nigeria	Qualitative	Nurses (*N* = 22)	Purposive sampling	Interview	Thematic analysis	TPB	Low
Squires et al., 2014	Canada	Qualitative	Physician, Resident, (*N* = 42)	Purposive sampling	Interview	Thematic analysis	TDF	Low
Mangochi et al., 2023	Malawi	Qualitative	HCW, Patient care giver (*N* = 23)	Purposive sampling	Interview	Thematic analysis	Not used	Moderate

Table 1 (continued)

Author and year of publication	Study area	Study design	Study population	Sampling	Data collection technique	Data analysis	Theoretical framework	Risk of bias
Douno et al., 2023	Guinea	Qualitative	Multiple HCW professionals (*N* = 38)	Purposive sampling	Interview, Focus Group Discussion	Thematic analysis	HBM	Low
Joshi et al., 2012	India	Qualitative	Multiple HCW professionals (*N* = 75)	Purposive sampling	Focus Group Discussion	Content analysis	Not used	Low
Nwaokenye et al., 2020	Nigeria	Qualitative	Doctors, Nurses (*N* = 19)	Purposive and convenience sampling	Interview	Thematic content analysis	Not used	Low
McDavid et al., 2024	Brazil	Qualitative	Not clearly indicated	Convenience sampling	Focus Group Discussion	Thematic Analysis	Not used	Low
Yilma et al., 2024	Ethiopia	Qualitative	Multiple HCW professionals (*N* = 23)	Purposive sampling	Interview, Focus Group Discussion	Thematic analysis	SEIPS	Low
Mutshatshi et al., 2023	South Africa	Qualitative	Nurses (*N* = 15)	Purposive sampling	Interview	Thematic analysis	Not used	Moderate

HBM: Health Belief Model; IBM-WASH: Integrated Behavioural Model for Water Sanitation and Hygiene; RAA: Reasoned Action Approach; SEIPS: Systems Engineering Initiative for Patient Safety; TDF: Theoretical Domain Framework; TPB: Theory of Planned Behaviour

Table 2 Theme, subtheme and codes of barriers to hand hygiene among healthcare workers, published between 2010 and 2023

Theme	Category	Codes
Behavioral barriers	Knowledge gap	Poor understanding of the importance and techniques of hand hygiene
		Gaps in understanding how infections are transmitted
	Cognitive barriers	Feeling of less susceptibility
		Mistrust in some products
	Attitudinal barriers	Negative attitudes regarding hand hygiene
		Indifferent attitudes towards hand hygiene
	Perceived barriers	Beliefs about negative consequences of hand hygiene
		No need for hand hygiene if gloves used
	Automaticity and Forgetfulness	Forgetfulness due to the routine nature of hand hygiene
		Forgetfulness due to workload
Physical barriers	Unavailability of hand hygiene resources	Unavailability, shortage or inconvenience of hand hygiene resources (Water, soap, ABHR, poster)
	Poor quality resources	Poor quality of hand hygiene resources
	Physical discomfort	Skin Irritation and allergies
		Unpleasant Sensation and Stickiness
Societal/Interpersonal barriers	Negative Societal influence	Improper childhood hand hygiene belief and practice
		Fear of offending patients
	Unsupportive colleagues	The unfavorable attitudes of senior staff discourage hand hygiene practices
Organizational barriers	Work load and Understaffing	Small number of staff overburdens the available staff which leads to non-adherence
		Fast-paced and demanding nature of healthcare work leads to non-adherence
	Poor professional development	Lack of training programs on hand hygiene
		Improper hand hygiene training delivery
	Absence of policies and guidelines	Unavailability of clear policy and guideline at facility level
	Weak leadership	Weak institutional leadership and inadequate policy enforcement
	Improper supervision and feed back	There were no supervision or intermittent supervision on hand hygiene
	Poor monitoring and evaluation	Absence of monitoring and evaluation program

we admit a patient before the (previous) one is discharged, before the bed is properly cleaned. So, I don't think that it's all related to handwashing, HH, probably there is a link (between HH and infections), but not all infections are related to handwashing." (Ay et al., 2019, p.113).

Attitudinal barriers

Two studies reported that negative or improper attitude of healthcare providers regarding the importance of hand hygiene influenced adherence [22, 23, 28, 42].

"Often, we do not practice hand hygiene because we do not believe in the importance of hand hygiene and do not get used to it. We would practice hand hygiene more if they reported monthly statistics of nosocomial infections and their complications." (Ahmadipour et al., 2022, p.5).

Interviewees in four of the included studies indicated that indifferent attitudes like negligence and laziness hinders hand hygiene adherence among healthcare providers [24, 25, 36, 37].

"Laziness is one of the reasons" that prevents HCWs from "[doing] the right thing" (McLaws et al., 2014, p.75).

Perceived barriers

The interviewees and FGD participants from one of the study mentioned that wrong beliefs about negative consequence of hand hygiene significantly affects adherence among the healthcare providers [44].

"As a result, it's going to be very, very violent for the flora of the skin. which is going to degrade. Moreover, because of the American studies that have come out on the use of this hydroalcoholic solution. They did a study saying that they didn't yet have enough data to know where we were going. we still don't know in the long term if daily dose can be harmful to the skin. It was kind of imposed on us a few years ago. We were told that it was the solution to all our problem. But then. in the end, it can have repercussions on the caregivers." (Calcagni et al., 2021, p.4).

Two of the studies revealed that health professionals believed that the use of gloves can exacerbate the noncompliance to hand hygiene due to the feeling of being protected and clean whenever using gloves [13, 46].

"Sometimes wearing medical gloves while providing patient care in the same room discourages us from washing our hands with water or antiseptic solutions." (Salmon et al., 2015, p.3).

Automaticity and forgetfulness

One of the study reported that the routine and repeated nature of the five critical moments of hand hygiene is letting the provider to forgot to wash their hands [44].

"Sometimes we think that the risk is less direct and so we pay less attention to hand washing, we forget about it or do it too quickly, and that's where it happens. So. So there you go. That's why, you have to be vigilant all the time, and be mindful of what you're doing." (Calcagni et al., 2021, p.5).

Forgetfulness due to busy work schedules was reported as one of the barrier for hand hygiene adherence among professionals in eight of the studies included [24, 29, 31, 35, 41, 43, 47, 48].

"It is likely I forget to wash my hands before attending to others… I may be attending to one patient, and they are bringing another patient in… I rush." (Ataiyero et al., 2023, p.300).

Physical barriers

Unavailability and inconvenience of hand hygiene resources

Twenty two of the studies included in the review reported that unavailability, shortage or inconvenience of hand hygiene products including sinks, water, soap/detergent, ABHRs and posters was the main barrier for hand hygiene noncompliance among healthcare professionals [13, 22–26, 28–31, 33–39, 41, 44–47].

"The ABHR is not compulsory– I mean, it's not always available" (Yehouenou et al., 2022, p.7).

Poor quality resources

The study participants in six of the studies mentioned that the poor quality of hand hygiene resources including the quality of water, soap/detergent and ABHR was one factor for noncompliance among professionals [23, 24, 26, 28, 35, 39].

"The difficulty is the great lack of infrastructure in our hospital. And sometimes the quality of water is also doubtful" (Yehouenou et al., 2022, p.8).

Physical discomfort

Study participants in ten of the studies reported that skin irritations and allergies caused due to repeated hand washing and rubbing makes them to quite or to malpractice hand hygiene inconsistently [22, 24–27, 29, 31, 32, 35, 41].

> *"…A lot of nurses have hand eczema and psoriasis because of too much hand washing and rubbing" (Kaveh et al., 2022, p.46).*

Two of the study participants stated that feeling of skin sensation and pungent odour from the detergents and ABHR was one of the reasons for poor adherence [30, 44].

> *"Biggest disadvantage with surgical spirit is smell of alcohol. patients will say: this "sottish" doctor is roaming the hospital drunken since early morning" (Joshi et al., 2012, p.342).*

Societal/interpersonal barriers

Negative societal influence

One of the study revealed that improper childhood hand hygiene habit that had been thought by families and community members significantly influences the hand hygiene practice at workplace [22].

> *"…No one taught us correct hand hygiene in childhood; only our parents forced us to wash our hands before eating, and we still do." (Kaveh et al., 2022, 46).*

Study participants in one of the study stated that washing hands in front of patient might offend clients giving wrong impressions to patients that they are contaminated, hence healthcare workers avoid to wash hand in front of them [13].

> *"Sometimes we [doctors] wash our hands once the patient leaves the consult room to avoid the patient observing and perhaps becoming offended." (Salmon et al., 2015, p.4).*

Unsupportive colleague

Six of the included studies reported that senior professional staffs demotivates colleagues and significantly influences the hand hygiene habit of team mates/colleagues, especially those who are newly recruited [22, 41, 45–48].

> *"There's even doctors who challenge the fact that hand washing actually prevents - like, they ask you, "Oh, where's the study that proves it?" (White et al., 2015, p.5).*

Organizational barriers

Work load and understaffing

Sixteen of the studies reported that the innate high work load nature of healthcare delivery and small number of healthcare providers within the facilities was responsible for noncompliance among healthcare providers [23, 25–27, 29, 31, 33–35, 37, 38, 40, 43, 44, 46, 47].

> *"Well, most of the time, I see like 200 patients per day. I don't know if it's possible towash your hands 200 times, so most of the time it's not feasible. That's the sincere truth. It's either you're finishing one examination, before you know it, patients they´re already queuing up and if you have to see 200 patients and one doctor that's killing, so washing your hands 200 times is stressful." (Nwaokenye et al., 2020, p.5-6).*

Poor professional development

The study participants from nine studies reported that trainings are not provided to healthcare professionals regarding hand hygiene which leads to poor understanding and low adherence [23, 31, 34, 35, 37, 39, 42, 45, 46].

> *"Well, apart from my knowledge from medical school and the periodic training I had during the Ebola disease outbreak, I can't think of any formal training on hand hygiene before." (Ataiyero et al., 2023, p.299).*

Three of the study participants mentioned that even though trainings were provided they found them improper due to the lack practical sessions and non-attractive approaches followed which don't support adherence [13, 22, 25, 28, 35, 48].

> *"Although we receive hand-hygiene training all of the time, we also need to know the practical aspects, not just the theoretical ones." (Yehouenou et al., 2022, p.6–7).*

Absence of policies and guidelines

Five of the studies identified that the absence of facility level hand hygiene policies and guidelines was resulting to noncompliance among healthcare providers [22, 30, 31, 33, 42].

> *"…It is important to comply with hand hygiene under any financial and temporal circumstances, but sometimes our hospital policies change because of financial issues, and hand hygiene is no longer a priority". (Kaveh et al., 2022, p.47)*

Weak leadership

Three of the articles revealed that weak institutional leadership among the higher and middle class leaders played a great role for staff noncompliance [22, 23, 32, 46].

"...In this ward, the head nurse is mostly busy with marginal issues such as documenting and going to the meeting, and she pays little attention to the main issues". (Kaveh et al., 2022, p.47)

Improper supervision

Two articles stated that improper or absence of supportive supervision from immediate supervisors and higher officials is one of the reasons for hand hygiene hesitancy [22, 23, 25].

"There is less supervision during evening and night shifts, so hygiene protocols such as hand washing are less likely to be observed." (Ahmadipour et al., 2022, p.5).

Poor monitoring and evaluation

One of the article mentioned that the available poor monitoring and evaluation system on hand hygiene is impeding hand hygiene adherence among health service providers [22, 42].

"...Despite what is generally claimed, hand hygiene is not a criterion for evaluation of head nurses". (Kaveh et al., 2022, p.47)

Discussion

The 28 studies were from 18 countries, comprising three from lower-income economies, four from lower-middle-income economies, four from upper-middle-income economies, and seven from upper-income economies. This highlighted how hand hygiene adherence is imperative and backlogged among healthcare providers within healthcare facilities across nations, regardless of economic development. Furthermore, the finding entailed that the barriers to hand hygiene adherence across the different economic regions of the globe are almost similar. It was evident that the WHO calls for universal movements to improve hand hygiene adherence within healthcare facilities by 2030 in concordance with United Nations Sustainable Development Goals (UNSDGs) 3 and 6, with a target of achieving 100% coverage of hand hygiene facilities [49, 50].

The study identified that poor awareness and knowledge of infection prevention and hand hygiene was one of the most significant barriers to hand hygiene adherence. Similarly, a systematic review conducted among health professionals in Sub-Saharan Africa revealed that a lack of adequate knowledge among healthcare providers prevents them from complying with hand hygiene guidelines [51]. Studies suggested that the knowledge gap could be filled with continuous professional development programs to acquaint health professionals with the required knowledge [52]. The American Centers for Disease Control and Prevention (CDC) and WHO recommended that to address the knowledge gap, training or professional development training effectively should incorporate theoretical and practical sessions and be delivered continuously between 6 and 12 months [2, 12]. However, the finding revealed that there was either a complete absence of professional development programs or the programs were delivered improperly and intermittently which exacerbated the knowledge gap vis-a-vis hand hygiene compliance.

Cognitive barriers, attitudinal barriers and perceived barriers were among the other behavioural barriers identified in the current study. Different studies reported that behavioural factors like cognition, attitude and perceived barriers significantly influences adherence to hand hygiene adherence among healthcare providers [53–55]. A systematic review study reported that these behavioural barriers existed mainly due to the prevalent poor awareness and knowledge regarding hand hygiene among professionals [56].

A study identified that the provision of hand hygiene resources had a pivotal role in maintaining hand hygiene adherence [57]. Similarly, the finding of the current study highly reported barrier to hand hygiene adherence was the absence of either water or soap or ABHR or a combination of these. In addition, the finding heightened that the inconvenience of hand washing facilities due to the poor design of healthcare facilities hinders noncompliance among low-income economies and high-income economies counties. Despite the high proportion of hand washing facilities among high-income economies, the finding signifies that the inconvenience of facilities is a challenge to all economic-income countries. This can be from attitudinal, leadership, and policy-related issues.

The finding revealed that physical discomforts like skin allergies and irritation, filling of sensation, and bad odor significantly affect healthcare providers' adherence with hand hygiene. These might likely be due to one of the reported poor quality of the hand hygiene products. The WHO indicated that whenever selecting hand hygiene products we should give due emphasis to the quality of the products on the biases of skin health and aesthetic values like odor to enhance high acceptance and utilization of hand hygiene products among professionals, otherwise the products might not be utilized leading to low adherence e [12].

Role models within the workplace play a critical role in improving behaviour and fostering adherence with good practices [58]. It was evident that modelling senior healthcare providers significantly reinforced the importance of hand hygiene adherence among junior staff [59]. Conversely, negative role modelling will lead to noncompliance among junior staffs. The current study findings supported that negative role modelling from senior staff

significantly affects adherence among junior professionals. The impact of role modelling might be critical in the healthcare facility due to the ingrained hierarchical and mentorship characteristics of health services delivery, where the actions of senior staff carry significant weight.

The WHO recommends healthcare professionals to wash their hand during all opportunities obtained at the five critical hand hygiene moment to achieve the highest effect [12, 18]. However studies suggested that hand hygiene will be compromised whenever the hand hygiene opportunity exceeded 30 times per hour. The study highlighted that in most cases the high rate of opportunity which leads to noncompliance is mainly attributed to high work load and understaffing of healthcare providers [60, 61]. Similarly, the finding of this study highlighted that workload and understaffing significantly affected adherence among healthcare providers.

Healthcare facilities are recommended to implement hand hygiene programs with a facility level policy and guidelines adopted from the WHO based on the facility context [12, 49, 50]. These policies and guidelines will help in ensuing the hand hygiene practice is practicable, standardized and measurable to specific contexts. These facility level policy and guidelines were found to be effective in achieving high level of adherence among professionals [62]. However, the finding of this study revealed that there was no facility level policy and guidelines that can support hand hygiene programs. This had led to poor adherence among providers, as there is no standardized protocol to guide and make them accountable for their practice.

The study revealed that the absence of supportive supervision, monitoring, evaluation and feedback mechanisms significantly played a role on the noncompliance. In argument to this finding, studies revealed that direct or indirect monitoring and evaluation coupled with feedback is the best practice to improve hand hygiene adherence among healthcare providers [56, 63, 64]. Moreover, WHO and CDC recommended that effective hand hygiene programs should have monitoring, evaluation and feedback system that provide tangible information on adherence and areas for improvement [2, 8]. In the absence of these systems healthcare providers will likely be ignorant to hand hygiene adherence.

These barriers identified are interconnected and reinforced one another, where behavioural barriers are fuelled by organizational failures and societal factors, while managerial attitude execrate organizational failures. This creates a cyclic form of barriers where each barrier under different theme sustains other.

Limitations and strengths of the study

The explicit inclusion of studies conducted in English language had contributed for missing of findings from Non-English studies. The other limitation of the study emanates from the difference in methodologies followed by the included studies. Specifically, the methods they follow on data collection, study populations, sample size and interpretation of results using theoretical models impacted the synthesis of the study. Furthermore, the study lacks meta-aggregation of results.

One of the studies strength is that the study exclusively included qualitative researches to fully understand the context specific barriers of hand hygiene to answer why barriers persisted despite the interventions. In addition, the study followed the PRISMA and JBI guidelines to include studies and to alleviate the limitations of the study. The search strategy was rigorous and searched all relevant data bases. Furthermore, the study enhanced the transferability of the results by identifying common codes, categories and themes than had not been done so far by other researchers.

Conclusion

The study highlights that the barriers to hand hygiene adherence among healthcare professionals are intertwined and complex, with the main interplaying among behavioural, societal/interpersonal, physical, and organizational barriers. The findings underscore that the intertwined nature of these barriers requires a multifaceted approach which mainly focuses on education and training of professionals and improving access to hand hygiene resources involving the relevant stakeholders to improve hand hygiene adherence among healthcare providers. The study recommended that focusing on the development and implementation of hand hygiene policy and guidelines, professional programs, fostering a supportive workplace culture, and implementing effective resource mobilization and management strategies coupled with supportive supervision, monitoring, evaluation, and feedback is necessary to tackle the problem. Finally, it is recommended that every health facility implement tailored interventions identifying the organization's challenge using this study as background evidence.

Abbreviations

ABHR	Alcohol Based Hand Rub
CDC	American Centers for Disease Control and Prevention
HH	Hand Hygiene
JBI	Joanna Briggs Institute
JMP	Joint Monitoring Program
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis guideline
UNSDGs	United Nations Sustainable Development Goals
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-10924-4.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements
The authors would like to acknowledge the authors of the studies included in the review.

Author contributions
Both AA and AT developed the protocol and were involved in the design, selection of study, data extraction, analysis, and developing of the manuscript. Both authors read and approved the final draft of the manuscript.

Funding
No funding for the study.

Data availability
All the relevant data are included in the study. However, any information required can be obtained from the corresponding author (agziabel@gmail.com).

Declarations

Ethical approval
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 7 February 2025 / Accepted: 4 April 2025
Published online: 10 April 2025

References

1. Glowicz JB, Landon E, Sickbert-Bennett EE, Aiello AE, deKay K, Hoffmann KK, et al. SHEA/IDSA/APIC practice recommendation: strategies to prevent healthcare-associated infections through hand hygiene: 2022 update. Infect Control Hosp Epidemiol. 2023;44(3):355–76.
2. Boyce JM, Pittet D. Guideline for hand hygiene in Health-Care settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. Infect Control Hosp Epidemiol. 2002;23(S12):S3–40.
3. Mathur P. Hand hygiene: back to the basics of infection control. Indian J Med Res. 2011;134(5):611.
4. Mouajou V, Adams K, DeLisle G, Quach C. Hand hygiene compliance in the prevention of hospital-acquired infections: a systematic review. J Hosp Infect. 2022;119:33–48.
5. Health care without avoidable infections. The critical role of infection prevention and control. World Health Organization; 2016.
6. Haenen A, De Greeff S, Voss A, Liefers J, Hulscher M, Huis A. Hand hygiene compliance and its drivers in long-term care facilities; observations and a survey. Antimicrob Resist Infect Control. 2022;11(1):50.
7. Onyedibe KI, Shehu NY, Pires D, Isa SE, Okolo MO, Gomerep SS, et al. Assessment of hand hygiene facilities and staff compliance in a large tertiary health care facility in Northern Nigeria: a cross sectional study. Antimicrob Resist Infect Control. 2020;9(1):30.
8. Lotfinejad N, Peters A, Tartari E, Fankhauser-Rodriguez C, Pires D, Pittet D. Hand hygiene in health care: 20 years of ongoing advances and perspectives. Lancet Infect Dis. 2021;21(8):e209–21.
9. Soboksa NE, Negassa B, Kanno G, Ashuro Z, Gudeta D. Hand hygiene compliance and associated factors among healthcare workers in Ethiopia: A systematic review and meta-analysis. Silva DAS, editor. Adv Prev Med. 2021;2021:1–10.
10. Grayson M, Stewardson A, Russo P, Ryan K, Olsen K, Havers S, et al. Effects of the Australian National hand hygiene initiative after 8 years on infection control practices, health-care worker education, and clinical outcomes: a longitudinal study. Lancet Infect Dis. 2018;18(11):1269–77.
11. WASH in health care. Facilities 2023 data update: special focus on primary health care. World health organization (WHO) and the united nations children's fund (UNICEF). World Health Organization (WHO) and the United Nations Children's Fund (UNICEF); 2024.
12. World Health Organization, WHO Patient Safety. WHO guidelines on hand hygiene in health care. 2009;(WHO/IER/PSP/2009/01):262.
13. Salmon S, McLaws ML. Qualitative findings from focus group discussions on hand hygiene compliance among health care workers in Vietnam. Am J Infect Control. 2015;43(10):1086–91.
14. Mearkle R, Houghton R, Bwonya D, Lindfield R. Barriers to hand hygiene in ophthalmic outpatients in Uganda: a mixed methods approach. J Ophthal Inflamm Infect. 2016;6(1):11.
15. Marjadi B, McLaws ML. Hand hygiene in rural Indonesian healthcare workers: barriers beyond sinks, hand rubs and in-service training. J Hosp Infect. 2010;76(3):256–60.
16. Opara PI, Alex-Hart BA. Hand washing practices amongst medical students in Port Harcourt. Nigeria. 2009;9(1).
17. Boyce JM, Laughman JA, Ader MH, Wagner PT, Parker AE, Arbogast JW. Impact of an automated hand hygiene monitoring system and additional promotional activities on hand hygiene performance rates and healthcare-associated infections. Infect Control Hosp Epidemiol. 2019;40(7):741–7.
18. WHO research agenda. For hand hygiene in health care 2023–2030: summary. World Health Organization; 2023.
19. Lambe KA, Lydon S, Madden C, Vellinga A, Hehir A, Walsh M, et al. Hand hygiene compliance in the ICU: A systematic review. Crit Care Med. 2019;47(9):1251–7.
20. Issa M, Dunne S, Dunne C. Hand hygiene practices for prevention of health care-associated infections associated with admitted infectious patients in the emergency department: a systematic review. Ir J Med Sci. 2023;192(2):871–99.
21. Lockwood C, Munn Z, Porritt K. Qualitative research synthesis: methodological guidance for systematic reviewers utilizing meta-aggregation. Int J Evid Based Healthc. 2015;13(3):179–87.
22. Kaveh MH, Motamed-Jahromi M, Ghahremani L, Nazari M, Faghihi A. Hand hygiene compliance barriers and facilitators in Iranian nurses: A qualitative study. 2022.
23. Ahmadipour M, Dehghan M, Ahmadinejad M, Jabarpour M, Mangolian Shahrbabaki P, Ebrahimi Rigi Z. Barriers to hand hygiene compliance in intensive care units during the COVID-19 pandemic: A qualitative study. Front Public Health. 2022;10:968231.
24. Ghaffari M, Rakhshanderou S, Safari-Moradabadi A, Barkati H. Exploring determinants of hand hygiene among hospital nurses: a qualitative study. BMC Nurs. 2020;19(1):109.
25. McLaws ML, Farahangiz S, Palenik CJ, Askarian M. Iranian healthcare workers' perspective on hand hygiene: A qualitative study. J Infect Public Health. 2015;8(1):72–9.
26. Alshagrawi S, Alhodaithy N. Determinants of hand hygiene compliance among healthcare workers in intensive care units: a qualitative study. BMC Public Health. 2024;24(1):2333.
27. Jeong Hjae, Jo Hsug, Lee Hjean, Kim M, ji, Yoon H. yeon. Factors affecting hand hygiene behavior among health care workers of intensive care units in teaching hospitals in Korea: importance of cultural and situational barriers. Quality Improvement in Health Care. 2015;21(1):36–49.
28. Singh G, Singh R, Burri RR. Barriers to hand hygiene compliance in intensive care units to prevent the spread of healthcare-associated infections. MGMJ. 2023;10(4):667–74.
29. Iswarya P, Ranganath T, George R. Compliance to hand hygiene practices, its barriers, and Influences - a qualitative study among the house surgeons of a tertiary care centre in Bengaluru, Karnataka. RNJPH. 2022;7(3):92–5.
30. Joshi SC, Diwan V, Tamhankar AJ, Joshi R, Shah H, Sharma M, et al. Qualitative study on perceptions of hand hygiene among hospital staff in a rural teaching hospital in India. J Hosp Infect. 2012;80(4):340–4.

31. Ataiyero Y, Dyson J, Graham M. The barriers and facilitators to hand hygiene practices in Nigeria: A qualitative study. Am J Infect Control. 2023;51(3):295–303.
32. Chioma OC, Taib F, Yusuf A. Exploring perceptions of hand hygiene compliance among neonatal and pediatric care unit nurses in Nigeria: A qualitative study. Mal J Med Health Sci. 2023;11(10):50–7.
33. Nwaokenye J, Lakoh S, Morgan J. Perceptions of Nigerian healthcare workers towards hand hygiene: a qualitative study. Pan Afr Med J [Internet]. 2020 [cited 2025 Feb 2];36. Available from: https://www.panafrican-med-journal.com/content/article/36/204/full
34. Mangochi H, Tolhurst R, Simpson V, Kawaza K, Chidziwisano K, Feasey NA, et al. A qualitative study exploring hand hygiene practices in a neonatal unit in Blantyre, Malawi: implications for controlling healthcare-associated infections. Wellcome Open Res. 2023;7:146.
35. Yehouenou CL, Abedinzadeh A, Houngnihin R, Baxerres C, Dossou FM, Simon A, et al. Understanding hand hygiene behavior in a public hospital in Benin using the theoretical domain frameworks: the first step for designing appropriate interventions. Healthcare. 2022;10(10):1924.
36. Douno M, Rocha C, Borchert M, Nabe I, Müller SA. F Mukumbang editor 2023 Qualitative assessment of hand hygiene knowledge, attitudes and practices among healthcare workers prior to the implementation of the WHO hand hygiene improvement strategy at Faranah regional hospital, Guinea. PLOS Glob Public Health 3 2 e0001581.
37. Yilma M, Taye G, Tefera M, Tassew B, Fentie AM, Abebe W. Exploring barriers to and facilitators of infection prevention and control practices in the pediatrics and child health department of Tikur Anbessa specialized hospital, Ethiopia. Antimicrob Resist Infect Control. 2024;13(1):121.
38. Mutshatshi TE, Rasweswe MM. We do not wash hands': barriers to the maintenance of five moments of hand hygiene among learner nurses at a university in Limpopo Province, South Africa. J Water Sanitation Hygiene Dev. 2023;13(11):857–65.
39. McDavid K, Craig C, Ly AN, Bivens N, Morey F, Manzanero R, et al. Perspectives on hand hygiene in Belizean healthcare facilities during the COVID-19 pandemic: a qualitative evaluation with healthcare workers. J Water Sanitation Hygiene Dev. 2024;14(10):905–15.
40. Ay P, Teker AG, Hidiroglu S, Tepe P, Surmen A, Sili U, et al. A qualitative study of hand hygiene compliance among health care workers in intensive care units. J Infect Dev Ctries. 2019;13(02):111–7.
41. Erasmus V, Brouwer W, Van Beeck EF, Oenema A, Daha TJ, Richardus JH, et al. A qualitative exploration of reasons for poor hand hygiene among hospital workers lack of positive role models and of convincing evidence that hand hygiene prevents Cross-Infection. Infect Control Hosp Epidemiol. 2009;30(5):415–9.
42. Lescure D, Haenen A, De Greeff S, Voss A, Huis A, Hulscher M. Exploring determinants of hand hygiene compliance in LTCFs: a qualitative study using flottorps' integrated checklist of determinants of practice. Antimicrob Resist Infect Control. 2021;10(1):14.
43. Von Auer C, Probst M, Schneider-Bachart W, Gaube S. Learning hand hygiene from the champions: Investigating key compliance facilitators among healthcare workers through interviews. Ibrahim MI, editor. PLoS ONE. 2024;19(12):e0315456.
44. Calcagni N, Venier AG, Nasso R, Broc G, Ardichen E, Jarrige B, et al. Barriers and facilitators on hand hygiene and hydro-alcoholic solutions' use: representations of health professionals and prevention perspectives. Infect Prev Pract. 2021;3(4):100169.
45. Squires JE, Linklater S, Grimshaw JM, Graham ID, Sullivan K, Bruce N, et al. Understanding practice: factors that influence physician hand hygiene compliance. Infect Control Hosp Epidemiol. 2014;35(12):1511–20.
46. Jang TH, Wu S, Kirzner D, Moore C, Youssef G, Tong A, et al. Focus group study of hand hygiene practice among healthcare workers in a teaching hospital in Toronto, Canada. Infect Control Hosp Epidemiol. 2010;31(2):144–50.
47. White KM, Jimmieson NL, Obst PL, Graves N, Barnett A, Cockshaw W, et al. Using a theory of planned behaviour framework to explore hand hygiene beliefs at the '5 critical moments' among Australian hospital-based nurses. BMC Health Serv Res. 2015;15(1):59.
48. Kaur R, Razee H, Seale H. Facilitators and barriers around teaching concepts of hand hygiene to undergraduate medical students. J Hosp Infect. 2014;88(1):28–33.
49. WHO/UNICEF. State of the world's hand hygiene A global call to action to make hand hygiene a priority in policy and practice. Geneva: World Health Organization; 2021.
50. WHO. Hand hygiene for all initiative: Improving access and behaviour in health care facilities. 2020.
51. Ataiyero Y, Dyson J, Graham M. Barriers to hand hygiene practices among health care workers in sub-Saharan African countries: A narrative review. Am J Infect Control. 2019;47(5):565–73.
52. Tartari E, Fankhauser C, Masson-Roy S, Márquez-Villarreal H, Fernández Moreno I, Rodriguez Navas ML, et al. Train-the-Trainers in hand hygiene: a standardized approach to guide education in infection prevention and control. Antimicrob Resist Infect Control. 2019;8(1):206.
53. Tantum LK, Gilstad JR, Bolay FK, Horng LM, Simpson AD, Letizia AG, et al. Barriers and opportunities for sustainable hand hygiene interventions in rural Liberian hospitals. IJERPH. 2021;18(16):8588.
54. Sands M, Aunger R. Determinants of hand hygiene compliance among nurses in US hospitals: A formative research study. Chughtai AA, editor. PLoS ONE. 2020;15(4):e0230573.
55. Chatfield SL, DeBois K, Nolan R, Crawford H, Hallam JS. Hand hygiene among healthcare workers: A qualitative meta summary using the GRADE-CERQual process. J Infect Prev. 2017;18(3):104–20.
56. Alvim ALS, Moreira SRBG, Emidio SCD, Carbogim FDC, Magalhães VC. Compliance and barriers to hand hygiene practice among professionals during the COVID-19 pandemic: an integrative review. Rev Epidemiol Control Infect [Internet]. 2023 Jul 31 [cited 2025 Feb 2];13(2). Available from: https://online.unisc.br/seer/index.php/epidemiologia/article/view/18397
57. Midzi N, Mutsaka-Makuvaza MJ, Charimari LS, Mangwiro P, Manengureni T, Mugadza G. Factors affecting hand hygiene practice during the COVID-19 pandemic in the Zimbabwean population: a qualitative study. BMC Infect Dis. 2024;24(1):385.
58. Sealy R, Singh V. The importance of role models in the development of leaders' professional identities. In: James KT, Collins J, editors. Leadership Perspectives [Internet]. London: Palgrave Macmillan UK; 2008 [cited 2025 Feb 3]. pp. 208–22. Available from: http://link.springer.com/https://doi.org/10.1057/9780230584068_15
59. Lambe K, Lydon S, Madden C, McSharry J, Marshall R, Boylan R, et al. Understanding hand hygiene behaviour in the intensive care unit to inform interventions: an interview study. BMC Health Serv Res. 2020;20(1):353.
60. Chang NCN, Schweizer ML, Reisinger HS, Jones M, Chrischilles E, Chorazy M, et al. The impact of workload on hand hygiene compliance: is 100% compliance achievable? Infect Control Hosp Epidemiol. 2022;43(9):1259–61.
61. Scheithauer S, Batzer B, Dangel M, Passweg J, Widmer A. Workload even affects hand hygiene in a highly trained and well-staffed setting: a prospective 365/7/24 observational study. J Hosp Infect. 2017;97(1):11–6.
62. Al Sawafi KM. Examining the importance of hand hygiene policy and patient safety culture on improving healthcare workers'. adherence to hand hygiene practice in critical care settings in the sultanate of Oman: A scoping review. Cureus [Internet]. 2021 Nov 20 [cited 2025 Feb 3]; Available from: https://www.cureus.com/articles/77446-examining-the-importance-of-hand-hygiene-policy-and-patient-safety-culture-on-improving-healthcare-workers-adherence-to-hand-hygiene-practice-in-critical-care-settings-in-the-sultanate-of-oman-a-scoping-review
63. Rosenfeldt Knudsen A, Bo Hansen M, Kjølseth Møller J. Individual hand hygiene improvements and effects on healthcare-associated infections: a long-term follow-up study using an electronic hand hygiene monitoring system. J Hosp Infect. 2023;135:179–85.
64. From-Hansen M, Hansen MB, Hansen R, Sinnerup KM, Emme C. Empowering health care workers with personalized data-driven feedback to boost hand hygiene compliance. Am J Infect Control. 2024;52(1):21–8.

Publisher's note