



Medical Healthcare Student's Knowledge, Attitude, and Practices Regarding Hand Hygiene and Its Relation to Patient Safety – A Global Scoping Review

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Introduction: For more than a century, Hand hygiene (HH) has been known to be the most cost-effective hygienic method to minimize infection transmission and risk in healthcare settings. Even though 50% of healthcare-associated infections (HAIs) can be prevented with proper HH, globally 7 per 100 patients from acute-care hospitals in high-income countries (HIC) and 15 per 100 patients in low and middle-income countries (LMIC) acquire at least one HAI during their hospital stay. Even though medical healthcare students do not have the primary responsibility of providing patient care, it is necessary to train, assess, and monitor HH as their interaction with patients could lead to an increased number of HAIs. By conducting this global scoping review, we aim to summarize the global trends surrounding the knowledge, attitude, and practice (KAP) of medical healthcare students regarding HH, and how it affects patient safety.

Methods: We followed the five stages of Arksey and O'Malley's Scoping Review Methodology. The literature search was done in three databases, specifically, EMBASE, Web of Science, and PubMed. Original published research in credible journals in English conducted between 2012 and 2023 discussing HH amongst medical healthcare students all over the world were included.

Results: Twenty-three studies were included in the final analysis. The overall knowledge of medical students regarding HH was low, with some studies reporting scores as low as 10.1%. However, the attitude towards HH was generally positive, with mean scores ranging from 55% to 93%. Notably, nursing students and females exhibited better attitudes and self-reported HH practices. Furthermore, studies indicated that providing training on HH resulted in an increase in positive attitudes towards and improved practices of HH.

Conclusion: By focusing on training and facilitating improved HH practices, future generations of doctors and nurses can contribute to minimizing HAIs and enhancing patient safety. Standardized approaches and comprehensive data collection are crucial for implementing effective HH interventions.

Keywords: hand sanitizing, hand washing, undergraduate medical students, healthcare students, patient care

Introduction

For more than a century, hand hygiene (HH) has been known to be the most cost-effective hygienic method to minimize infection transmission and risk in healthcare setting.¹ HH is a sanitary, hand cleansing action performed by hand-rubbing and/ or washing using an alcohol-based formulation such alcohol-based sanitizers and antiseptic wipes or detergents such as soap and water or is used as a general term to define any hand cleansing action including alcohol-based hand rub, antimicrobial soap, antiseptic agents, and antiseptic hand wipes.² However, washing hands with soap and water is proven to be the best way to cleanse the hands.³ Even though 50% of hospital associated infections (HAIs) can be prevented with proper HH in acute-care hospitals 7 per 100 patients in high-income countries (HIC) and 15 per 100 patients in low and middle-income countries (LMIC), acquire at least one HAI during their stay.^{4,5}

In 2009, the World Health Organization (WHO) introduced the “Five Moments of HH” with the aim of reducing HAIs by reiterating the best practices in HH and reminding healthcare providers to clean their hands when it mattered the most.⁶ Despite not being involved in healthcare decision-making, medical students play an integral part in patient safety

owing to their interaction with patients during clinical clerkships.⁷ Prior to the previous decade, most studies that evaluated the HH of medical students were based on self-reported data and questionnaires but did not evaluate the Five Moments of HH by WHO, until 2012 where it was studied by Al Kadi and Salati⁸ for the first time.⁹ This generated further research in the area, where different methodologies have been used to evaluate HH practices in medical students.⁹

Though medical students are provided with theoretical classes and materials about HH, studies have highlighted low knowledge and practice levels of HH among this group.¹⁰ Other factors that attributed to this low adherence included limited access to HH materials, low adherence among their senior mentors, and heavy workload.¹¹ Such improper hygiene practices amongst medical students have led to poor patient outcomes and are not a new occurrence. A study done as early as 1846 found a higher number of maternal deaths in maternity units where medical students were placed for their clerkships as compared to those run only by midwives. The study investigated, identified, and reported the risk factors and patients' symptoms suggesting infectious disease processes underlying this finding, possibly because the medical students often visited the maternity ward directly after attending autopsies and were transmitting infectious pathogens due to poor HH practices.¹ Even though medical students do not have the primary responsibility of providing patient care, it is necessary to train, assess, and monitor HH practices as their interaction with patients could lead to an increased number of HAIs.⁷

Since the COVID-19 pandemic, multiple studies have highlighted the importance of HH, not just as a best practice for healthcare providers including medical studies, but as a public health priority.^{12,13} An increased awareness regarding HH has been noticed among medical students and other healthcare providers, which can be attributed to the global campaigns about HH to minimize the transmission of COVID-19 and efforts invested by national healthcare systems in establishing more hand washing stations, with the provision of HH materials.¹³

With multiple approaches to incorporating HH in medical curricula, it is necessary to establish the knowledge levels, current attitudes, and practices across the globe.¹¹ Studies have discussed targeted improvement programs prior to commencing clinical clerkship and patient interaction to improve HH. One of the most recommended initiatives is providing HH training sessions to students at the beginning of clinical clerkships.¹⁴ While such initiatives have the potential to improve HH hence decreasing HAIs, they require regular monitoring and evaluation and must be consistently provided to ensure sustainable outcomes.¹⁴ By conducting this scoping review, we aim to gain a cross-sectional picture of the current global knowledge, attitude, and practices of medical students regarding HH while summarizing targeted interventions and their effectiveness geared at improving HH and reducing HAIs attributed to this cohort.

Methodology

Study Design

A scoping review was chosen to perform this study as it assesses the scope, extent, and reach of the available literature allowing us to identify key themes around this research topic. This scoping review followed the five stages of Arksey and O'Malley's Scoping Review Methodology, namely 1) identifying the research question, 2) identifying relevant studies, 3) selecting studies, 4) charting the data, and 5) summarizing and reporting the data.¹⁵

Step 1: Identifying the Research Question

Following the first step of the Arksey O'Malley's methodology, a research question was developed.¹⁵ The research question aims at answering the following questions:

1. What is the overall KAP in HH for medical healthcare students?
2. What (if any) are the interventions used to increase or assess KAP in HH for medical healthcare students and improve patient safety and what is their effectiveness?

To answer the first and second questions, data including author details, year of publication, country location, research method, study design, participants cohort, sample size, and key results in KAP were summarized. Details regarding types of interventions, their evaluation (if any), and outcomes pertaining to patient safety (if any) were discussed to answer questions 2 and 3.

Step 2: Identifying Relevant Studies

In this step, a set of inclusion and exclusion criteria was employed to focus the scope of the review and extract studies from selected databases. Original published research published in credible journals (in English language) in the past decade (2012–2023) that discussed hand hygiene practices amongst medical healthcare students all over the global were included. Studies in which participants other than medical students were recruited were excluded except when they were compared to medical students. Such participant cohorts include first- and second-year medical students, medical residents, trainees, nursing students, allied health students, and professional healthcare workers.

The team followed an iterative search strategy, whereby more articles were extracted with an expanding search vocabulary. The data search was carried out by four reviewers (JN, ST, SM, HM). The articles were obtained using three bibliographic databases (PubMed, EMBASE, and Web of Science). The team defined key search terms before the extraction to guide narrowing the search results; 1) knowledge/attitude/beliefs/practices 2) hand hygiene/hand sanitizing/hand washing/alcohol-based hand rub/hand rubbing 3) Medical students /undergraduate medical students 4) Patient safety/patient care. MeSH terms included were Attitudes of Health Personnel, HH, Health Knowledge Attitudes and Practice, and Students, Medicine. The search was implemented as: ((knowledge/attitude/beliefs/practices [Title/Abstract]) AND (hand hygiene/hand sanitizing/hand washing/alcohol-based hand rub/hand rubbing [Title/Abstract]) AND (Medical students /undergraduate medical students [Title/Abstract]) AND (Patient safety/patient care [Title/Abstract])). Our search was limited to studies on a population of medical students in English, and supplemented by a manual search for reference lists of identified papers. The PROSPERO database was evaluated using the steps described above (title/abstract section edited) to confirm that there were no systematic reviews or scoping studies on recent or ongoing work that has been completed on the topic. The database search was conducted from November 22, 2022, to June 19, 2023.

Step 3: Selection of Research Results

The studies were imported onto Rayyan software for screening and duplicates were deleted (Figure 1). The abstract screening was conducted by three reviewers (STM, HM, JN), who were blinded by each other's decisions. Conflicts were resolved by a fourth author (ST). Full-text reviews were conducted by three independent reviewers, and the majority vote was considered for the final decision. Full-text articles included in the list were also evaluated independently for eligibility (Figure 1).

To facilitate calibration, the authors met five times during the process, with the first meeting focused on creating a shared understanding of the inclusion and exclusion criteria. The next meetings compared selected studies and discussed differences in understanding. Throughout this process, one author (ST) monitored each meeting to ensure and verify the accuracy of the work and contributed to the analysis of the results.

Step 4: Data Mapping Process

The data extraction and recording process followed the Arksey and O'Malley's "descriptive-analytical" approach for data extraction (1), and the information was summarized from selected articles on an Excel spreadsheet. Author ST developed a data extraction form and STM, HM, and JN performed the data extraction. Data extracted was thoroughly reviewed by all authors, and disagreements were resolved by consensus among the group. The information extracted was recorded as follows:

- Author(s)
- Year of publication
- Study location
- Study populations
- Sample size
- Study Design
- Aims of the study
- Methodology
- Important results
- Intervention type, and comparator (if any)

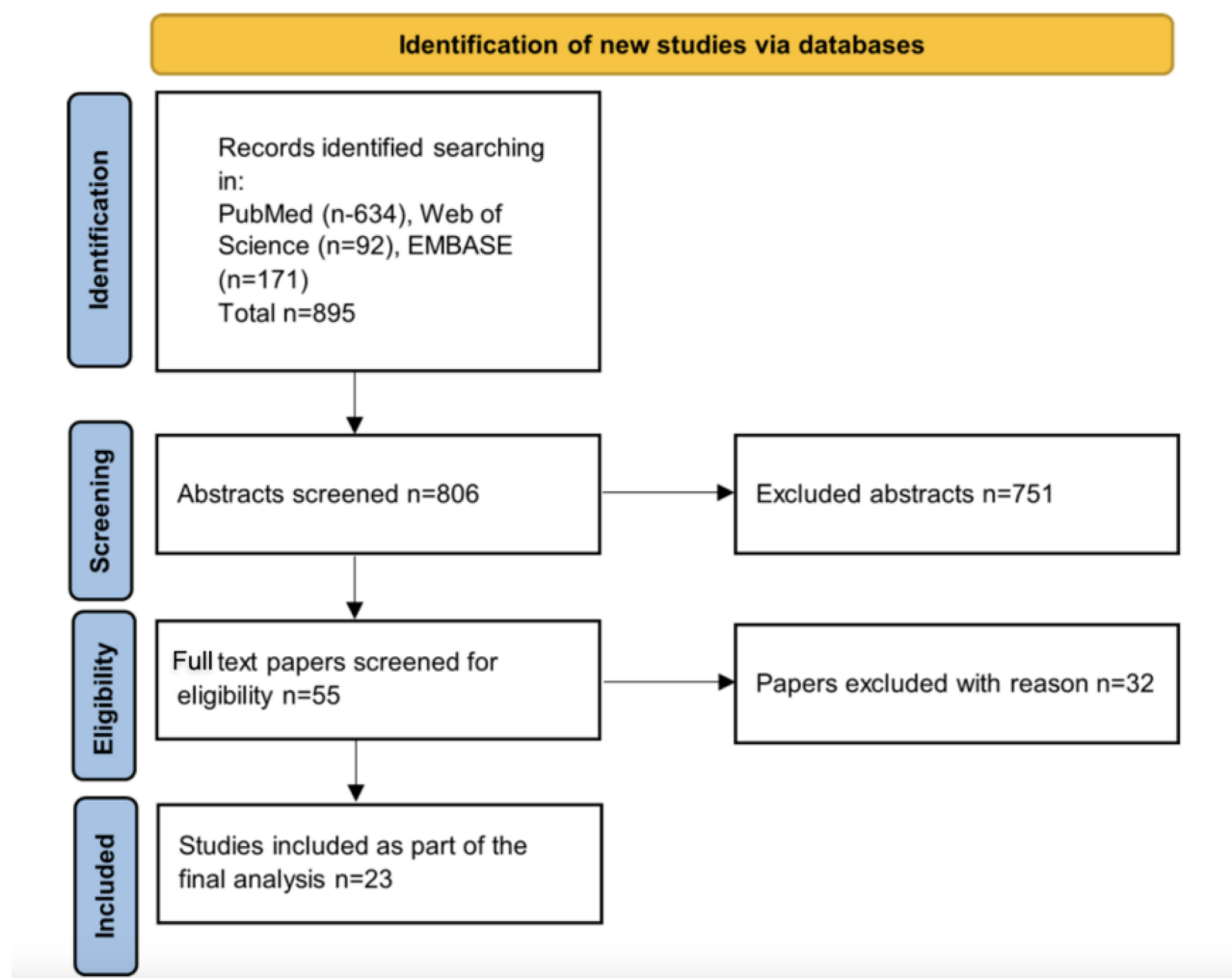


Figure 1 PRISMA Flow diagram of the literature selection procedure.

Notes: Adapted from: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg*. 2010;8(5):336–341. doi: 10.1016/j.ijsu.2010.02.007.¹⁶ Copyright © 2010 The Authors. Copyright © 2010 Surgical Associates Ltd. Published by Elsevier Ltd. All rights reserved. Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/legalcode>).

Step 5: Collating, Summarizing Findings, and Reporting the Results

Descriptive statistics were used to describe the review's characteristics of the data and attention was given to basic numerical analysis of the extent, nature and distribution of the studies included in the review. The authors shared the activity of summarizing the findings and reporting the results by coding the activity to identify the relevance of the article to the research question. Emergent themes were coded separately and discussed between the authors to generate the results.

Results

Overview (Table 1)

The process of identifying relevant articles and abstract screening was rigorous; out of 806 abstracts screened, 751 were excluded. Twenty-three studies were included as part of the final analysis based on the inclusion and exclusion criteria. Most of the studies were conducted in South & East-Asian countries ($n = 15$) of which 7 were from India. The remaining studies were from Europe ($n = 6$), Africa ($n = 1$), and the USA ($n = 1$). Of these, 13 fall under low-middle-income countries (LMICs), and 10 are high-income countries (HICs). Most studies were published prior to 2019, and COVID ($n = 17$) and 6 were published since 2019.

Table 1 Primary Outcome: Knowledge, Attitude, and Practice

Primary Outcome	No and Reference No of Studies Included	Counties Under Study	Study Populations Gender and Medical or Nursing	Methods	Scores (Range, Mean, Median, SD etc)
Knowledge	20	Sri Lanka, Italy, Pakistan, India, China, Poland, South Africa, UK, Saudi Arabia, US, Austria	Medical students, nursing students, residents. Both genders	Cross sectional study (19), interventional study (1)	56.8% to 77%
Attitude	10	Sri Lanka, China, India, UK, US, Saudi Arabia	Medical students, nursing students, interns, residents. Both genders	Cross sectional study (9), interventional study (1)	Positive attitude score range 55% to 93%.
Practice	15	Sri Lanka, Pakistan, Saudi Arabia, India, UK, US, Austria, Ireland, Taiwan	Medical students, nursing students, interns, residents. Both genders	Cross sectional study (13), observational study (1)	

All studies were cross-sectional and all barring 1 were quantitative ($n = 1$ qualitative). Two studies were observational, 2 were comparative (one comparing medical and nursing students, one comparing male and female medical students), and one was an interventional study evaluating the knowledge pre and post-training for HH and the other measured the hand bacterial contamination in medical and nursing students to verify the HH adherence. All studies included medical students as their participant cohort ($n = 13$ included only medical students, $n = 7$ included medical and nursing students, $n = 4$ included medical students, residents, and other groups).

Almost all studies used a self-administered questionnaire as a study tool ($n = 18$) of which 2 studies adapted theirs from the WHO hand hygiene knowledge questionnaire for healthcare workers. One study used this WHO hand hygiene knowledge questionnaire for healthcare workers tool itself, whereas one used a validated scoring sheet to assess the quality of HH amongst medical students. The qualitative study conducted narrative interviews using a semi-structured interview guide. All studies were conducted with the aim of evaluating either the knowledge, attitude, or practice of medical students regarding hand hygiene or a combination of the above ($n = 23$).

Knowledge Regarding Hand Hygiene (Table 2)

Almost all studies evaluated the knowledge regarding HH ($n = 20$). Most studies reported an overall low score regarding the knowledge of HH with scores as low as 10.1%; the individual scores % were reported on administered questionnaires. The studies' participants' mean scores reported regarding their knowledge about hand hygiene ranged from 56.8% to 77%.^{2,17} A total of five studies reported that nursing students had a higher level of knowledge compared to medical students regarding HH.^{2,3,18–20} Two studies also found that female medical students had better knowledge as compared to male students (Jayarajah et al, 2019; Azzam & Ahmad, 2012) while two other studies concluded that there was no significant difference between male and female medical students' knowledge regarding hand hygiene.^{14,21,22} However, there was no study that demonstrated a higher level of knowledge among male medical students compared to female medical students.

Attitude Regarding Hand Hygiene (Table 3)

A total of 10 studies collected data on the attitude regarding HH as compared to knowledge. Most of these reported a positive attitude towards HH with mean scores ranging from 55% to 93%. Ariyaratne et al (2013) and Nair et al (2014) found that nursing students have a better attitude towards hand hygiene; Kanyal & Butola (2020) did not find any significant difference between nursing and medical students regarding their attitude towards hand hygiene.^{2,19} On the other hand, the positive attitude regarding hand hygiene increased after providing training regarding the topic.⁷

Table 2 Summary of the Articles That Discusses Knowledge Regarding Hand Hygiene of Medical Healthcare Students

Study	Country	Study Type	Sample Size/ Participants	Results
(Ariyaratne et al, 2013) ²³	Sri Lanka	Cross-sectional	196 medical students, 93 nursing students	77% of the study population had moderate knowledge regarding HH. 9% of participants had good knowledge regarding HH. Nursing students had significantly better knowledge than medical students.
(Bargellini et al, 2014) ²¹	Italy	Cross-sectional	100 medical students, 100 nursing students	Nursing students had a slightly higher mean score compared to medical students ($p = 0.027$), ranging from 3 to 6 for both groups. The least known item by both groups was "HH requires specific technique and duration of the procedures", as 60% of nursing and 70% of medical students answered incorrectly. A significant difference between the two groups was observed only for the awareness of HH as a tool for self-protection (72% of nursing vs 39% of medical students gave the correct answer; $p < 0.001$). Mean scores were significantly higher in students who applied HH compared to those not applying it, particularly at the ward entry. The lowest scores were measured in those who declared hardly ever/never implementing HH teaching during daily practice.
(Qasmi et al, 2018) ¹¹	Pakistan	Cross-sectional	450 medical students	Moderate HH knowledge (61.8%) was observed among all study respondents. Public university students expressed greater knowledge than students in private and semi-private universities.
(Jayarajah et al, 2019) ¹⁷	Sri Lanka	Cross-sectional	333 medical students	The knowledge of HH was moderate. 3rd and 4th year students scored 67.07% while 5th year students scored 69.5% (p score 0.001). Female students showing better knowledge compared to male medical students
(Nair et al, 2014) ¹³	India	Cross-sectional	110 medical students	12.7% of the participants scored less than 50%. 70.9% of the participants scored between 50–74. It was noticed that good knowledge (≥ 75) on HH was least and accounted for 16.4%. No significant difference was observed between the knowledge of male and female participants (Chi-square value is 3.410, and the p -value is 0.182).
(Huang et al, 2013) ²⁴	China	Cross-sectional	272 medical students	The mean overall score of the students was 52.54 ± 0.45 (mean \pm SE). Students received fairly good scores in HH (77.57 ± 0.77). The year of education ($r = 0.089$, $P = 0.144$, $n = 272$) or internship placement ($r = 0.077$, $P = 0.206$, $n = 272$) had no significant influence on their level of knowledge.
(Tardivo, 2014) ²⁵	Italy	Cross sectional	607 medical students and 854 nursing students	Mean overall score (\pm SD) was 18.1 ± 3.2 . Nursing students (18.6 ± 2.9) obtained a higher overall score than medical students (17.4 ± 3.5) ($p < 0.001$).
(Róžańska et al, 2015) ²⁶	Poland	Cross-sectional	414 Medical students	52.9% of respondents answered correctly about situations where HH is necessary. 6.5% of respondents answered correctly on the choice between hand disinfection and washing per situation. Medical students in more advanced courses had more correct answers in the latter. There was no correlation between the duration of clinical practice or work experience in healthcare and principles of HH knowledge.

(Continued)

Table 2 (Continued).

Study	Country	Study Type	Sample Size/ Participants	Results
(Bouwer et al, 2018) ¹⁸	South Africa	Cross-sectional	107 final year medical students	The average score was 46.8%. Participants who felt that they had basic knowledge of HH had an average score of 47.9%. Participants with a self-reported knowledge level of more than basic but less than advanced had an average score of 44.9% while those who reported advanced knowledge had an average score of 50.8%. Three-quarters felt that their training was sufficient. Only 53.3% knew that the most important way to prevent the spread of infection is good HH. Only 10.5% of the students knew that hands should not be rinsed with water after using alcohol-based sanitizers.
(Kausar et al, 2018) ⁹	India	Cross-sectional	Medical students and nursing students (number not mentioned)	Nursing students were more knowledgeable than medical students.
(Chauhan et al, 2019) ²⁷	India	Interventional	152 medical students	The Knowledge component significantly increased on post training evaluation regarding correct steps of HH (98.68%). Similarly, few other areas which showed improvements (98–100%) after training sessions were knowledge regarding duration of HH, role of hand washing over hand rub for soiled hands and knowledge regarding cross infection and effectiveness of hand rub.
(Kanyal & Kanyal Butola, 2020) ²⁸	India	Cross-sectional	276 medical students	The knowledge regarding HH was found to be average, 186 (67.4%) of the medical students and nurses attending tertiary care hospital.
(Chugh & Baliga, 2013) ⁶	India	Cross-sectional	50 medical students	Following HH, the students of the test group who been given HH instructions prior had a significantly ($p=0.011$) lower mean bacterial colonization on their hands, in contrast to the control group. Moreover, 86.7% of the students from the control group harbored <i>Staphylococcus aureus</i> even after handwashing, whereas only 40% of the test group students had it.
(Cresswell & Monrouxe, 2018) ²⁹	UK	Cross-sectional	13 third-year medical students, 6 junior doctors, and 6 medical educators	Medical students seemed less aware of the evidence behind hygiene behaviors and how it can affect their practice; therefore, they tend to rely on knowledge that is imposed to them.
(Azzam & Ahmad, 2012) ³⁰	Saudi Arabia	Cross-sectional	60 fourth-year medical students (36 males and 24 females)	51.7% of males and 62.7% of females were able to identify positive indications for HH. Only 29% all students were able to identify all five indications of HH (five moments of HH).
(Barroso et al, 2016) ¹⁶	US	Cross-sectional	111 medical students and 169 residents	The knowledge index for medical students and residents were 0.73 and 0.80, respectively.
(Herbert et al, 2013) ³¹	Austria	Cross-sectional	192 third-year medical students	70% judged their knowledge as excellent or good.
(Nath et al, 2022) ¹⁴	India	Cross-sectional	72 third-year medical students, 25 junior doctors, and 36 nurses	34.7% of medical students were graded as having poor knowledge regarding HH. 58.3% of medical students were graded as having poor knowledge regarding HH. 6.9% of medical students were graded as having good knowledge regarding HH.

(Continued)

Table 2 (Continued).

Study	Country	Study Type	Sample Size/ Participants	Results
(Nair et al, 2014) ¹³	India, Raichur	Cross-sectional	98 medical students and 46 nursing students	Only 9% had good knowledge of HH. Nursing students had significantly better knowledge than medical students.
(Hamadah et al, 2015) ¹⁰	Saudi Arabia	Cross-sectional	111 fourth-year medical student	Several aspects of HH practice were assessed, but they were reported individually, per question.
(Ariyaratne et al, 2013) ²³	Sri Lanka	Cross-sectional	196 medical students, 93 nursing students	Medical students had poor attitudes that ranged from 8.1% to 39.3% in different questions that were asked. However, nursing students had significantly ($p < 0.05$) better attitudes (52%) compared to medical students (16%)
(Jayarajah et al, 2019) ¹⁷	Sri Lanka	Cross-sectional	333 medical students	The attitude of HH was moderate. 3rd and 4th year students scored 72.7% while 5th year scored 74.8% (p score 0.17). Female showed better knowledge on HH compared to male students.
(Kausar et al, 2018) ⁹	India	Cross-sectional	Medical students and nursing students (number not mentioned)	Awareness of HH was not satisfactory as the mean range of number of correct answers was 15–17 out of 28 questions, despite 83.3% of the sample having said that they got formal training in HH.
(Chauhan et al, 2019) ²⁷	India	Interventional	152 medical students	It was observed that the majority of students (>90%) had positive attitude but this increased to almost 98–100% after training.
(Huang et al, 2013) ²⁴	China	Cross-sectional	272 medical students	Though 99.6% of students knew the proper hand-washing procedure; they underestimated its importance because only 52.9% of them considered it as the most important preventive measure of infection control. Even though only 23.5% of students knew hand washing with water and soap is the preferred washing method for prevention of <i>Clostridium difficile</i> -associated infections, some other students thought alcohol hand rub or iodine solution was the right choice
(Kanyal & Kanyal Butola, 2020) ²⁸	India	Cross-sectional	276 medical students	190 (68.8%) of the medical students and nurses attending tertiary care hospital had average score for attitude of HH
(Cresswell & Monrouxe, 2018) ²⁹	UK	cross-Sectional	13 medical students, 6 medical educators, and 6 junior doctors	Both medical students and junior doctors reported that their HH behaviors are influenced by medical educators because they tend to copy their educators' behaviors.
(Barroso et al, 2016) ¹⁶	US	Cross-sectional	111 medical students and 169 residents	Scores were reported on a scale from 0 to 1, medical students' and residents' scores regarding attitudes to HH behavior was 0.55 and 0.56, respectively.
(Nair et al, 2014) ¹³	India, Raichur	Cross-sectional	198 medical students and 46 nursing students	52.1% of nursing students had better attitudes regarding HH compared to 12.9% of medical students with good attitude.
(Hamadah et al, 2015) ¹⁰	Saudi Arabia	Cross-sectional	111 fourth year medical students	Several aspects of HH attitude were assessed, but they were reported individually, per question.

Table 3 Summary of the Articles Discussing Attitudes of Medical Healthcare Students Towards Hand Hygiene

Study	Country	Study Type	Sample Size/ Participants	Results
(Ariyaratne et al, 2013) ²³	Sri Lanka	Cross-sectional	196 medical students, 93 nursing students	Medical students had poor attitudes that ranged from 8.1% to 39.3% in different questions that were asked. However, nursing students had significantly ($p < 0.05$) better attitudes (52%) compared to medical students (16%)
(Jayarajah et al, 2019) ¹⁷	Sri Lanka	Cross-sectional	333 medical students	The attitude of HH was moderate. 3 rd and 4 th year students scored 72.7% while 5 th year scored 74.8% (p score 0.17). Female showed better knowledge on HH compared to male students.
(Kausar et al, 2018) ⁹	India	Cross-sectional	Medical students and nursing students (number not mentioned)	Awareness of HH was not satisfactory as the mean range of number of correct answers was 15–17 out of 28 questions, despite 83.3% of the sample having said that they got formal training in HH.
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(Kanyal & Kanyal Butola, 2020) ²⁸	India	Cross-sectional	276 medical students	190 (68.8%) of the medical students and nurses attending tertiary care hospital had average score for attitude of HH
(Cresswell & Monrouxe, 2018) ²⁹	UK	Cross-sectional	13 medical students, 6 medical educators, and 6 junior doctors	Both medical students and junior doctors reported that their HH behaviors are influenced by medical educators because they tend to copy their educators' behaviors.
(Barroso et al, 2016) ¹⁶	US	Cross-sectional	111 medical students and 169 residents	Scores were reported on a scale from 0 to 1, medical students' and residents' scores regarding attitudes to HH behavior was 0.55 and 0.56, respectively.
(Nair et al, 2014) ¹³	India, Raichur	Cross-sectional	198 medical students and 46 nursing students	52.1% of nursing students had better attitudes regarding HH compared to 12.9% of medical students with good attitude.
(Hamadah et al, 2015) ¹⁰	Saudi Arabia	Cross-sectional	111 fourth year medical students	Several aspects of HH attitude were assessed, but they were reported individually, per question.

Practices Regarding Hand Hygiene (Table 4)

Similarly, a total of 15 studies reported individual data regarding the practice of HH. Ariyaratne et al (2013), Nair et al (2014), and Kingston et al (2018) found that nursing students have significantly better practices regarding hand hygiene compared to medical students.^{2,18,29} A study by Kausar et al (2018), on the other hand, did not find any significant difference between nursing and medical students' practices regarding hand hygiene; their practices regarding hand hygiene were comparably poor.¹⁶ According to gender, Jayarajah et al (2019) found that female students have better practice regarding hand hygiene compared to their male counterparts while Azzam & Ahmad (2012) did not find any significant difference between male and female students' practices regarding hand hygiene (16.7% and 17.7%, respectively).^{21,23} One study by Barry et al (2021) reported a combined KAP score where senior medical students (5th year) were found to have higher scores (73%) compared to junior medical students (4th and 3rd year, 72% and 67%, respectively).³²

Table 4 Summary of the Articles Discussing Hand Hygiene Practices Among Medical Healthcare Students and Their Findings

Study	Country	Study Type	Sample Size/ Participants	Results
(Ariyaratne et al, 2013) ²³	Sri Lanka	Cross-sectional	196 medical students, 93 nursing students	5.53% had good practices, while 26.9% had moderate practices and the majority (67%) had poor HH practices. Nursing students had better practices than medical students and the difference was statistically significant (p<0.05)
(Qasmi et al, 2018) ¹¹	Pakistan	Cross-sectional	450 medical students	Self-reported HH compliance was found to be low (56.8%). Superior HH practices were associated with better individual HH attitudes, positive perceived HH attitudes in other healthcare workers (HCWs), and higher HH knowledge scores
(Jayarajah et al, 2019) ¹⁷	Sri Lanka	Cross-sectional	333 medical students	3 rd and 4 th year medical students scored 76.1%. 5th year students scored 77.7% (P value 0.09). Female students showed better practices compared to male medical students.
(Barry et al, 2021) ⁵	Saudi Arabia	Cross-sectional	166 students, 48 interns, 105 residents.	Of 377 hCWs observed, 2.7% completely fulfilled all six steps of alcohol-based hand rubbing (ABHR) technique, 97.35% of HCWs had inadequate hand surface coverage and 69.23% did not achieve sufficient timing. The median scores, out of 12, for 3 rd -, 4 th - and 5 th -year medical students, were 6.4, 7.2 and 7.5, respectively. (P = 0.016). Participants with previous HH training sessions scored higher with mean scores of 7.4 versus 6.3 (P ≤ 0.001).
(Kausar et al, 2018) ⁹	India	Cross-sectional	Medical students and nursing students	Proper practice of HH was not satisfactory as the mean range of number of correct answers was 15–17 out of 28 questions, despite 83.3% of the sample having said that they got formal training in HH.
(Huang et al, 2013) ²⁴	China	Cross-sectional	272 medical students	The mean overall score of the students was 52.54 ± 0.45 (mean ± SE). Students received fairly good scores in HH (77.57 ± 0.77). e.
(Chauhan et al, 2019) ²⁷	India	Interventional	152 medical students	There was a significant increase regarding the practice element of HH on post training evaluation for all the five moments as per WHO recommendation.
(Kanyal & Kanyal Butola, 2020) ²⁸	India	Cross-sectional	276 medical students	173 (62.7%) of the medical students and nurses attending tertiary hospital had average score for practice of HH.
(Cresswell & Monrouxe, 2018) ²⁹	UK	Cross-sectional	13 third-year medical students, 6 junior doctors, 6 medical educators	From participants' self-reports, it was noted that HH practices were not considered as an integral part of patient care; they regarded it as an adjunct to patient care. Medical students report the constraints to proper hygiene practice at the hospital, and they included physical constraints such lack of equipment, social pressures, and time pressures.
(Azzam & Ahmad, 2012) ³⁰	Saudi Arabia	Cross-sectional	60 Fourth-year medical students	When given an opportunity to perform HH, male students performed HH on 16.7% of all occasions, while female students performed HH on 17.7% of all occasions, resulting in a total of 17% compliance.

(Barroso et al, 2016) ¹⁶	US	Cross-sectional	111 medical students and 169 residents	The practice index for medical students and residents are 0.55 and 0.45, respectively.
(Herbert et al, 2013) ³¹	Austria	Cross-sectional	192 third year medical students	49% of study participants reported adherence to HH guidelines.
(Nair et al, 2014) ¹³	India, Raichur	Cross-sectional	98 medical students and 46 nursing students	62.1% of nursing students had better practices regarding HH compared to 19.6% of medical students with good practices.
(Kingston et al, 2018) ²²	Ireland	Cross-sectional	323 medical and nursing students combined	Overall, there was higher compliance to the five moments for HH in nursing students than in medical students.
(Wu et al, 2017) ³³	Taiwan	Prospective, Observational	114 MD students+ 20 physical therapy students + 8 nursing students+ 4 from traditional Chinese medicine and 3 from dentistry	There was a total of 25,379 hH opportunities covertly observed by 93 observers. Overall HH compliance was 32.0%. Healthcare workers had the highest HH compliance for indication 4 (42.6%), and the lowest for indication 5 (21.7%). Overall hand rubbing percentage was high, reaching 83.6%. The HH compliance increased significantly with an increase in the number of indications within 1 hH opportunity ($P < .001$).

Perceptions Around Hand Hygiene

Some studies also inquired about the perceptions surrounding HH and positive factors that could improve the practice amongst medical students ($n = 5$). When asked about their perceived level of knowledge regarding HH, most students believed they had good knowledge or that their training was sufficient (mean range 90.6% to 50.3%). The 2 most common factors associated with better HH were the availability of working gel sanitizer dispensers ($n = 3$), and better HH practices modeled by their superiors ($n = 4$).

Interventions Supporting Improved HH and Patient Safety

One study compared medical students' knowledge, attitude, and practices regarding hand hygiene before and after an intervention. The intervention was to train medical students on hand hygiene using lectures and demonstration scenes followed by hands-on training. There was a significant improvement in students' knowledge regarding hand hygiene where students scored more than 98% on different questions asked in the post-interventional questions.⁶ Regarding the evaluation of attitude towards hand hygiene, the majority of students ($>90\%$) had positive attitude, which increased to 98–100% after training. There was also significant increase regarding the practice element of hand hygiene on post-training evaluation for all the five moments as per WHO recommendation.

Discussion

Main Findings

Our results highlight that despite evidence that HH significantly improves patient outcomes, knowledge, attitude, and practices towards HH amongst medical healthcare students remain low; therefore, we need to train and enable. Most studies are cross-sectional using self-administered questionnaires. Few interventions have been employed to improve these practices. Nursing students seem to have better outcomes with regard to HH than medical students. The same is found for female medical students. Lastly, there is a dearth of qualitative evidence that explains the reasons and barriers to HH among this cohort.

Comparison with Existing Literature

The WHO questionnaire is the most standard tool; however, only a few studies have used the tool, making comparison more challenging. Most studies have employed a self-administered questionnaire and the data collected has not been extrapolated to patient safety outcomes. Rather than developing another standardized evaluation method, researchers can be urged to use the WHO tool. Outcome measures can also be expanded to include patient safety outcomes so that the direct impact HH practices have on patient care could be quantified.

Nursing students have been found to have better HH knowledge, attitudes, and practices by some studies. The same is observed to be true for senior nurses and providers.^{2–5} Studies have found nurses to be intrinsically motivated and adherent to HH practices, whereas one study reports that physicians may be “defiant” to HH or forgetful in other contexts.^{2–5} Our review also indicates that female students may have better HH practices than males. This finding is consistent with other epidemiological and gender-based studies that analyze HH practices for senior physicians, nurses, and other healthcare providers.^{6,7,9} Overall, this indicates that individual characteristics could play a role in HH and HAIs and warrants comparative exploration between these cohorts.

Knowledge

Given the burden of transmittable diseases, HH remains one of the most important aspects of prevention among healthcare providers. Unfortunately, the majority of the studies we evaluated in our study highlighted low to moderate knowledge, on such a vital component. This resonates with findings from Zakeri H et al, which revealed more than 60% of healthcare workers had moderate HH knowledge with only 10.6% having good knowledge.³⁴ This consistency in results underlines the persistent knowledge gap that exists within the healthcare community regarding HH. However, it is essential to acknowledge that different studies we evaluated had different methods of evaluating and defining good knowledge ranging from a score of more than 75% being considered to be good to analysis of different factors positively associated with self-reported good knowledge in qualitative studies. Receiving HH training was reported to be among the factors that contributed to high knowledge. This differs from other studies that found no statistical differences in knowledge between participants who received prior HH knowledge and those who did not.^{34,35}

Attitude

The students' attitude regarding HH was defined as their behavioral and intellectual tendencies towards HH practices at the hospital. Overall, the studies have shown that medical students have an overall poor attitude towards HH than their nursing students' counterparts (Nair et al, 2014). Ariyaratne et al (2013) tested healthcare students on several topics relevant to HH and found that medical students had poor attitudes that ranged from 8.1% to 39.3%, which is lower than the nurse students' scores. However, Chauhan et al (2019)²⁷ and Hamadah et al (2015) had a different finding; the majority of the students (90%) had a positive attitude towards HH. Moreover, their attitude improved after a training program on HH, demonstrating the role of education and training on HH and, therefore, patients' safety. The year of study also affected the overall attitudes of medical students; the more advanced a student was in their medical training, the better the attitude. For instance, fourth-year medical students had a better attitude toward HH than their junior colleagues in the third year. Therefore, training, program, and year of study were good predictors of attitude towards HH. Other predictors include students' experience at the hospital (Barroso et al, 2016). Having a "role model" or attending physicians who regularly practice HH at the hospital had a positive influence on medical students and other healthcare students such as nurses (Cresswell & Monrouxe, 2018). Hamadah et al (2015) study also elaborates on the influence of good living examples on students' attitudes towards HH. Moreover, learning in an environment conducive of the practice of HH positively influences the students' attitude towards HH. Such an environment contains gel dispensers, role models, and other reminders of HH. Interestingly, knowledge regarding HH is not a good predictor of students' attitudes toward HH. For instance, residents and medical students had comparable attitudes towards HH even though their level of knowledge and compliance were different. This underpins the effectiveness of hands-on practices as a method of training healthcare workers. Unfortunately, though a good example instills a good attitude toward HH, the student's attitude toward hierarchy has a significant negative impact on HH advocacy (Barroso et al, 2016). Therefore, healthcare workers should be aware of their students' perception of the difference in the hierarchy and how it affects incidence reports, advocacy, and interaction at the hospital. Finally, Cresswell & Monrouxe (2018) found that medical students did not consider HH to be integral to patient care and were less prioritized. It demonstrates gaps in their understanding regarding the relevance and need for HH in patients. Moreover, it calls for a conscious shift in attitude because some students perceive HH as added unnecessary work or omit it due to unseen direct benefits of HH.

Practices

Similarly, to the knowledge and attitude of healthcare students towards HH, their practices trends towards average. In most studies, the HH practices among healthcare students were interpreted as a percentage of the moments of HH where healthcare students practiced HH. In other words, this is the compliance rate of healthcare students. For instance, Ariyaratne et al (2013)²³ found that, among 259 medical and nursing students, only 5.53% had good HH practices. These findings resonate with the studies by Barry et al (2012), Kanyal and Butola (2020), Azzam and Ahmad (2012), Herbert et al (2013),³¹ and Wu et al (2017),³³ who found that there was an overall unsatisfactory HH practices among healthcare students. Fortunately, some studies highlighted factors that reinforce positive HH practices, and they included role models, attitude towards HH, and prior HH training. Though Qasmi et al (2018) study results highlight an underlying gap in HH practices among healthcare students, they draw an association between good HH practices with students who have a positive attitude towards HH and those who have witnessed positive HH practices in other health workers. This association reinforces the importance of a positive environment in mediating the compliance of HH. On the other hand, a negative environment or negative social pressures were reported as a constraint to proper HH practices among healthcare students (Cresswell & Monrouxe, 2018). Lack of equipment and time pressures were also reported as major constraints to proper HH practices. Other factors that were reported to affect HH compliance include gender, year of study, academic program, and prior HH training. Better HH practices were reported among nursing students compared to medical students, and the difference was statistically significant (Nair et al, 2014). Unfortunately, despite better HH practices among female students, the overall HH practices among students remain inadequate (Azzam & Ahmad, 2012). Additionally, Chauhan et al (2019)²⁷ reported better HH practices among healthcare students after the training. This reinforces the importance of training programs in potentially improving HH practices in healthcare settings. Finally, a positive attitude towards HH was reported among factors that favor good HH practices (Qasmi et al, 2018).¹¹ This partly explains the findings by Cresswell and Monrouxe (2018) who found that students did not consider HH practices as an integral component of patient care. A shift in perspective would shift healthcare students' attitudes toward HH practices during patient care.

Strengths and Limitations

Qualitative evidence could help guide such research in understanding the motivations, barriers, and challenges certain groups may face in a hospital setting. Some studies have reported recommendations offered by the participant groups. These include having working alcohol-based dispensers and observing good HH practices among senior healthcare providers. Similar findings have been reported by other studies that emphasize the importance of having good role models to improve adherence to HH amongst medical students.^{10–13} With an overall lower rate of knowledge and dearth of interventions geared at improving HH amongst medical students, such evidence could help guide the creation of future programs and policies that are inclusive of the unique challenges this cohort faces.

This was a comprehensive scoping review collecting global data on this important topic. Most of the studies included in this review are quantitative, have a large sample size, and measure similar outcomes. With representation from most continents, the review produces a global picture of the recent HH knowledge, attitude, and practices amongst medical healthcare students. Lack of standardized definitions for terminology such as “attitudes”, and “practices” make comparisons between studies challenging and is a limitation of the study. Standardized tools such as the WHO questionnaire, while available, have not been incorporated by most studies. Further given the scope of this paper, quality assessment of the individual studies has not been included. A lack of interventional and prospective studies also limits this review’s ability to generate conclusive recommendations for improving HH practices.

Conclusion

This review has demonstrated that knowledge and practices of hand hygiene among healthcare students are low, but attitudes towards hand hygiene are largely positive which presents an opportunity to train and facilitate high-quality hand hygiene practices among future generations and doctors and nurses. While much research has been done around this topic, a focused collection of evidence using standardized tools to implement best practices amongst medical healthcare students is essential to improve HH outcomes globally.

Disclosure

The authors report no conflicts of interest in this work.

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