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Major Article

Guiding hand hygiene interventions among future healthcare workers: implications of knowledge, attitudes, and social influences

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Background: Medical students in their clinical years play an important role in healthcare delivery, yet poor levels of hand hygiene (HH) compliance in this population raise the risk for propagating nosocomial infections. To date, there has been a lack of dedicated interventions showing sustainable improvements in HH in this population.

Methods: A multicenter, cross-sectional study was conducted among 450 medical students in their clinical years (third to fifth years). A self-administered, pre-validated questionnaire based on the World Health Organization's "Knowledge" and "Perception" questionnaires was used to explore HH knowledge, attitudes, practices, and desired interventions.

Results: Self-reported HH compliance was found to be low (56.8%), and 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. Superior HH practices were associated with better individual HH attitudes, positive perceived HH attitudes in other healthcare workers (HCWs), and higher HH knowledge scores. The highest-rated interventions for improving HH compliance included role-modeling by HCWs, display of "clear HH instructions," and "ensuring availability of hand sanitizers."

Conclusion: Our results call for a multifaceted approach to improve HH compliance among medical students, by ensuring adequate HH supplies/hand sanitizers, providing HH training in curricula, and effecting a cultural change mediated by professional modeling and open communication.

Hand hygiene (HH) compliance among healthcare workers (HCWs) (including doctors, nurses, and clerkship/clinical medical students) has been found to be consistently poor.[1-3] A study by the Society for Healthcare Epidemiology of America[4] revealed that only 31% of HCWs employed proper HH techniques. This is potentially dangerous and can result in prolonged hospital stays and concomitant super infections transmitted by direct physical contact (i.e., shaking hands or delivering medications), all of which contribute to the morbidity and mortality of 1 in every 25 hospitalized patients per day.[5]

Medical students in their clinical years play an integral role in the delivery of patient care in tertiary-care, university-affiliated hospitals.[6] This role calls on them to adhere to the precautions and procedures of optimal HH, just as it is required of medical professionals. According to U.S. Centers for Disease Control and Prevention, performance of effective HH is the most effective preventive measure for reducing the rates of HCW-associated infections.[7]

As observed during Objective Structured Clinical Examinations (OSCEs) in Saudi Arabia, HH compliance among medical students was found to be only 17%.[8] Among medical students surveyed in Nigeria, only 9.5% could correctly recall the steps in proper HH.[9] Similarly, dismal HH trends among medical students have been documented in various settings worldwide.[6,10,11] Factors identified as contributing to poor HH compliance in this population include a lack of HH knowledge, misconceptions regarding HH, and poor HH practices by role models.[12] These issues are further compounded by the limited emphasis placed on effective infection control practices in an already full medical school curriculum.[13]

In Pakistan, the healthcare and medical education system is unique in that it is broadly divided into public/government setups

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and private setups. Public universities, and attached hospitals, receive government funding and provide subsidized medical education for local students; as such, admissions tend to be more competitive. In contrast, private universities, and attached hospitals, cater primarily to students from high-income backgrounds and can afford greater hospital resources. The differing administrative culture, funding capacity, and nature of the student body enrolled in each of these institute types may have significant implications for ongoing HH trends and the scope of future interventions aimed at the population of interest.

The aim of this study was to assess and compare the prevailing knowledge and practices of medical students in their clinical years (third to fifth year) who were enrolled in public/government, semi-private, and private universities, regarding the international 11-step World Health Organization (WHO)-recommended HH guidelines.[14] This study further aimed to evaluate the self-reported perceptions of students and other HCWs regarding the importance of performing optimal HH, in situations where it is deemed necessary by WHO guidelines.[14] The WHO guidelines provide both a thorough review of evidence on HH in healthcare and specific recommendations to improve infection control practices in various settings. Finally, this study explored the possible interventions that may increase HH compliance in this population.

METHODS

This cross-sectional study spanning 6 months was conducted among medical students enrolled in 3 different medical universities in Karachi, Pakistan, with each university corresponding to a different sector: public, private, or semi-private. A sample size of 384 respondents was calculated under a 95% confidence interval using Open Epi, however, we opted for a total sample of 450 medical students. The study received approval from the Ethical Review Committee of Baqai Medical University.

The inclusion criteria maintained during this study were as follows: medical students in their clinical years of study (years three to five) who were enrolled in 1 of 3 selected medical colleges. Any students in their preclinical years (years one to two) or those not enrolled in a 5-year Bachelor of Medicine, Bachelor of Surgery (MBBS) program were excluded. The target population was approached using nonprobability, judgmental/purposive sampling, whereby an equal proportion of medical students was sampled from each year of study and across each institution. Study participants were provided a description of the study objectives and methods, and written informed consent was obtained. Participation was voluntary, and respondents were ensured that the information provided was confidential and anonymous. The study instrument employed was a self-administered, English-language questionnaire, developed from the prevalidated WHO "Knowledge" and "Perception" questionnaires.[15] The devised questionnaires were adapted to ensure applicability to the target population and underwent thorough vetting by senior faculty members at Baqai Medical University. The approved questionnaires were piloted on a 5% sample and refined accordingly.

Questionnaire

The final questionnaire comprised 3 sections. The first section recorded basic demographic information such as age, sex, and year of study. The second section was adapted from the WHO "Knowledge" questionnaire and assessed respondents' knowledge regarding HH indications and procedures using multiple-choice questions. Questions assessing the use of alcohol-based hand rubs were not included in the WHO "Knowledge" Questionnaire, since hand rubs are not routinely available at points of care in our settings; thus, such questions would have limited applicability to our population of interest. The final section, adapted from the WHO "Perception" questionnaire, evaluated respondents' perceptions regarding the importance attached to HH performance by other HCWs, to HH practices, and to interventions aimed at improving HH adherence. Responses to this section were assessed using a condensed 3-point Likert scale. Questions beyond the scope of medical students, such as those evaluating institutional policies on HH, were not included in this section.

Statistical analysis

Data were analyzed using Statistical Package for Social Sciences, version 20.0, software. Categorical variables were expressed using frequencies and percentages. Continuous variables were presented as means and standard deviations (SDs). A knowledge score, derived from responses to the HH "Knowledge" questionnaire, was calculated to reflect a participant's overall knowledge regarding HH and was scored out of 18: each correct answer received a score of 1, and incorrectly answered questions received a score of 0. The chi-squared test with a 95% confidence interval was used to compare categorical variables. Differences in continuous variables, such as knowledge scores, with respect to categorical variables were assessed using independent t-tests or the analysis of variance test, as appropriate. A 5% level of significance was used throughout the study. Responses to desired HH interventions were coded as 1 = not effective, 2 = somewhat effective, and 3 = very effective and used to calculate the mean response for each intervention, which was illustrated graphically using Microsoft Excel.

RESULTS

Our response rate was 96%, as 15 of 450 questionnaires were left unfilled. Three-quarters of the participants (74.8%) were women. Participants were from the third year (n = 139), fourth year (n = 150), and fifth year (n = 145) of medical training. They were from public (n = 133), semi-private (n = 150), and private (n = 151) medical colleges, respectively (Table 1). The mean age of study participants was 22.0 ± 1.22 years. The mean age for men and women was 22.5 ± 1.32 years and 21.9 ± 1.14 years, respectively.

A knowledge score was calculated for each participant, with a maximum score of 18. The mean knowledge score for all participants was 11.1 ± 2.36. Mean knowledge scores did not differ significantly by sex or year of study. Analysis of variance showed a significant association between institute of study and knowledge scores, at the $P < .05$ level ($F[2,431] = 4.98$; $P = .007$). Post-hoc comparisons using Tukey's b-test showed the mean knowledge score for public university students (m = 11.7, SD = 2.19) was significantly higher than scores for students in semi-private (m = 11.0, SD = 2.42) and private universities (m = 10.9, SD = 2.22). However,

Table 1
Demographic data of study participants

Sex, n (%)	
Men	109 (25.2)
Women	323 (74.8)
Institute, n (%)	
Public Medical College	133 (30.6)
Private Medical College	151 (34.8)
Semi-Private Medical College	150 (34.6)
Year of Study, n (%)	
3rd Year	139 (32.0)
4th Year	150 (34.6)
5th Year	145 (33.4)

Table 2
Distribution of responses to WHO HH "Perception" questionnaire

Perception Questions		Respondent Rating		
		Low n (%)	Moderate n (%)	High n (%)
Individual HH Attitudes	How would you rate the impact of an HCAI on a patient's clinical outcome?	51 (11.8)	113 (26.0)	270 (62.2)
	How would you rate the effectiveness of HH in preventing HCAIs?	43 (9.9)	70 (16.1)	321 (74.0)
Individual HH efforts	How would you rate the effort required by you to perform HH when caring for patients?	73 (16.8)	101 (23.3)	260 (59.9)
Individual HH Practices	Rate the likelihood that you perform HH (either by handwashing or hand rubbing) in the required situations.	81 (18.7)	106 (24.5)	246 (56.8)
Perceived HH practices of other HCWs	Rate the likelihood that HCWs in your hospital perform HH (either by handwashing or hand rubbing) in the required situations.	197 (45.4)	104 (24.0)	133 (30.6)
Perceived "others" HH Attitudes	Rate the importance your head of department attaches to the fact that you perform optimal HH.	134 (30.9)	85 (19.6)	215 (49.5)
	Rate the importance your colleagues attach to the fact that you perform optimal HH.	100 (23.0)	104(24.0)	230 (53.0)
	Rate the importance that patients attach to the fact that you perform optimal HH.	159 (36.6)	89 (20.6)	185 (42.8)

WHO: World Health Organization, HCAI: healthcare-associated infection, HH: hand hygiene, HCW: healthcare worker.

no significant difference in mean knowledge scores was noted between semi-private and private university students.

The HH practices of individual respondents and the perceived practices of other HCWs were assessed by self-report. The perceived likelihood of other HCWs performing HH was reported to be "low" by 45.4% of respondents, with only 30.6% claiming a "high" likelihood of the same. In contrast, most (56.8%) respondents rated their own likelihood of performing HH as "high."

A chi-squared test of independence, performed under a 95% confidence interval, showed no significant trend in reported HH practices of respondents with respect to sex or year of study. However, a slight trend toward better HH adherence ($\chi^2[4] = 8.61$; $P = .072$) was found among respondents in private colleges, with 63.6% of private medical college students reporting a "high" level of adherence toward HH; the same was reported by 54.5% and 52.0% of students in public and semi-private medical colleges, respectively.

Responses to questions on Individual HH Attitudes showed encouraging results, as only a minority attached "low" importance to the effect of healthcare-associated infections (HCAIs) (11.8%) and the preventive role of HH (9.9%), as shown in Table 2. Chi-squared tests of independence, conducted under a 95% confidence interval, showed responses to these 2 questions did not vary by year of study; however, women were more likely to attach greater importance to the effect of HCAIs than men ($\chi^2[2] = 10.3$; $P = .006$).

Analysis of variance showed a significant association between individual HH attitudes, as expressed by the 2 perception questions (Table 2), and HH knowledge scores at the $P < .05$ level ($F[2,431] = 4.70$; $P = .01$) ($F[2,431] = 18.1$, $P = .00$). In each case, post-hoc analysis using Tukey's b-test showed that the mean knowledge score was significantly higher in students who attached a "high" importance to the clinical effect of HCAIs ($m = 11.4$, $SD = 2.22$) and the preventive role of HH ($m = 11.5$, $SD = 2.20$), respectively.

Moreover, public university students expressed the most positive HH attitudes with respect to the clinical effect of HCAIs ($\chi^2[4] = 19.4$; $P = .001$) and the preventive role of HH ($\chi^2[4] = 14.9$; $P = .005$).

The performance of HH was considered a demanding task by our respondents, as most rated the effort required to perform HH as "moderate" (23.3%) or "high" (59.9%) (Table 2). The reported individual HH efforts did not vary by sex, year of study, or institute of study. However, those who rated the effort required in HH as "high" were more likely to report superior HH practices among themselves ($\chi^2[4] = 21.4$; $P = .00$) and other HCWs ($\chi^2[4] = 24.6$; $P = .00$).

The perceived HH attitudes of other individuals, such as heads of departments, colleagues, and patients, are expressed in Table 2. A uniform response was observed, irrespective of sex, year of study, or institute of study; which showed a modest importance attached to HH performance by each group, with patients attaching the least importance to HH performance (36.6%).

Our analysis showed that positive individual HH attitudes, positive perceived HH attitudes in "others," and superior knowledge scores were predictive of greater HH adherence in our respondents ($P < .05$ in each case). However, only positive perceived HH attitudes in "others" were predictive of greater perceived HH adherence in other HCWs ($P = .00$).

Responses to proposed interventions aimed at improving HH are summarized in Figure 1. The interventions considered most effective by our respondents included the need for each HCW to perform HH "as a role model for others" (2.60), making "clear hand hygiene instructions visible to HCWs" (2.57), and "ensuring availability of hand sanitizers" (2.54). The intervention considered least effective was the provision of feedback on HH compliance by HCWs (2.29).

No variations in desired HH interventions were noted with respect to year of study, except for a decreased preference for "patients invited to remind HCWs to perform HH" among senior medical students ($\chi^2[4] = 9.75$; $P = .045$) (Table 3). Some institution-specific variations in desired HH interventions were observed (Table 3). The need to ensure availability of hand sanitizers was most strongly felt by public university students ($\chi^2[4] = 11.6$; $P = .021$). The need for "provision of HH training" ($\chi^2[4] = 16.5$; $P = .002$) and for providing HCWs with "feedback on HH compliance" ($\chi^2[4] = 20.3$; $P = .00$) were also most strongly felt by public university students, followed by those in private and semi-private universities, as shown in Table 3. The display of "clear HH instructions" ($\chi^2[4] = 18.8$; $P = .001$) was most strongly desired by semi-private university students, followed by those in public and private universities, respectively.

DISCUSSION

The results of this multicenter study conducted among medical students in their clinical years show that self-reported HH compliance is uniformly low irrespective of sex, year of study, and institute of study. Women comprised approximately three-quarters of our sample, which reflects the prevalence of female medical students in Pakistani medical colleges. Only 56.8% of students in our sample reported a "high" likelihood of performing HH when indicated, whereas the same was reported for only 30.6% of other HCWs. Given the possibility of over-estimation of self-reported compliance rates, actual adherence may be worse.[16]

Although many studies have explored multidisciplinary interventions aimed at improving HH practices among HCWs[1,17], only a few have addressed the persistently inadequate compliance among medical students.[12,18] Given the unique role played by medical

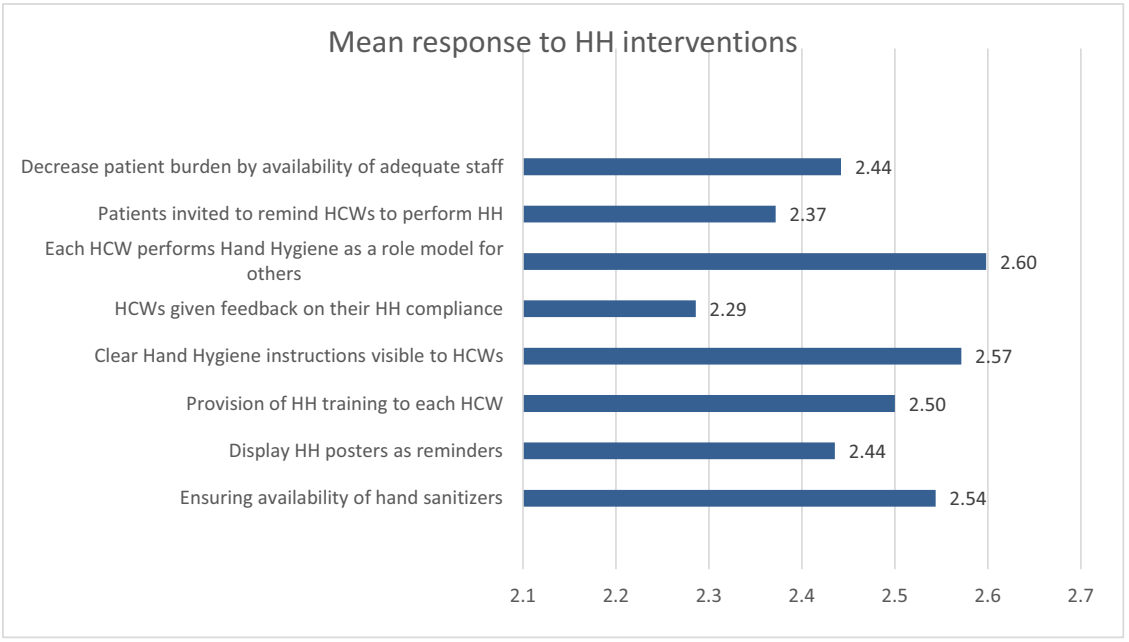

Fig 1. Mean response to proposed hand hygiene interventions. (Responses are coded as 1 = not effective, 2 = somewhat effective, and 3 = very effective.)

Table 3
Mean (standard deviation) of responses to proposed interventions for hand hygiene adherence, stratified by year of study and institute. (Responses are coded as 1 = not effective, 2 = somewhat effective, and 3 = very effective.)

	Year 3	Year 4	Year 5	Public University	Private University	Semi-Private University
Perception Question	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Ensuring availability of hand sanitizers	2.58 (0.780)	2.56 (0.764)	2.50 (0.756)	2.68 (0.622)	2.50 (0.791)	2.47 (0.841)
Display HH posters as reminders	2.45 (0.791)	2.44 (0.728)	2.42 (0.779)	2.47 (0.713)	2.38 (0.773)	2.46 (0.800)
Provision of HH training to each HCW	2.50 (0.802)	2.58 (0.735)	2.43 (0.771)	2.65 (0.652)	2.50 (0.738)	2.37 (0.871)
Clear HH instructions visible to HCWs	2.65 (0.678)	2.56 (0.719)	2.50 (0.737)	2.64 (0.667)	2.39 (0.783)	2.69 (0.645)
HCWs given feedback on their HH compliance	2.29 (0.827)	2.30 (0.817)	2.27 (0.860)	2.44 (0.742)	2.31 (0.802)	2.13 (0.914)
Each HCW performs HH as a role model for others	2.65 (0.635)	2.62 (0.631)	2.53 (0.679)	2.68 (0.579)	2.52 (0.720)	2.59 (0.626)
Patients invited to remind HCWs to perform HH	2.45 (0.809)	2.38 (0.817)	2.29 (0.792)	2.38 (0.790)	2.35 (0.768)	2.37 (0.862)
Decrease patient burden by availability of adequate staff	2.46 (0.754)	2.42 (0.755)	2.44 (0.782)	2.39 (0.734)	2.47 (0.755)	2.43 (0.797)

HH: hand hygiene, HCW: healthcare worker.

students as both learners and prospective healthcare providers in the clinical setting, future interventions should be tailored to the specific needs and expectations of this population. Such interventions carry far-reaching consequences, since faulty HH practices adopted during medical school may translate into poor HH practices among future HCWs.[7] Our study aimed to investigate current trends in HH awareness and practices among Pakistani medical students in public, semi-private, and private universities. In doing so, we aimed to identify determinants of superior HH practices and promising avenues for future interventions.

The respondents in our study were found to have moderate knowledge regarding HH (61.7%), as assessed using the modified WHO HH questionnaire. Furthermore, we observed that public university students demonstrated superior HH knowledge, compared to students in semi-private and private universities. In Pakistan, public university admissions are among the most competitive; as such, selected students tend to be highly driven and achievement-oriented individuals. Our findings therefore reinforce the observations of Schüttpelz-Brauns et al., which found that achievement orientation of students was associated with greater HH compliance during OSCEs.[19] A greater uptake of HH awareness and adherence may be accomplished by integrating HH into scenario-based learning (SBL) activities during the preclinical years and by performing regular assessments. OSCEs should also be revised to include HH checklists, thus ensuring students retain HH training throughout their clinical years.

Adherence to HH practices has been shown to be a multifaceted issue that is influenced by different aspects of human behavior.[17] One key domain influencing compliance is the role played by other HCWs, such as colleagues and heads of departments. Our respondents found the concept of "role-modeling" for HH adherence to be the most effective intervention. Moreover, we observed that a respondent's perceptions of "other" HCWs' attitudes toward HH to be predictive of superior HH compliance. Our findings therefore reinforce the role of social influences in this setting[20] and are strongly supportive of a cultural change driven by consistent professional modeling and open communication. This will inevitably require the adoption of HH as an institutional policy. However, on a short-term basis, clinical mentors may be directed to attend HH seminars/courses aimed at developing an awareness of their position as role models, imparting innovative and interactive models for HH teaching, and understanding subconscious cues that may shape students' understanding of the importance attached to HH. Incorporation of such seminars/courses into mandated continuing medical education activities would incentivize attendance and capture the interest of all healthcare providers. Cultural and religious constraints to the

use of alcohol-based hand rubs must also be adequately addressed, alongside development of feasible alternatives as necessary. Finally, safe and effective outlets for students to reflect and critically evaluate the HH practices of their seniors must be provided, as studies have shown that students are generally fearful of questioning those higher up in the hospital hierarchy.[20] This may be achieved by conducting anonymous surveys, preferably electronically, at an administrative level and investigating deviations from hospital policies as reported.

In our study, positive individual HH attitudes, denoting an internalization of the protective role of HH in preventing HCAIs, were found to be positively associated with an individual's HH compliance. We observed that women attached significantly more importance to the clinical effect of HCAIs than men. Variable sex-specific differences in HH compliance have been prominently reported among nursing students, with women expressing superior practices in a Spanish setting and men outperforming women in a Saudi cohort.[21] In the latter case, the authors attributed their findings to a male-dominated society where women are less likely to pursue actions not strictly in line with the prevalent social/traditional norms. In a broad cohort of HCWs (including physicians, nurses, and nursing assistants), Sax et al. found female sex to be predictive of superior HH practices and added that sex may partly confound reports of nurses outperforming physicians (who are predominantly men) in the performance of HH.[22] However, sex differences in HH compliance and awareness among medical students have been scarcely investigated and thus far have yielded equivocal results.[8,23] In our setting, no significant differences in HH awareness or compliance were observed on the basis of sex. Further study is needed to elucidate a relationship between sex and HH trends in this population and the scope for interventions based on resulting findings.

A higher self-reported compliance with HH practices was found to be associated with a higher perception of the "effort required" in performing HH. This may be reflective of the fact that most points of care in our setting do not have easy or reliable access to HH supplies, nor is there an organized institutional framework for supporting HH practices. As such, students who endeavor to maintain high levels of compliance are more likely to report a greater "effort required" than noncompliant students. Thus, it is not surprising that respondents rated the need for "provision of hand rubs/hand sanitizers" as the third most effective intervention to be implemented, with a greater demand expressed among respondents in public universities where HH resources may be scarce.[3] However, appropriate resource allocation of HH supplies, such as hand-washing sinks and antiseptic hand rubs, in a resource-limited setting such as ours will require careful administrative management, including adequate waste disposal and the establishment of systems to monitor their application in a cost-effective manner.

In contrast to reports among HCWs, for whom patient load is known to limit HH compliance,[1] we observed that medical students did not strongly rate the need for decreasing patient load. This may be explained by the limited clinical exposure and demands placed on medical students, as compared to senior physicians, thus precluding the need for decreasing patient load. Moreover, this suggests that a high degree of HH compliance among students is realistic, given the lower work load they face.

The final components of a system change to promote HH adherence consist of an evaluation and accountability of HH practices. Surprisingly, respondents in our setting were not enthusiastic about the prospects of this; they rated the concept of "HCWs receiving feedback on HH performance" as the least effective intervention. Such an aversion to further evaluation may be a consequence of an already demanding medical school curriculum. An innovative solution to promoting an atmosphere of evaluation and feedback was suggested by Pan et al. through the recruitment of medical students as covert observers of HH in other HCWs.[24] This must be coupled to a secure and independent administrative channel for reporting deviations from hospital policy. Such an approach has the benefit of providing an inexpensive audit of HH practices in a resource-limited setting and may empower students to become active stakeholders in their hospital's HH policy. An alternative and interesting approach to HH training and audit was proposed by Higgins et al. using automated gaming technology.[25] The authors conducted a quasi-experimental study using an adenosine triphosphate monitoring system, to measure hand washing technique, and an automated training and auditing unit (SureWash, Glanta Ltd., Dublin, Ireland) to provide staff training and education. The use of an interactive "gaming" interface for HH training would have an immediate appeal among young medical students. However, the implementation of such a system would be limited to institutions capable of financing and maintaining it.

LIMITATIONS

Despite our best efforts, this study is subject to limitations arising from its methodological design. The first of these is the use of a nonprobability sampling technique, which is predisposed to selection bias. However, the inclusion criteria applied during judgmental sampling were relatively broad (all medical students in their clinical years who were enrolled in the selected colleges were given equal consideration for inclusion). In addition, to ensure a representative and valid sample, a large sample (up to 50% of enrolled students) was taken from each group. Responses to certain questions, such as those assessing attitudes toward HH, may have been influenced by social desirability bias. Since participants were assured that their responses would remain strictly confidential, we think this bias was minimized. Due to financial and logistical constraints, we opted to investigate self-reported compliance rates as a surrogate for actual compliance. As such, over- or under-estimation of HH compliance was possible. It must be borne in mind, however, that the vast majority of studies investigating HH compliance in this population have used self-reporting. As such, we think that self-reporting allows for a more direct and valid comparison of our findings to those reported in the existing literature. Future studies should investigate HH trends among medical students using direct observation and, in doing so, assess the validity of self-reported HH practices in this subgroup. Longitudinal studies exploring changes in HH practices as students transition into their professional careers are warranted as well.

STRENGTHS

To our knowledge, this is the first large-scale study to investigate HH trends across multiple centers in Pakistan corresponding to 1 of 3 medical university types (public, private, and semi-private). It therefore provides an unmatched, holistic view of the situation in Pakistan. In contrast to previous studies, we did not include students from disciplines outside of medicine, such as nursing or dentistry, thus providing a uniform representation of HH trends in our chosen population.

CONCLUSION AND RECOMMENDATIONS

This study showed that HH awareness and compliance are uniformly low among medical students in public, private, and semi-private universities in Pakistan. Public university students demonstrated greater HH knowledge compared to their counterparts in other institution types. This may be attributed to the higher level of "achievement orientation" among public university students and

indicates that incorporation of HH training in assessment situations (such as SBLs and OSCEs) may improve HH knowledge. Perceived HH attitudes of other HCWs were independently associated with greater HH compliance among our respondents. Therefore, we recommend that hospital-wide HH policies be instituted, alongside training of HCWs to produce conscientious "HH role-models." In our study, women expressed superior HH attitudes in this setting; however, future studies are warranted to investigate the relationship between sex and HH practices.

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