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ORIGINAL RESEARCH

Impact of Educational Intervention for Hand Hygiene on Dental Students' Knowledge, Attitude, and Bacterial Contamination Level on Hands

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ABSTRACT

Aim: The present study aimed to investigate the impact of the educational intervention for hand hygiene (HH) on knowledge, attitude, and mean colony-forming bacterial counts and type of bacteria on hands of undergraduate dental students.

Materials and methods: A total of 86 dental students from different clinical grades were included in the study. They were divided into two groups, group I (55 students) received one-time educational session for HH at the start of the academic year and group II (31 students) received an extra reenforcement session 6 months later. After 2 weeks of reenforcement session, a self-administrated questionnaire was directed to all participants assessing their knowledge and attitude about HH. Fingertip prints of the five fingers of the dominant hand from every participant were pressed onto blood agar plates in triplets at the same clinical session, before and after HH. Bacterial colony-forming units (CFUs) on each plate were recorded and identified microbiologically.

Results: The overall scores of knowledge and attitude showed higher levels in group II than in group I with nonsignificant differences between both groups as regards knowledge and significant differences ($p < 0.05$) as regards attitude. Mean CFUs showed extremely significant differences ($p \leq 0.000$) between 2nd and 3rd counts and between 1st and 2nd counts except for students of group I where the difference was only significant ($p \leq 0.05$). Normal bacterial flora was identified in 94.9% of the plates (92.2% coagulase-negative *Staphylococci* and 2.7% *Micrococcus*). Potentially pathogenic bacteria isolated from the other plates were *Klebsiella pneumonia*, *Pseudomonas* spp., and spore-forming aerobic nonhemolytic *Bacilli.*

Conclusion: Reenforcement session had a positive impact on HH knowledge, attitude, and reduction of bacterial CFUs.

Clinical significance: Continuous education with frequent training sessions is recommended to reinforce HH compliance and reduce cross-contamination.

Keywords: Continuous education, Dental education, Hand hygiene, Handwashing, Infection control.

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INTRODUCTION

Contaminated hands of health care workers (HCWs) constitute the main element in the spread of microorganisms in clinical settings.[1] The microbial flora of the skin, first described in 1938, is either transient or resident microorganisms. Transient flora, which colonize the superficial layers of the skin and easy to be removed by routine hand washing, are usually acquired by HCWs during direct contact with patients or contaminated environmental surfaces and most frequently associated with health care-associated infections. Resident flora, attached to deeper layers of the skin, is not easily removed and less implicated in such infections.[2] Hand hygiene is essential to eliminate transient microflora and decrease resident microflora, even when gloves are worn as a mean of protection as it provides a warm, moist environment to organisms and facilitates their proliferation.[3]

Despite the simplicity of hand washing procedures and periodic updating of infection control guidelines, the compliance with HH and its adherence by health care practitioners is unsatisfactory and could reach as low as 40%.[4,5]

In dental practice, HH is the most important activity accomplished to reduce the risk of transmitting microorganisms from dental HCW to patient because of the ease of contamination of hands by blood, body fluids, and saliva.[2,6] Although published guidelines describe indications for HH, they do not rely on proof of microbiologic contamination acquired during routine patient practice.[7]

Hand washing should have an educational priority, with challenging educational interventions, to expand HH compliance that requires the need for ongoing reinforcement.[8,9] The educational process of health care students since the beginning of their clinical practice is recommended to improve HH compliance.[10]

The effectiveness of educational interventions on infection control knowledge and practices was previously studied by Israr et al[11] on private dental practitioners and by Baharvand et al[12] on dental students using questionnaires. As regards bacterial hand contamination, recent studies examined the bacterial counts on hands of dental students and dental assistants before and after HH without educational intervention.[13,14]

To our knowledge, previous studies on the effectiveness of HH educational intervention on dental students did not investigate types of bacteria isolated and its count before and after this intervention.

Hence, the present study was conducted to assess the knowledge, attitude, and level of bacterial hand contamination of undergraduate students at a dental teaching hospital with and without educational reinforcement session.

MATERIALS AND METHODS

Of the 143 clinical training students at 4th, 5th, and 6th years (66 males and 77 females), a total of 111 students agreed to participate in the study, where 25 students were engaged in testing the reliability and validity of the questionnaire.

Study Design

A cross-sectional study of four phases was carried out.

Phase I

At the start of the academic year (September 2015), all male and female students in the 4th, 5th, and 6th grades received a 4-hour educational session for HH (2 hours theoretical and 2 hours hands-on). During training, every student performed HH with hand soap, available in the clinics at the time, under trainer supervision.

Phase II

A 3-hour mandatory reenforcement educational session (theoretical and hands-on) was held for the 5th year students only (April 2016). Students in the 4th and 6th years did not receive the reenforcement course and were considered as group I, while those in the 5th grade who received reenforcement course were considered as group II.

Phase III

After 2 weeks of reenforcement session, a structured self-administrated questionnaire was given to all participants in the study to assess the knowledge and attitude about HH and enough time was given to fill it. The first part of the questionnaire measured the knowledge of participants about HH based on answering yes or no questions. The wrong answer was given 0 score, and the correct answer was given a score of 1. The second part was used to measure the attitude about HH and was composed of questions that were answered by a 5-scale spectrum (strongly agree [5], agree [4], no comment [3], disagree [2], and strongly disagree [1]). Knowledge and attitude were evaluated by considering score <40% as low, 40 to 70% as average, and a score of 70 to 100% as high according to Sharif et al.[15]

Reliability and Validity of the Questionnaire

The questionnaire was distributed to 10 dental students to test the clarification of the questions and modify them according to the comments and feedback before the commencement of the study. The questionnaire was later distributed twice to 15 dental students 1 week apart, and the difference between the two responses was tested statistically using Kappa test with a value of 0.85 to 0.94 to test its reliability and validity.

Phase IV

Only subjects who performed clinical treatment for a patient at the clinics during regular clinical sessions at scheduled times were selected to assess the bacterial hand contamination. Fingertip prints of the five fingers of the dominant hand from every participant were gently impressed on sheep blood agar plates (Saudi Prepared Media Laboratory Company Ltd.) for three times. The first prints were taken at the start of the session after performing routine HH using the hand soap available in the clinics at the time. The second prints were done at the end of the clinical session, after removing gloves and before HH; finally, the participants were asked to perform HH; then third prints were impressed on blood agar. Plates with fingertip prints were aerobically incubated at 37°C for 24 hours and after those total bacterial counts on each plate were recorded as the number of CFUs. Bacterial isolates were identified using standard microbiological procedures; colony morphology, Gram staining, and

further identification using Vitek 2 microbial identification system (Biomerieux, USA) was done.

Statistical Analysis

Data were collected, tabulated, and statistically analyzed using Statistical Package for the Social Sciences version 20. Comparison between qualitative data was done using chi-square test. Knowledge and attitude of HH and the level of bacterial contamination were detected among students using Chi-square test. Bacterial counts at the three measuring points were compared using t-test and one-way analysis of variance test. *Post hoc* analysis was performed to evaluate significant intergroup differences and $p < 0.05$ was considered as the level of significance.

Ethical Consideration and Confidentiality

Ethical approval was obtained from the Ethical Committee of the university teaching hospital. The participants were included in the study after signing an informed consent form.

Data were collected from participants through paper-based questionnaire not showing any nominative information. Participants were identified by serial study codes and initials. These were linked to participants' names in a separate identification log sheet, which was kept in a safe locked place.

RESULTS

This study was conducted in the academic year 2015 to 2016 on dental students at a university teaching hospital.

Demographic Characters of the Students included in the Study

A total of 86 dental students in different clinical grades responded to the questionnaire; 44 males and 42 females. Among them, 24 (28%) were in 4th grade, 31 (36%) were in 5th grade, and 31 (36%) were in 6th grade.

Knowledge and Attitude levels accessed by the Questionnaire

An extremely significant percentage of the students participating in the study (86%) had high knowledge ($p < 0.000$), while a highly significant percentage had a high attitude (65.1%; $p < 0.005$; Table 1).

As regards knowledge level, nonsignificant differences were found between students in the two studied groups, and in the three different grades (p 0.05), while a significant difference was found between both genders ($p < 0.05$). On the contrary, as regards attitude level, significant differences ($p < 0.05$) were found between students in the two studied groups, in the three different grades as well as between both genders (Table 1, Graphs 1 and 2).

Figure 1 shows that female students of the 5th year had the highest levels of knowledge and attitude in comparison with other grades. Although male students of 6 years had the highest knowledge, those of the 5th year had the highest attitude (Graph 3).

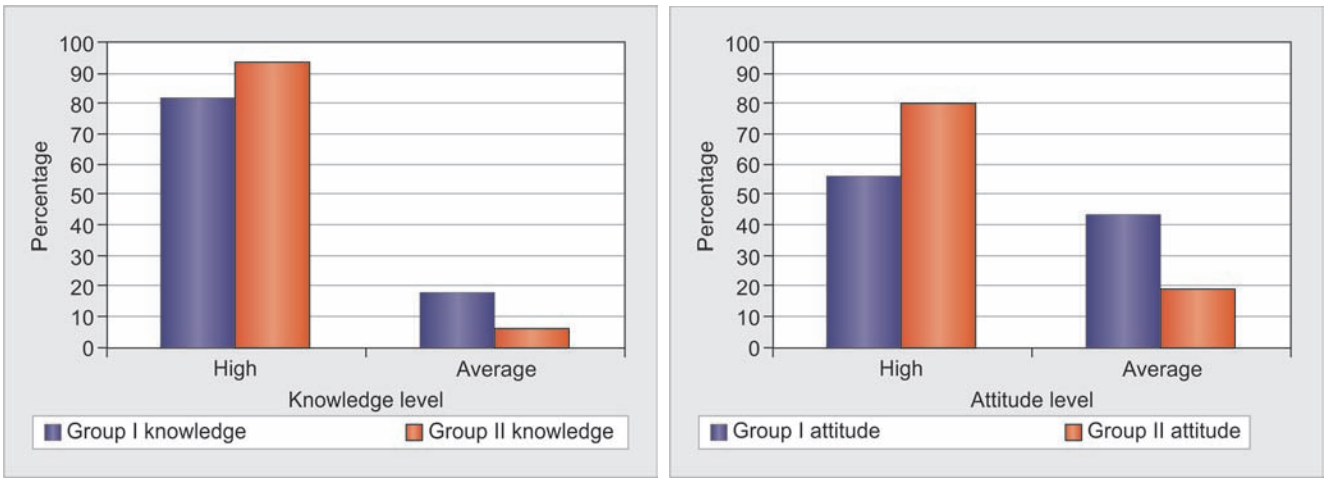
Bacterial Counts of Dominant Hand Fingertip Prints

Mean CFUs of bacterial growth on the three plates taken for every student shows nonsignificant differences between both genders, the two study groups, and between students in different grades. Furthermore, when CFUs were compared in relation to knowledge and attitude levels, nonsignificant difference was found ($p > 0.05$). On the contrary, mean CFUs were higher in group I than in group II with statistically significant difference ($p = 0.05$) before commencing treatment session (Table 2).

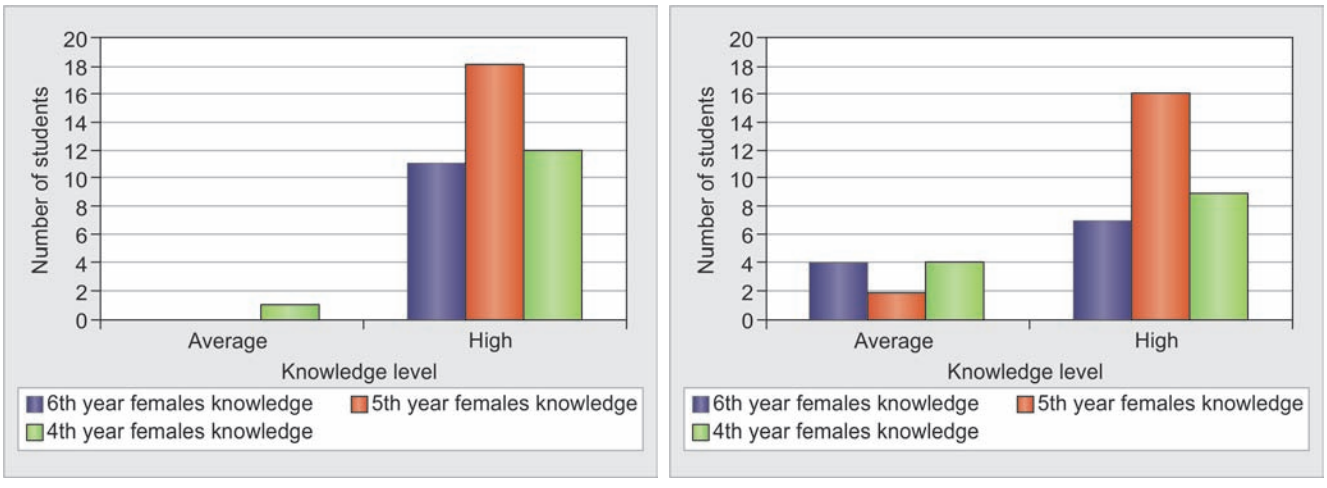
Table 1: Knowledge and attitude levels regarding students' grades and gender

	Knowledge level		χ^2	*Attitude level*		χ^2
Variable	*Average n (%)*	*High n (%)*	*p*	*Average n (%)*	*High n (%)*	*p-value*
Grouping						
Group I	45 (81.8)	10 (18.2)	2.272	31 (56.4)	24 (43.6)	5.145
Group II	29 (93.5)	2 (6.5)	–0.131	25 (80.6)	6 (19.4)	(0.02)*
Grades (years)						
4	20 (83.3)	4 (16.7)	2.353 (0.308)	15 (62.5)	9 (37.5)	5.852
5	29 (93.5)	2 (6.5)		25 (80.6)	6 (19.4)	(0.05)*
6	25 (80.6)	6 (19.4)		16 (51.6)	15 (48.4)	
Gender						
Males	34 (77.3)	10 (22.7)	5.776	24 (54.5)	20 (45.5)	4.432
Females	40 (95.2)	2 (4.8)	(0.02)*	32 (76.2%)	10 (23.8)	(0.04)*
Total level	74 (86)	12 (14)	44.69 (0.000)***	56 (65.1)	30 (34.9)	7.86 (0.005)**

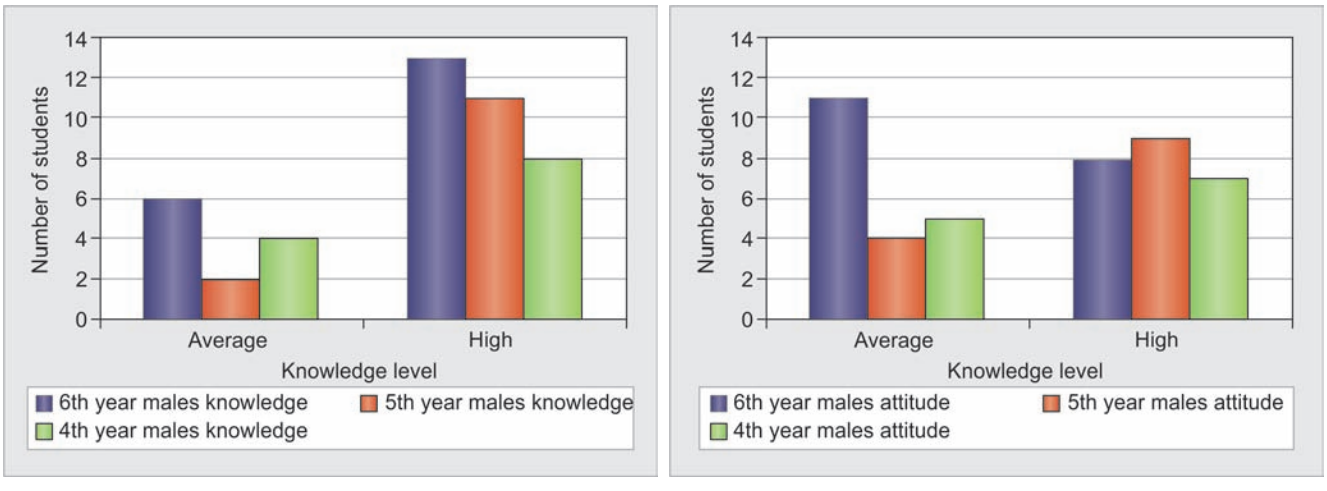
***extremely significant ≤0.000, **highly significant ≤0.00, *significant at p level ≤0.05, χ^2 = Chi-square



Graph 1: Level of knowledge and attitude of study participants in relation to students' groups



Graph 2: Level of knowledge and attitude of female participants in relation to students' grades



Graph 3: Level of knowledge and attitude of male participants in relation to students' grades

Comparing mean CFUs of the first and the third counts for every student showed no significant difference between both genders, groups, grades as well as between high and average levels of knowledge and attitude ($p > 0.05$). Extremely significant differences ($p \leq 0.000$) were found between second and third counts and between first and second counts except for students of group I, those with average knowledge and attitude, as well as for 4th year students where there was only significant difference ($p \leq 0.05$) (Table 3).

Table 2: Mean CFUs on students' dominant hands at the three times of hand printing in relation to study variables

	First count	*Second count*	*Third count*
Variable	*Mean ± SD*	*Mean ± SD*	*Mean ± SD*
Gender			
Males	53.9 ± 49.3	100.0 ± 58.1	50.9 ± 49.6
Females	49.7 ± 42.8	101.4 ± 65.1	51.0 ± 41.4
t (p-value)	0.180 (0.672)	0.11 (0.917)	0.001 (0.977)
Grouping			
Group I	59.25 ± 47.21	96.95 ± 67.3	50.35 ± 47.5
Group II	40.7 ± 29.4	108.8 ± 47.9	52.5 ± 36.8
t (p-value)	2.76 (0.05*)	0.936 (0.352)	0.217 (0.828)
Grades			
4th year	67.9 ± 60.6	100.9 ± 76	51 ± 57.4
5th year	40.7 ± 29.4	108.8 ± 47.9	52.5 ± 36.8
6th year	50.6 ± 44.6	92.4 ± 61.4	49.7 ± 44.6
F (p-value)	2.463 (0.091)	0.543 (0.583)	0.029 (0.972)
Knowledge levels			
High	49.9 ± 44.7	100.8 ± 60.4	49.1 ± 44.1
Average	64 ± 54.2	99.7 ± 69.3	62.8 ± 54.4
t (p-value)	0.988 (0.326)	0.059 (0.953)	0.962 (0.339)
Attitude levels			
High	54.3 ± 44.6	106.6 ± 58.2	54.8 ± 44.5
Average	47.2 ± 49	89.6 ± 66.2	44.1 ± 47.3
t (p-value)	0.682 (0.497)	1.235 (0.220)	1.042 (0.311)

SD: Standard deviation

Table 3: The *t* and *p*-values of Scheffe *post hoc* test between CFUs at the 3 times of fingertip printing in relation to study variables

	Pairwise comparison		
Variable	*First count vs third count*	*Second count vs third count*	*First count vs second count*
Gender			
Males	0.511 (0.612)	8.403 (0.000)***	8.194 (0.000)***
Females	0.254 (0.801)	6.522 (0.000)***	5.335 (0.000)***
Grouping			
Group I	0.966 (0.335)	4.089 (0.000)***	3.358 (0.01)*
Group II	1.844 (0.07)	8.128 (0.000)***	8.437 (0.000)***
Grades			
4th year	1.73 (0.09)	4.671 (0.000)***	2.734 (0.01)*
5th year	1.844 (0.07)	8.128 (0.000)***	8.437 (0.000)***
6th year	0.171 (0.865)	5.501 (0.000)***	5.109 (0.000)***
Knowledge levels			
High	1.56 (0.877)	9.787 (0.000)***	8.492 (0.000)***
Average	0.123 (0.904)	3.630 (0.02)*	2.577 (0.04)*
Attitude levels			
High	0.082 (0.935)	8.939 (0.000)***	8.700 (0.000)***
Average	0.543 (0.591)	3.390 (0.02)*	3.783 (0.01)*

***extremely significant ≤0.000; **highly significant ≤0.00; *significant at p level ≤0.05

Bacterial Identification

All 258 plates with fingertip prints showed bacterial growth. About 238 (92.2%) out of the plates showed coagulase-negative *Staphylococci* and 7 plates (2.7%) showed *Micrococcus*. Regarding pathogenic bacteria, pure *Klebsiella pneumonia* was grown on 2 plates (0.8%) and mixed *K. pneumonia* with coagulase-negative *Staphylococci* on 2 plates (0.8%). *Pseudomonas* spp. mixed with either coagulase-negative *Staphylococci* or *Micrococcus* on 4 plates (1.6%) and spore-forming aerobic nonhemolytic *Bacilli* were on 5 plates (1.9%) (Figs 1 and 2).

Klebsiella pneumonia was isolated from fingertip prints of two male 6th year students (one of them from first and second plates, the other from second and third plates). *Pseudomonas* spp. was isolated from fingertip prints on second and third plates of a 4th year male student and first and second plates of 5th year female student. Spore-forming aerobic nonhemolytic *Bacilli* was isolated from the second plate of a 5th year male student, first and second plates of a 4th year male student, and second and third plates of another 4th year male student.

A significant difference was detected between the mean CFUs of pathogenic bacteria identified at the three measuring points ($p < 0.05$). When first and third counts of pathogenic bacteria were compared, a nonsignificant

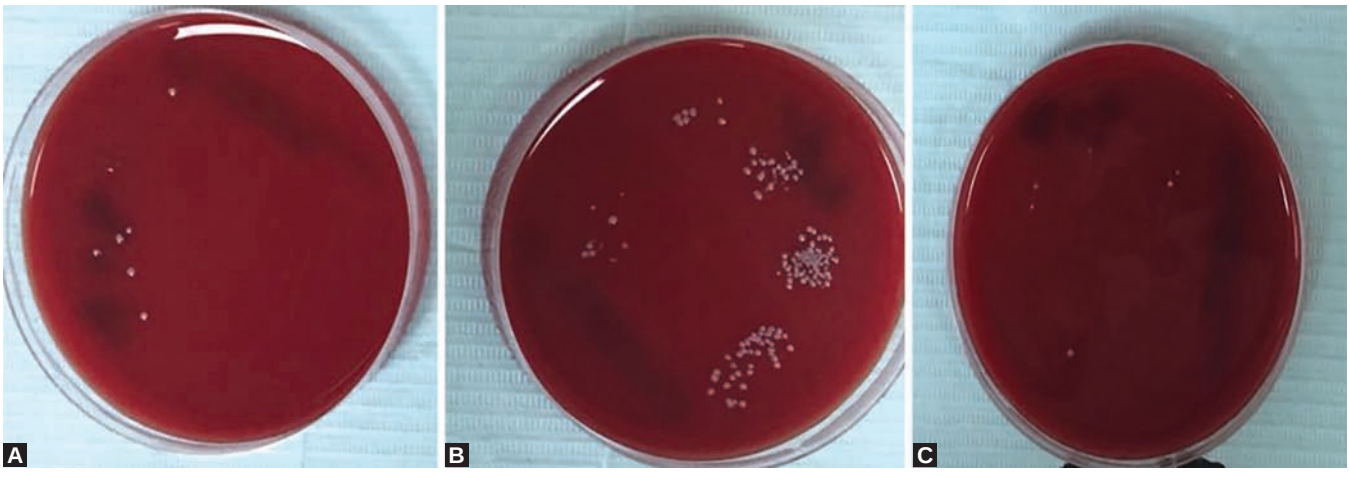


Fig. 1: Sheep blood agar plates showing bacterial growth of coagulase-negative *Staphylococci* on a student fingertip prints with an increase of CFU numbers at the end of the treatment session and decrease after HH. (A) Before treatment and after HH; (B) after removing gloves and before HH; and (C) after HH at the end of treatment session

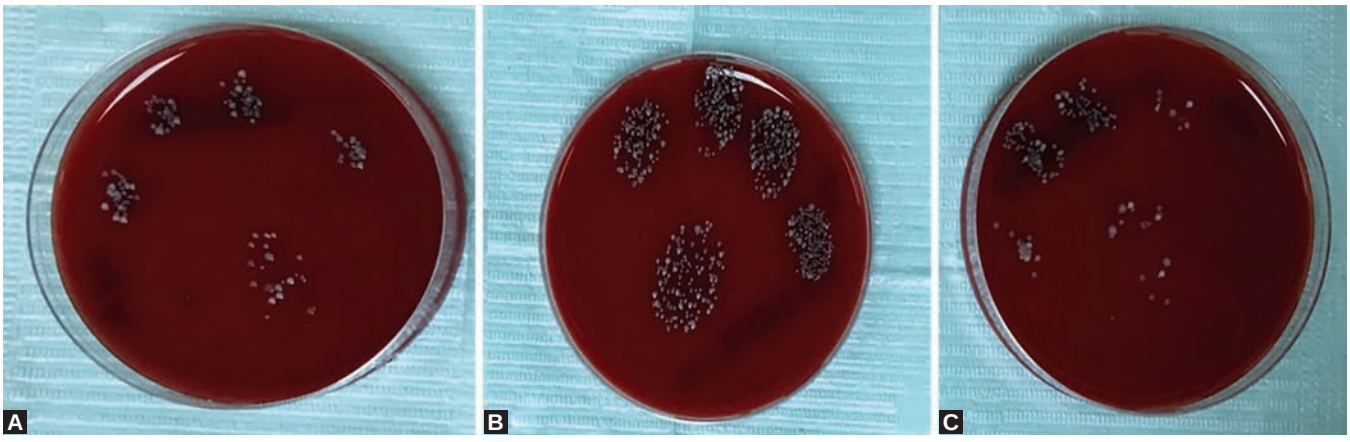
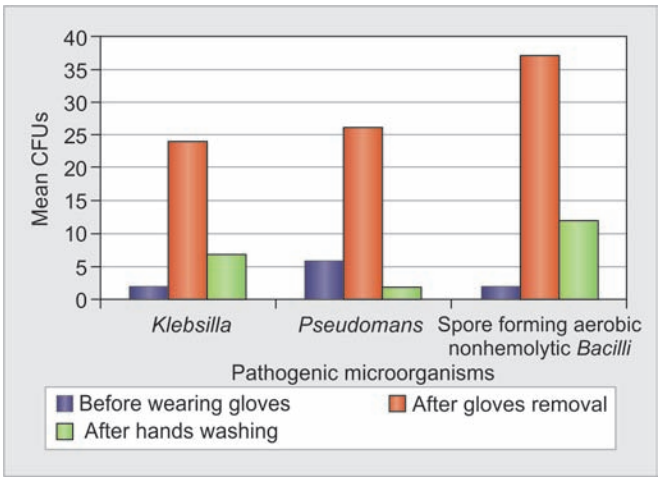


Fig. 2: Sheep blood agar plates showing bacterial growth of coagulase-negative *Staphylococci* and pathogenic bacteria on a student fingertip prints with an increase of CFU numbers at the end of the treatment session and decrease after HH. (A) Before treatment and after HH; (B) after removing gloves and before HH; and (C) after HH at the end of the treatment session

Table 4: Mean CFUs of the pathogenic bacteria identified at the three measuring points and their pairwise comparison

Counting	*CFUs (mean ± SD)*	*t (p-value)*
First count	0.198 ± 0.103	0.192 (0.828)[a]
Second count	1.127 ± 4.365	2.284 (0.02)*[b]
Third count	0.162 ± 1.309	2.322 (0.02)*[c]
F (p value)	2.246 (0.02)*	

[a]First count *vs* third count; [b]Second count *vs* third count; [c]First count *vs* second count; *significant at p level ≤ 0.05; SD: Standard deviation



Graph 4: Comparison of mean CFUs of the pathogenic microorganisms isolated at the three measuring points

difference was detected between them ($p > 0.05$), while differences were significant ($p < 0.05$) between first and second counts as well as between second and third counts (Table 4, Graph 4).

DISCUSSION

Dental students, the future dentists, who will provide oral health care for patients must have a high level of education on clinical skills as well as on infection control guidelines during training at the dental schools.[16,17] As HH is the core element of infection control, it should have an educational priority with continuous evaluation. Therefore, assessment of HH educational sessions' impact on knowledge, attitude, and reduction of bacterial hand contamination of dental students was done in the present study.

The majority of students participating in this study had high knowledge and attitude (86 and 65.1% respectively) with nonsignificant differences between both studied groups as regards to knowledge and significant differences regarding attitude. These results are higher than those recorded in the study of Thakker and Jadhav[18] on 74 dental students in a tertiary care teaching institute in India, where the majority (70.27%) of their students had moderate knowledge, while in 25.67% of them the knowledge was low. The difference from the present study could be attributed to the different scale used for assessment of the results as they considered more than 75% as a good knowledge, 50 to 74% as moderate, and <50% as poor. Using the same score, Jagdish et al's[19] study at the Institute of Medical and Dental Sciences in India found that only 8% of dental students participating in their study had good knowledge, 77% had moderate, and 15% had poor knowledge about HH practices.

The previous study by Omogbai et al[20] on 105 dentists and dental students treating patients in a University Teaching Hospital, Nigeria, concluded that 99.3% of their study participants had high knowledge about realizing the importance of HH in dentistry, while 69.5% of them desired more information especially about indications and steps of HH. The difference in methods of analyzing data could explain the differing percentages from the present study where the total score for the questions was used. Another explanation is that difference in HCWs' knowledge between countries could be due to the differences in educational background and participation in infection control training programs.[21]

In this study, overall, scores of knowledge and attitude were higher in group II when compared with group I. These results are in agreement with studies of Milward and Cooper[16] and Baharvand et al[12] on dental students, where they concluded that, the scores of students' knowledge, attitude, and practice improved significantly after their training.

The overall scores of knowledge and attitude in the present study showed significantly higher levels in females than in males. While among the group that received reenforcement course, female students had highest levels of knowledge and attitude among females of all grades, and male students had the highest attitude among males of all grades. These results reflect that the educational intervention was effective in both genders and confirm the previous work of Cruz et al,[22] on Saudi nursing students, who found that females had a better attitude and higher self-reported performance toward HH, while male students had better practice on HH.

As regards bacterial hand contamination, mean CFUs of the bacteria isolated from fingertip prints in the present study ranged from 40.7 ± 29.4 to 108.8 ± 47.9. These results are closely similar to those of Pittet et al,[7] who investigated bacterial hand contamination of hospital staff during routine patient care and concluded that a total number of bacterial CFU grown from five fingertips ranged from 0 to 300 CFU with a mean number of 100 ± 114. Recently, Chinaramrungraung et al,[14] found that bacterial count on the fingers of the dental assistants ranged from 1.5×10^1 to 4.8×10^5.

The mean CFUs in the current study were significantly increased at the end of the treatment session before performing HH and then reduced after HH in all study participants. However, the level of significance was lower in group I as well as 4th year students with fewer years of clinical experience. This is consistent with the study conducted by Yaembut et al,[13] where all participants showed a reduction of the bacteria on their hands after HH. In contrast to this study, they found that the effectiveness of dental student HH decreased with increased experience. The increased CFUs at the end of the treatment session confirm the declaration of Naik et al,[6] who reported that, despite the fact that the use of gloves reduces the risk of contamination by 70 to 80%, it also creates a warm moist environment in which organisms can proliferate. Gloves also may have microscopic imperfections through which hands of HCWs could be contaminated.

Controversially, Salmon et al[23] concluded that HH of HCWs using plain soap and unfiltered water was associated with minimal, nonsignificant bacterial reduction in surgical, pediatric, and other medical departments. The difference from the results of the present study could be explained by the fact that medical departments might be contaminated by different bacteria that are more resistant to removal.

The majority of fingertip prints in the present study showed growth of coagulase-negative *Staphylococci* and *Micrococcus,* which was stated by Kampf and Kramer[24] as common skin colonizers. They added that these organisms constitute the resident flora of the hands less likely to be associated with infections, but may cause infections in sterile body cavities, the eyes, or on nonintact skin. In contrast to this study, 8.3% of isolated strains from hand swab samples of 60 HCWs in a general hospital by Kumari et al[25] were coagulase-negative *Staphylococcus*.

Three potentially pathogenic bacteria isolated from fingertip prints in the present study (*K. pneumonia*, *Pseudomonas* spp., and spore-forming aerobic nonhemolytic *Bacilli*) were different from those isolated by Messano.[26] The different strains isolated in their study may be attributed to the site of sampling as their samples were taken by swabbing over the entire ventral surface of the hand and on both sides of rings.

Klebsiella pneumonia was isolated from fingertip prints of two senior students who received re-enforcement course in this work. The most unacceptable point is that one of these two students did not effectively perform HH and *Klebsiella* was still present after HH at the end of the session. This pathogen was among the microorganisms recovered by Salmon et al.[23] However, it is not possible to extend their results to dental settings, as their study was conducted at a general medical hospital where the immune-compromised patients were hospitalized.

Pseudomonas spp. was isolated on fingertip prints of two students; one junior student from group I who did not perform an effective HH as the organisms remained on his fingertip prints after HH at the end of the session. The other student who had *Pseudomonas* on his hand was from group II, but he effectively performed HH, and the organism was not present after HH at the end of the session. This pathogen was among the organisms isolated in the study conducted by Kumari et al.[25]

Pseudomonas has the ability to survive on hands for differing times, indicating that it might be a source of cross-contamination in dental settings. This ability was stated by Fryklund et al[27] who concluded that most Gram-negative bacteria survive on the hands for 1 hour or more. Moreover, the study of Döring et al[28] concluded that *Pseudomonas aeruginosa* was transmissible by handshaking for up to 30 minutes when it was suspended in saline, and up to 180 minutes when suspended in sputum. Foca et al,[29] added that artificial fingernails had been associated with a higher risk for colonization with *P. aeruginosa*.

Spore-forming aerobic nonhemolytic *Bacilli* were isolated from fingertip prints of three students, one of them was from group II, but he effectively performed

HH, and the organism disappeared after HH at the end of the session. While the other two cases were isolated from two junior students, who did not receive reenforcement course, and both of them did not effectively perform HH. These results confirm the previous work of Sasahara et al,[30] who suggested that HCWs' hands are commonly contaminated with bacterial spores, where they were isolated from the hands of 76.1% of their study participants, and they persisted under insufficient HH.

The pathogens isolated in the present work raise the assumption that insufficiently cleaned hand after clinical session could be a probable route of cross-transmission of infections, but according to Mondal and Kolhapure,[31] the critical density needed for the spread of the pathogens remains unknown. They reported that this spread might depend on the type of microorganism, type and duration of contact, the patient's resident flora, and their colonization resistance.

The present study has both strengths and limitations. The most important strength is that it is one of the few studies that identify the bacteria that are contaminating fingertip prints in the dental field and assess the impact of educational interventions on such contamination. The first limitation is the small sample size, which is explained by the fact that the study was performed at a newly established dental teaching hospital with limited numbers of students. The second limitation is that the present findings are restricted to dominant hands examined; that may not be generalizable to the nondominant hand.

CONCLUSION

- Reinforcement educational session had a positive impact on HH knowledge, attitude, reduction of bacterial CFUs, and removal of pathogenic bacteria.
- Potentially pathogenic bacteria could be present on the hand of dentists especially after removing gloves.
- Continuous education with frequent training sessions is recommended to reinforce HH compliance and reduce cross-contamination by future dentists.

Clinical Significance

Contaminated hands of dental HCWs constitute the main element in the spread of microorganisms in dental clinics. The HH is the most important activity accomplished to reduce the risk of transmitting microorganisms from dental HCWs to patients. Therefore, studies are needed to discover the impact of educational intervention for HH on dental HCWs' knowledge, attitude, and level of hands' bacterial contamination.

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