Review Article

Educator and Student Hand Hygiene Adherence in Dental Schools: A Systematic Review and Meta-Analysis

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Abstract: Health professionals and their patients are subject to cross-contamination and potential exposure to harmful infectious diseases. A common form of cross-contamination is through dental procedures without proper instrument care and lack of hand hygiene. The aim of this systematic review was to evaluate the published research on the adherence of educators and students in academic dental institutions to hand hygiene procedures. This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and included articles collected in the Cochrane, LILACS, PubMed, Science Direct, Scopus, and Web of Science databases. The initial search identified 1,196 articles. Ultimately, three studies were included for qualitative synthesis and two for the meta-analysis. The three articles had similar characteristics of observational hand hygiene research involving educators and dental students. In all three, hand hygiene among dental students did not reach 50% of the total number of opportunities, which is a troubling result. Although the hand hygiene rate of educators was higher than that of dental students, these findings point to a need to further promote hand hygiene to future professionals to avoid cross-contamination between health professionals and patients.

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Health professionals and their patients are at high risk of cross-contamination. The World Health Organization (WHO) estimates that more than 1.4 million cases of health-associated infections occur worldwide at all times.[1] Cross-transmission can occur between patient and professional and vice versa through direct and indirect contact of contaminated hands.[2] Transmission of pathogenic microorganisms can occur during dental treatments, especially in oral surgical procedures including extractions, biopsies, implant installation, grafting, and soft tissue manipulation.[3] Many microorganisms are potentially pathogenic and resistant and can be transmitted to the oral cavity, not being a usual component of this flora.[3-5] The entry of pathogenic microorganisms into the oral cavity can lead to severe systemic alterations and diseases, which can result in mortality.[3,6] Thus, cross-infection associated with health care remains high, although there is evidence of improvement in the practice of surveillance and infection control with hand washing.[7]

A simple, low-cost practice for the prevention of cross-contamination is hand hygiene.[8] Hand hygiene (HH) includes hand washing, hand washing with common soap and water, and use of alcohol hand sanitizer containing 60% ethanol or 95% isopropyl alcohol.[9,10] Such procedures should be taught at the beginning of the clinical experience in dental education, emphasizing the risks of transmission of infectious and contagious diseases. Responsibility for this teaching lies with the dental educators who are the closest direct example for students. The aim of this systematic review was to evaluate the published research on the adherence of educators and students in academic dental institutions to hand hygiene procedures.

Methods

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) and was based on the PRISMA checklist.[11,12] The protocol was registered at the International Prospective Register of Systematic Reviews PROSPERO Center for Reviews and Dissemination under the registration number CRD42018088174.[13]

A PICOS acronym was used to formulate the questions for this study: P=participants (dental educators and dental students), I=intervention (hand hygiene), C=comparison (non-adherence to HH), O=outcomes measures (quantification of any type of HH compliance), and S=study design (observational studies). In addition, HH must have been assessed through observational studies of the groups evaluated in dental schools. Criteria for exclusion of articles were as follows: studies that did not describe educator and student HH in dental schools; studies that did not assess HH quantity, quality, or compliance; articles that did not report HH in dental schools; reviews, conference abstracts, editorials, theses, books, letters, and personal opinions; and articles not written in the Roman alphabet.

The studies to be included were selected by developing detailed individual search strategies for each of the following bibliographic databases: Cochrane, Latin American and Caribbean Health Science (LILACS), PubMed, Science Direct, Scopus, and Web of Science. A gray literature search was conducted using Google Scholar and ProQuest Dissertations & Theses Global databases. The search considered all articles published on or before January 27, 2018. Duplicate references were removed using reference manager software (EndNote X7, Thomson Reuters, New York, NY, USA). Then, the references were transferred to and worked in Rayyan (Rayyan, Qatar Computing Research Institute, Qatar Foundation, Dohar, Qatar), a free web and mobile app.[14]

Two phases were used to select the studies. In the first phase, two of the authors (KKMR and LFN) reviewed the titles and abstracts of all references selected as relevant considering all inclusion and exclusion criteria. The next step involved the participation of a third author (LJOM), who reviewed all articles on which there was no consensus in the initial evaluation to determine which would be included in the second phase. The second phase involved two authors (KKMR and LFN) who reviewed the full text of the articles. Disagreements were resolved by discussion until a consensus was reached among the three authors.

Two of the authors (KKMR and LFN) collected the required information from each included article. The third author (LJOM) checked the information. Any disagreements were discussed until a consensus was reached among these three authors. The participation of a fourth reviewer (author CRRC) was requested if a consensus could not be reached.

For all of the included studies, the following information was recorded: author(s), year of publication, country, journal of publication, study design, number of participants, hygiene products, school sector, methods of evaluation, results, and main conclusion (main reported findings related to the research question). Risk of bias was assessed by the same two authors (KKMR and LFN) and checked by expert reviewers (LJOM and CRRC).

Methodology of the selected studies was evaluated using Risk of Bias in Nonrandomized Studies of Interventions (ROBINS-I) and Grading of Recommendations Assessment, Development, and Evaluation (GRADE). ROBINS-I was used to evaluate risk of bias in estimates of the comparative effectiveness (harm or benefit) of interventions from studies that did not use randomization to allocate units to comparison groups.[15] GRADE is a corresponding system to evaluate the quality of study evidence.[16] We scored each item as yes, no, or unclear when assessing the quality of each included study. All decisions on the scoring system were agreed upon by all reviewers prior to commencement of the critical evaluation, and the studies were rated based on the following definitions: very low risk of bias if the study scored greater than 80% yes; low risk of bias if yes scores reached 60-80%; moderate risk of bias if yes scores were between 40% and 60%; and high risk of bias if yes scores were below 40%.

Studies with adequately quantitative data were included in the meta-analysis. This meta-analysis was performed to address the research question with the aid of statistical software package R (version 3.3.2; www.r-project.org/). The level of significance was set at 5%. We analyzed the statistics by indices of inconsistency (I^2) to understand the data heterogeneity. The closer I^2 is to 0, the more homogeneous the studies are. I^2 >75% indicates significant heterogeneity.[17]

We used the Gunning fog index (FOG) to assess the readability of the studies.[18-20] The FOG graduation was calculated based on the full text of the selected studies. A FOG index >18 means that the text is

highly complex, 14-18 is difficult to understand, 12-14 is ideal for reading, 10-12 is acceptable, and 8-10 indicates text that children can understand.[19]

Results

In the first phase of the selection, 1,196 articles were identified from the six databases. After we removed duplicates, 1,158 articles remained (Figure 1). Evaluation of titles and abstracts resulted in exclusion of 1,150 articles, leaving eight articles remaining. Only one study was found on Google Scholar, but it was excluded. Using Proquest, we identified 250 articles, two of which were included. One additional article was identified and included from the reference lists, resulting in 11 articles for the final phase.

After the selection process, we read the texts completely and evaluated them. Eight studies were excluded based on the exclusion criteria,[21-28] leaving

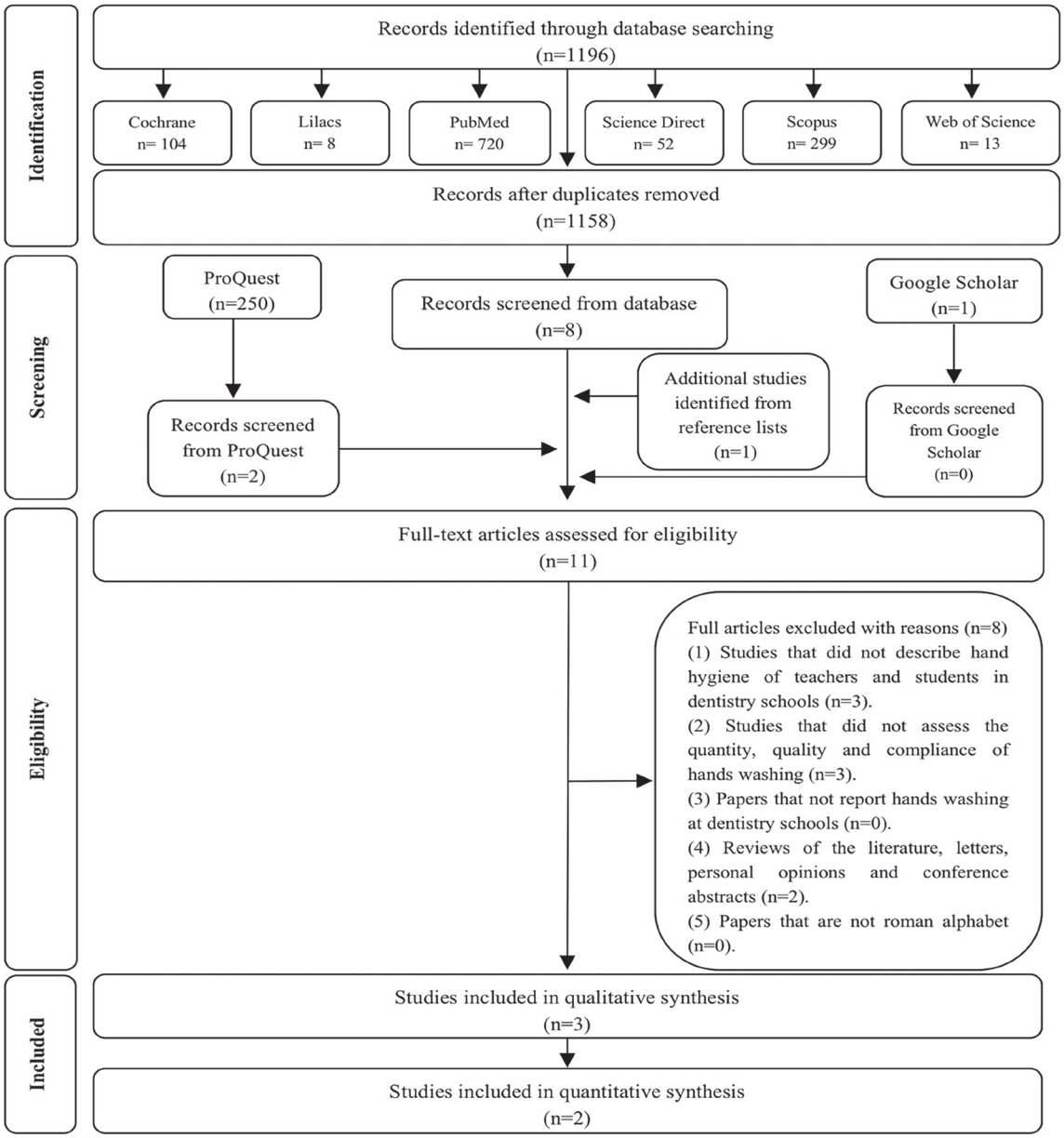


Figure 1. Flow diagram of literature search protocol and selection criteria adapted from PRISMA

three articles for final analysis.[8,29,30] The reasons for excluding the eight studies at this phase were as follows: studies that did not describe hand hygiene of educators and students in dental schools,[21-23] studies that did not assess the quantity, quality, and compliance of hands washing,[24-26] and reviews of the literature, letters, personal opinions, and conference abstracts.[27,28]

All articles included in this systematic review were observational studies, with evaluations of dental educators and students in a university environment. The three selected articles were published in English-language dental journals. Sample sizes ranged from 35 to 295 participants; only the observation methods differed (Table 1). The studies were conducted in Brazil,[8] France,[29] and the United Kingdom[30] and were published between 1995 and 2014.

In the risk of bias analysis, one study was scored in the ROBINS-I checklist as having moderate risk of bias because there was no specific information about the groups of educators and dental students (Figure 2).[30] However, the other two studies were judged to be low risk of bias with regard to strategies for dealing with confounding factors and methods of assessing HH.

In the GRADE analysis, two studies were judged as having low quality of evidence due to not reporting specific data from the group division (Table 2).[29,30] The results did not fully answer our questions, as well as showing imprecision for not properly describing the HH of dental educators. Therefore, considering the overall risk of bias, only one study was judged as having high-quality evidence for the questions of this systematic review.[8]

Table 1. Descriptive characteristics of the included studies (n=3)

First Author, Year	Country	Journal	Study Design	Methods	Results	Main Conclusion
Amorim-Finzi, 2010	Brazil	European Journal of Dentistry	Observational prospective longitudinal study	Groups were observed for hand washing on daily care. Authors stated their intention was not to evaluate effectiveness of HH.	Dental educators had highest compliance with 78.4% of 361 opportunities. For graduate students and residents, rate of compliance did not reach 50%. 91% of participants preferred to use water and soap.	Study showed the importance of preventive measure in clinical routine of dental professionals. In groups studied, number of hand washings performed was minimal compared with recommendations.
Porter, 1995	United Kingdom	Oral Diseases	Observational longitudinal study	Groups were observed by a hidden video camera and assessed by two clinicians. No determination of effectiveness of HH.	Students had a compliance rate of 46.1%. 87% of dentists and students wore gloves for treatment, but 76.8% did not wash their hands before donning gloves. Face masks were used by 38.1% and protective eyewear by 28.8%.	Dentists and dental students did not comply completely with procedures for infection control in the hospital area. Improvement was needed in staff education, regular use of antiseptic agents and personal protective equipment, and monitoring practices.
Thivichon-Prince, 2014	France	European Journal of Dentistry	Observational longitudinal study and questionnaire	Groups were observed for hand cleaning and rubbing to evaluate duration, steps, and product quantity. Questionnaires were completed for each person observed. Efficacy was assessed when hands were washed for more than 20 s and used at least 5 steps described in French Society of Hospital Hygiene.	Educators had a higher compliance rate than students: 63.7% compared to 35.8%, respectively. However, results of hand washing and rubbing remained at lower levels as a consequence of lack of execution of all steps and shorter duration.	Study highlighted importance of knowledge about infection control and protocols for better compliance, making it possible for dental professionals to choose the appropriate technique and procedure for each situation. Those who had training demonstrated a higher level of infection control practices.

HH=hand hygiene

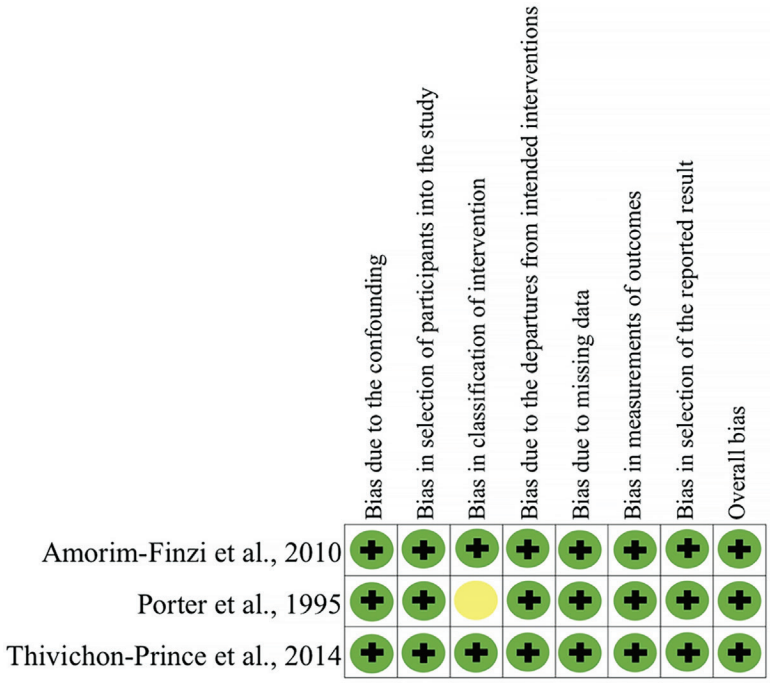


Figure 2. ROBINS-I tool assessment: risk of bias summary of included studies showing risk of bias on each factor

Note: The green balls indicate low risk of bias, and the yellow ball indicates a moderate risk of bias.

Table 2. Assessment of quality of evidence in the included studies (n=3)

First Author, Year	Study Design	GRADE Factors: Study Limitation	Inconsistency	Indirectness	Imprecision	Bias	Overall Quality
Amorim-Finzi, 2010	With comparable baseline	√	√	√	√	√	++++
Porter, 1995	With comparable baseline	X (Did not show group of dental educators)	√	X (Did not answer question about dental educators' compliance in hand hygiene)	X (Did not show auxiliary hygiene mechanisms, such as washing hands)	√	++
Thivichon-Prince, 2014	With comparable baseline	Unclear (Did not show specific data; divided group of educators and students)	√	Unclear (Did not answer question about dental educators' compliance in hand hygiene)	X (Did not report dental educators' hand hygiene)	√	++

√=no serious limitations; X=serious limitations
For overall quality of evidence: +=very low; ++=low; +++=moderate; ++++=high

Articles assessed in this systematic review involved 82 educators and 320 graduate students, totaling 402 participants. A total of 2,110 HH opportunities were available for educators and students in the selected studies, of which only 1,149 showed HH adherence. Only one study demonstrated the effectiveness of HH.[29] In this study, efficacy was assessed when the hands were washed for more than 20 seconds and used at least five steps described in the French Society of Hospital Hygiene.

Two of the selected studies found that educators had a significantly higher compliance rate than students (63.7-78.4%, $p \leq 0.05$) (Table 3).[8,29] In addition, these two studies included results on the use of additional antiseptic products, with alcohol being the most common. One study did not evaluate educators' HH.[30] In the three studies, the HH compliance rate of the students was less than 50%. Although dental educators' HH compliance rates were higher than those of the students, the studies suggested that the levels were lower than expected considering educators set the example for students to follow.

Two studies presenting quantitative data describing the HH of educators and dental students were included in the meta-analysis (Figure 3).[8,29] One study was not used because the sample did not include dental educators.[30] The meta-analysis I^2 was 98.64% (p=0.2338), which suggests that the studies were heterogeneous. Thus, at the 95% confidence level, there was statistical evidence that the average HH adherence of educators and dental students for both studies was the same. Together, these data suggest that the dental educators washed their hands on average 2.31 times more often than did the students.

Two studies discussed the use of antiseptics to aid hand cleaning and found that alcohol was the most frequently used for greater effectiveness.[8,29] Alcohol-based hand sanitizer was used in gel and liquid forms; however, it was used less frequently than soap and water. In Amorim-Finzi et al.'s study, only 9% of participants used hand rubbing with alcohol immediately after hand washing.[8] However, the Trivichon-Prince et al. study found that 50% of participants used alcohol between hand washes but never directly after hand washing.[29]

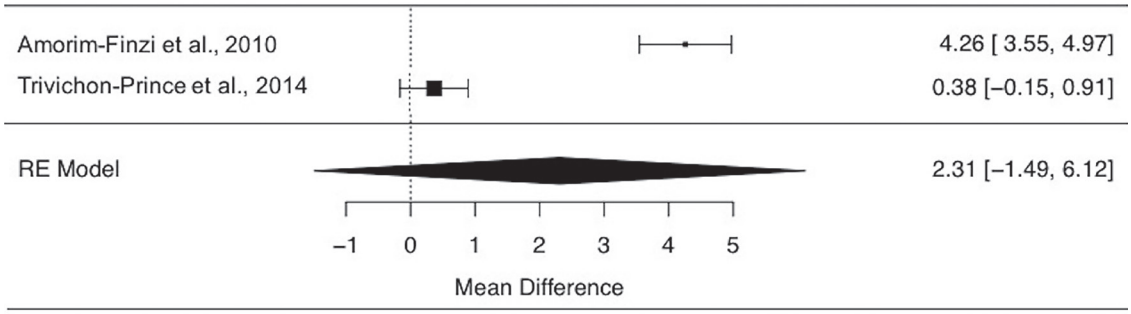
One study assessed the use of masks and goggles.[30] It found that dental students were less likely than educators to use the masks; protective eyewear was used by only 28.8% of the evaluated team during treatment contact. Another study evaluated the use of jewelry, the number and duration of HH steps, and the quality of cross-contamination protection.[29] However, that study did not provide detailed descriptions, only reporting that 61.5% of the educators and 31.8% of the students used watches incorrectly.

All three studies used the observational method, altering only the method of observation.[8,29,30] Two studies included a follow-up and observation period without the knowledge of the students and educators evaluated.[8,29] However, only one study was supplemented by a questionnaire on the stages of HH, to assess whether there was agreement between theoretical knowledge and practice.[29] Finally, one study used hidden cameras to enable two clinicians to collect and evaluate the data through the images obtained.[30]

All selected studies were evaluated using the FOG index. In ascending order, the individual scores were 11.52 for Thivichon-Prince et al.,[29] 12.33 for

Table 3. Summary of evaluation of the included articles (n=3)

First Author, Year	School Sector	Number of Participants	Follow-Up	Characteristics of Groups	Hygiene Products Evaluated	Other Ratings	Hand Hygiene Opportunities	Hand Hygiene Compliance
Thivichon-Prince, 2014	Dental teaching hospital	190 (39 dental educators, 151 dental students)	Groups observed for 77 hours; each individual observation for 40.5 minutes	Students with training in dentistry over period of 3 years	Alcohol	Watch, jewelry, long sleeve, and those with theoretical or practical training	993	396 (39.9%) Educators: 63.7% Students: 35.8%
Porter, 1995	Emergency oral medicine clinic in dental hospital	35 (0 dental educators, 35 dental students)	Groups observed for 5 weeks (Dec. 1992 to Jan. 1993)	Dentists and students performing surgical and restorative procedures	None determined	Use of gloves, face masks, and eye protection	65	30 (46.1%) Students only
Amorim-Finzi, 2010	University dental school	177 (43 dental educators, 134 dental students)	Groups observed for 11 months (Jan. to Dec. 2006)	Oral and maxillofacial surgery residents and graduating students	Alcohol	None determined	1,052	688 (56.4%) Educators: 78.4% Students: 45.0%



Random-Effects Model (k = 2; tau^2 estimator: DL)

tau^2 (estimated amount of total heterogeneity):	7.4344 (SE = 10.6588)
tau (square root of estimated tau^2 value):	2.7266
I^2 (total heterogeneity / total variability):	98.64%
H^2 (total variability / sampling variability):	73.51
Test for Heterogeneity:	Q(df = 1) = 73.5068 (P < 0.0001)

Model Results:

estimate	se	zval	pval	ci.lb	ci.ub
2.3115	1.9412	1.1907	0.2338	-1.4932	6.1163

Synthesis of the results:

Study	Dental Educator			Dental Student		
	Mean	SD	Total	Mean	SD	Total
Amorim-Finzi et al., 2010	6.5813	2.3830	43	2.3208	0.2574	134
Trivichon-Prince et al., 2014	2.3846	1.6320	39	2.0066	0.7980	151

Figure 3. Forest plot of hand hygiene compliance in association with educators and dental students

Amorim-Finzi et al.,[8] and 13.48 for Porter et al.[30] From these data, the average FOG index of the articles selected for this systematic review was 12.44. Thus, these articles about educator and dental student HH had an ideal level for reading and understanding the studies.

Discussion

In the dental routine of university clinics, educators and students are vulnerable and susceptible to contact with microorganisms, allowing cross-contamination.[31] Dental procedures may introduce pathogens into the bloodstream or lymphatic system via direct hematogenous dissemination or aspiration, causing various medical conditions, including bacteremia, aspiration pneumonia, coronary heart disease, low birthweight preterm delivery, infective endocarditis, gastrointestinal infections, and osteogenic infections.[32] Thus, preventive mechanisms that include HH and aseptic solutions should be adopted.

Proper hand washing is considered the most important and efficient way to remove microorganisms. Thivichon-Prince et al.'s study demonstrated

the importance of rubbing hands for 20 seconds or more in five to seven steps.[29] Singh et al. noted the importance of focusing on the difficulty of removing contaminated material from the hands, particularly the subungual and nail fold areas.[33] In addition, it is important to know the hygiene products and their components to avoid irritations and allergies, as dentists must ensure that their skin remains healthy and intact without breaking the skin barrier.[34]

Our review is the first systematic review evaluating hand hygiene compliance in dental education, comparing the attitudes of educators and students during clinical dental health care. Three studies met the inclusion criteria. All three studies found inadequate hand hygiene in universities.[8,29,30] There were confounding factors in the learning and clinical attitudes of students. These students were not counted or controlled in the studies, such as level of motivation, subject knowledge, learning style, social and psychological aspects, and pedagogical context.[35] The teaching style of educators was unclear, and how they may have influenced outcomes in relation to the low rate of student compliance is not known.

Proper hygiene with traditional hand washing requires considerable time for effective cleaning but does not provide as rapid and effective bactericidal activity as an alcohol-based hand sanitizer.[36-38] The use of alcohol was emphasized by two studies in our systematic review, being reported in the form of gels and liquids.[8,29] Alcohol use was only established when there was access to the antiseptic. Therefore, it is necessary for alcohol-based hand sanitizer to be readily available and easily accessible to dentistry to improve sanitation and reduce the chance of cross-contamination.

Although HH is the most important form of infection prevention and the focus of our study, there is concern about the use of accessories during health care. Thivichon-Prince et al. explored the presence of adornments preventing complete asepsis of the hands noting that watches, rings, jewelry, and bracelets serve as reservoirs for microorganisms.[29] These microorganisms are difficult to remove during HH and result in a high bacterial count, which can be transferred to the patient and cause infections.[39] Therefore, the WHO guidelines recommend that practitioners remove all jewelry during provision of health care.[1]

The use of personal protective equipment (PPE) was also considered in this study. Two of the selected articles discussed the importance of the use of masks, gloves, and goggles for protection against contaminating material and particles.[29,30] However, it should be emphasized that the use of PPE does not completely prevent the risk of infection and should be used as a complement to HH and exchange between patients. Gloves create a warm, moist environment in which organisms can proliferate,[29] and glove replacement after each patient is the most important factor for cross-infection control after HH.[40]

In the three studies evaluated, we analyzed HH opportunities and adherence among educators and students.[8,29,30] The dental educators had a higher compliance rate and more frequent use of protective equipment than the students. The dental students did not achieve more than 50% HH conformity. However, educators do not have direct and constant contact with patients when compared to students who perform the procedures. Thus, we do not consider the isolated results of the educator group to be good since they should ideally achieve 100% adherence to HH opportunities. This fact suggests a need for educators to be incentivized to meet these requirements given the importance of professional identity as a dentist and the advancement of clinical competence.[41] It is possible that the failure of educators to adhere to HH procedures is related to failures in dental education and a consequent poor professional attitude of dental graduates.[42]

In this systematic review, all three studies evaluated hand-washing compliance by observational means,[8,29,30] but only one of them associated observation with questionnaires.[29] In that study, the evaluated educators received a theoretical course on correct HH procedures, and the questions were based on their knowledge, attitudes, and opinions. A limited connection was observed between knowledge and compliance, suggesting the professionals benefited from the training program. Even so, a limitation was noted between knowledge and practice. In recent studies, predoctoral dental students were found to have adequate knowledge about the subject of hygiene; however, their practice was unsatisfactory with regard to infection control.[43,44] Therefore, we emphasize the importance of implementing educational and observational projects to improve student performance. In addition, health education programs need to be expanded for educators because the behavior of students is strongly influenced by their mentors.

LaDonna et al. found that the university clinical environment in medicine lacked sufficient information about HH methods and lacked evaluation and instruction of educators with students.[45] Similarly, Assiri et al. found that educators failed to teach dental

students how to perform to prevent patient infections.[46] As Singh et al. reminded us, dental education plays an important role in training students to adopt infection control measures they will then continue to use as practitioners.[33]

From the moment that theoretical training is established, it is extremely important that educators demand the exercise of all care in the clinical environment, as well as practicing this care in front of students to serve as an example.[47] Practical training can be reinforced and have a positive effect if there is planning of all clinical dynamics, such as organization of materials, development of risk maps, availability of aseptic solutions, adequate cleaning of the environment, and correct planning of every procedure.[48] Such methods prevent the interruption of the dental procedure and contact with contaminated areas, which undermines the hygiene process.

The level of evidence of this systematic review was considered low according to the GRADE criteria and our assessments, supporting the need for more well-designed research to fill the remaining data gaps. Evidence for the relationship between HH and teaching in dental schools is weak because of the limited number of studies and methodologies applied. Further studies should be conducted in the area of biosafety to inform dental school teaching.

Conclusion

Evidence from the studies reviewed in this systematic review suggests that educators' and students' hand hygiene compliance may be inadequate in dental schools. Dental students in these studies showed a need for greater attention to attitudes during learning. Educators, even with higher hand hygiene compliance rates, did not seem to set suitable standards for their students. However, we found insufficient scientific evidence in the literature to support the higher hand hygiene performance of students and educators from other universities and countries.

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