Odovtos-International Journal of Dental Sciences (Odovtos-Int. J. Dent. Sc.), Online First, 2025.
https://doi.org/10.15517/p60xse63 ISSN: 2215-3411

ODOVTOS
International Journal of Dental Sciences

UNIVERSIDAD DE COSTA RICA FOd Facultad de Odontología

https://revistas.ucr.ac.cr/index.php/Odontos

CLINICAL RESEARCH:

Knowledge and Compliance with the Infection Control Protocol in Dentistry at a Costa Rican University

Conocimiento y cumplimiento del protocolo de control de infecciones en odontología en una universidad costarricense

Carmen Dittel-Jiménez DDS, MTE[1] https://orcid.org/0000-0003-4234-0989
Andrea López-Soto DDS, MSc[2] https://orcid.org/0000-0003-2707-9671
Yadira V. Boza-Oreamuno DDS, MSc[3] https://orcid.org/0000-0002-0367-8664

[1]Universidad de Costa Rica, Departamento de Ciencias Restaurativas, Facultad de Odontología, San José, Costa Rica.
[2]The University of Texas at Austin, Department of Kinesiology and Health Education, Austin, TX, United States.
[3]Universidad de Costa Rica, Departamento de Ciencias Diagnósticas y Quirúrgicas, Facultad de Odontología, San José, Costa Rica.

Correspondence to: Yadira V. Boza Oreamuno - YADIRA.BOZA@ucr.ac.cr

Received: 3-XII-2025 Accepted: 10-XII-2025

ABSTRACT: Biosafety is essential for reducing exposure to infections and preventing contamination in dental practices. This study aimed to assess the knowledge level and compliance with the infection control protocol at a dental school within a university in Costa Rica. An online survey was distributed to all students, faculty, and support staff working in the university's dental clinics between May and June 2022. The questionnaire included items on sociodemographic characteristics, training and mechanisms of information dissemination, access to personal protective equipment (PPE), perceptions of protocol adherence, sharps injuries, and vaccination practices. Descriptive statistics and chi-square tests were used to analyze the data. A total of 232 individuals participated; the majority were women (71%). Clinical students represented 35% of respondents, followed by faculty (30%), preclinical students (25%), and support staff (10%). While 98% reported being familiar with the protocol and 79% had received training, the proportion of trained faculty was notably lower (55%). Faculty also reported lower adherence to PPE use and biomedical waste management procedures. Preclinical students reported limited access to handwashing stations and related supplies. Only 66% of participants reported performing proper hand hygiene, and 70% cleaned electronic equipment appropriately. Vaccination rates for hepatitis B and COVID-19 were high, but antibody testing frequency was low. Despite widespread awareness of infection control protocols, adherence varies across groups. Faculty and preclinical students exhibit greater challenges in compliance. Strengthening training efforts and improving access to essential biosafety resources are critical to enhancing protocol implementation and ensuring safer clinical environments.

KEYWORDS: Biosafety; Dental clinics; Communicable disease control; Education; Occupational health.

RESUMEN: La bioseguridad es esencial para reducir la exposición a infecciones y prevenir la contaminación en la consulta odontológica. El objetivo de esta investigación fue determinar el nivel de conocimiento y cumplimiento del protocolo de control de infecciones en una Facultad de Odontología en una universidad en Costa Rica. Se aplicó una encuesta por correo electrónico a todos los estudiantes, docentes y personal de apoyo en las clínicas entre mayo y junio de 2022. El cuestionario incluyó variables sociodemográficas, capacitación y divulgación de la información, acceso a equipo de protección personal (EPP), percepción del cumplimiento del protocolo, accidentes punzocortantes y vacunación. Se utilizó estadística descriptiva y la prueba de chi-cuadrado para el análisis de variables. Participaron 232 personas, la mayoría mujeres 71%. Estudiantes de clínica 35%, docentes 30%, estudiantes de preclínica 25% y personal de apoyo 10%. El 98% conocía el protocolo y el 79% había recibido capacitación, siendo menor en docentes (55%). Los docentes mostraron menor cumplimiento en el uso de EPP y manejo de residuos. Los estudiantes de preclínica percibieron menor acceso a estaciones de lavado de manos e insumos. Solo el 66% cumplía con la higiene de manos, y el 70% limpiaba equipos electrónicos. La vacunación contra hepatitis B y COVID-19 fue alta, los análisis de anticuerpos fueron bajos. Aunque el conocimiento sobre bioseguridad es elevado, su implementación práctica varía entre los grupos. Los docentes y estudiantes de preclínica enfrentan mayores desafíos. Se debe fortalecer la capacitación y mejorar el acceso a recursos.

PALABRAS CLAVE: Bioseguridad; Clínicas dentales; Control de enfermedades transmisibles; Educación; Salud ocupacional.

INTRODUCTION

Biosafety involves implementing safety measures to minimize exposure to potentially infectious microorganisms and prevent contamination of the work environment (1, 2). Research shows that healthcare workers face various occupational risks (physical, biological, chemical, ergonomic, and psychosocial), especially those in hospitals and healthcare centers, making it a major public health concern (3). In dentistry, infection control is a critical priority because clinical procedures inherently carry risks of exposure to pathogenic microorganisms. Such exposure may occur through contact with blood, saliva, and other bodily fluids (whether directly or indirectly) via contaminated instruments, equipment, aerosols, or clinical surfaces (4, 5).

In recent years, both internationally and in Costa Rica, numerous studies have been conducted to strengthen safety protocols for dental care and encourage adherence to biosafety recommendations (6-10). However, in the Costa Rican context, scientific evidence on infection control remains limited. Existing research has largely centered on hospital environments and the surveillance of nosocomial infections. For instance, Cole-Gutiérrez *et al*. (2006) conducted a retrospective descriptive study on hospital-acquired infections at San Rafael Hospital in Alajuela (11), and Mena Young *et al*. (2017) evaluated microbiological monitoring of healthcare-associated infections in national hospitals (12). Despite these contributions, no studies to date have specifically examined biosafety practices or infection control protocols within university-based dental clinical settings.

Dental schools are complex biological environments where academic training, clinical practice, and direct patient care converge. In these

settings, strict implementation of biosafety protocols is crucial to protect patients, faculty, and students alike (13). Students are an essential part of the team, actively involved in daily care activities (1,14), and faculty members serve crucial roles as educators and promoters of safe practices (15,16). The success of these practices and their adoption by students largely depends on the knowledge and leadership demonstrated by faculty in biosafety matters (17).

In this context, perceptions and levels of knowledge regarding infection control protocols are critical factors that require particular attention from health-related educational institutions. Such knowledge directly influences compliance with, and the effective implementation of, these protocols (18). Although some dental schools in Costa Rica have established infection control guidelines and committees responsible for periodically updating them (19), no studies have yet evaluated how these protocols are implemented in practice. Therefore, this study aims to assess the knowledge level and compliance with the Infection Control Protocol at a university dental school in Costa Rica. It explores the perceptions of students, faculty, and support staff to help improve a safe academic and clinical environment.

METHODS

This cross-sectional study was conducted in the clinical setting of a dental faculty at a public university from May to June 2022. The inclusion criteria covered students, faculty, and support staff involved in patient care. Individuals who declined participation or did not provide informed consent were excluded.

ETHICAL CONSIDERATIONS

This study received approval from the Scientific Ethics Committee of the public university (protocol CEC-162-2022). The survey header explained the project's nature, confidentiality and anonymization measures. The estimated time to complete the survey was provided. Informed consent was obtained from participants.

DATA COLLECTION

Data were collected via an online survey that assessed knowledge and perceived adherence to biosafety elements and practices in line with institutional protocols. The survey included single- and multiple-choice questions. Before distribution, the questionnaire was validated with 10 individuals with characteristics similar to those of the study participants. This ensured the clarity and relevance of the items. The survey was sent to all participants via institutional email using the LimeSurvey platform (General Public License). Three reminder emails were sent to increase the response rate. Confidentiality and data anonymization were guaranteed.

Sociodemographic variables included sex (male or female) and participant type (support staff, faculty, or clinical/preclinical students). Variables related to knowledge and perceptions of compliance with the Infection Control Protocol were defined as: (a) the presence or absence of training and information sharing; (b) access (yes/no) to equipment and materials for hand hygiene, cleaning and disinfection, personal protective equipment (PPE), and waste management; (c) perceived compliance with biosafety standards in these areas; (d) reported experiences (yes/no) with contaminated sharp instruments; and (e) up-to-date adherence (yes/no) to vaccination schedules.

STATISTICAL ANALYSIS

Data were recorded in an Excel spreadsheet (Microsoft, Inc., Redmond, WA, USA). Identified inconsistencies were reviewed and corrected. Descriptive statistics were used to show absolute and relative frequencies. Variable analysis was done using the Chi-square test. P-values below

0.05 were considered statistically significant, with 95% confidence intervals. All analyses were performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

The survey was distributed to 245 individuals, of whom 232 responded, yielding a response rate of 94.6%. Among respondents, 71% identified as women. The largest groups were clinical students (35%) and faculty members (30%), followed by preclinical students (25%) and support staff (10%) (Table 1).

Since completing the questionnaire was optional, item-level response rates ranged from 67% to 98%. Overall, 98% of participants reported being familiar with the Faculty's Infection Control Protocol. By group, familiarity was reported by 95% of support staff, 98% of faculty, 99% of clinical students, and 98% of preclinical students.

Table 2 summarizes the distribution of responses across questionnaire categories and indicates whether statistically significant differences were observed among the Faculty groups. Regarding training and dissemination of information, 79% of participants reported having received training on the Infection Control Protocol, with significant differences across groups; faculty reported the lowest rate (55%). This lower pattern of affirmative responses among faculty was consistent for the appropriate use of PPE (73%, $p<.01$) and for the selection and handling of dental care waste (64%, $p<.01$). Concerning informational posters, 61% of respondents considered the content appropriate, and 40% believed the number was sufficient. Preclinical students reported the lowest approval rates for both content (38%, $p<.01$) and quantity (22%, $p=.03$).

Access to equipment and materials was evaluated in four areas: hand hygiene, cleaning and disinfection, PPE, and waste management. For hand hygiene, alcohol-based disinfectant was identified as the least accessible resource (78%, $p<.01$), although support staff unanimously reported easy access (100%). Only 71% of respondents considered the number of handwashing stations at the building entrance adequate ($p<.01$), with preclinical students reporting the lowest agreement (42%). Additionally, 78% believed the Faculty provides appropriate supplies for cleaning and disinfecting their work areas.

In the PPE access category, the lowest favorable response rates were for surgical masks (77%, $p<.01$) and surgical gloves used in specific procedures (75%, $p<.01$). In waste management, participants reported lower rates of adequacy for containers designated for infectious waste (78%), general waste (81%), and especially sharps disposal (57%). Statistically significant differences were observed for sharps containers, with clinical students reporting the lowest adequacy rate (39%, $p<.01$).

Perceptions of compliance with the Infection Control Protocol were also assessed in four parallel categories. For hand hygiene practices, 55% of respondents stated they wash their hands when visibly soiled and before donning gloves. Additionally, 66% reported washing their hands after touching instruments, equipment, materials, or other potentially contaminated surfaces with bare hands, with faculty reporting the lowest compliance (51%, $p<.01$). A total of 64% indicated they wash their hands immediately after removing gloves.

In the cleaning and disinfection category, 70% reported disinfecting electronic devices used for accessing electronic records, with preclinical

students again showing the lowest compliance (47%, p<.01). Only 33% of students reported cleaning and disinfecting all clinical surfaces with 70% or higher alcohol solution at the end of patient care or their clinical session (p=.03). Nearly all respondents (99%) reported proper handling of hazardous and non-hazardous waste. Regarding PPE use, the lowest adherence rates were observed for surgical masks (40%, p<.01), protective goggles (57%, p<.01), and face shields (83%, p<.01).

Regarding sharps-related accidents, 91% of participants reported never having experienced such an incident (80% of support staff, 91% of faculty, 86% of clinical students, and 52% of preclinical students; p=.02; 91% response rate). Among the 20 individuals who reported an incident, 17 involved puncture injuries and 4 involved cuts. Most respondents (98%) indicated that sharps injuries should be reported to the university entity (Dental Services and Laboratories Directorate) within 24 hours (100% of support staff; 98% of faculty, clinical, and preclinical students; 71% response rate). Regarding the recommended timeframe for visiting the National Insurance Institute, 81% reported that this should also occur within 24 hours (94% support staff, 77% faculty, 79% clinical students, and 81% preclinical students; 67% response rate).

Finally, regarding vaccination schedules, 96% of participants (100% support staff, 92% faculty, 100% clinical students, and 94% preclinical students; 86% response rate) reported having a complete vaccination schedule for clinical work. Fewer participants (77% overall) reported having undergone Hepatitis B surface antibody testing, with significant group differences (60% support staff, 61% faculty, 97% clinical students, and 75% preclinical students; 90% response rate; p<.01). All participants reported being vaccinated against COVID-19 (90% response rate), and 89% indicated having received three doses (90% support staff, 95% faculty, 80% clinical students, and 92% preclinical students; p=.02).

Table 1. Distribution of sociodemographic variables.

	Participants				
	Total (100%)	**Support staff (10%)**	**Professor (30%)**	**Clinical student (35%)**	**Preclinical student (25%)**
Sex					
Male	67 (29%)	3 (14%)	27 (39%)	26 (32%)	11 (19%)
Female	165 (71%)	19 (86%)	43 (61%)	56 (68%)	47 (81%)
Total	232 (100%)	22 (100%)	70 (100%)	82 (100%)	58 (100%)

Table 2. Response Distribution on Knowledge, Access, and Use of Biosafety Elements and Practices at the Faculty of Dentistry, University of Costa Rica.

Survey Questions by Category	Survey Population					
	Total (% response per item)	Support Staff (%)	Professor (%)	Clinical Student (%)	Preclinical Student (%)	p
Training and Information Dissemination (N, Yes responses)						
Training on biosafety practices (223, Yes)	177 (79%)	14 (70%)	37 (55%)	79 (99%)	47 (84%)	<0.01
Training related to cleaning and disinfection of work area (214, Yes)	131 (61%)	9 (45%)	28 (42%)	60 (79%)	34 (67%)	<0.01
Training on appropriate use of personal protective equipment (210, Yes)	187 (89%)	17 (89%)	48 (73%)	74 (100%)	48 (94%)	<0.01
Training on selection and proper handling of dental care waste (209, Yes)	179 (86%)	16 (84%)	41 (64%)	73 (99%)	49 (94%)	<0.01
Informational poster content on biosafety is adequate (209, Yes)	127 (61%)	11 (52%)	41 (65%)	57 (73%)	18 (38%)	<0.01
Quantity of biosafety informational posters in the Faculty is sufficient (215, Yes)	85 (40%)	9 (45%)	28 (43%)	37 (47%)	11 (22%)	0.03
Access to Equipment and Materials						
Hand Hygiene						
Dental care personnel have easy access to sinks inside the building (223, Yes)	218 (98%)	20 (95%)	68 (99%)	77 (96%)	53 (100%)	NS
Dental care personnel have easy access to liquid soap inside the building (223, Yes)	214 (96%)	20 (95%)	69 (100%)	73 (91%)	52 (98%)	0.04
Dental care personnel have easy access to paper towels inside the building (223, Yes)	205 (92%)	20 (95%)	67 (97%)	70 (88%)	48 (91%)	NS
Dental care personnel have easy access to alcohol-based hand sanitizer in-side the building (223, Yes)	175 (78%)	21 (100%)	51 (74%)	56 (70%)	47 (89%)	<0.01
Dental care personnel have access to informational posters with proper hand hygiene instructions (194, Yes)	176 (91%)	19 (95%)	53 (90%)	66 (89%)	41 (93%)	NS
It is considered that the number of handwashing stations placed at the building entrances is sufficient (219, Yes)	155 (71%)	16 (76%)	53 (79%)	64 (81%)	22 (42%)	<0.01
Cleaning and Disinfection						
The Faculty has appropriate supplies for cleaning and disinfecting the work area (214, Yes)	166 (78%)	17 (89%)	47 (70%)	64 (83%)	38 (75%)	NS
Personal Protective Equipment						
The Faculty provides appropriate PPE: gloves (213, Yes)	210 (99%)	20 (100%)	66 (99%)	74 (100%)	50 (96%)	NS
The Faculty provides appropriate PPE: N95 respirator (213, Yes)	192 (90%)	18 (90%)	57 (85%)	68 (92%)	49 (94%)	NS
The Faculty provides appropriate PPE: surgical mask (213, Yes)	164 (77%)	19 (95%)	62 (93%)	59 (80%)	24 (46%)	<0.01
The Faculty provides appropriate PPE: cap (213, Yes)	212 (100%)	20 (100%)	66 (99%)	74 (100%)	52 (100%)	NS
The Faculty provides appropriate PPE: disposable gown (213, Yes)	210 (99%)	20 (100%)	65 (97%)	74 (100%)	51 (98%)	NS
The Faculty provides appropriate PPE: surgical gloves for surgical procedures (213, Yes)	160 (75%)	17 (85%)	43 (64%)	72 (97%)	28 (54%)	<0.01
The Faculty provides easy access to PPE (202, Yes)	177 (88%)	18 (95%)	59 (89%)	64 (88%)	36 (82%)	NS

Survey Questions by Category	Survey Population					
	Total (% response per item)	Support Staff (%)	Professor (%)	Clinical Student (%)	Preclinical Student (%)	p
The clinics have red bins labeled with the biohazard symbol (212, Yes)	211 (100%)	20 (100%)	65 (98%)	74 (100%)	52 (100%)	NS
It is considered that the number of red bins for disposing of infectious clinical waste is adequate (212, Yes)	166 (78%)	15 (79%)	57 (85%)	58 (78%)	36 (69%)	NS
The clinics have bins for general waste (211, Yes)	209 (99%)	18 (95%)	67 (100%)	74 (100%)	50 (98%)	NS
It is considered that the number of bins for general waste in the clinical environment is adequate (208, Yes)	169 (81%)	12 (71%)	57 (86%)	63 (85%)	37 (73%)	NS
The clinics have red containers for the disposal of sharps (210, Yes)	209 (100%)	19 (100%)	66 (100%)	73 (99%)	51 (100%)	NS
It is considered that the number of red containers for the disposal of sharps is adequate (206, Yes)	118 (57%)	13 (72%)	47 (76%)	29 (39%)	29 (56%)	<0.01
Perception of Compliance with the Infection Control Protocol						
Hand Hygiene						
Performs handwashing when hands are visibly dirty (223, Yes)	123 (55%)	8 (38%)	34 (49%)	51 (64%)	30 (57%)	NS
Performs handwashing after touching instruments, equipment, materials, and other objects that may be contaminated with blood, saliva, or respiratory secretions with bare hands (223, Yes)	148 (66%)	12 (57%)	35 (51%)	60 (75%)	41 (77%)	<0.01
Performs handwashing before and after treating each patient (223, Yes)	199 (89%)	14 (67%)	62 (90%)	74 (93%)	49 (92%)	<0.01
Performs handwashing before putting on gloves (223, Yes)	123 (55%)	10 (48%)	35 (51%)	40 (50%)	38 (72%)	NS
Performs handwashing immediately after removing gloves (223, Yes)	143 (64%)	15 (71%)	48 (70%)	46 (58%)	34 (64%)	NS
Cleaning and Disinfection						
Performs cleaning and disinfection of their workspace (215, Yes)	207 (96%)	20 (100%)	62 (91%)	77 (100%)	48 (96%)	0.03
Performs cleaning and disinfection of electronic devices used to access electronic records (computer, tablet, phone, etc.) (210, Yes)	148 (70%)	20 (100%)	48 (72%)	58 (76%)	22 (47%)	<0.01
As a student, performs cleaning and disinfection with 70% or higher alcohol solution on all surfaces at the end of patient treatment or clinical shift (129, Yes)	43 (33%)			20 (26%)	23 (44%)	0.03
As a student, performs cleaning and disinfection with medical/dental-grade disinfectant on all surfaces at the end of patient treatment or clinical shift (129, Yes)	116 (90%)			73 (95%)	43 (83%)	0.03
As a student, uses protective barriers (adhesive plastic sheets) on equip-ment as appropriate (129, Yes)	129 (100%)			77 (100%)	52 (100%)	NS
As a student, replaces protective barriers (adhesive plastic sheets) between patients (129, Yes)	128 (99%)			77 (100%)	51 (98%)	NS
All instruments used in clinical care have undergone a sterilization process (207, Yes)	203 (98%)	19 (95%)	59 (95%)	73 (100%)	52 (100%)	NS

Survey Questions by Category	Survey Population					
	Total (% response per item)	Support Staff (%)	Professor (%)	Clinical Student (%)	Preclinical Student (%)	p
Wears gloves during clinical care (213, Yes)	213 (100%)	20 (100%)	67 (100%)	74 (100%)	52 (100%)	NS
Wears N95 respirator during clinical care (213, Yes)	203 (95%)	19 (95%)	62 (93%)	71 (96%)	51 (98%)	NS
Wears surgical mask during clinical care (213, Yes)	86 (40%)	14 (70%)	35 (52%)	27 (36%)	10 (19%)	<0.01
Wears cap during clinical care (213, Yes)	209 (98%)	20 (100%)	63 (94%)	74 (100%)	52 (100%)	0.03
Wears protective goggles during clinical care (213, Yes)	122 (57%)	6 (30%)	33 (49%)	48 (65%)	35 (67%)	<0.01
Wears face shield during clinical care (213, Yes)	176 (83%)	14 (70%)	55 (82%)	72 (97%)	35 (67%)	<0.01
Wears gown during clinical care (213, Yes)	206 (97%)	20 (100%)	66 (99%)	74 (100%)	46 (88%)	<0.01
Wears one-piece shoes for patient care tasks (213, Yes)	182 (85%)	7 (35%)	49 (73%)	74 (100%)	52 (100%)	<0.01
Waste Management						
Properly handles hazardous and non-hazardous waste (205, Yes)	203 (99%)	19 (100%)	62 (98%)	73 (100%)	49 (98%)	NS

PAO: dental care personnel; PPE: personal protective equipment.

DISCUSSION

This study represents the first systematic effort in Costa Rica to assess knowledge and compliance with the Infection Control Protocol in a university dental school setting. The findings indicate widespread awareness of the institutional protocol and high participation in training activities; however, significant differences emerged among faculty groups, with lower compliance observed among faculty members and preclinical students. Strengths included vaccination coverage and appropriate management of biological waste, while areas requiring improvement included access to essential supplies, adherence to hand hygiene practices, and the correct use of personal protective equipment. Overall, these results provide an initial overview of protocol compliance within the school and underscore the need to strengthen educational strategies, supervision, and resource allocation to support a safer academic and clinical environment. The following sections discuss each evaluated component in greater detail.

Most participants reported familiarity with the Faculty's Infection Control Protocol, particularly regarding training and information dissemination. This contrasts with previous studies that have documented gaps in infection control training in university settings. For example, a study conducted at a Romanian university found that only 76% of dental students were aware of standard precautions (1). Such differences may reflect a more consolidated implementation of guidelines in the present institutional context. However, perceptions of poster-based dissemination revealed important areas for improvement, especially among preclinical students. These findings are consistent with a Brazilian study showing that students in the later stages of their training (who had received both theoretical and practical biosafety instruction) demonstrated significantly higher knowledge scores (20). Prior research has emphasized that inadequate educational resources limit adherence to infection control protocols (18), underscoring the need for well-structured, continuous training initiatives.

Despite high familiarity with the protocol, faculty participation in training is lower, potentially reducing compliance. Improving communication, supervision, and ongoing education is critical for maintaining biosafety standards. The study finds adequate access to safety resources but reveals differences between perceived and actual compliance, echoing previous work that notes knowledge does not always translate into practice.

Hand hygiene is one of the most effective and accessible measures for reducing the transmission of microorganisms, with handwashing with soap and water widely recognized as a fundamental preventive practice (22). Despite its importance, low compliance has been documented across multiple settings. At a university dental hospital in Japan, for example, baseline adherence was only 15.6%, although rates improved following targeted educational interventions (23). Similarly, in a university dental clinic in Germany, only 31.4% to 39.1% of staff performed hand hygiene after removing gloves (24). In Brazil, dental students demonstrated adequate knowledge of hand hygiene, yet insufficient infrastructure and inadequate faculty modeling were identified as key barriers to consistent practice (25). Consistent with this evidence, our findings show that although most participants considered the number of handwashing stations sufficient, faculty members reported lower compliance with handwashing practices. This pattern highlights the need for strengthened continuous training and more active supervision to support effective implementation of infection control protocols.

Regarding cleaning and disinfection, the findings of this study align with recent literature, which emphasizes the need to strengthen infection

control practices in dentistry, particularly during aerosol-generating procedures. In Saudi Arabia, a good level of knowledge about these measures was reported, but significant gaps in practice were also identified, such as insufficient disinfection of digital equipment between patients (26). In our study, a low percentage of students (especially in preclinical training) reported disinfecting electronic devices, as well as limited use of 70% alcohol for surface cleaning at the end of treatment. More standardized training and faculty supervision are needed to bridge the gap between resource availability and use.

Use of PPE shows a comparable pattern. Although multiple measures (such as proper PPE use, high-volume suction, and filtered ventilation) are recognized as effective infection control strategies, their implementation in clinical practice is often inconsistent or not sustained over time (27). Studies conducted during the COVID-19 pandemic reported increased use of N95 respirators and face shields among dental healthcare workers, but also noted barriers such as discomfort and limited availability (28). Research from China found that although nearly 94% of dentists reported using surgical masks, only about 64% used goggles or face shields, and fewer than 55% replaced them as recommended (29). Our results reflect these international trends. While participants acknowledged the importance of PPE and indicated access to necessary supplies, faculty members demonstrated lower compliance rates, suggesting opportunities for improvement in both supply management and actual use. These findings underscore the need for targeted training initiatives and institutional protocols that promote the systematic and consistent use of not only masks and respirators, but also of eye protection and full-face shields.

Waste management emerged as another area with notable deficiencies, particularly in the handling of sharps waste and in differing perceptions of the adequacy of disposal containers between faculty and students. Lower faculty compliance compared to students suggests a more pronounced gap between knowledge, perception, and daily practice among faculty in the dental education environment. These findings align with research from other Latin American settings, which have documented both structural and educational barriers. For instance, at the University Dental Clinic in Juliaca, Peru, the final disposal of solid waste did not consistently meet institutional standards due to insufficient containers and inadequate staff training (30). Likewise, a study conducted in Brazil identified significant gaps in students' and clinicians' knowledge of waste categorization, relevant legislation, and routine disposal procedures, reinforcing the notion that a disconnect often exists between what individuals know and what they actually do in clinical practice (31).

Sharps injuries are infrequent but mostly involve needlesticks. Reporting knowledge is adequate, but the prevalence and underreporting elsewhere highlight the importance of ongoing vigilance. These findings differ from international evidence, which consistently shows a high prevalence of sharps injuries in dental settings and frequent underreporting. Globally, the prevalence among dental students has been estimated at approximately 44%, with procedures such as local anesthesia administration, scaling, and waste disposal posing the greatest risk (32). Studies have also highlighted substantial underreporting and insufficient knowledge of post-exposure management, both of which elevate the risk of pathogen transmission. Sharps injuries remain a significant occupational hazard in dentistry, as they markedly increase the likelihood of acquiring bloodborne infections, including hepatitis B; dentists have been reported to be three to four times more likely to contract this infection compared with the general population (26).

Vaccination of healthcare workers is a critical component of infection control, as it protects clinical personnel from vaccine-preventable

diseases and reduces the risk of transmission to vulnerable patients (33). Adherence to immunization schedules, such as those for influenza and tetanus-diphtheria-pertussis (Tdap), has been shown to significantly lower infection rates in both hospital and community settings (34). In Costa Rica, the National Vaccination Law mandates immunization of healthcare workers against diseases designated as priorities by the Ministry of Health (35). Within this framework, the findings of the present study demonstrate high adherence among participants: most reported completing the vaccination schedule required for clinical activities, and all indicated being vaccinated against COVID-19, with the majority having received at least three doses. However, fewer participants reported undergoing serological testing to confirm hepatitis B immunity. This gap highlights the need to strengthen post-vaccination follow-up as part of comprehensive infection control efforts in clinical-educational environments.

Several limitations should be considered when interpreting the findings of this study. First, variation in response rates across participant groups may affect the representativeness of the results, particularly for smaller subgroups. Second, the data rely on self-reported information, which may introduce social desirability and recall biases. Third, because no direct observations of clinical practices were conducted, the study could not objectively verify compliance with infection control measures. Finally, the research was conducted within a single university setting, limiting the generalizability of the findings to other institutions or regions. Despite these limitations, the study provides valuable, up-to-date insights into access, perceptions, and compliance with infection control protocols in a university dental clinic. Important differences among support staff, faculty, and students were identified, revealing specific areas for improvement, including inconsistent PPE use, suboptimal hand hygiene practices, gaps in waste management, and limited training among preclinical students. The study also contributes to regional evidence by situating local findings within the broader international literature.

The observed discrepancies between knowledge and actual practice suggest that training alone is insufficient to ensure compliance. Access to resources, continuous supervision, and a supportive institutional culture appear to play critical roles in promoting safe practices. Implementing strategies such as internal audits, clinical simulations, and periodic protocol reinforcement may strengthen adherence to infection control protocols within the dental school.

CONCLUSIONS

The findings of this study reveal partial and uneven compliance with infection control protocols within the dental faculty, with lower adherence observed among preclinical students and certain faculty members, particularly in key areas such as hand hygiene, PPE use, and surface disinfection. Although most participants reported completing their vaccination schedules, gaps remain in serological testing and in the timely reporting of sharps injuries. Overall, the results highlight the need to strengthen ongoing training, supervision, and auditing processes to promote consistent adherence to infection control standards. Implementing these measures will enhance protection for both staff and students and contribute to a safer clinical environment for healthcare trainees and the patients they serve.

AUTHOR CONTRIBUTION STATEMENT: Conceptualization and design: A.L.S. and Y.B.O.; Literature review: C.D.J and Y.B.O.; Methodology and validation: A.L.S. and Y.B.O.; Formal analysis: A.L.S. and Y.B.O.; Research and data collection: C.D.J. and Y.B.O.; Resources: Y.B.O.; Data analysis and interpretation: A.L.S. and Y.B.O. Writing-preparation of the original draft: C.D.J., A.L.S. and Y.B.O. Writing-reviewing and editing: C.D.J., A.L.S. and Y.B.O. Supervision: Y.B.O. Project management: Y.B.O. Acquisition of funds: Y.B.O.

FUNDING: University of Costa Rica Vice Rector's Office for Research ordinary funds Project C2345 given to MSc. Yadira V. Boza-Oreamuno.

CONFLICTS OF INTEREST: None declared.

REFERENCES

1. Dincă F.I., Dimitriu B.A., Săndulescu O., Sîrbu V.D., Săndulescu M. Knowledge, Attitudes, and Practices of Dental Students from Romania Regarding Self-Perceived Risk and Prevention of Infectious Diseases. Dent J. 2024; 12 (4): 97. doi: 10.3390/dj12040097
2. Zhou D., Song H., Wang J., Li Z., Xu S. Biosafety and biosecurity Dongsheng. J Biosaf Biosecur. 2020; 1: 15-8. doi:10.1016/j.jobb.2019.01.001
3. Che Huei L., Ya-Wen L., Chiu Ming Y., Li Chen H., Jong Yi W., Ming Hung L. Occupational health and safety hazards faced by healthcare professionals in Taiwan: A systematic review of risk factors and control strategies. SAGE Open Med. 2020; 8: 1-12. doi: 10.1177/2050312120918999
4. Săndulescu M., Nicolescu M.I., Funieru C., Şahin G.Ö., Săndulescu O. Exposure to Biological Fluids in Dental Practice. Narrative Review on Appropriate Risk Assessment to Guide Post-Exposure Management. Vol. 12, Pathogens. Multidisciplinary Digital Publishing Institute (MDPI); 2023; 12: 968. doi: 10.3390/pathogens12070968
5. Centers for Disease Control and Prevention. Resumen de prácticas para la prevención de enfermedades en entornos odontológicos: expectativas básicas para la atención segura [Internet]. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Oral Health; 2017. p. 44. Available from: http://www.cdc.gov/hai/settings/outpatient/outpatient-care-guidelines.html
6. La-Rotta E.I.G., Garcia C.S., Pertuz C.M., Miquilin I. de O.C., Camisão A.R., Trevisan D.D., Aoki F.H., Correa-Filho, H.R. Knowledge and compliance as factors associated with needlestick injuries contaminated with biological material: Brazil and Colombia. Ciência & Saúde Coletiva. 2020; 25 (2): 715-27. doi: 10.1590/1413-81232020252.04812018
7. Llapa-Rodriguez E.O., da Silva G.G., Neto D.L., Campos M.P. de A., de Mattos M.C.T., Otero L.M. Measures for the adhesion to biosafety recommendations by the nursing team. Enfermeria Global. 2018; 17 (1): 36-46. doi: 10.6018/eglobal.17.1.276931
8. Tipayamongkholgul M., Luksamijarulkul P., Mawn B., Kongtip P., Woskie S. Occupational Hazards in the Thai Healthcare Sector Mathuros. New Solut. 2016; 26 (1): 83-102. doi:10.1177/1048291116633871
9. Vazquez-Alcaraz S.J., Rodriguez-Soto M.C., Monroy-Salcedo R.A., Cardenas-Delgado R.K. Development and validation of an instrument to assess adherence to occupational health protocols in dentistry. J Dent Educ. 2021; 1-10. doi:10.1002/jdd.12454
10. Lorosa A.H., Pereira C.M., Hussne R.P., Silva-Boghossian C.M. Evaluation of dental students' knowledge and patient care towards HIV/AIDS individuals. European Journal

of Dental Education. 2019; 23: 212-9. doi:10.1111/eje.12423
11. Cole-Gutiérrez R., Martínez-Mairena J., Cedeño-Cascante T. Incidencia de infecciones intrahospitalarias en el Hospital San Rafael de Alajuela durante el año 2002. Rev Costarric Cienc Med. 2006; 27 (3): 87-91.
12. Mena Young K., Elizondo Wallace D., Delgado Picado M.E. Monitoreo microbiológico en las infecciones asociadas a la atención en salud (IASS): Una propuesta para la atención con calidad y seguridad del paciente. Revista Médica de Costa Rica y Centroamérica. 2017;LXXIV(624): 129-35.
13. Binalrimal S., AlDrees A., AlWehaibi M., AlAsmary M., AlShammery A., AlHaidri E., et al. Awareness and compliance of dental students and interns toward infection control at Riyadh Elm University. GMS Hyg Infect Control. 2019; 14: 1-6. doi:10.3205/dgkh000326
14. Ayub S.S., Sinor M.Z., Ahmad B., Ibrahim N. Compliance towards Infection Control Practice among Clinical Dental Students, Universiti Sains Malaysia, Malaysia. Health Sci J. 2019, 13 (5): 675. doi: 10.21767/1791-809X.100675
15. Kuhar D.T., Henderson D.K., Struble K.A., Heneine W., Thomas V., Cheever L.W., et al. Updated US Public Health Service Guidelines for the Management of Occupational Exposures to Human Immunodeficiency Virus and Recommendations for Postexposure Prophylaxis. Infect Control Hosp Epidemiol. 2013; 34 (9): 875-92. doi:10.1086/672271
16. Tapias Torrado L.E., Fortich Mesa N., Castellanos Pérez V. Evaluación de los conocimientos y prácticas de bioseguridad para prevenir los eventos adversos y los accidentes ocupacionales en estudiantes de odontología. Ciencia y Salud virtual. 2013; 5 (1): 87-94. doi:10.22519/21455333.338
17. Diaz-Tamayo A.M., Vivas M. M.C. Riesgo biológico y prácticas de bioseguridad en docencia. Rev. Fac. Nac. Salud Pública. 2015; 34 (1): 62-69. doi:10.17533/udea.rfnsp.v34n1a08
18. Ghimire B., Chandra S. Awareness of Infection Control among Dental Students and Interns. J Nepal Med Assoc. 2018; 56 (210): 598-601.
19. Facultad de Odontología, Universidad de Costa Rica. Protocolo de control de infecciones de la Facultad de Odontología, versión 002. San José, Costa Rica: Universidad de Costa Rica; 2023. p. 1-36.
20. Fernández M.S., Cascaes A.M., Muniz F.W.M.G., Silva N.R.J. Da, Bielavski C.H., Silva A.E.R. Knowledge About Biosafety Measures in Clinical Setting During the COVID-19 Pandemic: A Cross-Sectional Study With Brazilian Dental Students. Disaster Med Public Health Prep. 2022; 17: 1-10. doi:10.1017/dmp.2022.9
21. Alharbi G., Shono N., Alballaa L., Aloufi A. Knowledge, attitude and compliance of infection control guidelines among dental faculty members and students in KSU. BMC Oral Health. 2019; 19: 7. doi:10.1186/s12903-018-0706-0
22. Freeman M.C., Stocks M.E., Cumming O., Jeandron A., Higgins J.P.T., Wolf J., et al. Systematic review: Hygiene and health: Systematic review of handwashing practices worldwide and update of health effects. Tropical Medicine and International Health. 2014; 19 (8): 906-16. doi:10.1111/tmi.12339
23. Kuroda H., Sawai N.Y., Yamazaki Y., Matsumoto H., Tsujigami H., Tsukimoto S., et al. Impact of Direct Observation on Hand Hygiene Compliance in a Dental University Hospital: A Retrospective Cohort Study. Cureus. 2024; 16 (9): e68827. doi:10.7759/cureus.68827

24. Mutters N.T., Hägele U., Hagenfeld D., Hellwig E. Compliance with infection control practices in an university hospital dental clinic. GMS Hyg Infect Control. 2014; 9 (3):1-5. doi:10.3205/dgkh000238
25. Costa E.D. da, Ambrosano G.M.B., Pinelli C. Behavior and perceptions of hand hygiene practices among dental students. Rev Gaúch Odontol, Porto Alegre. 2016; 64 (4): 434-41. doi:10.1590/1981-86372016000300003113044
26. Alkadi L., Farook F.F., Binmoghaiseeb I., Alyousef Y., Alabdulwahab A., Aljohani R, et al. Knowledge and Compliance with Infection Prevention and Control Practices in Prosthodontic Procedures Among Dental Students and Professionals. Healthcare. 2024;12(24):2536. doi:10.3390/healthcare12242536
27. Ghoneim A., Proaño D., Kaur H., Singhal S. Aerosol Generating Procedures and Associated Control/Mitigation Measures: A position paper from the Canadian Dental Hygienists Association and the American Dental Hygienists' Association. Journal of dental hygiene. 2024; 98 (1): 6-57.
28. Vogt L.C., Reske K.A., Park D., Habrock Bach T., Stewart H.B., Arter O.G., et al. Personal protective equipment use among dental healthcare personnel during the coronavirus disease 2019 (COVID-19) pandemic and the impact of an educational video in clinical practice. Infect Control Hosp Epidemiol. 2023; 44: 1472-1480. doi:10.1017/ice.2023.6
29. Wan Q., Han L., Yang X., Yu S., Zheng X. Dental professionals' use of personal protective equipment during COVID-19: a cross-sectional study in China. Front Public Health. 2023; 11:1183580. doi:10.3389/fpubh.2023.1183580
30. Cari H., Zúñiga E. Manejo y disposición final de residuos sólidos en la clínica odontológica universitaria en Juliaca. Rev. Evid. Odontol. Clinic. 2016; 2 (1): 8-11.
31. Puri S., Smriti K., Pentapati K.C., Singh R., Vineetha R., Tamrakar A. Assessment of awareness about various dental waste management practices among dental students and practicing clinicians. Pesqui Bras Odontopediatria Clin Integr. 2019;19:e4839. doi:10.4034/PBOCI.2019.191.136
32. Huang J., Li N., Xu H., Liu Y., An N., Cai Z. Global prevalence, risk factors, and reporting practice of needlestick and sharps injuries among dental students: a systematic review and meta-analysis. Journal of Hospital Infection. 2022; 129: 89-101. doi: 10.1016/j.jhin.2022.06.015
33. Maltezou H.C., Poland G.A. Immunization of health-care providers: Necessity and public health policies. Healthcare (Basel). 2016; 4 (3): 47. doi:10.3390/healthcare4030047
34. Clari M., Albanesi B., Comoretto R.I., Conti A., Renzi E., Luciani M., Davide A., Azzurra M., Valerio D. Effectiveness of interventions to increase healthcare workers' adherence to vaccination against vaccine-preventable diseases: a systematic review and meta-analysis, 1993 to 2022. Euro Surveill. 2024; 29 (9): pii=2300276. doi:10.2807/1560-7917.ES.2024.29.9.2300276
35. Ministerio de Salud. Decreto Ejecutivo N.° 42889-S, Presidente de la República y el Ministro de Salud [Internet]. Costa Rica: Ministerio de Salud; 2021 [cited 2025 Sep 20]. Available from: https://www.ccss.sa.cr/arc/actas/OFICIOS/2021/9169/Artículo60/GM-3560-2021-anexo.pdf