

## ORIGINAL ARTICLE

# Knowledge and Attitude towards Dental Unit Waterline System Decontamination among Undergraduate and Postgraduate Dental Students in Universiti Sains Malaysia

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## ABSTRACT

**Introduction:** Dental unit waterline system (DUWLS) decontamination is an important infection control in dental practice. This study aimed to determine knowledge and attitude towards DUWLS decontamination and its associated factors among undergraduate and postgraduate dental students in Universiti Sains Malaysia. **Methods:** A cross-sectional study was conducted using a validated questionnaire administered online using Google Forms to assess the knowledge and attitude of dental students towards DUWLS decontamination. Descriptive and inferential statistics using independent t-test, Pearson, and Spearman correlation were carried out using SPSS version 24.0. **Results:** A total of 169 dental students participated in the study, and the majority were female (71.6%) and Malay (59.2%). The mean (SD) age was 23.2 (0.93) and 34.4 (2.65), for the undergraduates and postgraduates, respectively. The mean (SD) knowledge scores for the undergraduates and postgraduates were 11.6 (4.23) and 18.0 (2.82), respectively, whereas the mean attitude scores were 51.3 (7.86) and 54.6 (4.74), respectively. The postgraduates had significantly higher mean knowledge and attitude scores than the undergraduates ( $p < 0.001$ ). The significant factors associated with the undergraduates' knowledge were received information and guidance and their personal experience in managing DUWLS ( $p < 0.05$ ). However, only received information on DUWLS was significantly associated with the postgraduate's knowledge score ( $p = 0.011$ ). Age factor had a significant association with the attitude score among the postgraduates ( $p = 0.014$ ). **Conclusion:** The knowledge regarding DUWLS decontamination was relatively moderate in both groups. However, both groups showed a favourable attitude towards DUWLS decontamination. Significantly higher knowledge and attitude scores were presented among the postgraduates than the undergraduates. *Malaysian Journal of Medicine and Health Sciences* (2022) 18(4):50-61. doi:10.47836/mjmhs18.4.8

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## INTRODUCTION

The unprecedented emergence of the COVID-19 pandemic has had ramifications across many industries, including dental healthcare (1). Due to the unclear danger of the COVID-19 in the early phases of the pandemic, many dental clinics operations were halted, and dental practitioners faced the risks of biological hazards and challenges when providing dental care to their patients (1,2). According to the literature, it was reported that human-to-human transmission of the infectious disease might occur through direct contact with aerosols and splatters created during dental procedures and indirect contact with contaminated surfaces and inanimate objects (3–5). Recently, there has been evidence that the severe acute respiratory syndrome coronavirus 2 (SARS-

CoV-2) was found in the infected person's saliva (6). An experimental study showed that the virus might survive on the environmental surfaces and in solutions for up to seven days at room temperature (7), making dental clinics a potential source of infection transmission.

In response to the health hazards posed by the dental clinics, various international agencies such as the U.S. Centers for Disease Control and Prevention (CDC) have suggested guidance to conduct dental treatment during the COVID-19 pandemic, which includes strict adherence to infection control measures (8). The pandemic has brought critical insight into maintaining water quality in the dental unit waterline system (DUWLS) to minimise cross-infection owing to dental unit contamination. Improper maintenance of the DUWLS and failure to comply with the infection control recommendations of DUWLS decontamination procedures such as not flushing the waterline system at the beginning and in between patients and not using an anti-retraction valve in the dental handpieces may

cause the oral microorganisms to be aspirated into the waterline system (9). The microorganisms may form colonies, resulting in biofilm formation in the tubing wall of DUWLS (9).

Additionally, concerns were raised about the health risks posed by the contaminated water in the DUWLS, even before the pandemic (10,11). A significant quantity of microorganisms was detected in the sample water collected from the DUWLS, indicating that the water used during dental procedures was not sterile (12). Numerous microorganisms were detected, including water bacteria, such as *Legionella spp.*; skin bacteria, such as *Staphylococcus aureus*; and bacteria from the oropharynx, such as *Acinetobacter lwoffii* (13). In some studies, fungi such as *Aspergillus* (13,14) and protozoans such as *Acanthamoeba* (15) were also identified. The need to decontaminate the DUWLS is multiplied by the presence of the more important and possibly dangerous microorganisms, namely *Legionella pneumophila* (16), *Pseudomonas aeruginosa* (17), and the present discovery of SARS-CoV-2 in saliva (18).

While the impact of the contaminated DUWLS may be minimal in healthy individuals, it can be potentially fatal in vulnerable patients, such as those with cancer, diabetes, or transplant recipients (19). Therefore, risk management should be appropriately planned and implemented in dental clinics to ensure the DUWLS decontamination processes are efficiently conducted following the recommendations (20). Although it is almost impossible to completely sterile the water, efforts should be made to keep the microbial contamination within the acceptable level of potable water, of less than 500 CFU/ml heterotrophic bacteria (5,21).

The dental team must be well informed about the hazards posed by the contaminated DUWLS and committed to performing the DUWLS decontamination procedure to ensure a safer environment for both patients and themselves. Dental students are exposed to the same occupational risks and hazards as the rest of the workforce (22). Thus, it is critical to instil sound knowledge and a positive attitude about DUWLS decontamination as early as during their training years in dental schools. To the best knowledge of the researcher, there was very little information on the knowledge and attitude towards DUWLS decontamination, especially among dental students in Malaysia. Hence, this study aimed to determine the knowledge and attitude of the undergraduate and postgraduate dental students regarding DUWLS and the factors associated with the knowledge and attitude towards DUWLS decontamination.

## MATERIALS AND METHODS

### Study design and sample selection

A cross-sectional study was conducted in April 2020

among the undergraduate and postgraduate dental students in the School of Dental Sciences, Universiti Sains Malaysia (USM). All undergraduate students in their clinical years (third, fourth, and fifth years) and the postgraduate students in all specialist training programs were invited to participate in this study. The inclusion criteria were the dental students who have prior experience operating a dental chair unit. The sample size was calculated using a single mean formula,  $n=(z \sigma/\Delta)^2$ . Standard deviation was set as 0.586 based on the knowledge score reported by Kengadaran et al. (23), with the precision set at 0.09. Therefore, the calculated sample needed in the study was 163 individuals. With 30% non-response rate anticipated due to online survey, 212 samples were required. However, because the total number of eligible dental students was 211, the researchers included all undergraduate and postgraduate students who met the study criteria.

### Research tool

A self-administered questionnaire from Kengadaran et al. (23) was adapted with ten questions added based on the literature review (24–26). The questionnaire was content and face validated. The content validity of the questionnaire was evaluated by six Dental Public Health Specialists from USM and Ministry of Health Malaysia through a non-face-to-face approach, as recommended by Yusoff (27). The experts rated their judgement on the relevancy of each item in the measured domains using a four-point Likert scale from score one if the item was not relevant to score four if it was very relevant to the domain (27). Then, the content validation index (CVI) was calculated using the item-level content validity index (I-CVI) and scale-level content validity index average (S-CVI/Ave) with acceptable value of 0.83 (27). The items with the I-CVI score of less than 0.83 were removed, and the S-CVI/Ave score obtained in this study was 0.94 for both knowledge and attitude domains. All written and verbal comments from the experts were noted to improve the domain and items.

The questionnaire was pre-tested on a convenient sample of ten students from the undergraduate and postgraduate groups to ensure practicality and face validity. The students were requested to rate the clarity and comprehension of the questionnaire using a four-point Likert scale from score one if the sentence was not clear and understandable to score four if the sentence was very clear and understandable (28). A face validity index (FVI) of 0.97 was obtained for both the knowledge and attitude domains. Some items were subsequently revised and re-phrased based on the comments given.

The final set of the questionnaire consisted of 48 items and was divided into three sections. Section A contained a total of 12 items, including the sociodemographic profiles (such as sex, age, race, level of study, year of study, years of experience in clinical practice and postgraduate programme), and training and experience

regarding DUWLS with the following variables: the experience of attending any talk/course on DUWLS, source of information received, the experience of receiving guidance/demonstration on DUWLS, source of guidance received and personal experience in managing DUWLS. The questionnaire was prepared in Google Forms format for an online survey. Except for the two branching items from the preceding questions, the online form required respondents to reply to all items before going on to the next part. Only those who responded "yes" to the initial question had to answer the branching questions.

In Section B, 13 items regarding the students' knowledge of DUWLS were answered as either true, false, or did not know. There were another 11 subitems under this domain, giving a total of 24 questions. For every correct answer, one mark was given, whereas for every wrong answer or do not know, a zero mark was given. The total knowledge score ranged from 0 to 24. The higher mean knowledge scores indicate better knowledge of DUWLS decontamination.

Section C consisted of 12 items and subitems regarding the attitude of the students towards DUWLS. A five-point Likert scale from strongly agree to disagree strongly was used. All items were in positive forms; thus, the answers were scored with five for strongly agree and one for strongly disagree. The total scores ranged from 12 to 60. The higher mean attitude score indicates a better attitude towards DUWLS decontamination.

### **Data collection**

The students were identified from the name list obtained from the Academic Office, School of Dental Sciences USM, and were invited to join the study via messages, emails, and WhatsApp. The students were given a brief overview of the research's scope and objectives and assurances that their participation in the study was optional and that their confidentiality would be respected. The link to the online questionnaire was attached to the message, and those who are interested in joining the study may access the link given using their electronic devices. The respondents were required to read through and provide their consent before answering the questionnaire. Only those who consented to join the study could proceed with the questionnaire on the next page. Those who were not interested in participating in this research were immediately directed to the end of the form. The Google Forms was set as 'allow only one response per user' to avoid the respondents answered the questionnaire twice. The link to the questionnaire was open for two weeks from the invitation messages given. The link was disabled at the end of the data collection period. All the responses obtained from the respondents were automatically collected and stored in an online spreadsheet and later were downloaded into the principal researcher's laptop that was protected with a password to ensure the security of the data during data

handling.

### **Statistical analysis**

All data were entered, cleaned, and analysed using IBM SPSS version 24.0. Descriptive analysis was carried out to obtain frequency and percentage for the categorical variables. The numerical variables were presented as mean and standard deviation (SD) for normally distributed data or median and interquartile range (IQR) for skewed data. The association between age, sex, study level, clinical experiences, received information, guidance, and personal experience with the knowledge and attitude scores were assessed using Pearson's correlation and independent t-test. The data that were not normally distributed, such as years of experience in clinical practice of the undergraduate group, were analysed using the Spearman correlation coefficient. The significant value was set at  $p$  less than 0.05.

### **Ethical consideration**

The study was conducted following the Declaration of Helsinki, and ethical approval was obtained from the Human Research Ethics Committee of Universiti Sains Malaysia (JEPeM code: USM/JEPeM/19120858). This study was registered under the National Medical Research Register, Ministry of Health Malaysia (NMRR ID: NMRR-20-210-52842).

### **RESULTS**

Out of 211 eligible dental students, 169 students, comprised of 126 (74.6%) undergraduate and 43 (25.4%) postgraduate students, participated in this study. The response rate was 80.1%. Table I presented the sociodemographic profiles, training, and experience of the respondents. In total, most of the respondents were female (71.6%) and Malay (59.2%). The mean (SD) age for the undergraduate students was 23.2 (0.93) with a median (IQR) year of experience in clinical practice of 1.5 (2.00), whereas, for the postgraduate students, the mean (SD) age was 34.4 (2.65) with mean (SD) years of experience in clinical practice of 11.7 (3.47). The percentage of undergraduate students in each study year was almost similar, where there were 34.9% year three students, 33.3% year four students, and 31.7% year five students. In contrast, the distribution of the postgraduate students in each study year varied depending on the programme they enrolled in the specialist training. There were 27.9% postgraduate students who were in year one of their specialist training, 32.6% year two students, 18.6% year three students, and 20.9% year four students.

Regarding previous training received by the students, most undergraduate students (62.7%) claimed that they never received the information on DUWLS, and about 17.5% were unsure whether they had the experience of receiving any talk or course on DUWLS. From 25 out of 126 undergraduate students (19.8%) who claimed

**Table 1: Sociodemographic profiles, training and experience of the undergraduate and postgraduate students (n = 169)**

Variables	Level of study	
	Undergraduate (n=126)	Postgraduate (n=43)
	n (%)	n (%)
Age (years)	23.2 (0.93) <sup>a</sup>	34.4 (2.65) <sup>a</sup>
Years of experience in clinical practice	1.5 (2.00) <sup>b</sup>	11.7 (3.47) <sup>a</sup>
<b>Sex</b>		
Male	35 (27.8)	13 (30.2)
Female	91 (72.2)	30 (69.8)
<b>Race</b>		
Malay	71 (56.3)	29 (67.4)
Chinese	41 (32.5)	3 (7.0)
Indian	12 (9.5)	7 (16.3)
Others	2 (1.6)	4 (9.3)
<b>Year of study</b>		
Year 1		12 (27.9)
Year 2		14 (32.6)
Year 3	44 (34.9)	8 (18.6)
Year 4	42 (33.3)	9 (20.9)
Year 5	40 (31.7)	
<b>Receive information on DUWLS</b>		
Yes	25 (19.8)	35 (81.4)
No	79 (62.7)	5 (11.6)
Not sure	22 (17.5)	3 (7.0)
<b>Source of information received</b>		
Lecture undergraduate	3 (12.0) <sup>c</sup>	10 (28.6) <sup>d</sup>
Lecture postgraduate	0 (0) <sup>c</sup>	22 (62.9) <sup>d</sup>
Attended talk/course	1 (4.0) <sup>c</sup>	13 (37.1) <sup>d</sup>
Briefing by PIC	23 (92.0) <sup>c</sup>	15 (42.9) <sup>d</sup>
Others	0 (0) <sup>c</sup>	2 (5.7) <sup>d</sup>
<b>Receive guidance on DUWLS decontamination procedure</b>		
Yes	60 (47.6)	31 (72.1)
No	45 (35.7)	9 (20.9)
Not sure	21 (16.7)	3 (7.0)
<b>Source of guidance received</b>		
During undergraduate	19 (31.7) <sup>e</sup>	13 (41.9) <sup>f</sup>
During postgraduate	0 (0) <sup>e</sup>	7 (22.6) <sup>f</sup>
During talk/course/CDE	0 (0) <sup>e</sup>	10 (32.2) <sup>f</sup>
Demo by PIC	50 (83.3) <sup>e</sup>	19 (61.3) <sup>f</sup>
Others	1 (1.7) <sup>e</sup>	1 (3.2) <sup>f</sup>
<b>Personal experience in managing DUWLS</b>		
Yes	53 (42.1)	19 (44.2)
No	37 (29.4)	22 (51.2)
Not sure	36 (28.6)	2 (4.7)

<sup>a</sup> = Mean (SD); <sup>b</sup> = Median (IQR)

<sup>c</sup> total response = 27; <sup>d</sup> total response = 62; <sup>e</sup> total response = 70; <sup>f</sup> total response = 50

they had received information on DUWLS, 23 of them (92%) claimed that the information was received from the briefing session by the person-in-charge (PIC) of the clinics such as the matron or sister. Furthermore, more than one third (35.7%) of the undergraduate students claimed they never received any guidance, and 16.7% were unsure whether they had received any guidance or demonstration regarding DUWLS decontamination procedures. Out of 47.6% of undergraduate students who claimed to have received the guidance on DUWLS decontamination procedure, the majority (83.3%) received guidance or demonstration by the PIC of the clinics.

In contrast, for the postgraduate group, the majority (81.4%) claimed that they had received the information regarding DUWLS, mainly from the lecture sessions in the postgraduate curriculum (62.9%) and briefing from

the PIC of the clinic (42.9%). Most of the postgraduate students (72.1%) also claimed that they had received guidance on DUWLS decontamination procedure, mainly from the demonstration given by the PIC in the clinic (61.3%). Regarding personal experience in managing DUWLS, less than half of the undergraduate (42.1%) and postgraduate (44.2%) students had the self-experience in managing the DUWLS.

Table II depicts the knowledge of undergraduate and postgraduate dental students on DUWLS. The total mean (SD) knowledge score for the undergraduate and postgraduate students was 11.6 (4.23) and 18.0 (2.82), respectively. For the general knowledge on DUWLS, the lowest percentage obtained by both groups was regarding the type of water that can be supplied to the dental chair unit, specifically on the hard water. Only 6.3% and 4.7% of the undergraduates and postgraduates, respectively, answered the question correctly. Concerning the undergraduate's knowledge of DUWLS, the majority (71.4%) of them answered correctly about using water from DUWLS for non-surgical procedures such as tooth restoration and scaling. However, more than half (58.7%) of these students did not know it could not be used for surgical procedures.

For the knowledge on contamination of the DUWLS, about 44.4% of undergraduate students were unaware that the biofilm in the DUWLS might serve as a reservoir for bacteria, and 54.8% were unaware that the DUWLS water includes potentially harmful microorganisms. More than a third (35.7% and 34.1%, respectively) of the undergraduate students did not know that the contaminated water in the DUWLS may pose an occupational hazard to the dental personnel and can be potentially dangerous to the immunocompromised patients.

Regarding the knowledge on DUWLS decontamination, the majority (77%) of the undergraduate students knew that DUWLS decontamination is a part of infection control measures. However, most of the undergraduate students also did not know about the availability of the national (80.2%) and international guidelines (65.9%) and also about the standard level of DUWLS water (84.9%). Regarding the interval to conduct DUWLS decontamination, less than half (46.8%) of them knew that it should be conducted daily and weekly. There were only 15.1% knew that DUWLS decontamination procedures should not be conducted on a weekly basis only, and more than half (61.1%) gave incorrect answers. Contrarily, the postgraduate students' knowledge in general and regarding contamination and decontamination of DUWLS were higher in which 18 out of 24 items (75%) in the knowledge domain were correctly answered by more than 65% of respondents in the postgraduate group.

The summary of the attitude towards DUWLS

**Table II. Knowledge of the undergraduate and postgraduate dental students on DUWLS (n=169)**

Variables	Undergraduate (n=126)			Postgraduate (n=43)		
	n (%)			n (%)		
	Correct answer	Incorrect answer	Do not know	Correct answer	Incorrect answer	Do not know
<b>General knowledge on DUWLS</b>						
Bottle fed is the best method	33 (26.2)	14 (11.1)	79 (62.7)	35 (81.4)	2 (4.7)	6 (14.0)
Types of water						
Hard water	8 (6.3)	25 (19.8)	93 (73.8)	2 (4.7)	26 (60.5)	15 (34.9)
Soft water	22 (17.5)	10 (7.9)	94 (74.6)	9 (20.9)	14 (32.6)	20 (46.5)
Distilled water	104 (82.5)	5 (4.0)	17 (13.5)	39 (90.7)	0 (0)	4 (9.3)
Deionised water	18 (14.3)	17 (13.5)	91 (72.2)	8 (18.6)	7 (16.3)	28 (65.1)
Provide water to						
Dental handpiece	111 (88.1)	4 (3.2)	11 (8.7)	43 (100)	0 (0)	0 (0)
Ultrasonic Scaler	111 (88.1)	4 (3.2)	11 (8.7)	43 (100)	0 (0)	0 (0)
Three-way syringe	106 (84.1)	3 (2.4)	17 (13.5)	43 (100)	0 (0)	0 (0)
Cup-filler	71 (56.3)	31 (24.6)	24 (19.0)	23 (53.5)	19 (44.2)	1 (2.3)
Spittoon	53 (42.1)	39 (31.0)	34 (27.0)	19 (44.2)	22 (51.2)	2 (4.7)
Used for						
Non-surgical	90 (71.4)	6 (4.8)	30 (23.8)	42 (97.7)	1 (2.3)	0 (0)
Surgical	52 (41.3)	34 (27.0)	40 (31.7)	31 (72.1)	11 (25.6)	1 (2.3)
<b>Knowledge on Contamination of the DUWLS</b>						
Biofilm formation act as reservoir in DUWLS	70 (55.6)	0 (0)	56 (44.4)	41 (95.3)	0 (0)	2 (4.7)
Contain potentially pathogenic microorganisms	51 (40.5)	6 (4.8)	69 (54.8)	41 (95.3)	1 (2.3)	1 (2.3)
Occupational hazard to dental personnel	62 (49.2)	19 (15.1)	45 (35.7)	36 (83.7)	4 (9.3)	3 (7.0)
Dangerous to immunocompromised patients	74 (58.7)	9 (7.1)	43 (34.1)	42 (97.7)	1 (2.3)	0 (0)
<b>Knowledge on DUWLS Decontamination</b>						
Part of infection control measures	97 (77.0)	2 (1.6)	27 (21.4)	43 (100)	0 (0)	0 (0)
National guidelines	22 (17.5)	3 (2.4)	101 (80.2)	29 (67.4)	1 (2.3)	13 (30.2)
International guidelines	42 (33.3)	1 (0.8)	83 (65.9)	33 (76.7)	0 (0)	10 (23.3)
Frequency DUWLS decontamination						
Daily & weekly	59 (46.8)	23 (18.3)	44 (34.9)	39 (90.7)	1 (2.3)	3 (7.0)
Weekly only	19 (15.1)	77 (61.1)	30 (23.8)	34 (79.1)	6 (14.0)	3 (7.0)
Monthly only	79 (62.7)	11 (8.7)	36 (28.6)	37 (86.0)	2 (4.7)	4 (9.3)
Yearly only	85 (67.5)	5 (4.0)	36 (28.6)	40 (93.0)	0 (0)	3 (7.0)
Standard water quality	18 (14.3)	1 (0.8)	107 (84.9)	22 (51.2)	5 (11.6)	16 (37.2)
<b>Mean (SD) knowledge score</b>			11.6 (4.23)			18.0 (2.82)

decontamination among undergraduate and postgraduate students is portrayed in Table III. Generally, both the undergraduate and postgraduate groups showed a positive attitude with a mean (SD) attitude score of 51.3 (7.86) and 54.6 (4.74), respectively. Regarding general attitude towards DUWLS, the majority of the undergraduate (89.7%) and postgraduate (97.7%) students were concerned about water quality in the dental chair unit. About 66.7% of the undergraduate and 79.1% of the postgraduate students were agreed/strongly agreed that the quality of the incoming and outgoing water from the dental unit should be similar. Furthermore, the majority of the undergraduate and postgraduate students agreed/strongly agreed that they are responsible for ensuring the water from the DUWLS is safe for the dental operators, dental assistants, and their patients and that they must have good knowledge of DUWLS management. Regarding the attitude towards DUWLS decontamination procedures, most (84.9%) of the undergraduate students were strongly agreed/ agreed that it was their responsibility to ensure that the DUWLS decontamination procedures were adhered to the recommended guidelines. About 85.7% undergraduate and 97.7% postgraduate students believed that the

water from DUWLS should be tested microbiologically, and funds should be given to undertake the DUWLS decontamination process (81.7% and 97.7%, respectively).

Concerning attitude on DUWLS training, 80.9% and 97.7% of the undergraduate and postgraduate students, respectively, were interested in receiving training on DUWLS. Besides that, 73% and 93% of them were strongly agreed/agreed that the DUWLS decontamination procedures should be taught during the undergraduate programme. About 74.6% and 90.6% of the students, respectively, felt that the DUWLS decontamination should be taught in the curriculum of the postgraduate programme.

Independent t-test showed that the mean (SD) knowledge and attitude scores of the undergraduate students were statistically lower compared to the postgraduate students. The level of study (undergraduate or postgraduate) was significantly associated with the mean (SD) knowledge and attitude scores of the dental students ( $p < 0.001$ ) (Table IV). With these findings, data analysis was done separately for the undergraduates' and postgraduates'

**Table III: Attitude of the undergraduate and postgraduate dental students towards DUWLS (n=169)**

Variables	Undergraduate (n=126)			Postgraduate (n=43)		
	n (%)					
	Strongly disagree/ Disagree	Neither agree nor disagree	Strongly agree/ Agree	Strongly disagree/ Disagree	Neither agree nor disagree	Strongly agree/ Agree
<b>General attitude towards DUWLS</b>						
Concern about the quality of water	4 (3.1)	9 (7.1)	113 (89.7)	1 (2.3)	0 (0)	42 (97.7)
Quality of water coming in and out from the dental unit should be similar	12 (9.5)	30 (23.8)	84(66.7)	6 (13.9)	3 (7.0)	34 (79.1)
Responsible to ensure safe water for:						
Dental operators	4 (3.2)	14 (11.1)	108 (85.7)	1 (2.3)	3 (7.0)	39 (90.7)
Dental assistants	6 (4.8)	15 (11.9)	105 (83.3)	1 (2.3)	3 (7.0)	39 (90.7)
Patients	9 (7.1)	17 (13.5)	100 (79.4)	0 (0)	5 (11.6)	38 (88.4)
I must have good knowledge on DUWLS management	6 (4.8)	16 (12.7)	104 (82.5)	0 (0)	0 (0)	43 (100)
<b>Attitude on conducting DUWLS decontamination procedure</b>						
Ensure adherence to guideline	2 (1.6)	17 (13.5)	107 (84.9)	0 (0)	1 (2.3)	42 (97.7)
Water should be tested microbiologically	4 (3.2)	14 (11.1)	108 (85.7)	0 (0)	1 (2.3)	42 (97.7)
Funding should be allocated	3 (2.4)	20 (15.9)	103 (81.7)	0 (0)	1 (2.3)	42 (97.7)
<b>Attitude on DUWLS training</b>						
Interested to receive training	4 (3.2)	20 (15.9)	102 (80.9)	0 (0)	1 (2.3)	42 (97.7)
DUWLS decontamination should be taught in the curriculum:						
Undergraduate program	12 (9.5)	22 (17.5)	92 (73.0)	1 (2.3)	2 (4.7)	40 (93.0)
Postgraduate program	12 (9.5)	20 (15.9)	94 (74.6)	2 (4.7)	2 (4.7)	39 (90.6)
<b>Mean (SD) attitude score</b>			51.3 (7.86)			54.6 (4.74)

**Table IV: Association between level of study with the knowledge and attitude towards DUWLS (n=169)**

	Mean (SD)	Mean difference (95% CI)	t-stat (df)	p-value
<b>Knowledge of DUWLS</b>				
<b>Level of study</b>				
Undergraduate	11.6 (4.23)	-6.36	-11.13	<0.001
Postgraduate	18.0 (2.82)	(-7.49,-5.23)	(110)	
<b>Attitudes towards DUWLS</b>				
<b>Level of study</b>				
Undergraduate	51.3 (7.86)	-3.34	-3.31	0.001
Postgraduate	54.6 (4.74)	(-5.33, -1.34)	(122)	

Independent t-test

groups to determine the factors associated with the knowledge and attitude towards DUWLS. No statistical comparisons were made between the groups.

The knowledge of DUWLS among the undergraduate students was significantly associated with the experience in receiving information (p=0.001), the experience in receiving guidance on DUWLS decontamination (p=0.001), and personal experience in managing DUWLS (p=0.003). Whereas for the postgraduate students, only the experience in receiving information regarding DUWLS was significantly associated with the knowledge of DUWLS (p=0.011) (Table V).

No significant association with the attitude towards DUWLS decontamination was found among the undergraduate students. However, for the postgraduate students, the age factor was positively correlated with the attitude towards DUWLS decontamination (p=0.014). This indicates that as the age of the postgraduate

students increases, their attitude towards DUWLS decontamination becomes better. Other factors were not significantly associated with the attitude towards DUWLS decontamination in both groups, and the results are presented in Table VI.

## DISCUSSION

Although there have been extensive experimental studies on the microbial contamination of the DUWLS since the 1960s (26,29,30), however, to date, there have been limited studies assessing the knowledge and attitude towards water quality in the DUWLS, especially among dental students. It is known that dentists acquire their knowledge and behaviour from their professional education. Therefore, sufficient training on infection control, particularly regarding DUWLS decontamination, should be given to dental students (22). The previous study supports the importance of incorporating the infection control subject in dental school curricula, highlighting that preclinical teaching serves as foundational knowledge to prevent disease transmission and promote a safe working environment for dental students in dental clinics (31).

In this study, the overall response rate obtained from both groups was lower than a previous study regarding an airborne spread of infection in dentistry (32). The authors reported a response rate of 95.3% from 383 undergraduate and postgraduate dental students in two dental teaching institutions in India. The lower response rate may be attributed to the data collection method used in this study, whereby an online survey

**Table V: Factors associated with knowledge on DUWLS (n=169)**

Variables	Undergraduate students (n=126)				Postgraduate students (n=43)			
	Mean (SD)	Mean diff. (95% CI)	t-stat (df)	p-value	Mean (SD)	Mean diff. (95% CI)	t-stat (df)	p-value
Age			0.104 <sup>a</sup>	0.246			0.179 <sup>a</sup>	0.252
Years of clinical experience			0.146 <sup>b</sup>	0.103			0.039 <sup>a</sup>	0.804
Sex								
Male	12.0 (4.45)	0.64	0.72	0.480	18.5 (1.85)	0.66	0.70	0.487
Female	11.4 (4.16)	(-1.07, 2.27)	(124)		17.8 (3.16)	(-1.24, 2.56)	(41)	
Race								
Malay	11.1 (4.12)	-1.07	-1.41	0.162	18.0 (2.98)	0.11	0.11	0.910
Non-Malay	12.2 (4.34)	(-2.56, 0.43)	(124)		17.9 (2.56)	(-1.77, 1.98)	(41)	
Received information								
Yes	13.9 (2.96)	2.99	3.28	0.001	18.5 (2.20)	2.76	2.68	0.011
No/Not sure	10.9 (4.30)	(1.19, 4.79)	(124)		15.8 (4.13)	(0.68, 4.85)	(41)	
Received guidance								
Yes	12.9 (3.27)	2.46	3.44	0.001	18.1 (2.76)	0.46	0.48	0.635
No/Not sure	10.4 (4.67)	(1.04, 3.87)	(116)		17.7 (3.08)	(-1.49, 2.42)	(41)	
Personal experience								
Yes	12.9 (3.66)	2.25	3.04	0.003	18.7 (3.04)	1.23	1.43	0.159
No/Not sure	10.6 (4.39)	(0.79, 3.72)	(124)		17.5 (2.57)	(-0.50, 2.95)	(41)	

Independent t-test; <sup>a</sup>Pearson Correlation Coefficient, *r*; <sup>b</sup>Spearman Correlation Coefficient, *r<sub>s</sub>*

**Table VI: Factors associated with the attitude towards DUWLS (n=169)**

Variables	Undergraduate students (n=126)				Postgraduate students (n=43)			
	Mean (SD)	Mean diff. (95% CI)	t-stat (df)	p-value	Mean (SD)	Mean diff. (95% CI)	t-stat (df)	p-value
Age			0.131 <sup>a</sup>	0.150			0.373 <sup>a</sup>	0.014
Years of clinical experience			0.042 <sup>b</sup>	0.640			0.257 <sup>a</sup>	0.096
Sex								
Male	53.7 (7.60)	2.47		0.115	54. (4.41)	-0.28	-0.18 (41)	0.860
Female	50.6 (7.89)	(-0.61, 5.54)	1.58 (124)		54.7 (4.95)	(-3.49, 2.94)		
Race								
Malay	52.1 (6.35)	1.92		0.197	55.0 (4.02)	1.39		0.374
Non-Malay	50.2 (9.41)	(-1.01, 4.85)	1.30 (90)		53.6 (6.03)	(-1.73, 4.52)	0.90 (41)	
Received information								
Yes	49.4 (11.0)	-2.25		0.340	54.5 (4.41)	-0.51		0.786
No/Not sure	51.7 (6.86)	(-6.98, 2.47)	-0.98 (28.7)		55.0 (6.35)	(-4.31, 3.28)	-0.270 (41)	
Received guidance								
Yes	51.3 (8.32)	0.01		0.996	54.8 (4.49)	0.81		0.623
No/Not sure	51.2 (7.49)	(-0.78, 2.79)	0.005 (124)		54.0 (5.51)	(-2.48, 4.09)	0.496 (41)	
Personal experience								
Yes	50.9 (8.26)	-0.46		0.749	55.5 (4.71)	1.59		0.277
No/Not sure	51.4 (7.61)	(-3.28, 2.36)	-0.32 (124)		53.8 (4.75)	(-1.34, 4.53)	1.101 (41)	

Independent t-test; <sup>a</sup>Pearson Correlation Coefficient, *r*; <sup>b</sup>Spearman Correlation Coefficient, *r<sub>s</sub>*

was used compared to a paper-based survey in the other study (32). Two studies reasoned that most people use the internet for leisure and entertainment, which makes them exempt from the requests for participation in research surveys, leading to a lower response rate of the online survey than the paper-based survey (33,34). The online survey was chosen for this study because it provides more efficient data collection, a more appealing interface, lower costs, more manageable data collection, and automated data entry and management (35). This method was particularly beneficial during the current unprecedented pandemic as the Malaysian government's Movement Control Order (MCO) had disallowed the researcher to meet the respondents

physically during the data collection period.

Besides that, the majority (71.6%) of the respondents were female, which was in contrast to a study by Kengadaran et al. (23) on the knowledge, attitude, and practice (KAP) regarding DUWLS, who reported more male respondents (51.4%). This composition was due to the imbalance ratio between male and female students enrolled in higher education institutions in Malaysia (36). Furthermore, most of the students were Malay (59.2%), which reflected the total Malaysian population whereby the Malay ethnic makeup majority of the population (37). The ethnic quota for scholarships and admission to public universities since the Second Malaysia Plan

(1971-1975) also played an important role in distributing students' ethnicity in Malaysian public universities (38).

Regarding the training received by the dental students on DUWLS, it is worth noting that there was a considerably large percentage of the undergraduate students claimed that they never received any information and guidance on the DUWLS decontamination procedure. This finding may be due to the demonstration sessions regarding infection control were conducted by the assigned trained infection control nurses or clinical supervisors at the very early of the clinical year. Consequently, they may not have recalled the training given to them related to DUWLS at the point when this survey was conducted. Our finding was supported by an Indian study involving the third-year and final-year dental students and the interns (graduated students who worked at the same dental school where they graduated from) (39). The authors reported a significantly lower infection control knowledge and practice among the final year students and the interns compared to the third-year students reflecting the students' memory retention ability (39).

The undergraduate students were taught about the decontamination of DUWLS as part of the topic in the infection control subject, and reinforcements were given to both undergraduate and postgraduate students once they were in the clinics (40). A similar approach was used by most dental schools in the United States where there was no independent course for infection control; however, lectures and clinical demonstrations were used as teaching methods for this subject to their students (31). Previous study among clinical undergraduate dental students in Malaysia regarding infection control practice revealed that overall student compliance to infection control practices in this dental school was high (90.3%), indicating that they had sufficient exposure to infection control training (40). However, the study was conducted based on real-time observation of the general infection control practices. In contrast, in this study, the researcher sought to evaluate their basic knowledge and current attitude regarding a specific topic in infection control related to DUWLS decontamination.

Furthermore, our study found that the knowledge concerning DUWLS among undergraduate students was relatively moderate. More than half of them (58.7%) were unaware that the water from DUWLS should not be used during surgical procedures. An almost similar finding was found among dentists in America (41), whereby only 58% used sterile water during surgical procedures, and only about one-third (32.5%) correctly identified the surgical procedures recommended to use the sterile water. This knowledge is vital, especially during the management of patients, as the water from the DUWLS was proven to be highly contaminated, and its use during the surgical procedures may cause undesirable surgical complications such as delayed healing or surgical site infection (16,42). Additionally, international and local

guidelines had also recommended using sterile water when performing any dental surgical procedures (5,21). This finding should be addressed when educating dental students on the DUWLS.

In the cloud of COVID-19, dental practitioners, including dental students, remain at a high risk of nosocomial infections. Our study showed that more than one-third of the undergraduate students were unaware of the occupational hazard from the contaminated DUWLS and its potential risk to the vulnerable patients, especially to the immunocompromised patients. However, our finding among the postgraduate students was better than studies in Poland and France, where the authors reported that 55.1% and 28% of the dentists were unaware of the health risk created by the aerosol-generating procedures for the dental practitioners and their patients (43,44).

The finding from the present study indicated that the postgraduate students had a relatively high knowledge of DUWLS, whereby the majority of them knew regarding the biofilm and various types of microorganisms in the DUWLS and were fully aware of the national and international guidelines to control the water quality in DUWLS. Our finding was considerably better than the previous study among Irish dentists, as it was found that none of the respondents was aware of the national and international guidelines on DUWLS (24). Similarly, only 2% of dentists in Europe were aware of the recommendations for DUWLS decontamination (25). The dental practitioners who had known about the latest recommendations on infection control were most likely to implement the recommendations given (41). Hence, training and continuous professional development, especially about the infection control guidelines, should be strengthened for the dental personnel, including the dental students (43). The scrupulous adherence to the infection control guidelines, particularly on DUWLS management, is vital to prevent them from contracting the infectious disease, especially during the current pandemic while conducting dental procedures.

Most of the postgraduate students in this study portrayed good knowledge concerning decontamination frequency. However, relatively opposite results were observed among the undergraduate students whereby only less than half (46.8%) knew that it should be conducted daily and weekly, and 61.1% thought that it should be conducted on a weekly only interval. The DUWLS was recommended to decontaminate in the daily and weekly intervals (21). An experimental study had shown that the daily and weekly DUWLS decontamination frequency were statistically significant to achieve the recommended standard for the DUWLS output water compared to no disinfection measures taken, whereas once a month decontamination showed no significant reduction in microbial contamination in the DUWLS (45).



Regarding the water quality standard aimed by the DUWLS decontamination procedures, most undergraduate (84.9%) and some postgraduate (37.2%) students in this study did not know about the water standard in the DUWLS. Total removal of the microorganisms from the waterlines system was almost impossible, even in a newly installed dental chair unit (10). The unstandardised designs of the dental chair units between various brands in the market make it even more difficult to conduct a universal decontamination procedure (46).

Despite the knowledge gap between the undergraduate and postgraduate students, both groups showed a favourable attitude towards DUWLS decontamination. Most of the students were concerned about the water quality in the dental chair unit that they used. Similar findings were reported among dentists in the European countries (25), whereby 65% raised concern about the water quality in the DUWLS. Less than half of the undergraduate and the postgraduate students believed that the quality of water coming in and out from the dental unit should be similar. Even though this is desirable, it is difficult, if not impossible, to achieve as the water entering the DUWLS is constantly becoming highly contaminated from the biofilm that serves as a microbial reservoir (17).

Concerning the students' belief in their responsibility to ensure safe water for themselves, other dental personnel, and their patients, the majority of the students in both groups showed positive attitudes as they were agreed/strongly agreed that the responsibility lies on their shoulders. The majority of them felt that they must have a good knowledge regarding DUWLS management. Polish dentists (44) also showed a similar attitude whereby most (80%) expressed a lack of knowledge about DUWLS. Almost all of them (97%) intended to learn more about this topic to improve their knowledge as they perceived the importance of having sound knowledge of DUWLS decontamination (44).

Education about the water quality from DUWLS is vital, and great emphasis should be given, especially to the future dentists and dental specialists who are regularly exposed to aerosols during their practices. The present study also reported that most undergraduate (80.9%) and postgraduate (97.6%) students were interested in receiving training regarding DUWLS. Similarly, 90.7% of the Polish dentists expressed a need for knowledge and guidance on the DUWLS (44). Furthermore, it has been suggested that conducting workshops or continuous professional development (CPD) on decontamination of DUWLS may strengthen the knowledge and improve the attitude toward DUWLS management (23).

Besides that, most of the undergraduate and postgraduate students in this study agreed that the water should be tested microbiologically. This finding was comparable

to Burke et al.(24), in which 96% of the dentists had a positive attitude towards routine microbial testing in their clinics. A study in France revealed that only 2.6% of the respondents had carried out the test (43), as to date, no guidelines have indicated the obligatory need to do regular testing. Based on an audit study in America (12), the findings revealed that the microbial levels in the DUWLS were still within unacceptable safe range even after the third cycle of decontamination procedures in some of the tested waterline systems. This may indicate that the dentists should not entrust entirely on the manufacturer's claim about the effectiveness of the disinfectant products, and instead, microbiological testing of the water should be conducted (12).

In order to ensure all the recommended decontamination procedures to be carried out effectively, funding is essential and should be allocated to purchase appropriate disinfectants. In our study, most students showed a positive attitude by agreed/strongly agreed that funding should be allocated for DUWLS decontamination. However, cautious interpretation should be made as our respondents were dental students and were not appropriate to plan the budget. This issue has also been highlighted by the previous study in Ireland which there were more than half (54%) of the respondents did not provide an answer to the question regarding cost for decontamination of DUWLS as they were the health board employee and not involved directly in any financial allocation (24). Nevertheless, the finding in the current study was in concordance with the study in India, which reported that the dental practitioners showed a positive attitude on DUWLS decontamination and were ready to put in around 1350 INR for the disinfection process (23).

In the present study, the level of study was significantly associated with the knowledge and attitude of the dental students towards managing DUWLS. A similar finding was seen among dental practitioners in India, where the authors reported a significant difference in the mean knowledge score between the dentist with undergraduate and postgraduate educational backgrounds (23). The relatively more knowledge and attitude on DUWLS among the postgraduate students were due to their higher level of understanding, greater independence in information seeking, and attainment of more specialised knowledge than an undergraduate study (23,47). However, the study by Kengadaran et al. (23) reported no significant association between the level of study and attitude towards DUWLS, contrary to our finding. Our finding was in concordance with a study among dental healthcare professionals in Saudi Arabia where the author reported that higher education qualification such as PhD holders was significantly associated with a positive attitude towards adopting standard precaution during aerosol-generating procedures (48).

Other factors that were significantly associated with knowledge of DUWLS among the undergraduate

students were the training that they received, including the experience of receiving information on DUWLS, the experience of receiving guidance on DUWLS decontamination and their personal experience in managing DUWLS. Contrarily, only the experience of receiving information regarding DUWLS was significantly associated with the postgraduate students' knowledge. Our findings were similar to other American (41) and Canadian (49) studies where it was reported that the dentists who had received more continuing dental education credits on infection control, such as from the workshops they attended, were more knowledgeable about the DUWLS decontamination procedures. The information and guidance that they received had made them more aware of the recommended infection control procedures (41,49), particularly concerning DUWLS management.

Furthermore, this study showed the age of the postgraduate students had a significant association with the attitude score. This finding was supported by a study conducted among American dentists regarding their compliance with the CDC guideline, where age was reported to be significantly associated with compliance towards DUWLS decontamination (41). In a systematic review study, it was found that younger healthcare personnel with less experience were more prone to follow the clinical practice guidelines than older professionals with more experience (50). However, our findings found the opposite in which as age increased, the postgraduate students would attain much more clinical experience regarding infection control in dentistry.

The findings of this study offered a valuable insight into an essential topic of infection control in dentistry, particularly during the emergence of the COVID-19 pandemic. More educational activities such as talks, seminars, and training workshops should emphasise on DUWLS decontamination topic. Dental students would benefit from good infection control practices that provide them with a safe workplace throughout their training years and, subsequently, in their future careers.

The findings of this study may be subjected to response bias as the students may have provided answers that they perceived to be socially or professionally desirable. Additionally, recall bias may have occurred in some items, such as regarding the experience of receiving information and guidance. Although the findings of this study are limited because the samples were from only one dental school in Malaysia, the results have provided baseline data on the knowledge and attitude of dental students towards DUWLS decontamination. Further studies are needed with larger samples of dental students from all public and private dental schools in Malaysia. The scope of the study can also be expanded to the dental practitioners practising in the government and private dental clinics.

## CONCLUSION

The knowledge regarding DUWLS decontamination was relatively moderate among the undergraduates but relatively higher among the postgraduates, and significantly different between the two levels of study (undergraduates and postgraduates). Both groups showed a favourable attitude towards DUWLS decontamination, and the postgraduates significantly had a higher attitude score than the undergraduates. The factors that were significantly associated with the mean knowledge score among the undergraduate students were the experience of receiving information on DUWLS, the experience of receiving guidance or demonstration on DUWLS decontamination, and personal experience in managing DUWLS. In contrast, only the experience in receiving information on DUWLS was significantly associated with the mean knowledge score for the postgraduate students. There was no studied variable associated with the mean attitude score of the undergraduates. However, the age of the postgraduate students was significantly associated with the mean attitude score.

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