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Knowledge, attitude, and practices regarding methicillin-resistant *Staphylococcus aureus* (MRSA) infection control and nasal MRSA carriage rate among dental students of Al-Quds university, Palestine

Suzan Mustafa[1], Afnan Atallah[2], Ibrahim Abbasi[3] and Murad Ibrahim[3*]

Abstract

Background The nose is the primary colonization site of *S. aureus which* is a known risk factor for causing *S. aureus* infection. Evaluating the knowledge, attitudes, and actual practice of dental students is imperative to put together guidelines on how to achieve adequate infection control when treating patients. The purpose of this study was to assess the knowledge and attitude regarding Methicillin-resistant *S.aureus* (MRSA) and compliance to hygiene practices. And to determine the nasal carriage rate of *S.aureus* and MRSA and identifying the associated factors for *S.aureus* and MRSA nasal colonization among dental students in Al-Quds University– Palestine.

Methods Two-hundred eighty (280) dental students from Al-Quds University dental school were recruited to participate in a cross-sectional survey and undergo nasal sampling of MRSA. The survey included demographic questions, eight questions about knowledge, eight questions about attitudes/perceptions and six questions about practices/behaviors regarding MRSA infection control. Nasal samples from the participants were analyzed for MRSA presence and antimicrobial susceptibility.

Results Among the 280 dental students, 68 (24.3%) were *S. aureus* nasal carriers, whereas 21 (7.5%) were MRSA nasal carriers. Among 21 tested MRSA isolates, resistance to amoxicillin was most common (100%), followed by resistance to amoxicillin / Clavulanic acid (28.5%). Five isolates (23.8%) were found resistant to erythromycin, four isolates (19%) were resistant to clindamycin, and three isolates (14.2%) were resistant to gentamicin. None of the MRSA isolates were resistant to vancomycin. Risk factors such as using antibiotics within the previous six months, visiting a hospital recently, having a previous *Staphylococcus* bacterial infection and having a member of the family working in healthcare were significantly associated with carrier status ($P < 0.05$). The knowledge score suggests that dental students had intermediate knowledge regarding MRSA, while the attitude score showed that dental students had

*Correspondence:
Murad Ibrahim
mibrahim@staff.alquds.edu

Full list of author information is available at the end of the article

positive attitudes towards MRSA infection control, and the practice score suggests that the dental students' practices regarding MRSA infection prevention are good.

Conclusion The prevalence of MRSA nasal colonization among the dental student population was higher than that reported in the Palestinian population. This indicates that the implementation of strategies on interfering with the transmission of MRSA is of utmost importance. In addition, further educating dental students on MRSA is needed to improve MRSA infection control in the dental setting.

Keywords KAP, Infection control, MRSA, Dental students, Antibiotics

Background

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been considered a pathogen of great concern because of its association with many different community and hospital-acquired bacterial infections. Infections could range from mild skin infections to serious life-threatening diseases such as endocarditis, sepsis, and osteomyelitis [1].

The continuous spreading of antimicrobial-resistant *S. aureus* isolates, particularly methicillin-resistant *S. aureus* (MRSA), is contributing to a worldwide challenge to infectious specialists [2]. MRSA colonization in the anterior nares, which is the most frequent site in humans, can act as a source of crosscolonization for community dissemination, and as an endogenous reservoir for clinical infections [3].

Although the rate of transmission of MRSA in dental settings is rarely reported, this does not discard the fact that it is a common source of cross-contamination, and that it is imperative for dentists to adhere to the infection prevention standard precautions (SP) guidelines [4]. Earlier research has shown that dental healthcare professionals and dental students have significant levels of MRSA nasal colonization [4, 5]. Additionally, dental healthcare workers' hands have the potential to be contaminated with a variety of pathogens. Hence, either direct or indirect contact with them can cause the spread of multidrug resistant germs [6].

The source of MRSA transmission in dental settings is most likely due to contamination of environmental surfaces, such as dental syringes, dental chairs, light handles, microbial aerosols, and splashes from patients [7]. Therefore, knowledge, attitude, and hygienic practices regarding MRSA play a major role in the dental practitioners' adherence to preventive measures [4].

Hitherto, no studies investigating risk factors resulting from MRSA nasal carriage among dental students have been conducted. The aim of this study was to evaluate dental students' knowledge and attitude regarding MRSA and their compliance to hygienic practices. In addition, the nasal carriage rate of *S. aureus* and MRSA as well as identifying the associated factors for S. aureus and MRSA nasal colonization.

Methods

Subjects

A cross-sectional survey was conducted during a 2-month period in 2022. The subjects of the study were two hundred and eighty (280) dental students at Al-Quds University School of Dentistry, West Bank, Palestine. Fourth and fifth-year dental students were approached and asked to participate in the study (Full sample population). They were included in the study after they signed a consent form to participate in the study and give nasal swabs. The total number of students initially was two hundred and ninety-four (294) dental students. Ten students involved in the pilot study, two students who were on antibiotics, and two students who did not consent to providing a nasal swab, were excluded from the study.

Questionnaire

A self–administered questionnaire was distributed among dental students. The questionnaire included socio-demographic, lifestyle, and brief medical history questions. It also included eight questions about knowledge, eight questions about attitudes/perceptions and six questions about practices/behaviors regarding MRSA transmission control. In the knowledge section, the participants were instructed to answer by using (X) or (√) for the option that best suited their response to each topic. The responses were given on a 3-point Likert scale: (3) True, (2) Not sure and (1) False. With a maximum score of 24 points and minimum score of 8 points, for every participant in the knowledge section. In the attitude section responses were given on a 5-point Likert scale: (5) strongly agree, (4) agree, (3) not sure, (2) disagree, and (1) strongly disagree. With a maximum score of 40 points and minimum score of 8 points, for every participant in the attitude section. In the compliance section responses were given on a 4-point Likert scale: (4) very often, (3) often, (2) less often, and (1) never. With a maximum score of 24 points and minimum score of 6 points, for every participant in the compliance section.

Questionnaire validation

Most of the survey questions were borrowed from the assessment tools of previous published studies [33, 4]. A pilot study was conducted by these studies that first

employed these tools to validate the questionnaire. However, some modifications were done to be relevant to our study, so further validation was established.

Cognitive validation was done by presenting the research tool to a panel of arbitrators who are specialized in this field. As they were asked to express their opinions, and the questionnaire was completed, based on these notes.

The survey was piloted to 10 randomly selected dental students from the sample population. Cronbach's alpha was used to evaluate the internal consistency of the survey questions. The scores of knowledge variables, attitude variables and practice variables were 0.754, 0.772 and 0.840, respectively. A value of Cronbach's alpha of ≥ 0.7 is an indication of high intercorrelation in a set of questions. The students involved in the pilot study did not participate into the final survey.

Sample collection and processing

Swab samples were obtained by inserting a sterile nasal swab (Transystem ™ sterile transport swab) into each anterior nostril to a depth of about 1.5 cm and rotating it five times, as preformed in earlier investigations [4]. The swabs were then labeled with a code number, time and date of collection. The collected swabs were immediately delivered to the Al-Quds University Microbiology lab for storage and analysis.

Culturing and isolation of *S. aureus*

Nasal swabs were cultured using Mannitol Salt Agar (MSA), which is a selective media for the isolation of *S. aureus*. Unlike other bacterial species, *Staphylococcus* species can grow in MSA media containing high salt concentrations [8]. The nasal swabs were immediately used to streak for isolation on the MSA media, and was incubated at 37 °C for 24–48 h [9]. By fermenting the mannitol, *S. aureus* creates yellow colonies and the appearance of these colonies served as a sign of the growth of the bacteria [8]. Further identification was carried out with catalase as well as the more accurate coagulase tests [10, 11].

Identification of MRSA

S. aureus isolates were tested for susceptibility using the disk diffusion method in accordance with the recommendations of the Clinical Laboratory Standards Institute (CLSI). After inoculating isolates of the 0.5 McFarland standard suspension on a Mueller Hinton agar plate, a cefoxitin disk was added.

The CLSI recommendations state that *S. aureus*, is sensitive if the diameter is ≥ 22 mm, and resistant if the diameter is ≤ 21 mm, these are the interpretative criteria for cefoxitin. Cefoxitin testing is very accurate and clearly distinguishes methicillin-resistant strains of *S. aureus* from methicillin-susceptible strains [12]. This is especially true as cefoxitin is a more potent inducer of mecA expression than other agents [13].

Susceptibility testing

Antimicrobial susceptibility patterns of *S. aureus* and MRSA were assessed against several antibiotics (cefoxitin (30 µg), amoxicillin (10 µg), amoxicillin/clavulanic acid (30 µg), gentamicin (10 µg), vancomycin (30 µg), clindamycin (2 µg), and erythromycin (15 µg) (HiMedia Laboratories)). Resistance or susceptibility to each agent was determined according to the minimal inhibitory concentration (MIC) as described [14]. Manual placement of antibiotic discs on Mueller-Hinton agar medium followed by an 18-hour incubation period at 37 °C was followed with the measurement of the zones of inhibition. The results were interpreted based on the CLSI criteria described above.

Statistical analysis

Statistical analysis of the data was performed using the IBM SPSS version 20 (statistical package for social sciences). Specifically, the software was used to calculate the proportions of MRSA from the total isolates of *S. aureus*. The Chi-square was used to see whether there is a significant association between nasal carriage and various factors captured in the questionnaire.

For the KAP results, the total score of every participant was calculated, followed by calculating the total mean ($n = 280$ student) for every KAP dimension.

The t-test was used for testing the relationship between knowledge, attitudes, practice, and MRSA nasal prevalence. A value of $P < 0.05$ was considered to be statistically significant.

Results

Demographic characteristics of subjects

In the present study, 280 dental students have participated and provided nasal swabs. Most of the participants were females; 73.2% ($n = 205$), whereas 26.8% ($n = 75$) were males. More than half (53.9%) of the participants were 5th -year dental students and 46.1% were 4th -year dental students. The majority (87.9%) had more than 4 family members, while 12.1% had 4 family members or less. Approximately 40% ($n = 112$) of dental students had a family member who worked in healthcare. 70% (70%) didn't have any contact with pets. 38% (38%, $n = 107$) participated in sports, but the majority (61.8%, $n = 173$) did not. The majority (77.9%, $n = 218$) were non-smokers.

17% (17%) have indicated that they had visited a hospital during the past six months, and 4.1% implied that they had surgery. 47% (47%) of the students had used antibiotics in the last six months, and 12.9% stated that they had a previous *staphylococcus* bacterial infection.

Table 1 Antibiotic resistance results of MRSA and MSSA isolates

Antibiotics	MRSA (21)	MSSA (47)
Cefoxitin	21 (100%)	0
Amoxicillin	21 (100%)	45 (95.7%)
Amoxicillin / Clavulanic acid	6 (28.5%)	2 (4.2%)
Gentamicin	3 (14.2%)	0
Clindamycin	4 (19%)	0
Erythromycin	5 (23.8%)	0
Vancomycin	0	0

*MRSA: Methicillin-Resistant *Staphylococcus aureus*, MSSA: Methicillin-Susceptible *Staphylococcus aureus*

Microbiological results

The nasal colonization of *S. aureus* among dental students was 24.3% (68/280), while MRSA nasal colonization was 7.5% (21/280). Among 21 tested MRSA isolates, resistance to amoxicillin was most common (100%), followed by resistance to amoxicillin / Clavulanic acid (28.5%). Five isolates (23.8%) were found resistant to erythromycin, four isolates (19%) were resistant to clindamycin, and three isolates (14.2%) were resistant to gentamicin. None of the MRSA isolates were resistant to vancomycin.

As for the methicillin-susceptible *S. aureus* (MSSA), 95.7% were found resistant to amoxicillin, and two isolates (4.2%) were found resistant to amoxicillin/clavulanic acid. All MSSA isolates were susceptible to gentamicin, clindamycin, erythromycin, and vancomycin. Antibiotic resistance results of MRSA and MSSA isolates to antimicrobials is shown in Table 1.

Knowledge, attitude, and practices among dental students

According to the survey results, 177 (63.2%) students indicated that they have heard of MRSA, while 103 (36.8%) students indicated that they had not. More than half of students 155-(55.3%) knew about MRSA from academic lectures, while the others knew about it from social media (6.4%) or group discussions (1.4%).

The results of the knowledge questions showed that 70.7% of dental students answered correctly that standard precautions such as wearing gloves and personal protective equipment can prevent infection, 66% indicated correctly that MRSA is typically disseminated through the hands of medical professionals. Moreover, 64.2% of dental students realize that the source of MRSA infection could be the hospital or the community. 56% of dental students knew that MRSA is resistant to Methicillin and several other B-lactam antibiotics. Furthermore, 58.5% knew that MRSA is a gram-positive *coccus*, whereas 18.2% did not. In addition, 42.1% of students were not sure if *staphylococcus* could develop resistance to antibiotics causing skin infections that can't be cured. More than a third of the students (36.4%) answered correctly that asymptomatic carriers could be a source of infection, while 21.4% answered it incorrectly, and 42.1% were not sure about it. A little less than half (47.1%) of the students answered correctly that MRSA can survive on surfaces for days. The knowledge score showed a mean of 18.40 with a SD of 2.73 (Table 2). It, therefore, concluded that dental students had intermediate knowledge regarding MRSA.

Table 2 Means of KAP dimensions regarding MRSA

Themes	Number of questions	Maximum/Minimum score points for each section	Mean	SD
Knowledge	8	24/8	**18.40**	2.73
Attitude	8	40/8	**32.12**	4.19
Practice	6	24/6	**22.21**	2.35

With respect to attitude questions, the majority of dental students (88.9%) agreed that there is a need for infection control education, and 80.7% of students expressed willingness to take additional educational courses to increase their knowledge regarding MRSA, and 43.9% strongly agreed to participate in an infection control education program. Furthermore, 86.1% of students said that as dental practitioners they play a role in preventing MRSA among patients. More than 60% (61.8%) of students concurred that unnecessary antibiotic prescriptions by dentists could cause MRSA. Approximately one-quarter (24.6%) of students disagreed that MRSA is considered a serious problem globally. 30% (30%) strongly agreed that gloves and good hand hygiene can prevent the spread of MRSA. In addition, 34.6% of the students were not sure if they were exposed to MRSA infection while working.

The attitude score showed a mean of 32.12 with a SD of 4.19 (Table 2). It, therefore, can be concluded that dental students had positive attitudes towards MRSA.

Regarding questions dealing with practice, the overwhelming majority of students (98.9%) answered that they always use gloves when exposed to patient's mucosa. The majority (98.9%) also indicated that they wash their hands after coming into contact with the patient's blood or saliva. Moreover, 96.8% of students answered that they wear a mask when there is a possibility of a patient's saliva or blood splashing. The majority (96.8%) also performed hand hygiene after touching a patient, and 88.6% performed hand hygiene before getting in contact with a patient. A very small percentage (2.5%) of the students surveyed answered that they never perform hand hygiene before or after wearing gloves. The practice score showed a mean of 22.21 with a SD of 2.35 (Table 2). Such data suggests that dental student's practices regarding MRSA infection prevention are good.

The relationship between nasal MRSA carriage and questionnaire results (KAP)

The nasal MRSA carriers showed slightly higher knowledge, attitude and practice scores compared with non-carriers. However, these differences were not statistically significant.(Table 3).

The relationship between sociodemographic, lifestyle, medical characteristics, and MRSA nasal carriage

Results showed a significant relationship between MRSA nasal carriage and visiting a hospital or healthcare facility in the past 6 months, and using antibiotics during the same period of time. Moreover, there was a clear relationship with statistical significance between MRSA nasal carriage and having a previous *staphylococcus* bacterial infection. In addition, there is a clear significant relationship between MRSA nasal carriage, and dental students who have a member of their family working in health care (Table 4).

Discussion

In our study, *S. aureus* nasal colonization prevalence among dental students (280 students) of Al-Quds University was found to be 24.3%, whereas MRSA nasal colonization was 7.5%. These percentages are consistent with a cross-sectional study conducted in Duhok, Kurdistan Region of Iraq, which found the *S. aureus* and MRSA nasal carriage rates to be 22.3% and 4.3%, respectively [31]. The higher MRSA nasal carriage than the general community in this study, illustrates the need for further commitment to infection control measures, like hand hygiene and proper wearing of personal protective equipment while taking care of patients in the dental clinic, to prevent cross contamination.

According to the United States Centers for Diseases Control and Prevention (CDC), 33% of the population are *S. aureus* asymptomatic nasal carriers, and 2% of the population are MRSA nasal carriers [15]. Higher nasal colonization rates were found among HCWs and people who cared for in-patients [3, 8]. These results were consistent with other studies which found the *S. aureus* nasal carriage rates to be higher in hospital nurses [16, 17]. Another study stated that the highest carriage rate of MRSA was found among HCWs from surgery wards [18].

Table 3 Comparison of knowledge, attitude and practice scores between nasal methicillin-resistant *Staphylococcus* aureus (MRSA) carriers and non-carriers

Fields	MRSA	*N*	Mean	**P*-value
Knowledge	**No**	259	18.3838	0.906
	Yes	21	18.4571	
Attitude	**No**	259	32.0463	0.271
	Yes	21	33.0952	
Practices	**No**	259	22.1853	0.528
	Yes	21	22.5238	

*The relationship between knowledge, attitudes, practice, and MRSA nasal prevalence was tested by using the t-test

A few studies in Palestine assessed the rate of *S. aureus* and MRSA nasal colonization. An investigation of the MRSA strains that cause infections in the northern part of Palestinian healthcare facilities and the general public found *S. aureus* nasal carriers to be 24% and MRSA rate to be 2% [19].

Another study conducted for the detection of *S. aureus* and MRSA isolated from healthcare personnel nares at three Gaza hospitals, found that the nasal carriage rate of *S. aureus* and MRSA to be 42.1% and 22.6%, respectively [18]. Another study preformed to determine the rate of *S. aureus* and MRSA nasal carriage among healthcare workers at Al-Shifa hospital in Gaza, reported that *S. aureus* to be (31%) and MRSA was reported to be (25.5%) [20]. This was reported to be a major risk factor for MRSA transmission which could lead to systemic and severe infections [21].

Risk factors associated with increased MRSA nasal colonization include prolonged hospitalization, antibiotic exposure, and previous *S. aureus* infection [8, 22]. Other risk factors also include crowding, family size, smoking, inappropriate hygiene, and contact with a domestic animal [23].

According to our results, the investigation showed a positive statistical association between *S. aureus* nasal carriage and using antibiotics or visiting a hospital within the previous six months, and having a previous *Staphylococcus* bacterial infection, which is in agreement with previous studies [3, 11, 24]. Moreover, there was a positive statistical association between MRSA nasal carriage and using antibiotics or visiting a hospital within the previous six months, having a previous *Staphylococcus* bacterial infection and having a member of the family working in healthcare (Table 4). This is because healthcare professionals that work at the intersection of a hospital setting and the community could be a source of MRSA cross-contamination between the two settings [25].

In a typical dental practice, MRSA carriage rates vary greatly between nations and it ranges between 0 and 21% [5, 26, 27, 28]. This could be explained by variations in antibiotic use by nation, differences in application of infection prevention and control practices, or maybe due to the use of different techniques and different interpretation guidelines [29, 30].

There have been very few reports of MRSA transmission from DHCPs to patients in dental settings [6, 32]. However, the dental healthcare facility has certain important characteristics from the standpoint of infection prevention. For instance, using traditional dental tools like air/water syringes, dental seat buttons, dental seat armrests, light knobs, etc. can be a vector of infection and

Table 4 The association between the sociodemographic characteristics and the MRSA nasal carriage

Variables	*N*	%	MRSA		Chi	*P*-value
Gender			**No (*N*, %)**	**Yes (*N*, %)**	**Chi**	***P*-value**
Male	75	26.8	(72, 96)	(3, 4)	1.809	0.210
Female	205	73.2	(187, 91.2)	(18, 8.8)		
Clinical year			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
4th -year dental student	129	46.1	(122, 94.6)	(7, 5.4)	1.483	0.261
5th -year dental student	151	53.9	(137, 90.7)	(14, 9.3)		
Place of residence			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Rural	138	49.3	(126, 91.3)	(12, 8.7)	0.561	0.502
Urban	142	50.7	(133, 93.7)	(9, 6.3)		
Number of family members			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Up to 4	34	12.1	(31, 91.2)	(3, 8.8)	0.098	0.728
More than 4	246	87.9	(228, 92.7)	(18, 7.3)		
Profession of family			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Healthcare	112	40.0	(100, 89.3)	(12, 10.7)	2.780	0.008
Other	168	60.0	(159, 94.6)	(9, 5.4)		
Participate in sports			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	107	38.2	(98, 91.6)	(9, 8.4)	0.207	0.648
No	173	61.8	(161, 93.1)	(12, 6.9)		
Do you have contact with pets			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	84	30.0	(78, 92.9)	(6, 7.1)	0.022	0.999
No	196	70%	(181, 92.3)	(15, 7.7)		
Smoking			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	62	22.1%	(58, 93.5)	(4, 6.5)	0.126	0.899
No	218	77.9%	(201, 92.2)	(17, 7.8)		
Have you visited the hospital in the past 6 months			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	48	17.1	(43, 89.6)	(5, 10.4)	0.710	0.035
No	232	82.9	(216, 93.1)	(16, 6.9)		
Had surgery in the past 6 months			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	12	4.3	(11, 91.7)	(1, 8.3)	0.013	0.999
No	268	95.7	(248, 92.5)	(20, 7.5)		
Used antibiotics in the last 6 months			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	131	46.8	(115, 87.8)	(16, 12.2)	7.884	0.006
No	149	53.2	(144, 96.6)	(5. 3.4)		
Have you ever had a previous*staphylococcus*bacterial infection			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	36	12.9	(27, 75)	(9, 25)	0.041	0.043
No	244	87.1	(226, 92.6)	(18, 7.4)		
Do you have an underlying medical condition			**No (N, %)**	**Yes (N, %)**	**Chi**	**P-value**
Yes	10	3.6	(9, 90)	(1, 10)	0.093	0.547
No	270	96.4	(250, 92.6)	(20, 7.4)		

*The chi-square test was used to investigate the association between the sociodemographic characteristics and the MRSA nasal carriage

contaminate the dental clinics [7]. Therefore, DHCPs must always be aware of the potential for transmitting MRSA by droplets or an airborne mode as aerial spread of MRSA from individuals with MRSA carriage has been observed [33].

Since dental students interact closely with patients during clinical practice, they are more prone to contract MRSA and disseminate it to patients [34]. So, the use of masks by dentists and dental students during consultation and dental care, is an effective infection prevention and control measure to fight infection due to *S. aureus* nasal carriage. Moreover, understanding the pathogen, its mode of transmission, and risk factors are crucial for the appropriate implementation of infection prevention and control practices [33].

The antibiotic resistance and susceptibility patterns may vary considerably from region to region. This variability could be due to various factors such as; exposure to antibiotics, or use of different antibiotics in different countries, ongoing genetic mutation of strains, transmission of the resistance genes from one bacterium to another, the unique characteristics of each study population, and the various exclusion criteria employed by each study [14, 35, 36]. In this study, all MRSA isolates (100%) were found resistant to amoxicillin. The widespread use of amoxicillin in the region's gram-positive bacterial illness treatment regimen may be to blame for the high prevalence of resistance that has been documented. Another contributing factor is the access that people in Palestine have to various types of antibiotics without physicians' prescriptions. Moreover, 28.5% were found resistant to amoxicillin/clavulanic acid, 23.8% were found resistant to erythromycin, four isolates (19%) were resistant to clindamycin, and three isolates (14.2%) were found to be gentamicin resistant. Vancomycin resistance was not discovered in any of the isolates. Our findings were in line with a study carried out in Palestine in 2013, which discovered that all MRSA isolates were penicillin-resistant and all strains of *S. aureus* were vancomycin-sensitive. The resistant rates to amoxicillin/clavulanic acid, erythromycin, and clindamycin were higher than what we observed in our study [19].

Knowledge, attitude, and practices are three important key elements in the dynamics of life. Hence, the right information, positive perception, and good compliance are imperative to guide dental students and practitioners in treating and serving their patient [37].

Previous studies reported that students had very poor knowledge of the pathogen, and the attitude of the study participants to MRSA was inadequate [33, 38]. Thus, assessment of the knowledge, attitudes and practice of dental students and dental health practitioners is essential for creating appropriate MRSA infection control measures [4].

Knowledge scores obtained from our study were compatible with a previous study conducted among DHCPs in Korea [4]. These scores suggest that there is further need for education on MRSA, especially its seriousness. Another study conducted among nursing students in Ohio, USA; revealed that knowledge regarding MRSA was inadequate [39]. Our result was not compatible with a study designed to evaluate the knowledge, attitudes, and compliance to infection prevention and control practices among HCWs in Nepal, where the level of the staff's knowledge there was acceptable [40]. This discrepancy could be due to the Nepali's staff being more experienced than our study population. Our study suggests that dental students had a positive attitude toward infection control, as many students were aware that infection control education is necessary. The majority of the student participants expressed willingness to take additional educational courses to increase their knowledge regarding MRSA.

Failure to adhere to basic infection prevention and control practices would increase infection risk significantly. One of the best methods to stop the spread of MRSA is by good hand hygiene, thus every DHCP should wash their hands thoroughly before and after coming in contact with all patients. It takes only one time for germs to be disseminated from dirty hands, hence, regardless of how many times hands are washed after contacting patients, it might be too late to prevent infection. Although the percentage is small, 1.8% of the dental students participating in this study stated that they never performed hand hygiene before getting in contact with a patient, and 2.5% of the participants stated they never washed their hands either before or after wearing gloves. Every HCW, should know that hygienic practices are essential to prevent the spread of infections.

It can be hypothesized that nasal MRSA carriers exhibit worse knowledge, attitude, or practice scores than non-carriers due to their ignorance of infection prevention. In contrast to non-carriers, nasal MRSA carriers in this study demonstrated somewhat higher attitude and practice ratings. However, these variations lacked statistical significance.

A limitation of this study was the approach used to assess adherence to infection prevention and control guidelines. We were unable to directly observe the participants' practices and had to depend on their self-reported assessments. As a result, the responses may not have accurately represented their actual compliance to infection prevention practices.

It is recommended to broaden students understanding of MRSA. This can be done by putting more emphasis on this knowledge in the curricula of dental schools and by recommending to these schools to integrate infection control courses in their academic curricula, along with

periodic training of dental students on infection prevention. Also, an increase in awareness of the concept of antimicrobial stewardship, and how the misuse and overuse of antibiotics contribute to antibiotic resistance. More research is needed to determine how dentists and dental students contribute to the spread of MRSA in the dental setting and its transmission to patients. Moreover, it is recommended that further research is done across the nation to determine the risk variables that contribute to *S. aureus* and MRSA colonization, especially in university settings.

Conclusion

In conclusion, the present study showed that most dental students reported intermediate knowledge of, good compliance with, and positive attitudes towards, infection control routines regarding MRSA in dental practice. The prevalence of MRSA nasal colonization among the dental student population is 7.5%, which is higher than the rate among the general community in Palestine (2% MRSA rate), but lower than the rate among HCWs in hospital settings. This emphasizes the importance of the implementation of appropriate and effective strategies that can help in minimizing the transmission of MRSA. In addition, it is recommended to enhance dental students' knowledge of MRSA, and increase their awareness regarding antibiotic resistance.

Abbreviations

CLSI	Clinical Laboratory Standards Institute
KAP	Knowledge Attitude Practice
MRSA	Methicillin-Resistant Staphylococcus aureus
MSSA	Methicillin-Susceptible Staphylococcus aureus
HCWs	Health Care Workers
DHCPs	Dental Health Care Professionals
CDC	Centers for Diseases Control and Prevention

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions

S.M: participated in the development of the study design, collecting and Analysis samples, interpretation of the data, and in writing of the manuscript.M.I: participated in the development of the study design, analysis samples, interpretation of the data, and in writing of the manuscript.A.A and I.A participated in interpretation of the data and in the writing of manuscript. All authors read and approved the final manuscript.

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Data availability

The datsets used in the current study are available from corresponding upon request.

Declarations

Ethics declaration

The Al-Quds University School of Public Health Research Committee approved conducting this study (School of Public Health Ethical Committee: REF. 1/2022) and this study complies with all relevant ethical standards including the principles outlined in the Declaration of Helsinki and applicable ethical guidelines. The faculty of dentistry at Al-Quds University also gave its authorization to carry out the study. Prior to experiments starting, informed consent was obtained from all dental student participants involved in the study and were given information about the study's purpose and goals. Participants received assurances that the information they provided and the swab results would be kept private and that the researcher would not expose any personal information to anyone. Participants with positive MRSA results were informed privately, and advised to consult a clinician regarding decolonization.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Author details

[1]Faculty of Dentistry, Al-Quds University, Jerusalem, Palestine
[2]Department of Physiology and Pharmacology, Faculty of Medicine, Al-Quds University, Jerusalem, Palestine
[3]Department of Microbiology and Immunology, Faculty of Medicine, Al-Quds University, Jerusalem, Palestine

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