Prevalence of *Staphylococcus aureus* Nasal Carriage and Methicillin-resistant *S. aureus* Among Medical Students: A Systematic Review and Meta-analysis

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Abstract

**Context:** Evaluating the prevalence of *Staphylococcus aureus* nasal carriage and methicillin-resistant *S. aureus* (MRSA) that are sources of nosocomial infection among medical students.

**Evidence Acquisition:** Electronic databases were searched by preferred subject headings and free-text keywords. After omitting duplicates, retrieved articles were screened by two independent reviewers in a three-step process based on inclusion criteria. Then, reviewers critically appraised the selected studies by JBI checklists and extracted the required data. Finally, the pooled prevalence rates of *S. aureus* nasal carriage and MRSA were meta-analyzed by Stata V.16 software. The heterogeneity of included studies was calculated by $I^2$ and chi-square. Subgroup analysis was carried out according to study designs, as well as the continent origin of clinical and preclinical students.

**Results:** Of 858 retrieved studies, 15 were included in the meta-analysis. The results showed that the pooled prevalence of nasal *S. aureus* carriage was 28% (prevalence rate: 0.028, 95% CI: 0.21 - 0.34, P < 0.001, $I^2$: 96.40%, chi$^2$: 360.98 (df = 14)). The prevalence of *S. aureus* among clinical students was 33% (pooled prevalence rate: 0.33, 95% CI: 0.18 - 0.47) whereas, in preclinical students, it was 25% (pooled prevalence rate: 0.25, 95% CI: 0.23 - 0.28). Also, in a subgroup analysis of continents, Australia (Oceania) had the highest prevalence rate. According to an evaluation of publication bias, the distribution of studies was very high. Moreover, pooled MRSA prevalence among medical students was 2% (prevalence rate: 0.02 95% CI: 0.01 - 0.03, P < 0.001).

**Conclusions:** In this meta-analysis, *S. aureus* and MRSA prevalence rates among medical students were estimated at 28% and 2%, respectively. More attention should be given to the prevention of MRSA colonization and screening strategies among medical students across the world.

**Keywords:** Meta-analysis, *Staphylococcus aureus*, Methicillin-resistant, Prevalence, Systematic Review

1. Context

*Staphylococcus aureus* is an important human bacterial pathogen that is often found in the skin and the upper respiratory tract (1). It is known to be one of the main bacterial agents responsible for nosocomial and community infections (2). Methicillin-resistant *S. aureus* (MRSA) was reported for the first time in the 1960s and spread rapidly in the 1980s (3). Over the past 45 years, hospital-related MRSA clones and community-acquired MRSA (CA-MRSA) spread around the world. Without taking any specific control measures, the risk of occurrence of an epidemic with these strains is high (4). The first cases of CA-MRSA among children were reported in the late 1990s (5). It has been documented that this infection is more prevalent in gyms, military bases, and newborn nurseries. Moreover, it has been reported in homosexuals (6).

Carrying *S. aureus* pathogens in the nose increases the risk of infection, especially in the hospital setting (7), and is the most important risk factor for the transmission of this pathogen (8). Studies on the transmission of *S. aureus*...
by hospitalized patients in Madagascar showed that the prevalence of MRSA was between 4 and 13%, and the prevalence of S. aureus in outpatients was reported to be 38%, of which 15% were MRSA cases (9). Another study in Brazil revealed that the nasal carriage of S. aureus is 40.8% of which, 5.8% were MRSA (10). Medical staff members, including medical students, act as a bridge between the hospital and the community. Nasal carriage of S. aureus, especially CA-MRSA, has recently been proposed by medical students as a possible mechanism for increasing the transmission of these species between hospitals and the community (11).

The prevalence of MRSA carriage among hospital staff is associated with the length of stay in the ward. Several studies on the prevalence of S. aureus nasal carriage have been published by medical students in recent decades (7,10-12). Several studies have also been conducted to estimate the prevalence of S. aureus in nasal carriage worldwide, including some national studies about the estimation of S. aureus nasal carriage by medical students, which shows the need for a comprehensive study for pooling their reported data in this field. In this approach, several systematic reviews and meta-analyses have been published; however, different health-related populations have been investigated in them, except for medical students. For example, Emaneini et al. (13) carried out a systematic review and meta-analysis on nasal carriage rates of S. aureus and MRSA among Iranian healthcare workers. Their study showed the prevalence of S. aureus to be 22.7% and MRSA to be 32.8% among Iranian healthcare workers (13).

In addition, in another systematic review and meta-analysis, the prevalence of community-associated methicillin-resistant S. aureus carriage in the Asia-Pacific region from 2000 to 2016 has been investigated, which shows a prevalence of 0% to 23.5% in the general public and 0.7% to 10.4% in hospital settings (14). The pooled data in S. aureus and MRSA nasal carriage will help the world’s policymakers and health authorities to conduct more useful strategies to reduce the burden of the infection and reach the ultimate goal of healthier medical staff and students. For this purpose, the current systematic review evaluated studies and pooled their data on the prevalence of S. aureus and MRSA nasal carriage among medical students.

2. Evidence Acquisition

This systematic review was performed based on the JBI methodology for a systematic review of prevalence evidence (15). In addition, the method of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was utilized in this project (16).

2.1. Review Questions

The questions of this review were as follows:

What is the prevalence of S. aureus among medical students?

What is the prevalence of MRSA among medical students?

2.2. Inclusion Criteria

2.2.1. Participants

Studies including medical students (preclinical or clinical) as the population were considered in this review.

2.2.2. Condition

Studies in which the prevalence of S. aureus and MRSA nasal carriage were evaluated. We excluded all studies evaluating only the skin or pharyngeal samples.

2.2.3. Context

Studies performed in the medical education setting, including the hospital or university campus, were included in this review.

2.2.4. Types of Studies

All analytical-observational studies, including prospective and retrospective cohorts, as well as case-control, analytical, and descriptive cross-sectional studies, were included in this review. Moreover, studies published in English from 1967 were considered for inclusion in the current review.

2.2.5. Search Strategy

To find the studies (published and unpublished) on the subject, a three-stage method was used. In the first stage, the PubMed database was searched limitedly. In the next stage, the words were searched in the titles and abstracts, as well as the index terms used to describe the articles. The final search was conducted electronically using all detected keywords and index terms. This step was implemented on January 26, 2020, through the following databases: Medline (PubMed), Embase, Scopus, and Web of Science. The unpublished studies and gray literature such as ProQuest (dissertations and theses) and google scholar were searched, as well. In the final stage, the lists of references of all reports and studies of the review were investigated to find any other articles. The strategy by
which the full search was performed in PubMed and Em-
base databases is provided in Appendix 1 in Supplementary
File.

2.2.6. Study Selection
After searching, the detected citations were entered in
Endnote software version X7.1.3, and the duplicate titles
were omitted. Then, two independent critics reviewed and
screened the titles and abstracts to make sure of the qual-
ification of the studies concerning the inclusion criteria
for the review. The full-texts of the selected studies were
obtained and investigated in full detail by two reviewers,
and the inclusion criteria were assessed for them. The full-
text articles not having the inclusion criteria were omitted
from the research. Any disagreements between the two re-
viewers were resolved using sessions of discussion.

2.2.7. Assessment of Methodological Quality
Two independent reviewers critically reviewed the pos-
sible articles for the study using standard critical review-
ing tools obtained from the Joanna Briggs Institute Stud-
ies Reporting Prevalence Data (17). Any disagreements be-
tween the two reviewers were resolved by holding discus-
sion sessions. All studies that were assessed as moderate or
high level in terms of quality were included in this review.

2.2.8. Data Extraction
Two independent reviewers were asked to extract the
needed information from the studies with the inclusion
criteria using a modified standardized JBI data extraction
tool (15). The extracted data included information on popu-
lations, sample size, study methods, and publication year,
as well as the region of the study, mean age, gender, and
measurement of outcomes and prevalence of S. aureus
and MRSA among students of medicine. Any disagreements
that arose between the critics were resolved using discus-
sion sessions. In addition, the corresponding authors of
the articles were contacted for missing data and additional
information.

2.2.9. Data Synthesis
Data were pooled using statistical meta-analysis with
Stata software version 16. The effect size was reported using
the event rate (pooled prevalence rate). In addition, a
confidence level of 95% was reached to begin the meta-
analysis. The heterogeneity of the studies was calculated
using the standard chi-square test, as well as the I² test for
heterogeneity. Statistical analyses were conducted by the
random-effects method (18). Moreover, subgroup analyses
were performed based on study designs and continents in
which the study was performed. A sensitivity analysis was
performed to locate heterogeneous studies. A funnel plot
was generated in Stata software version 16 to assess publi-
cation bias.

3. Results

3.1. Study Inclusion
From comprehensive searching, 1,312 studies were re-
trieved in the electronic search and 51 studies with ad-
ditional methods. Then, they were imported in Endnote
X7.1.3, and duplicated records were removed. In the three
steps of screening (title, abstract, and full-text), two expert
reviewers selected 28 studies, of which 17 studies remained
finally for the critical appraising process. You can find this
selection process in PRISMA flowchart 1. Also, the reasons
for excluding the articles in the full-text step are presented
in Figure 1.

3.2. Methodological Quality
Totally, 16 studies were critically appraised by JBI ap-
praisal tools for prevalence and cohort studies to evalu-
late the risk of biases. On that account, the quality of nine
studies was assessed as high (19-27), six studies as moderate
(28-33), and one study as low (34). The study with the low-
est quality was excluded from this systematic review and
meta-analysis (34) (Appendix 2 in Supplementary File; Ta-
ble 1). Fifty percent of these studies had not appropriately
sampled their populations. In most of them, they had col-
clected participants voluntarily.

3.3. Characteristics of Included Studies
Finally, after critical appraising of 16 studies, 15 studies
were included. The study designs were observational, in
which two studies were cohort (28, 32) and the others were
cross-sectional (19, 26, 28-30, 33, 34). The characteristics of
the included studies are presented in Table 2.

3.4. Staphylococcus aureus Prevalence
The SA prevalence was reported in 15 studies that were
included in the meta-analysis. According to the results, the
pooled prevalence of nasal S. aureus was 28% (prevalence:
0.028, 95% CI: 0.21 - 0.34, P < 0.001), which was varied from
10 to 72%. Moreover, the calculated heterogeneity was very
high (I²: 96.40%, chi²: 360.98 (df = 14) P < 0.001) (Figure
2). Subgroup analysis based on study design was also per-
fomed in this analysis, which demonstrated 28% in cross-
sectional studies and 24% in cohort studies. Furthermore,
the prevalence of *S. aureus* among clinical students was 33% [pooled prevalence: 0.33, 95% CI: 0.18 - 0.47]; however, it was 25% among preclinical students [pooled prevalence: 0.25, 95% CI: 0.23 - 0.28] (Figure 3). In addition, subgroup analysis based on continents showed that Oceania had the highest prevalence rate of *S. aureus* nasal carriage (40%), and Asia (30%), Europe (26%), America (24%), and Africa (12%) had lower prevalence rates of *S. aureus* nasal carriage (Figure 4). Moreover, the results of the meta-analysis showed that this rate was 33% among clinical students (Figure 5) and 25% among preclinical students (Figure 6). Furthermore, to evaluate publication bias, a funnel plot was drawn. It showed that the distribution rate of studies was very high (Figure 7).

3.5. Methicillin-resistant *Staphylococcus aureus* Prevalence

The results of the meta-analysis of 15 studies that had reported nasal MRSA showed that the total prevalence

**Figure 1.** PRISMA flowchart of the selection process (16)
Table 1. Critical Appraisal Results of Eligible Studies

| Study                        | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Quality     |
|------------------------------|----|----|----|----|----|----|----|----|----|-------------|
| Bhatta et al. (19)           | Y  | U  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Highb       |
| Ansari et al. (20)           | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | High        |
| Collazos Martin et al. (21)  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | High        |
| Manipura et al. (22)         | N  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | High        |
| Hogan et al. (23)            | Y  | Y  | Y  | Y  | Y  | N  | Y  | Y  | Y  | High        |
| Bettin et al. (24)           | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | Y  | High        |
| Santhosh et al. (28)         | N  | U  | Y  | N  | Y  | Y  | Y  | Y  | Y  | Moderatec   |
| Abroo et al. (29)            | N  | N  | Y  | N  | Y  | Y  | Y  | Y  | Y  | Moderate    |
| Conceicao et al. (34)        | N  | N  | N  | N  | U  | Y  | U  | Y  | Y  | Lowd        |
| Syafinaz et al. (25)         | Y  | Y  | Y  | N  | Y  | Y  | Y  | Y  | Y  | High        |
| Zakai (26)                   | Y  | U  | Y  | Y  | Y  | Y  | U  | Y  | Y  | High        |
| Szymanek-Majchrzak et al. (30)| N | Y | Y | N | Y | Y | Y | N | Y | Moderate    |
| Stubbs et al. (31)           | N  | N  | Y  | N  | Y  | Y  | Y  | Y  | Y  | Moderate    |
| Shreyas et al. (27)          | Y  | Y  | Y  | N  | Y  | Y  | Y  | Y  | Y  | High        |
| Gualdoni et al. (32)         | N  | N  | N  | Y  | Y  | Y  | U  | Y  | N  | Moderate    |
| Trepanier et al. (33)        | Y  | N  | Y  | Y  | N  | Y  | Y  | N  | N  | Moderate    |

Total, %

|       | 56.25 | 50   | 50   | 56.25 | 50   | 87.5 | 56.25 | 87.5 | 93.75 | 93.75 | 81.25 | 93.75 |

Abbreviations: N, no; U, unclear; Y, yes.

*JBI critical appraisal checklist for randomized controlled trials: Q1 = was the sample frame appropriate to address the target population?; Q2 = were study participants sampled in an appropriate way?; Q3 = was the sample size adequate?; Q4 = were the study subjects and the setting described in detail?; Q5 = was the data analysis conducted with sufficient coverage of the identified sample?; Q6 = were valid methods used for the identification of the condition?; Q7 = was the condition measured in a standard, reliable way for all participants?; Q8 = was there appropriate statistical analysis?; Q9 = was the response rate adequate, and if not, was the low response rate managed appropriately?

bHigh: Seven to nine positive criteria.
cModerate: Four to six positive criteria.
dLow: Fewer than four positive criteria.

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Figure 2. Staphylococcus aureus prevalence among medical students

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Table 2. Characteristics of Included Studies

| Number | Author            | Year | Study Design     | Country        | Study Population                                                                 | Sample Size | Subject Characteristics                                                                 | Study Duration | Methods for Outcome Measurement |
|--------|-------------------|------|------------------|----------------|----------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------|----------------|----------------------------------|
| 1      | Bhatta et al.     | 2018 | Cross-sectional  | Nepal          | Clinical and preclinical (first year, interns)                                   | 210 (100 preclinical, 100 clinical) | A: 34; B: 34; C: 34; D: 34; E: 34 | 10 - 30 | Nasal and pharyngeal swabs        |
| 2      | Ansari et al.     | 2016 | Cross-sectional  | Nepal          | Clinical and preclinical (first year, interns)                                   | 208 (100 preclinical, 100 clinical) | 345 | 10 - 30 | Nasal swabs                      |
| 3      | Calliano Moser et al. | 2015 | Cross-sectional  | Colombia       | Clinical and preclinical (first year, interns)                                  | 206 | 59 - 60 | 59 - 60 | Skin and nasal swabs              |
| 4      | Montgoury et al.  | 2016 | Cross-sectional  | India          | Medical students (second year)                                                   | 448 | 50 - 52 | 18 - 22 | Nasal swabs                      |
| 5      | Hogan et al.      | 2016 | Cross-sectional  | Madagascar     | Nonmedical students (%) different hospitals                                      | 148 | 90 - 92 | 10 - 22 | Nasal swabs                      |
| 6      | Rezai et al.      | 2016 | Cross-sectional  | Colombia       | Medical student                                                                  | 372 | 10 - 20 | 10 - 20 | Nasal swabs                      |
| 7      | Sathish et al.    | 2016 | Cohort study     | India          | Preclinical students                                                             | 67 | 10 - 20 | 10 - 20 | Nasal swabs                      |
| 8      | Almeida et al.    | 2017 | Cross-sectional  | Iran           | Medical students (basic medical science course)                                 | 351 | 225 | 10 - 60 | Nasal swabs                      |
| 9      | Carvalho et al.   | 2017 | Cohort study     | Portugal        | Nursing student                                                                  | 47 | 18 - 22 | 18 - 22 | Nasal swabs                      |
| 10     | Sukli et al.      | 2015 | Cross-sectional  | Malaysia        | Preclinical and clinical students                                                 | 269 | 50 - 60 | 10 - 20 | Nasal swabs                      |
| 11     | Zakari et al.     | 2015 | Cross-sectional  | Saudi Arabia    | Clinical students                                                                | 60 | 75 | 10 - 20 | Nasal swabs                      |
| 12     | Smyrnakis et al.  | 2018 | Cross-sectional  | Poland          | Preclinical students                                                             | 955 | 100 | 10 - 20 | Nasal swabs                      |
| 13     | Shabbir et al.    | 1994 | Cross-sectional  | Australia       | Preclinical and clinical                                                          | 988 | 577 | 10 - 20 | Nasal swabs                      |
| 14     | Sherpa et al.     | 2017 | Cross-sectional  | India           | Interns                                                                         | 150 | 48 | 10 - 20 | Nasal swabs                      |
| 15     | Guadalupe et al.  | 2015 | Cohort study     | Austria         | Medical students (clinical)                                                       | 78 | 10 - 20 | 10 - 20 | Nasal swabs                      |
| 16     | Tripathi et al.   | 2013 | Cross-sectional  | Canada          | Medical students and residents                                                    | 250 | 65 (medical res: 125.125); residents: 20 | 61.25 | Medical swabs                    |

Among medical students was 2% (prevalence rate: 0.02, 95% CI: 0.01 - 0.03, P < 0.001) (Figure 8). This rate varied from 0 to 26% in these studies. In addition, the heterogeneity of the included studies was very high (I²: 84.97%, chi²: 86.48 (df = 14) P < 0.001). Therefore, a subgroup analysis was performed according to the study design. This meta-analysis disclosed that the pooled prevalence of MRSA was 2% and 0% in cross-sectional and cohort studies, respectively (Figure 9).

4. Discussion and Conclusions

In this meta-analysis, 15 studies on S. aureus prevalence among medical students in different countries were analyzed. The prevalence rates varied widely over a range between 0 and 72%. The pooled prevalence of nasal S. aureus was 28%, which is comparable with the Kluytmans study. In this study, a mean carriage rate of 26.6% was found among Health Care Workers (HCWs) (36). However, the range of carriage rate was large (16.8 - 56.1%). This may be due to differences in the quality of sampling methods and culture techniques used in these studies (37-42). The range of carriage prevalence rate of S. aureus was higher among clinical students (33%) than in preclinical students (28%). This could be due to the increment in the possibility of exposure with S. aureus because of frequent visits to wards and clinics in the hospital setting (43).

This review incorporated 15 studies on MRSA prevalence among medical students around the world. The pooled prevalence of nasal MRSA colonization among clinical students was estimated to be 2%. The estimations of the present study are more than the results of a previous review to a certain extent. That study estimated the average rate of MRSA among HCWs to be 1.8% in Europe and the United States (44). Two other reviews reported the preva-
lence of MRSA colonization among HCWs to be around 5% (45, 46). In both reviews, the data belonged to endemic situations and outbreaks, which was a different aspect of our review.

Despite that most of the articles were evaluated as high-quality and moderate-quality (in addition to one study evaluated as poor), the methodological assessment of the studies indicated that the quality of the articles was somehow inconsistent with the sample size and bias resolving method. Moreover, nine articles were evaluated to be of high quality. The high-quality studies showed a higher pooled MRSA involvement rate among medical students than moderate-quality studies. Possible explanations include differences in human populations, predominant strain(s), study design, and laboratory testing methods for determining resistance (47).

The major cause of classification bias was seen in the sampling location, as well as the time of evaluation of medical students (45). In most studies, sampling sites were anterior nares, and it might have led to an underestimation of the accuracy of the results of MRSA rate. The nasal samples were taken by different staff members instead of one educated person, and this could affect the reliability. Another factor was the timing of the screening test that would impact the findings of cohort studies, indicating that MRSA colonization is basically momentary (12).

Our study showed that the MRSA rate in medical students had a large variation in a range from 0% to 26%. Carriage rates among HCWs are higher than in normal populations that have no recognized risk factors (circa 0.2%) (48). This is of high importance because colonized HCWs give service to high-risk patients, including those with infections of the surgery site, neonates, and patients admitted to the intensive care unit.
### Figure 4. Staphylococcus aureus prevalence among medical students, sub-grouped by continent

| Study                  | % (ES 95% CI) | Weight |
|------------------------|---------------|--------|
| Asia                   |               |        |
| Bhatta et al (2016)    | 0.35 (0.29, 0.42) | 0.02   |
| Ansari et al (2016)    | 0.15 (0.11, 0.21) | 0.20   |
| Radhakrishna et al (2016) | 0.53 (0.45, 0.61) | 0.78   |
| Abro et al (2017)      | 0.18 (0.14, 0.22) | 0.07   |
| Nordin et al (2012)    | 0.10 (0.07, 0.15) | 0.07   |
| Zakai et al (2015)     | 0.38 (0.32, 0.45) | 0.95   |
| Shreyas et al (2017)   | 0.47 (0.40, 0.55) | 0.79   |
| Santcho et al (2006)   | 0.24 (0.18, 0.31) | 0.02   |
| Subtotal (I^2 = 96.00%, p = 0.00) | 0.30 (0.20, 0.40) | 0.55   |
| America                |               |        |
| Collazos Marin et al (2015) | 0.20 (0.16, 0.24) | 0.21   |
| Bettin et al (2012)    | 0.27 (0.23, 0.32) | 0.02   |
| Subtotal (I^2 = %, p = ) | 0.24 (0.21, 0.28) | 0.52   |
| Africa                 |               |        |
| Hogan et al (2016)     | 0.12 (0.09, 0.14) | 0.52   |
| Europe                 |               |        |
| Szymank-Majchrzak et al (2019) | 0.26 (0.23, 0.29) | 0.99   |
| Guadoni et al (2012)   | 0.25 (0.17, 0.36) | 0.98   |
| Subtotal (I^2 = %, p = ) | 0.26 (0.23, 0.28) | 0.97   |
| Oceania                |               |        |
| Stubbs et al (1994)    | 0.40 (0.36, 0.43) | 0.44   |
| Heterogeneity between groups: p = 0.000 |        |        |
| Overall (I^2 = 96.40%, p = 0.00) | 0.28 (0.21, 0.34) | 0.00   |

### Figure 5. Staphylococcus aureus prevalence among clinical students

| Study                  | % (ES 95% CI) | Weight |
|------------------------|---------------|--------|
| Zakai et al (2015)     | 0.25 (0.19, 0.33) | 34.36  |
| Shreyas et al (2017)   | 0.47 (0.40, 0.55) | 33.53  |
| Guadoni et al (2012)   | 0.25 (0.17, 0.36) | 32.11  |
| Overall (I^2 = 89.73%, p = 0.00) | 0.33 (0.18, 0.47) | 100.00 |
In addition, it was shown that several factors can affect the design and implementation of primary studies. These factors are also effective in calculating the prevalence. It was found during this meta-analysis that cohort studies reported a lower prevalence of MRSA carriage. Although the final prevalence of MRSA carriage was reported to be circa 2%, which is similar to previous articles, a high rate of heterogeneity was seen in study populations, as well as study designs. These estimations might help find more precise estimations of the global phenomenon incidents. We might also be able to consider different factors affecting the prevalence rates.
Figure 8. MRSA prevalence among medical students

Figure 9. MRSA prevalence among medical students, sub-grouped by study design
It can be stated that the results from the present meta-analysis provide an estimation of SA and MRSA prevalence rates among medical students. This estimation comes from several performed studies among different populations. Regarding the fact that medical students are at the highest exposure risk for MRSA colonization, the prevention of MRSA colonization in this group should be considered more seriously. The results of this meta-analysis indicate that decision-makers and officials need to focus more on this public health matter and develop more accurate screening strategies for medical students in all countries.

Health care workers who are at the interface between the hospital and community may serve as specialists of cross-contamination of hospital-acquired MRSA and community-acquired MRSA. The identification of HCWs in outbreak settings colonized with MRSA is valuable in reducing the transmission and controlling the spread of MRSA. Since reducing the carrier rate of SA, especially methicillin-resistant cases, can be effective in reducing infections caused by this organism, studying and knowing the number of carriers, especially in the medical staff, can reduce nosocomial infections caused by this organism. It is suggested that the prevalence of nasal S. aureus carriage of all health professionals, including medical doctors and specialists, nurses, and other medical staff and patients at risk of infections, be evaluated in the next studies. In addition, the carrier rate of MRSA may be considered.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

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Footnotes

Authors’ Contribution: YAO contributed to the conception and design, data collection and interpretation, and final approval of the version to be published. MA and ATZ contributed to the statistical analysis and drafting of the manuscript. FP contributed to data collection and interpretation. HEL and SAO contributed to revising the article and final approval of the version to be published.

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