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STAPHYLOCOCCUS AUREUS AMONG ATHLETES IN ZAKHO CITY, KURDISTAN REGION, IRAQ: NASAL CARRIAGE RATE, RISK FACTORS, AND ANTIBIOTIC SENSITIVITY PROFILE

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ABSTRACT:

Background and aims: *Staphylococcus aureus* is a leading cause of infectious diseases and responsible for outbreaks among athletes' team. This study aimed to analysis the prevalence rate of *S. aureus* among athletes, and evaluate the antibiotic resistance and associated risk factors.

Materials and methods: This cross-sectional study was performed to evaluate the nasal carriage rate of *S.* aureus among athletes applying different sports. Nasal swabs were collected from 510 athletes aged between 14-55 years. Conventional bacteriological methods were used for the isolation and identification of the *S. aureus*. According to the Clinical and Laboratory Standards Institute (CLSI), the profile of antibiotic sensitivity test was performed.

Results: Out of recruited samples, *S. aureus* carriage rate among athletes was 30.2% (154/510) The highest infection rate was reported among boxing athletes 33.33% (8/24) and gym 32.65% (80/245). *S. aureus* colonization was significantly higher among the athletes who had low body mass index (p=0.001), longer duration of training/day (p=0.001) and higher number of training session /week (p=0.012). *S. aureus* carriage was significantly higher among male athletes 77.27% (119/154) than female athletes 22.73% (35/154) (p=0.002). The oxacillin resistance rate was 26.61%. *S. aureus* isolates were highly susceptible to rifampicin (100%), gentamycin (98.05%) and fusidic acid (98.7%).

Conclusion: The prevalence of nasal carriage of *S. aureus* is comparatively high and the highest prevalent reported among male athletes. It is suggested that the control prevention program to be applied to reduce nasal carriage rate of infection, and associated risk factors with *S. aureus* among athletes. More studies on carriage rate of *S. aureus* should be applied using molecular study

KEYWORDS: Nasal Carriage, *Staphylococcus aureus*, Antibiotic Sensitivity Profile, Athletes, Zakho, Iraq.

1. INTRODUCTION

Staphylococcus aureus (S. aureus) is a Gram-positive bacterium that colonizes roughly 30% of healthy people in various body parts (Oliveira *et al*., 2018). *S. aureus* is one of the species that is clinically recognized as being significant, and it is crucial in the development of both community- and hospital-acquired infections**.** The infection spectrum ranging from abscesses, bacteraemia, septicaemia, soft tissue infections, endocarditis, bone infections, pneumonia, and meningitis to life threating (Oliveira *et al.*, 2018, Bitrus *et al*., 2018). Colonization of body by *S.* aureus is influenced by several risk factors including age, variations accompanied with different seasons, and specific infections (Habeeb *et al*., 2014b, Brugger *et al*., 2016). Additionally, individuals with poor immunity, such as health-care professionals, diabetics, and patients receiving intravenous drugs are a potential risk factors for *S.* aureus colonization (up to 80 %) (Barah, 2012).

Methicillin-resistant *S.* aureus (MRSA) is increasingly problematic within athletic and have been previously well documented (Cohen, 2008b, Grosset-Janin et al., 2012). It is known that contact skin-to-skin, and inadequate personal hygiene are a major risk factor for community-associated methicillin-resistant *S.* aureus (CA-MRSA) (Tenover and Goering, 2009). CA-MRSA infections among athletes in the United States have grown increasingly common with high risk with those who requiring physical direct contact including rugby, wrestling and American football (Grosset-Janin *et al*., 2012). Sporting activities requiring minimal physical contact, but the use of shared equipment, including martial arts fencing, cross-country runners, football, volleyball, basketball, weight-lifting and baseball are also related to CA-MRSA outbreaks (Cohen, 2008b). Moreover, usage of equipment that causes skin abrasion, and poor sanitation are also risk factors for *S.* aureus infection in sports (Grosset-Janin *et al*., 2012).

Several antibiotics have been developed resistance to *S.* aureus in our region (Rasheed and Hussein, 2020a, Naqid *et al*., 2020b, Naqid *et a*l., 2020a) and methicillin-resistant *S.* aureus (MRSA) have also reported among hospitalized patients (Abdulkareem *et al*, 2020, Hussein *et al*., 2017), and the community (Hussein *et al*., 2019, Rasheed and Hussein, 2020d). The prevalence of community-associated MRSA among athletes is higher particularly those people participate in direct contact sports (Rice et al., 2008), even three times greater when compared to the general community (Graham et al., 2006). MRSA is a risk to the whole team once contracted by an athlete; thus, it is very essential to apply prevention and control ways of the spreading of the infections, such as good personal hygiene, dressing of the wounds, cleaning, and avoid the sharing of items that direct contact with the skin (Mascaro *et al*., 2019).

Several studies have been performed in the United States, the United Kingdom, Germany, and Japan to describe the nasal carriage rate of *S.* aureus among athletes (Cohen, 2008b, Grosset-Janin *et al*., 2012), but no studies have been conducted among athletes in Kurdistan Region, Iraq. Therefore, the aims of this study were to evaluate the prevalence of S. aureus in different types of contact sports athletes, to investigate antibiotics resistance of isolated *S.* aureus isolates, and the risk

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factors associated with nasal carriage rate of *S.* aureus among practicing sport was investigated

2. MATERIALS AND METHODS

2.1 Study design

The design of this study was a cross-sectional and conducted among athletes at Zakho City, Kurdistan Region-Iraq. This study was performed from September 2021 to February 2022. A total of 510 samples were collected from various athletic groups (Figure 1). Out of these, 245 were collected from gyms, 24 from boxing and 56 from football clubs, and 185 samples from students (106 from sport institute and 79 from Physical Education Department at University of Zakho). The mean age of subjects was 22.33 years (Range: 14-55 years).

2.2 Sampling and data collection

A standard questionnaire was used to gather information from athletes, including sociodemographic details and a number of potential risk factors for S. aureus nasal colonization, including training duration per day, training sessions per week, previous hospital admissions, renal dialysis, surgery, and subjects who had previously been found to have MRSA (Mascaro et al., 2019). The data were collected using interviews face-to-face with each subject during collection of samples.

Sterile swabs were collected from the anterior nares of the subjects. The swabs were firstly moistened with sterile normal saline and then rolled briefly in both nostrils for a few second by about 2 to 3 cm (Rasheed and Hussein, 2020d). Swabs were directly sent to the microbiological laboratory after being inoculated with Brain Heart Infusion (BHI) broth (Neogene, UK).

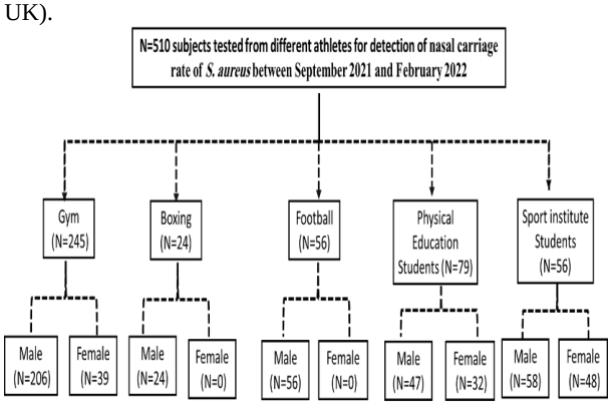

Figure 1: Flow chart of subjects from different type of athletes.

2.3 Body mass index (BMI)

We calculated BMI using the formula: weight (kg) divided by height (m) squared. BMIs were categorised as obesity (≥30·0 kg/m²), overweight (25·0–29·9 kg/m²), healthy weight (18·5–24·9 kg/m²), and underweight (<18.5kg/m^2)

2.4 Detection of *S. aureus*

Bacteriological methods were used to isolates of *S. aureus* among athletes. The collected samples were immediately streaked on selective media (mannitol salt agar) (Neogen, UK) and incubated for 24 to 48 hrs at 37 °C. Plates were then examined for colony phenotypic features such as golden colonies and stained with Gram-stain. Consequently, colonies that demonstrated with mannitol fermentation were chosen and sub-cultured once more on mannitol salt agar using streak plate method to obtain pure culture. Biochemical assays such as catalase and tube agglutination were used to further identify presumptive *S. aureus* colonies (Rasheed and Hussein, 2020c)

2.5 Antibiotic susceptibility test

The Kirby-Bauer disk-diffusion method was used to determine the antibiotic sensitivity profile for each isolate of *S. aureus*. Different classes of antibiotics were used (Bioanalyse, Turkey), and the Mueller Hinton Agar (Neogen, UK) was used for this test. The antibiotics used in this study were Oxacillin (5 ug/ml), Tetracycline (10 ug/ml), Vancomycin (30 ug/ml), Gentamicin (10 ug/ml), Clindamycin (10 ug/ml), Rifampin (5 ug/ml), Fusidic acid (30 ug/ml) and Ciprofloxacin (5 ug/ml) (Rasheed and Hussein, 2020c). The antibiotic sensitivity profile was achieved according to the Clinical according to the Clinical and Laboratory Standards Institute (CLSI) and the results were also interpreted accordingly.

2.6 Ethics

The study procedure and informed consent forms were approved by the College of Medicine ethical committee, University of Zakho, Kurdistan region, Iraq. Ethical considerations including privacy of personal data were considered during all steps of the study. Written informed consent was acquired from each subject before sampling.

2.7 Statistical analysis:

GraphPad Prism version 8 was used for statistical analysis The data were calculated for categorical data as frequency (%) and for continuous data as mean ± standard deviation. Qualitative variables were analysed using the Chi-square (Fisher's exact test) and quantitative variables were analysed using student *t* test. Univariate logistic regression model was also used to measure associated risk factors with *S. aureus* among athletes. 95% confidence intervals (CIs) and Odds ratios (ORs) were also calculated. p value <0.05 is considered significant.

3. RESULTS

3.1 Athlete's characteristics:

In total, 510 different athletes were recruited in the present study including 391 (76.67%) males and 119 (23.33%) females. The mean age of subjects was 22.21 years (± 6.29), and the average of body mass index 22.78 (± 3.52) (Table 1). Other characteristics of athletes are presented in Table 1. Regarding the type of athletes, the number of athletes performed boxing 24 (4.71%), football 56 (10.98%), gym 245 (48.04%) and students at physical education department 80 (15.69%) and at sport institutes 105 (20.59%) (Table 2/Figure 1).

3.2 Prevalence of *Staphylococcus aureus*

S. aureus was present in 154 people (30.2%) on average, ranging from 24.76% for sport institute students to 33.33% for the boxing athletes (Table 2). No significant difference was detected between different type of sports (p=0.623). The nasal colonisation of *S. aureus* was more prevalent among the athletes who had low body mass index (p=0.001), longer duration of training/day (p=0.001) as well as increasing number of training session /week (p=0.012) (Table 3). Other risk factors including age, gender, residence, before hospitalization, use of antibiotics, renal dialysis, surgical operation, previous history of MRSA was not significantly associated with *S.* aureus (Table 3).

3.3 Association between gender and athletes with colonisation of *S. aureus*

There was significantly associated between gender and types of athletes (P=0.002) (Table 4). Overall *S. aureus* carriage rate was 119 (77.27%) among male athletes, that was significantly higher than female athletes 35 (22.73%) (Table 4).

3.4 Risk factors among athletes with *S. aureus* colonisation

Univariate logistic analysis found that nasal colonisation of S. aureus was significantly associated with duration of training/ day (p=0.02) and number of training session/week (p=0.001), but not significantly with athletes age, gender, BMI, previous hospitalisation, renal dialysis, surgical operation and previous history of MRSA) (Table 5).

Table 1: General characteristics of athletes of the present study

Label	**Mean**	**Stv Dev**
Age	22.33	6.24
Height (mm)	170.305	8.775
Weight (Kg)	67.9	13.09
BMI	22.78	3.52
Variable	**No. of subjects**	**Percent (%)**
Gender		
Male	391	76.67
Female	119	23.33
Residence		
Home	489	95.88
Dorm	21	4.12
Duration of training /Day		
1 hr	188	36.86
2 hr	176	34.51
3 hr	146	28.63
No. of training session/ Week		
1 Session	14	2.75
2 Session	36	7.06
3 Session	460	90.19
Use of antibiotics		
Yes	178	34.9
No	332	65.1
Hospitalisation		
Yes	93	18.24
No	417	81.76
Renal Dialysis		
Yes	2	0.39
No	508	99.61
Surgical Operation		
Yes	55	10.78
No	455	89.22
Previous history of MRSA		
Yes	13	2.55
No	497	97.45

Abbreviation: *BMI; body mass index*

Table 2: Frequency distribution of nasal carriage rate of *S. aureus* among different type of athletes

		***Staph. aureus* colonisation (No.%)**		
Athletes	**Total, No. (%)**	**Non-Carriers**	**Carriers**	**P value**
Boxing	24 (4.71)	16 (66.67)	8 (33.33)	
Football	56 (10.98)	40 (71.43)	16 (28.57)	
Gym	245 (48.04)	165 (67.34)	80 (32.65)	0.623
Physical Education	80 (15.69)	56 (70)	24 (30)	
Sport institute	105 (20.59)	79 (75.24)	26 (24.76)	
Total	**510 (100)**	**356 (69.8)**	**154 (30.2)**	

p value is determined using Chi-square test

Table 3: Frequency distribution of *S. aureus* nasal carriage rate of the athletes

Variables	Total (No.%) 510	*S. aureus nasal carrier (No.%)*		*p value*
		Non-Carries 356 (69.8)	Carries 154 (30.2)	
Age (Mean ± SD)	22.33 ± 6.24	22.19 ± 6.21	22.64 ± 6.31	0.45
BMI (Mean ± SD)	22.78 ± 3.52	23.83 ± 4.19	21.73 ± 2.85	0.001
Gender				
Male	391 (76.67)	272 (69.57)	119 (30.43)	0.91
Female	119 (23.33)	84 (70.59)	35 (29.41)	
Residence				
Home	489 (95.88)	342 (69.94)	147 (30.06)	0.81
Dorm	21 (4.12)	14 (66.67)	7 (33.33)	
Duration of training /Day				
1 hr	188 (36.86)	158 (84.04)	30 (15.96)	0.001
2 hr	176 (34.51)	127 (72.16)	49 (27.84)	
3 hr	146 (28.63)	71 (48.63)	75 (51.37)	
No. of training session/ Week				
1 Session	14 (2.75)	13 (92.86)	1 (7.14)	0.012
2 Session	36 (7.06)	31 (86.11)	5 (13.89)	
3 Session	460 (90.19)	312 (67.83)	148 (32.17)	
Use of antibiotics[a]				
Yes	178 (34.9)	126 (70.79)	52 (29.21)	0.67
No	332 (65.1)	230 (69.28)	102 (30.72)	
Hospitalisation[b]				
Yes	93 (18.24)	68 (73.12)	25 (26.88)	0.53
No	417 (81.76)	288 (69.06)	129 (30.94)	
Renal Dialysis[b]				
Yes	2 (0.39)	2 (100)	0 (0)	0.99
No	508 (99.61)	354 (69.69)	154 (30.31)	
Surgical Operation[b]				
Yes	55 (10.78)	42 (76.36)	13 (23.64)	0.28
No	455 (89.22)	314 (69.01)	141 (30.99)	
Previous history of MRSA				
Yes	13 (2.55)	7 (53.85)	6 (46.15)	0.23
No	497 (97.45)	349 (70.22)	148 (29.78)	

Abbreviations: *S. aureus*, Staphylococcus aureus; MRSA, methicillin-resistant Staphylococcus aureus; BMI; Body Mass Index. [a]In the previous 6 months. [b]In the previous last year. P value is determined by: Unpaired student t test; Chi-square test, Fisher exact test were used according to the variables.

Table 4: Association between gender and type of athletes with *S. aureus* colonised subjects (n=154)

Type of Athletes	Total of positive No.%	Gender (no. %) Male	Female	P value
Boxing	8 (5.19)	8 (100)	0 (0)	
Football	16 (10.39)	16 (100)	0 (0)	
Gym	80 (51.95)	65 (81.25)	15 (18.75)	0.002
Physical Education Institute	24 (15.58)	14 (58.33))	10 (41.67)	
Sport Institute	26 (16.88)	16 (61.54)	10 (38.46)	
Total	154 (100)	119 (77.27)	35 (22.73)	

p value is determined using Chi-square test

3.5 Risk factors among athletes with *S. aureus* colonisation

Univariate logistic analysis found that nasal colonisation of S. aureus was significantly associated with duration of training/ day (p=0.02) and number of training session/week (p=0.001), but not significantly with athletes age, gender, BMI, previous hospitalisation, renal dialysis, surgical operation and previous history of MRSA) (Table 5).

Table 5: Univariate logistic regression results for the estimation of colonisation of *S. aureus* with potential risk factors among athletes

Variables	Odd Ratio	95% CI	p value
Gender	1.05	0.67-1.65	0.83
Age, years (ordinal)	1.01	0.98 -1.04	0.45
BMI (ordinal)	0.85	0.81 -0.91	0.69
Residence	0.86	0.34 - 2.17	0.74
Duration of training /Day (ordinal)	0.92	0.71 -1. 18	0.02
No. of training session/ Week (ordinal)	3.47	1.45-8.45	0.001
Use of antibiotics	1.09	0.74 - 1.63	0.65
Hospitalisation	0.82	0.49 - 1.34	0.44
Renal Dialysis	3.51	0.58 -21.25	0.17
Surgical Operation	0.69	0.36- 1.32	0.26
Previous history of MRSA	2.02	0.67 -6.11	0.21

3.6 Antibiotic sensitivity test

Out 510 athletes, 154 cases had *Staph. aureus* isolates, and antibiotic sensitivity profile were assessed against these isolates. Oxacillin resistance as a surrogate marker was initially used for the detection of MRSA. Among the studied isolated strains, 41 (26.61%) of them were resistant to oxacillin. About 27 (17.53%) of the samples were also resistance to vancomycin and the highest sensitivity was found to rifampicin 154 (100%), fusidic acid (98.7%) and gentamycin (98.05%). The results of

other antibiotics sensitivity profile in the present study are summarized in Table 6.

Table 6. Antibiotic Susceptibility of detected Staphylococcus aureus Isolates among athletes (n=154)

Antibiotics	*Values of antibiotic susceptibility profile		
	Susceptible	Intermedia te	Resistant
Oxacillin	113 (73.38)	--------	41 (26.61)
Vancomycin	48 (31.17)	79 (51.29)	27 (17.53)
Tetracycline	16 (10.39)	51 (33.12)	87 (56.49)
Gentamicin	151 (98.05)	1 (0.65)	2 (1.29)
Clindamycin	145 (94.16)	0 (0)	9 (5.84)
Rifampicin	154 (100)	0 (0)	0 (0)
Ciprofloxacin	144 (93.51)	20 (0)	10 (6.49)
Fusidic acid	152 (98.70)	1 (0.65)	1 (0.65)

4. DISCUSSION

Numerous studies in our area have found high rates of *S. aureus* among general population (Rasheed and Hussein, 2020e), healthcare worker (Hussein *et al*., 2019) and students (Rasheed and Hussein, 2020c). In the present study, however, we assessed the prevalence rate of *S. aureus* and risk factors among athletes in Zakho city, Iraq. According to our knowledge, this is the first study reported the frequency of S. aureus and associated risk factors among athletes in our region.

The previous study conducted in Rotterdam, Netherlands and reported that the anterior nares serve as a reservoir for nasal colonisation of *S*. aureus (Wertheim *et al*., 2005). Additionally, a recent study found that *S. aureus* may colonize the oropharynx (Couvé-Deacon *et al*., 2017). In the our study, the overall frequency of *S. aureus* nasal carriage among population of athletes was 30.2%, that is quite lower than that observed among students and healthcare worker in our region approximately estimated to be 37.6%-50.4 (Hussein *et al*., 2019, Rasheed and Hussein, 2020c). In the present study, the highest carriage rate of *S*. aureus was 33.3% among boxing athletes, followed by gym sport 32.65%, but statistically not significant differences (P=0.62). This high prevalence of *S. aureus* carriage among athletes is not unexpected given that sharing equipment's and direct skin-to-skin contact both facilitate the spread of *S. aureus*. Additionally, athletes are notorious to have poor personal hygiene, sharing of personal sports equipment's and being exposed to the environment while participating in sports, all of these may be strongly related to outbreaks of Community-associated MRSA infections (CA-MRSA) in sport team (Cohen, 2008a). According to a recent Italian study, the nasal carriage rate of *S. aureus* among contact athletes participating in contact sports was 42%, ranging from 23.8% to 54.8% for judo players and wushu/kung fu athletes, respectively (Mascaro *et al*., 2019). In contrast to our study, several studies found that the prevalence of nasal carriage rate of *S*. aureus among college students athletes' was 21.2% in Taiwan (Lear *et al*., 2011) and 23. 2% in USA (Lear *et al*., 2011) and 61% in French athletes (Couvé-Deacon *et al*., 2017). This discrepancy between our results and several studies could be partially due to differences in the study population size, geographical distribution, bacterial isolation techniques, and environmental factors during sample collection and procedure, which may be a high-risk factor for *S. aureus* nasal colonisation in the body.

In this study, several associated risk factors with *S. aureus* among athletes were evaluated. We found that age, gender, renal dialysis, previous history of hospitalisation, prior surgical operation and prior antibiotic usage are not a major risk factor associated with nasal *S. aureus*. In contrast to the present study, gender (male), older age, and before antibiotic use were reported a risk factor for colonisation of *S. aureus* (Olsen *et al*., 2012). These results may be influenced by the recruited participants and the conducted region. Consistent with a study conducted in Italy (Mascaro *et al*., 2019), our results indicate that nasal colonization of *S. aureus* was more prevalent in athletes who had low body mass index (p=0.001); these could be partially due that the bacteria are more active among athletes who had low body mass index than obese or overweight. Additionally, the present results proposes that the high body weight could not act as a host determinant for raised exposure to nasal colonization *of S*. aureus. Further studies are required to analysis the prevalence of *S*. aureus and association risk factors affecting its spreading of pathogen. Our study was in agreement with a study who found that the normal body weight were higher carriers of nasal *S*. aureus than obese and overweight (Stensen *et al*., 2019). However, our finding was disagreeing with a previous study who found a positive association between nasal carriage of *S*. aureus and high BMI values and (Olsen *et al*., 2013). We also detected a positive association between athletes who practicing longer duration of training/day (3 hrs/day) (p=0.001) and increasing number of training session performed per week (3 sessions/week) (p=0.012). This is a consistent with a study performed in Italy, they reported that colonization of *S*. aureus was significantly associated with number of weekly training days (5-7 days/week), sharing of sports equipment's during training, and not taking a shower directly after training sessions (Mascaro *et al.*, 2019).

In the current study, we reported a positive association between gender and type of athletes (p=0.002); it was found that *S. aureus* nasal colonisation was significantly higher among male (77.27%) than female (22.7%). The higher infection rate in male could be due to male participated in athletes more than females and this cause that male is highly susceptible to nasal colonisation of *S. aureus*. Furthermore, several studies have demonstrated that female hormones predominantly oestrogens have immune-modulating roles, and that may attribute to lower colonization of *S*. aureus and infection rates in females (Humphreys *et al*., 2015). These findings are consistent with a study conducted in Italy among contact sport athletes, reported that colonisation of *S. aureus* is higher among male than female (Mascaro *et al*., 2019).

In the present study, 26.61% of *S*. aureus isolates were resistant to oxacillin, this resistant rate was comparatively lower when compared to other studies done in Iraq (41.1%) (Rasheed and Hussein, 2020b), and was higher than the report conducted in Syria (9.4%) (Tabana *et al*., 2015) and Iraq (2.04%) (Habeeb *et al*., 2014a), 4.2% (Assafi *et al*., 2015) and 21.95% (Hussein *et al.*, 2015). This highly resistance rate of *S*. aureus in the current study to oxacillin is alarming and required special action to control this problem. Additionally, about 17.53% of *S*. aureus were resistant to vancomycin and this rate was higher than other studies conducted in Iraq (7.56%) (Rasheed and Hussein, 2020b), and in Syria (2%) (Tabana *et al*., 2015) and in China (4.2 %) (Lin *et al*., 2016). This highly resistance rate of bacterial strains to vancomycin in the present study could be due to overusing of antibiotics in the region without prescription and the crucial multidisciplinary planning is urgently needed to control this highly resistance rate to vancomycin among athletes. These differences could be due to variation in sampling collection, number of samples, study population, inclusion criteria and design of the research. In this study, however, *S. aureus* showed highly sensitive to rifampicin, fusidic acid and gentamycin among the tested samples, which is simar to the finding in Iraq (Rasheed and Hussein, 2020b). This could be due to these antibiotics used in our environment are limited and used under medical prescription. The variation in antibiotic resistance profile among different studies could be due to the regional and geographical location and also indiscriminate use and availability of these antibiotics in a certain location.

Our study has limitations. Firstly, lower number of samples was collected from boxing and football athletes, these may

reduce the evaluation of sample size and may indirectly influence the statistical analysis of association. Secondly, more studies are urgently required to calculate the frequency of bacterial strains from axillary, fingers and inguinal among athletes to overcome these limitations. Despite the above limitations, our study was added an important data on the nasal carriage rate of *S. aureus* in our region among athletes, and focusing antibiotics resistance to *S. aureus* including vancomycin and methicillin resistance.

To conclude, the frequency of nasal carriage rate of *S. aureus* in the present study is relatively higher compared to previous studies from elsewhere and this bacterial species was predominant among male athletes. Age, gender, use of antibiotics, renal dialysis and previous history of hospitalisation and surgical operation were not recorded as a major risk factor for *S. aureus* nasal colonisation among athletes. However, in the present study, lower body mass index, longer duration of training performed per day and higher number of training session performed per week were reported as a significant risk factors for *S.* aureus nasal colonisation. The present study is considered primary and studies with larger number of sample sizes among athletes from different provinces in Kurdistan Region, Iraq are needed in the future. More studies are also needed to investigate MRSA over the time among different type of contact sport. Prevention control efforts should be applied to reduce *S. aureus* nasal colonization, and therefore potentially reducing the infection rate among athletes in our country.

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ETHICAL APPROVAL

The study was approved by the Scientific and Ethics Committee, College of Medicine, University of Zakho, Kurdistan region, Iraq.

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COMPETING INTERESTS

The authors have declared that no competing interest exists

AUTHORS' CONTRIBUTION

We confirm that the manuscript has been contributed, reviewed and approved by all authors. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

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