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Preventing MRSA Infections in Sports: Effective Strategies and Approaches

Karolina Pawłuszkiewicz

Faculty of Medicine at the Wroclaw Medical University

Wybrzeże L. Pasteura 1, 50-367 Wrocław

karolina.pawluszkiewicz@student.umw.edu.pl

ORCID: 0009-0006-1297-5958

Natalia Kucharczyk

Zespół Opieki Zdrowotnej w Oławie

K.K Baczyńskiego 1, 55-200 Oława

kucharczyk.natalia99@gmail.com

ORCID: 0009-0002-6531-9787

Emilia Kucharczyk
Faculty of Medicine at the Wroclaw Medical University
Wybrzeże L. Pasteura 1, 50-367 Wrocław
emilia.kucharczyk@student.umw.edu.pl
ORCID: 0009-0008-9100-9321

ABSTRACT

Introduction: Infections caused by community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) are a growing concern, particularly among asymptomatic individuals. CA-MRSA can lead to various conditions such as skin infections, septic arthritis, pyomyositis, endocarditis, and pubic osteomyelitis, with athletes being especially vulnerable due to shared equipment, close contact, and skin trauma. Prolonged colonization of the anterior nares and persistence on shared surfaces contribute to its spread.

Purpose of work: This study aims to review MRSA prevalence in sports and provide effective strategies for prevention and management.The purpose of this paper is to evaluate MRSA prevalence in sports and provide effective strategies for prevention and management.

Materials and methods: A comprehensive analysis of research papers available on PubMed, Google Scholar and Scopus was undertaken using the search terms encompassing the following keywords: Community- acquired MRSA / MRSA and Sport / MRSA and athletes / MRSA Prevention Strategies in Sports / MRSA Infection Risks in Athletes / MRSA Colonization and Sports Participation.

Results: A meta-analysis found that about 6% of asymptomatic athletes are colonized with MRSA, though rates vary by sport and country. Decolonization methods may reduce infection risk, but their effects are often temporary. This study examines MRSA colonization and infections in athletes, stressing the importance of preventive measures.

Keywords: Community-acquired methicillin-resistant Staphylococcus aureus; MRSA; colonization, athletes; Staphylococcus aureus

INTRODUCTION

Infections caused by community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) are increasingly becoming a concern among healthy, asymptomatic individuals [1,2]. CA-MRSA can lead to various conditions, including skin infections, septic arthritis, pyomyositis, endocarditis, and pubic osteomyelitis [3]. Athletes, due to sharing of equipment, skin trauma, and close contact situations, are particularly susceptible to CA-MRSA infections [1,4]. A significant factor in the transmission of this pathogen is its prolonged colonization in the anterior nares [3,5]. Additionally, Staphylococcus aureus can persist on shared surfaces within sports facilities [3,6,7]. A meta-analysis of 15 studies revealed that around 6% of asymptomatic athletes are colonized with MRSA [1], with colonization rates varying depending on the type of sport and the prevalence of MRSA in different countries. Research indicates that decolonization could be an effective method to break the transmission chain and lower the infection risk within sports teams, although this effect might be short-lived [8]. In this study, we aim to present epidemiological data on MRSA colonization and infections among athletes, emphasizing the significance of preventive measures due to the temporary nature of decolonization.

WHAT IS MRSA?

Methicillin-resistant *Staphylococcus aureus* (MRSA) was first identified in England in 1961 [8,9], shortly after methicillin was introduced into clinical practice. Due to the toxicity of methicillin, it is no longer used for human treatment. It has been replaced by similar but more stable penicillins, such as oxacillin, flucloxacillin, and dicloxacillin [8,10. Despite the discontinuation of methicillin, the term "methicillin-resistant *Staphylococcus aureus*" remains in use [8].

MRSA has been responsible for numerous hospital outbreaks worldwide, leading to the identification of health-care-associated MRSA (HA-MRSA). Notably, in the 1980s, MRSA was detected among indigenous populations in Australia who had no prior contact with healthcare settings, resulting in the classification of community-associated MRSA (CA-MRSA). Since the mid-2000s, MRSA has also been linked to exposure to livestock, referred to as livestock-associated MRSA (LA-MRSA) [2].

Table 1. Comparison of Characteristics Between HA-MRSA and CA-MRSA [2,11].

Characteristic	**HA-MRSA**	**CA-MRSA**
Origin	Healthcare-associated	Community-acquired
Staphylococcal Chromosomal Cassette mec (SCCmec) Type	Type I, II, III [2]	Type IV, V [2]
Antibiotic Resistance	All penicillins and the majority of other β-lactam antibiotics, with the exception of ceftaroline and ceftobiprole [11]. Often resistant to multiple classes of non-β-lactam antimicrobial agents	All penicillins and the majority of other β-lactam antibiotics, with the exception of ceftaroline and ceftobiprole [11].Resistant to fewer classes of non-β-lactam antimicrobial agents
Carriage of Panton-Valentine Leukocidin (PVL) Genes	Rarely [2]	Frequently [2]
Affected Patient Groups	Primarily isolated from individuals exposed to healthcare settings; patients are older and often have one or more comorbidities [2]	Infections tend to occur in younger, previously healthy individuals [2]
Types of Infections	Commonly associated with pneumonia, bacteremia, and invasive infections [2]	Primarily associated with skin and soft tissue infections (SSTIs) but also linked to severe clinical syndromes such as necrotizing pneumonia and severe sepsis [2]

ATHLETES AS A HIGH-RISK GROUP FOR CA-MRSA INFECTIONS

Athletes are among the populations at elevated risk for CA-MRSA infections, alongside other groups such as neonates, children beyond the neonatal period, urban underserved communities, emergency department patients, household contacts of MRSA SSTI patients, cystic fibrosis patients, military personnel, detainees, HIV patients, indigenous populations, veterinarians, livestock handlers, and pet owners [12,13]. The high incidence of skin injuries, frequent close physical contact, and the common practice of sharing equipment in athletic environments make athletes particularly susceptible to CA-MRSA infections [12,14].

MRSA colonization is considered a reservoir for transmission between individuals [1]. The pathogen commonly spreads via droplets (aerosol) from a colonized area, direct contact with nasal secretions, or fomites (contaminated objects). In some cases, the strain responsible for the onset and spread of *Staphylococcus aureus*-related conditions is acquired from an endogenous source other than the nose or from environmental sources [3].

Due to the conditions during training and competitions, MRSA easily spreads among athletes, facilitated by repeated skin-to-skin contact, skin abrasions, poor hygiene practices such as not washing hands or showering after training or competition, and sharing equipment and restrooms [4,5,6,15,16,17,18]. Surfaces responsible for skin abrasions, such as synthetic turf, can further promote the transmission of infections between teams [8,15]. For example, during the 2003 football season, a study conducted on the St. Louis Rams football team included 58 players, 5 of whom (9%) developed MRSA infections, all at sites of turf abrasions. MRSA was not found in nasal samples or environmental samples, but methicillin-sensitive *Staphylococcus aureus* (MSSA) was isolated from tape gels, hot tubs, and 35 of 84 nasal swabs from players and staff (42%) [3,15]. Dalman et al. investigated environmental contamination in CrossFit gyms, sports halls, and fitness centers, finding an overall prevalence of *S. aureus* on environmental surfaces at 38.2% [6], with particularly high contamination on weightlifting balls (62.5%), weightlifting plates (56.3%), and treadmill handles (50%) [8,19].

Contaminated objects appear to play a crucial role in the transmission and spread of *S. aureus* [8]. If fomites are contaminated with *S. aureus*, athletes who develop *S. aureus*-related skin infections are at greater risk of disease recurrence [3]. Marasco et al. observed that shared sports equipment (such as helmets and pads) and not showering after training [20] contribute to *S. aureus* carriage among Italian contact sport athletes [8,20]. Additionally, body shaving by American football players has been linked to the transmission of *S. aureus* [8,16,20]. Shaban et al. studied *S. aureus* carriage in an Australian professional football team in 2018, finding a high carriage rate in the team (48.9% MSSA and 8.5% MRSA). Sharing towels among players and

using an ice bath that was not cleaned after each use were identified as possible routes of pathogen transmission [8,21]. Haghverdian et al. demonstrated that viable *S. aureus* bacteria survived on a volleyball and basketball for at least 72 hours, highlighting the potential key role these items play as vectors for bacterial transmission [7,8].

During the sports season, due to increased contact between athletes, the spread of *S. aureus* can intensify, potentially leading to outbreaks [3,5,6]. Recently, a high rate of *Staphylococcus aureus* (SA) infections and an epidemic of methicillin-resistant strains (MRSA) were observed in male football teams during the regular season [3,15]. Creech et al. reported increased nasal MRSA carriage during competition seasons in college football and lacrosse teams, although this did not correlate with a higher infection rate [5,8].

EPIDEMIOLOGY OF MRSA COLONIZATION IN ATHLETES

A meta-analysis of 15 studies found that approximately 6% of asymptomatic athletes are colonized with MRSA, with rates of 13% among collegiate athletes and 8% among athletes in the USA. These rates are comparable to MRSA colonization in HIV-infected individuals (6.9%) [1,22] and dialysis patients (6%) [1,23]. In contrast, the MRSA colonization rate in the general community population ranges from 0.84% to 2% [1,24,25] Among Japanese athletes (69 nasal samples, median age 20 years) with no hospitalization or surgery in the past year and no history of being a compromised host, the CA-MRSA nasal carriage rate was 5.6% [12].

The MRSA colonization rate among athletes depends on several factors, including the country of origin and the type of sport played. MRSA carriage was more prevalent among Italian athletes, at 1.3% [8,20], compared to 0.3% among their French counterparts [8,26]. These rates are similar to those observed in the general European population, ranging from 0% in Sweden to 2.1% in Belgium [8,27]. However, comparing MRSA carriage rates among athletes from different countries is challenging due to varying levels of MRSA prevalence in different communities. In a study by Champion et al., a significantly higher MRSA carriage rate of 36.8% was reported among athletes and their coaches at a U.S. university, with exceptionally high rates observed in the men's wrestling team [8,28]. This difference is likely due to the distinct epidemiology in the United States, where skin and soft tissue infections caused by PVL-positive MRSA strains are much more common [8].

In a study by Jiménez-Truque et al., freshman students engaged in contact sports had a 90% higher risk of *Staphylococcus aureus* colonization compared to those participating in non-contact sports. The colonization process in this group occurred more quickly and persisted

longer [8,29]. Table [2], based on [30], presents the MRSA isolation rates across different sports disciplines.

Table 2. A detailed summary of methicillin-resistant *Staphylococcus aureus* (MRSA) prevalence across different sports, based on [30].

Sports Included	**Authors**	**MRSA Prevalence**
Football	Moriya et al. [12]	5.8%
	Lear et al. [31]	0%
	Oller et al. [32]	8.4%
	Garza et al. [33]	0%
	Romano et al. [34]	4.4%
	Creech et al. [5]	4–19% in men; 11–23% in women
	Rihn et al. [35]	2.9%
	Kazakova et al. [16]	8.6%
	Archibald et al. [36]	3.7%
	Sutton et al. [37]	60%
Soccer	Huijsdens et al. [38]	21.4%
Wrestling	Oller et al. [32]	8.4%
Basketball	Stevens et al. [39]	30.7%
Rugby	Couvé-Deacon et al. [40]	0%
	Stacey et al. [41]	25%
Taekwondo, judo, karate, wushu/kung fu, boxing, kick-	Mascaro et al. [20]	1.3%

boxing, mixed martial arts (MMA), Muay Thai, football		
Rugby, wrestling, basketball, volleyball, handball, fencing, martial arts, football, weight-lifting, baseball	Couvé-Deacon et al. [26]	0,33%
Football, baseball, soccer, track, wrestling, basketball, dance/cheer, golf, volleyball, rowing, swimming, softball, diving	Rackham et al. [42]	1.8%
Soccer, basketball, taekwondo, judokas, tennis, table tennis	Wang et al. [43]	0.72%
Wrestling, baseball, tennis, softball, track, basketball, lacrosse	Champion et al. [28]	34.9%
Football, wrestling, soccer, hockey, baseball, indoor track, lacrosse, basketball, cheerleading, cross country, outdoor track, volleyball	Braun et al. [44]	0.155%; 0.163%
Modern pentathlon, athletic swimming, synchronous swimming, water polo	Zaborova et al. [45]	13.8% (synchronous swimmers); 10.3% (pentathlon athletes)

The most commonly colonized sites by *S. aureus* were the oropharyngeal region (67.3%), followed by the nose (45.5%) and hands (29.7%) [8,20], which represent risk factors

for skin infections and potential modes of transmission within the population, especially in close-contact settings such as sports teams [8,46].

MRSA DECOLONIZATION

Evidence suggests that decolonization may be an effective strategy for interrupting the transmission cycle and reducing infection risk within sports teams [8]. According to the updated protocol, decolonization involves the use of mupirocin ointment, possibly in conjunction with chlorhexidine baths, as well as the implementation of universal decolonization strategies [1,47]. This approach should be evaluated within the athlete population, particularly among those at the highest risk. Additionally, when applying specific decolonization protocols, which have been studied and found to be acceptable within this environment, the unique risk factors associated with this group of young adults should be considered [1].

Research has demonstrated that effective decolonization is highly successful in this population and can significantly alter the dynamics of MRSA colonization, reducing the risk of infections among athletes by approximately one-third. However, despite an initial 100% success rate in decolonization, the risk of MRSA-related skin and soft tissue infections (SSTIs) remains high, indicating that the effect of MRSA decolonization is only temporary [1,48]. Decolonization does not eliminate the risk of re-colonization [1,49], and the persistent presence of risk factors in the sports environment means that athletes are continually exposed to MRSA. Furthermore, non-compliance with hygiene protocols may be a significant factor contributing to re-colonization [1].

MRSA INFECTION PREVENTION

Although decolonization may be effective at the conclusion of treatment, there is a lack of data regarding its long-term sustainability. Due to the repeated exposure of athletes to *Staphylococcus aureus*, the effect of decolonization is likely to be only temporary [50].

Therefore, it is essential to consistently adhere to hygiene practices and regularly decontaminate sports surfaces and equipment to reduce the risk of re-colonization, in line with the guidelines provided by the Centers for Disease Control and Prevention (CDC) [50].

Table 3. MRSA Prevention and Control [50]

MRSA Prevention and Control		
Good hygiene	Hand Hygiene	Maintain proper hand hygiene by frequently washing with soap and water, or using an alcohol-based hand sanitizer. Opt for soap and water when hands are visibly dirty.
	Pre- and Post-Activity Hygiene	Ensure thorough hand cleaning before and after participating in physical activities, particularly when: ● Using shared weight-training equipment. ● Administering wound care. ● Utilizing restroom facilities.
	Post-Exercise Hygiene	Shower immediately after physical exercise and avoid sharing personal items such as bar soap and towels.
	Laundry Practices	Launder uniforms, towels, and other clothing after each use. Follow the manufacturer's instructions for washing and drying, ensuring that all items are

		completely dried in a dryer. Always perform hand hygiene after handling dirty laundry.
Prevent skin injuries	Employ suitable protective clothing or equipment to mitigate the risk of skin injuries during physical activities.	
Personal item	Avoid sharing personal items that come into direct contact with the skin, including: ● Towels and washcloths. ● Razors. ● Clothing, such as uniforms. ● Topical ointments from open containers.	
Cuts and wounds	Manage infected wounds with care, as they may contain methicillin-resistant *Staphylococcus aureus* (MRSA). Ensure that cuts and wounds are covered with clean, dry bandages until completely healed.	

	Adhere to the instructions provided by healthcare professionals for wound care and bandage replacement. Dispose of used bandages and tape in regular trash, and perform thorough hand hygiene after handling these items.	
Infection Precautions	Refrain from self-treating infections without proper medical advice. Avoid picking at or popping sores, as this can worsen the condition.	
	When using shared surfaces such as sauna benches or weight-training equipment, use a barrier like clothing or a towel to prevent direct skin contact.	
	If you have an active infection or open wound, avoid using public water facilities (e.g., whirlpools, therapy pools, and swimming pools) that are not cleaned between uses.	

SUMMARY AND CONCLUSION

Athletes are at elevated risk for community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections due to factors such as frequent skin injuries, close physical contact, and shared equipment. Other high-risk groups include neonates, underserved communities, military personnel, and livestock handlers. MRSA colonization, particularly in the nasal passages, serves as a transmission reservoir, spreading through droplets, direct contact, or contaminated surfaces (fomites). The athletic environment, characterized by skin abrasions, poor hygiene practices, and contaminated equipment, promotes the spread of MRSA. Studies have shown significant environmental contamination in sports facilities, with shared surfaces like synthetic turf and weightlifting equipment being hotspots. Notably, a 2003 study on the St. Louis Rams football team reported MRSA infections in players with turf abrasions. Additional studies on CrossFit gyms and professional football teams highlight how shared equipment, lack of hygiene, and improper cleaning contribute to the spread of MRSA. During sports seasons, the frequent close contact between athletes increases the risk of outbreaks, emphasizing the need for stringent hygiene and equipment cleaning practices.

To prevent the spread of community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) among athletes, a multifaceted approach is essential. Emphasizing proper hygiene practices, such as regular hand washing, showering immediately after training or competition, and avoiding shared personal items like towels or razors, is critical. Sports equipment and facilities should be regularly cleaned and disinfected, particularly high-touch surfaces like weightlifting equipment, mats, and locker rooms. Athletes should cover wounds or abrasions to reduce the risk of infection and avoid practices like body shaving, which can increase susceptibility. Additionally, educational programs on MRSA prevention and early detection should be implemented to raise awareness among athletes and staff. Routine screening and decolonization efforts may also be considered in high-risk environments, though these measures should be paired with continuous prevention strategies to ensure long-term effectiveness. Through consistent hygiene practices and facility management, the risk of MRSA transmission can be significantly reduced in athletic settings.

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