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Survey on Oral Health and History of Muscle Injury in Professional Athletes of Brazilian Women's Soccer: A Cross-Sectional Self-Reported Study

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Abstract: This study aimed to investigate behavioral eating habits and oral health care habits of professional women's soccer athletes and their relation to the history of muscle injuries from the last season. 44 female professional soccer athletes answered a specific questionnaire, comprising the length of professional sports practice, educational level, eating habits, oral hygiene care, individual perception of the oral health condition, history of muscle injury and time off due injuries. The individual perception about the importance of oral health care and periodic maintenance is still limited among female soccer players. The existence of oral diseases with an inflammatory profile, especially periodontal diseases, was associated with muscle events, such as limiting pain or discomfort, muscle injuries and longer time off due to injury. Even with monitoring by the medical department, the oral health of professional women's soccer athletes is poor and should be considered as a priority, reducing the risk of harm to health, performance and improving the time to recover from injuries. Knowledge of the practice of oral health care and the possible relationship between oral health, muscle integrity and injury recovery time, helps to understand the health/disease process and contributes to the development of more effective prevention and treatment actions.

Keywords: Athletes, Dental Clinics, Dentistry, Muscle Injury, Oral Health

Introduction

The Oral Health (OH) condition is gaining crescent interest in sports science and more Specifically, in soccer players. Studies investigating these athletes indicate a poorer OH status when compared with age-matched non-athletes (Needleman *et al*., 2016a). Furthermore, research has also found important relationships between OH and muscle alterations, as well as the perception of loss of physical performance (Gay-Escoda *et al*., 2011; Solleveld *et al*., 2015). After carrying out some exploratory analyzes in the study by Needleman *et al*. (2013), it was possible to observe that dental caries negatively impacts the quality of life and self-reported performance, due to its painful symptoms. In addition to the presence of symptomatic effects, the psychosocial influence of poor OH is also identified as an important factor in the quality of life and in the routine of sports practice and, therefore, it would be plausible to consider a potential impact on performance (Needleman *et al*., 2013; Márquez-Hidalgo *et al*., 2020).

Noteworthy, the impact of OH on general health and quality of life, extends to daily activities or even the performance in sports practice and particularly of the athlete patient (Needleman *et al*., 2016b; Márquez-Hidalgo *et al*., 2020). Moreover, OH changes can trigger painful stimuli, psychological and emotional changes, which can interfere with the performance of daily or professional activities (Márquez-Hidalgo *et al*., 2020). There are many potential challenges for athletes' OH, including nutritional aspects, oral dehydration, immune suppression induced by strenuous exercise, lack

of awareness of their own need for health care, negative health behaviors and lack of knowledge about the importance of OH (Needleman *et al*., 2016a; 2013). High-performance athletes make great efforts to achieve high levels of health and performance within their sport; however, a large part of this population has a high prevalence of odontogenic diseases, which may be related to muscle injuries (Solleveld *et al*., 2015).

Muscle injuries are frequent complications in soccer. It is estimated that 65 to 95% of players have at least one injury each season (Waldén *et al*., 2005; Gay-Escoda *et al*., 2011; Ekstrand, 2013). The study by Gay-Escoda *et al*. (2011), found a significant association between the presence of oral diseases and reported muscle injuries. This association would be related to inflammatory factors superimposed between the two conditions: The inflammatory response caused by oral diseases (Silva *et al*., 2007) and the inflammatory response produced by the action of exercise on muscle tissue, especially in areas of injury (Ament and Verkerke, 2009; Miller *et al*., 2010). Therefore, the OH condition can be considered an important factor in the planning of actions of the health departments of clubs and sports institutions aimed at preventing injuries.

The precarious OH present in the population of soccer players was associated with behavioral and eating habits, oral hygiene and health care habits and routine style of training and competitions (de Sant'Anna *et al*., 2004; Needleman *et al*., 2016b; Botelho *et al*., 2021). Hence, soccer athletes are a potential risk group for oral diseases development, especially caries and periodontal diseases, justifying the implementation of prevention and continued care strategies for the athlete's OH (Needleman *et al*., 2016a). Although the OH condition can limit the activities of athletes, both professional and amateur, in their training and competition, few studies approach this theme in soccer players and, still, the information about the OH and its impact on the women's soccer athletes' health is more restricted. Therefore, this study aimed to investigate the behavioral eating habits and OH care of professional women's soccer athletes and relate these data with the history of muscle injuries in the last season.

Materials and Methods

Ethical Considerations

The study was approved by the Ethics and Research Committee of the Center for Higher Education of Campos Gerais-CESCAGE, Ponta Grossa, Brazil, protocol number 4.868.586. Participants were informed about the research objectives at the beginning of the questionnaire. Participation was voluntary and informed consent was obtained with each volunteer's questionnaires. The participants were not identified and the material presented offered no plausible harm to the volunteers.

Study Design

This is a cross-sectional web-based and self-reported survey. The applied questionnaire was previously validated (de Souza *et al*., 2021).

Study Sample

The study included the voluntary participation of elite professional female athletes, a Brazilian soccer club, from the A-series (first division).

Inclusion Criteria

Professional female athletes from a Brazilian soccer club were considered suitable for the research. Athletes were from the main group or the sub-18 group.

Data Collection Procedures

Recruitment of volunteers was carried out through contact with the club's health department. The online survey was carried out during the month of July 2021, through the Google Forms platform. Answers were made through single restricted access, whereas duplicate answers were not possible.

Research Instruments

The questionnaire consisted of 30 closed multiple-choice questions. The nature of the questions considered the length of professional sports practice, the level of literacy, eating habits, care with oral hygiene, individual perception of the OH condition, history of muscle injury and time of absence due to injuries.

Data Analysis

All collected data were analyzed, categorized and presented as frequencies and percentages. Pearson's correlation coefficients were estimated between variables related to OH and muscle conditions reported in the last season. Data were analyzed using the Statistical Package for Social Sciences (SPSS para Windows™, versão 22.0, SPSS Inc., Chicago, IL, EUA). Descriptive and analytical statistics were performed, with the level of significance set at 5% ($p<0.05$).

Results

General Characteristics of the Sample

The total study sample consisted of 23 athletes (24.3±4.5) from the main group and 21 athletes (17±1.1)

from the sub-18 category. The longest period as a professional athlete reported was 3 to 6 years old (60.8%), considering the main group and up to 2 years (66.6%), for the under-18 category athletes. The evaluation of the level of education showed that most athletes from the main group and athletes from the sub-18 category completed their studies up to high school (78.2 and 85.7%, respectively) (Table 1).

Perception of Oral Health, Behavioral and Eating Habits

Descriptive analysis of behavioral habits and OH showed similar data between groups of players (Table 2). Athletes from the professional group and from the sub-18 category indicated dental floss as the main supplementary oral hygiene care (87 and 85.7%, respectively). The same groups of athletes also indicated the use of some type of mouthwash (56.5 and 57.2% respectively), as a supporting agent for cleaning teeth. Regarding the last appointment with the dentist, 39% of the players in the main category and 52.4%, from the sub-18, reported that it took place in the last two months, prior to the survey. In general, athletes seem to be educated about the harmful effects of smoking and the use of anabolic steroids. Only one athlete in the main group declared herself a smoker (4.3%) and there were no reports of the use of anabolic substances at the time, despite a previous history in both groups, main group and base category (4.3 and 4.8%, respectively). However, the use of food supplements is quite frequent, even without nutritional guidance (82.4%, for the main group and 62%, for the sub-18 group).

Table 3 presents data regarding some dietary and health care habits, used to estimate the athletes' risk to OH[15], in addition to information on the self-reported periodontal health status. Although the frequency of daily oral hygiene is reported, for the most part, as 3 to 4 times in both groups (56.6 and 57.1%), the presence of gingival bleeding, loose or softened teeth and teeth lost due to periodontal disease. Additionally, 78.5% of the athletes in the main group and 38.2% of the sub-18 players, declare that they have already undergone some type of clinical treatment for gingivitis.

After analyzing the frequency of consumption of foods with high sucrose content, the frequency of ingestion of beverages with low pH, the assessment of oral hygiene habits and care for health maintenance, it was possible to estimate the risk to OH in athletes, reflecting the degree of vulnerability to the most prevalent oral diseases, such as caries and periodontal disease. According to the information reported, most athletes are at medium risk (66.7% for the main group and 65.2% for the sub-18 group) (Fig. 1).

Research participants were also asked about their perception of the OH condition during the last year. The presence of situations such as bad breath, toothache, loose or softened teeth, clenching teeth, dry mouth outside of training or games, pain during oral hygiene and gingival bleeding were investigated. The most prevalent conditions reported were gingival bleeding and dry mouth sensation, for the main group and bad breath, toothache, teeth clenching, dry mouth outside of training or games and gingival bleeding, for the sub-18 group. The percentage of each response was indicated on a scale, according to the regularity of the occurrence (often, sometimes, rarely, or never) (Fig. 2).

Oral Health and Muscle Changes Reported

The data collected on muscle symptoms and the diagnosis of muscle injuries, which occurred in the last season, indicate a high prevalence of these events (Fig. 3). The occurrence of muscle pain and discomfort was reported by 60.9% of the main group players and 52.4% of the base athletes, with potential limitations for their routine activities, at least once, during the last year. Also, zero to one muscle injuries were reported by most athletes (82.6 and 85.6%) for the same groups and period. Considering the time of absence due to diagnosed muscle injury, most athletes stayed at least a week away from training and competitions (65.2% for the main group and 76.2% for the sub-18 group). It is important to emphasize that 30.5% of the injured players, belonging to the main group, reported a total absence from their activities for more than 4 weeks.

The correlation analysis between the variables indicated an association between some OH and muscle parameters (Table 4). For athletes in the main group, significant correlations ($p<0.05$) were observed between muscle injury and periods of more than one year without dental care ($p = 0.015$), gingival bleeding ($p = 0.025$) and higher risk for OH according to eating and behavioral habits ($p=0.043$). The variable muscle pain and discomfort showed a significant correlation ($p<0.05$) when associated with the frequency of daily oral hygiene less than twice ($p = 0.016$) and also with the risk for OH according to eating habits and behavioral ($p = 0.03$). Considering the sub-18 group athletes, it was possible to observe a correlation ($p<0.05$) between the presence of muscle injury and the variables periods greater than one year without dental care ($p = 0.0001$), gingival bleeding ($p = 0.016$) and presence of loose or softened tooth ($p = 0.001$). A longer time off due to muscle injury was correlated with periods of more than one year without dental care ($p = 0.004$), gingival bleeding ($p = 0.019$) and higher risk for OH according to eating and behavioral habits ($p = 0.013$).

Table 1: Sample characteristics

Variables	Main Group N (%)	Sub-18 N (%)
Sample	23 (52.3%)	21 (47.7%)
Average age by group (± sd)	24.3 (±4.5)	17 (±1.1)
Time as a professional athlete		
Up to 2 years	6 (26%)	14 (66.6%)
From 3 to 6 years old	14 (60.8%)	6 (28.6%)
From 7 to 10 years old	1 (4.4%)	1 (4.8%)
More than 10 years	2 (8.8%)	0 (0%)
Education level		
Never studied	0 (0%)	0 (0%)
Elementary school	0 (0%)	3 (14.3%)
High school	18 (78.2%)	18 (85.7%)
Incomplete higher	3 (13%)	0 (0%)
Graduated	2 (8%)	0 (0%)

Table 2: Behavioral and oral health habits

Variables	Main Group N (%)	Sub-18 N (%)
Do you share your toothbrush with anyone?		
Yes	1 (4.3%)	0 (0%)
No	22 (95.7%)	21 (100%)
Besides the toothbrush, what do you use to clean your teeth?		
Nothing	1 (4.3%)	2 (9.5%)
Toothpick	2 (8.7%)	1 (4.8%)
Dental floss	20 (87%)	18 (85.7%)
Interdental brush	0 (0%)	0 (0%)
Do you use mouthwash?		
None	10 (43.5%)	9 (42.8%)
Listerine®	10 (43.5%)	10 (47.7%)
Colgate Plax®	2 (8.7%)	2 (9.5%)
Periogard® or chlorhexidine	0 (0%)	0 (0%)
Other	1 (4.3%)	0 (0%)
When was your last dentist appointment?		
Many years ago	2 (8.7%)	0 (0%)
1 to 3 years ago	4 (17.6%)	4 (19%)
Less than 1 year ago	6 (26%)	6 (28.6%)
Less than 2 months ago	9 (39%)	11 (52.4%)
I don't usually go	2 (8.7%)	0 (0%)
Are you smoker?		
Yes	1 (4.3%)	0 (0%)
No	22 (95.7%)	0 (0%)
Have you been a smoker?		
Yes	2 (8.7%)	0 (0%)
No	21 (97.3%)	0 (0%)
Do you use any type of anabolic?		
Yes	0 (0%)	0 (0%)
No	0 (0%)	0 (0%)
Have you ever used any type of anabolic?		
Yes	1 (4.3%)	1 (4.8%)
No	22 (95.7%)	20 (95.2%)
Do you use any type of food supplement such as whey protein?		
Yes	19 (82.4%)	13 (62%)
No	4 (17.6%)	8 (38%)

Table 3: Eating and oral hygiene habits

Variables	Main Group N (%)	Sub-18 N (%)
Frequency of daily oral hygiene		
More than 4	3 (13%)	1 (4.8%)
From 3 to 4	13 (56.6%)	12 (57.1%)
2 times	5 (21.7%)	8 (38%)
From 0 to 1 time	2 (8.7%)	0 (0%)
Frequency of consumption of sweets or sugary foods a day		
From 0 to 1 time	18 (78.1%)	9 (42.8%)
2 times	4 (17.6%)	10 (47.7%)
From 3 to 4	0 (0%)	2 (9.5%)
More than 4	1 (4.3%)	0 (0%)
Frequency of consumption of low pH beverages per day		
From 0 to 1 time	12 (52%)	12 (57.1%)
2 times	5 (21.7%)	6 (28.6%)
From 3 to 4	4 (17.6%)	3 (14.3%)
More than 4	2 (8.7%)	0 (0%)
Frequency of visits to the dentist in the last year		
More than 4	7 (30.7%)	7 (33.3%)
From 3 to 4	2 (8.7%)	3 (14.3%)
2 times	2 (8.7%)	5 (23.9%)
From 0 to 1 time	12 (52%)	6 (28.6%)
Presence of gingival bleeding		
Absent	8 (35%)	13 (62%)
At some points	14 (60.9%)	8 (38%)
Across the gum	1 (4.3%)	0 (0%)
Gingivitis treatment		
I have never had gum bleeding and my dentist never informed me about the presence of this condition.	5 (21.7%)	13 (62%)
I have had gum bleeding, but I underwent treatment and it didn't happen anymore.	11 (47.8%)	5 (23.9%)
I have gum bleeding at times. When I undergo treatment, this situation stops happening, but I return after some period.	7 (30.7%)	1 (4.8%)
I have gingival bleeding and, even taking care and undergoing treatment, the situation remains.	0 (0%)	2 (9.5%)
Presence of loose teeth		
Absent	20 (87%)	18 (85.7%)
1 to 2 teeth	3 (13%)	2 (9.5%)
3 to 4 teeth	0 (0%)	1 (4.8%)
More than 4 teeth	0 (0%)	0 (0%)
Tooth loss due to periodontal disease		
Absent	21 (91.3%)	19 (90.5%)
1 to 2 teeth	2 (8.7%)	2 (9.5%)
3 to 4 teeth	0 (0%)	0 (0%)
More than 4 teeth	0 (0%)	0 (0%)

Table 4: Analysis of the association between variables using the pearson correlation coefficient

	Muscle pain or discomfort in the last season		Diagnosed muscle injury		Time off due to injury last season	
Main Group	r	P	r	P	r	P
Last dentist appointment more than 1 year ago			0,501	0,015		
Frequency of oral hygiene less than twice a day	0,496	0,016				
Presence of gingival bleeding during oral hygiene			0,465	0,025		
Risk to OH according to eating and behavioral habits	0,453	0,03	0,425	0,043		
Sub-18						
Last dentist appointment more than 1 year ago			0,737	0,0001	0,737	0,004
Presence of gingival bleeding during oral hygiene			0,520	0,016	0,509	0,019
Presence of loose or softened tooth			0,662	0,001		
Risk to OH according to eating and behavioral habits					0,530	0,013

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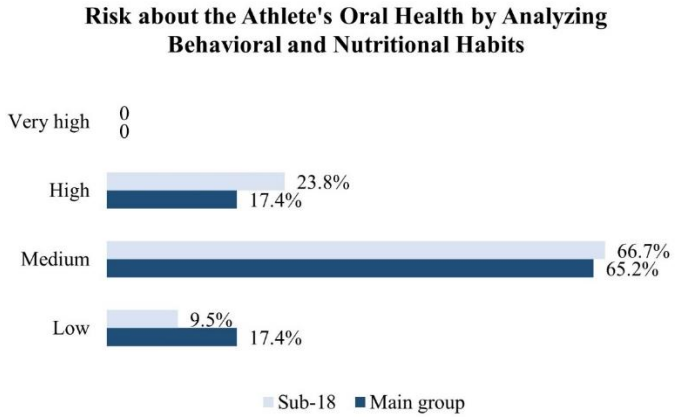


Fig. 1: Identification of risk to oral health. Risk analysis performed through the assessment of behavioral habits, oral hygiene habits, and nutritional habits reported by the athletes

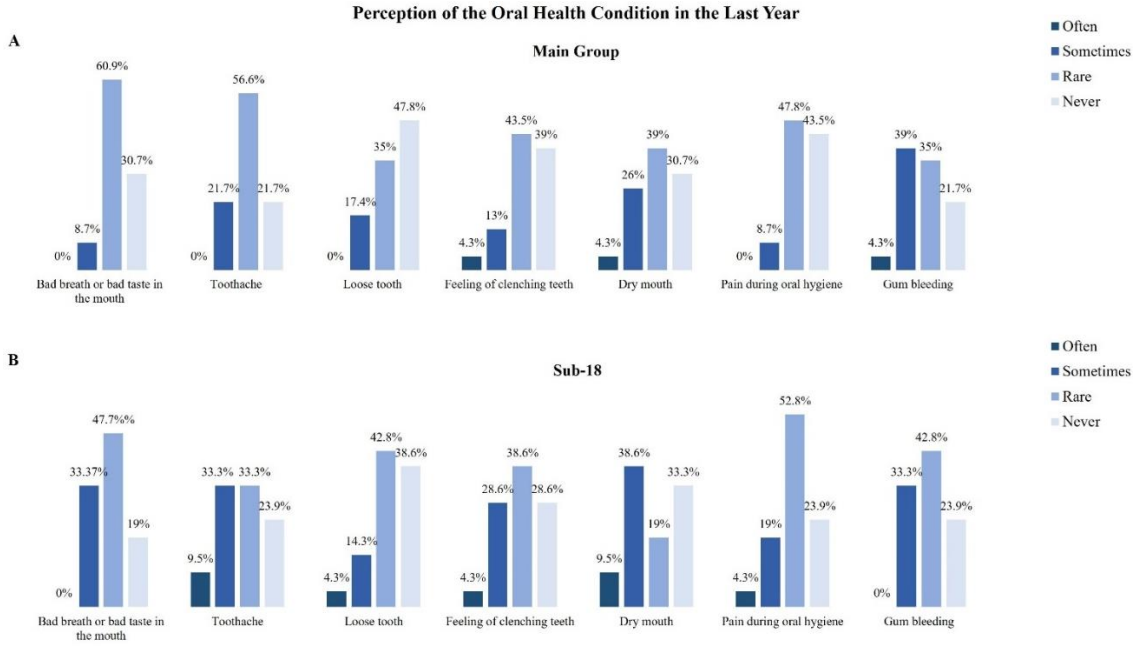
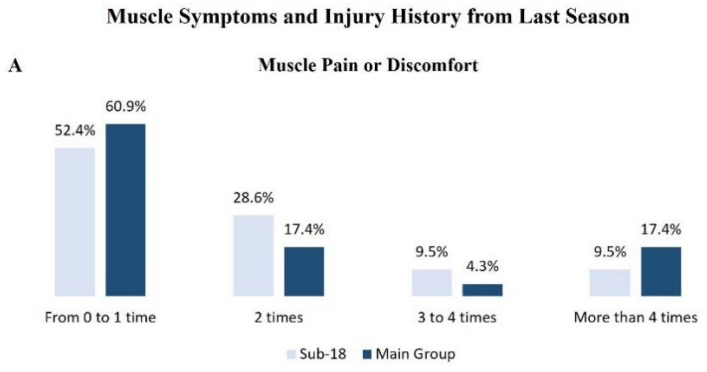


Fig. 2: Needs related to oral health. Reported oral health conditions with an indication of the need for treatment, observed by athletes and occurred in the last year.



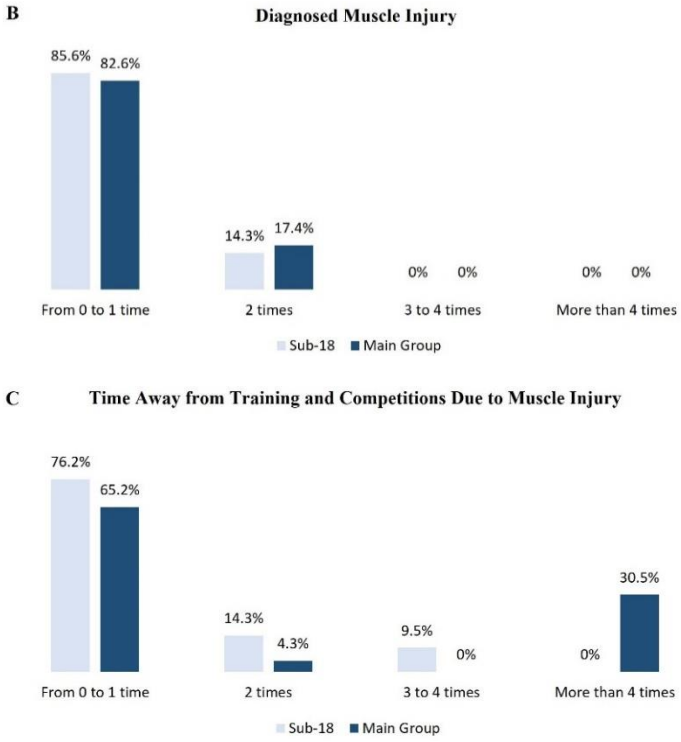


Fig. 3: Muscle symptoms. History of symptoms and muscle injuries from last season

Discussion

In this study, we observed that the individual perception of the importance of care and periodic maintenance of OH is still limited among female soccer players and that the report of the existence of oral diseases with an inflammatory profile, especially periodontal diseases, was associated with muscle events, such as limiting pain or discomfort, muscle injuries and longer time off due to injury. Studies show that infectious-inflammatory diseases, such as periodontal diseases, can modulate the degree of response of systemic immunity, regulating the profile of circulating leukocytes and the serum levels of interleukins, which can influence the muscle tissue processes of regeneration and repair (de Souza *et al*., 2017; 2020), more specifically with an increased number of inflammatory cells among the tissue fibers (Leite *et al*., 2017). The inflammatory process that occurs in periodontal tissues is systemic, influencing the stimulation and release of inflammatory mediators, especially cytokines such as IL-1β, IL-6, IL8 e TNF-α, which are responsible for modulating the immune response. Furthermore, another study also suggests that these diseases act in the maintenance of chronic inflammation through the activation of specific intracellular pathways (Hoare *et al*., 2019).

The prognosis of the recovery time following injury is of great interest to the sports technician team and is related to the magnitude of the injury that occurred (Ekstrand *et al*., 2012). This is directly important in team sports since an athlete's departure from routines training and competitions can compromise individual physical performance, due to the interruption of conditioning and favors the loss of muscle mass, the reduction of adaptations, the loss of power and technical performance (Hallén and Ekstrand, 2014). The present data indicate that the OH condition is related to the time to recover from injury, especially related to the reported gingival inflammation in sub-18 athletes. More robust clinical studies or correlations with more participants may contribute to clarifying the plausibility and underlying mechanisms of this association. Further, this information is of great relevance and reinforces the importance of OH care, in addition to suggesting that periodontal health may have an additional impact on muscle alterations.

The inflammatory process, according to the review study published by Collins *et al*. (2018), can affect the integrity of several tissues, which are; bone, tendon and muscle, thus increasing the risk of injury. We know that muscle recovery after an injury depends on complex mechanisms that involve macrophage recruitment, satellite cell differentiation and fibroblast participation and that an increase in previous inflammatory markers can cause inappropriate recruitment of these cells, delaying recovery. The presence of chronic inflammation can impair the predictable inflammatory response and the regenerative capacities of skeletal muscle, limiting the activation, proliferation and differentiation of satellite cells, which are mainly responsible for the regeneration of muscle tissue, resulting in a longer recovery time of

different muscle injury types (Karalaki *et al*., 2009; Paulsen *et al*., 2012). For an athlete with an injury history or previous inflammatory disease, this condition can be responsible for great prejudice to the club and the player.

The analysis of access to dental services showed that part of the athletes had at least one dentist appointment in the last year, as indicated in Table 3; however, we can still observe that there are athletes who do not have access or do not usually perform dental follow-up as a routine as reported in Table 2, 17.4% of the athletes in the main group reported that they do not go to the dentist for many years or do not usually perform these appointments. This information should be viewed carefully, as 52.2% of the total study participants report that they have gingival bleeding, 36.3% have already undergone some type of periodontal treatment and 18.1% reported symptoms to return after some time of treatment (summed results in Table 3). Furthermore, despite the young age of the players, there was a report of the presence of loose teeth and tooth loss due to periodontal disease. These data reinforce the importance of periodic dental maintenance, especially for improving the quality of hygiene performed since the literature correlates the low OH and periodontal status with the lack of access to dental services (Bahannan *et al*., 2018).

In addition, the low frequency of tooth brushing and the little use of dental services were associated with the prevalence of untreated caries and missing teeth (Broadbent *et al*., 2016). The estimated risk to OH can be used as a way of tracking athletes at risk, helping in the construction of a patient-centered model of access to health care, in which health needs are perceived and treated effectively and quickly (de Souza *et al*., 2021). When the need for dental care is not necessarily perceived and when perceived, treatment is not sought immediately, the risk to OH increases concomitantly to dental pain and acute episodes of infections, which can limit the athlete's activities, with a substantial negative impact on well-being, training and performance (Needleman *et al*., 2013; Opazo-García *et al*., 2021). The perception of the OH condition, during the period of the last year, is an indicator of the health needs perceived by the athletes (Fig. 2). The information collected indicates that there are demands for dental treatment, which should be considered by the health team as a priority. Both groups reported complaints at different frequencies of onset, including toothache, gingival bleeding and clenching sensation, as potential agents for acute events.

The impact of OH on general health and quality of life is plausible given the fact that some common illnesses are caused by the direct action of untreated OH problems. In athlete patients, OH presents an interface with behavioral and dietary habits and the training and competition routine, which is linked to each sport, in addition to the usual risk factors for diseases. Problems associated with OH are an important factor for investment in public health and the World Health Organization (WHO) has adopted prevention and health promotion measures, working on awareness of care, as a component of OH (WHO, 2016). Likewise, the work of health education and construction of care in OH can be interesting for groups of athletes, since it manages to reach a greater number of individuals with low investments (Buunk-Werkhoven *et al*., 2011; Petersen, 2008). Education in OH aims to improve general knowledge, which can lead to the adoption of favorable behaviors that, in turn, reduce the morbidity of OH and situations of greater risk for emergency events (Nakre and Harikiran, 2013; Ghaffari *et al*., 2018).

Conclusion

Even in situations where the medical department is monitored, professional women's soccer athletes have needs related to OH, which should be considered as a priority, with the objective of reducing the risks of health problems, performance and improvement in recovery time of injuries. The presence of gingival bleeding, identified in the survey, was correlated with muscle changes, suggesting that this analysis variable should be better investigated in clinical studies.

Practical Implications

Knowledge of the practice of care in OH, the prevalence of oral diseases in athletes and the possible relationship between OH, muscle integrity and time to recover from injuries, helps to understand the health/disease process of this population and contributes to the development of actions of prevention and more effective treatments in relation to health care, directing investments towards the needs presented. Additionally, this information can be used to carry out analyzes of disease distribution in athletes, individually or in groups, in order to identify causal factors of oral diseases, health damage, or associated events.

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Author Contributions

Flávia Costa Oliveira Magalhães: Study conception and design acquisition of data.

Cimar Eustáquio Marques da Silva, Randhall Bruce Carteri and André Luiz Lopes: Critical recision.

Cornelis Robert Springer: Acquisition of data.

Bruno Costa Teixeira: Study conception and design analysis and interpretation of data drafting of manuscript.

Bárbara Capitanio de Souza: Study conception and design acquisition of data analysis and interpretation of data drafting of manuscript.

Ethics Declarations

The research was undertaken with the understanding and written consent of each participant and according to the ethical principles.

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