

Association between oral health and changes in athlete's routine and physical condition: systematic review

Associação entre a saúde bucal e as mudanças na rotina dos atletas e condição física: revisão sistemática

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ABSTRACT

Objectives: Oral health can affect athlete's training routine negatively impacting their performance. Therefore, the objective of this review was to evaluate the influence of oral health on the physical condition of athletes. **Design:** Systematic review. **Methods:** A systematic search of multiple databases was conducted to identify studies that reported the association between oral health and the physical performance of athletes. The inclusion criteria were observational studies that evaluated the impact of oral health on the physical performance of athletes in English, Portuguese and Spanish. **Results:** Twelve papers were included, and most of the relevant papers evaluated the influence of oral health conditions on physical performance, using self-assessment type questionnaires, with heterogeneous methodology. The association between oral health and physical performance varied from 7% to 88%. **Conclusion:** We observed an association between oral health in physical performance of athletes, however, there is still insufficient evidence to quantify this influence.

Key-words: Oral health, Athletic performance, Athletes, Observational study.

RESUMO

Objetivo: A saúde bucal pode afetar a rotina de treinamento dos atletas de forma a impactar negativamente no seu desempenho físico. Sendo assim, o objetivo dessa revisão sistemática foi de avaliar a influência da saúde bucal na condição física dos atletas. **Desenho da pesquisa:** Revisão sistemática. **Métodos:** Realizou-se uma busca sistemática de múltiplas bases de dados para identificar estudos que reportassem associação entre a saúde bucal e o desempenho físico dos atletas. Foram incluídos estudos observacionais que avaliavam o impacto da saúde bucal no desempenho físico dos atletas escritos em inglês, português e espanhol. **Resultados:** Doze artigos foram incluídos, e a maioria dos artigos relevantes avaliaram a influência da condição de saúde bucal no desempenho físico por meio de questionários de autoavaliação, cuja metodologia era heterogênea. A associação entre a condição de saúde bucal e o desempenho físico variou de 7% a 88%. **Conclusão:** Observou-se associação entre a condição de saúde bucal e o desempenho físico dos atletas, entretanto, ainda não há evidência científica suficiente para quantificar essa influência.

Palavras-chave: Saúde bucal, Desempenho atlético, Atletas, Estudo observacional.

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Introduction

Athletes are commonly regarded as completely healthy individuals, even though studies in the literature have shown that they often are not [1]. Oral health may be closely linked to systemic health; a great example of this is the periodontal disease, which is the second leading cause of dental pathology, is presented as a risk factor for some systemic complications such as respiratory disease, heart complications and diabetes control [2-5].

The last systematic review of the oral health of athletes showed a 75% occurrence of caries among the studied athletes, who also presented several other oral problems such as periodontal disease, dental erosion and facial trauma [6]. It has been reported in the literature that the oral health of athletes can impact on their well-being and in the development of their physical activities; a negative effect on their daily life was observed in 41% of athletes and 5% reported changes in their activity routine [7]. In the case of elite athletes, one study found an even higher level of impact on physical condition, about 18% [8]. Given the investment that is made in the careers of high-performance athletes it is important to consider the impact of oral health conditions, which can potentially have a huge effect on athletes' health and in the development of training activities and competitions.

Thus, the aim of this systematic review was to evaluate the influence of oral health status on the physical condition of athletes, as well as analysing the methodologies of those studies. The central research question of this review was to answer the following question: can poor oral health influence in the development of training activities and competitions of athletes compared to the performance of athletes with good oral health?

Methods

Protocol and registration

This study was registered at the International Prospective Register of Systematic Reviews (CRD42018096935) and followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [9].

Eligibility criteria

The electronic search strategy was based on the following PECO categories:

- Population (P): athletes;
- Exposure (E): poor oral health;
- Comparison (C): good oral health;
- Outcome (O): changes in the development of sports activities

No date restrictions were applied to the search; there was a limitation in terms of language because the assessed studies were in English, Spanish and Portuguese. Observational studies were included if they contained any variable to measure the impact of oral health on athletic physical activities. In which the development of sports activities could be assessed by questionnaires. The questionnaires were assessed either self-reported association between oral health and physical condition of athletes.

Information sources and search strategy

The search was performed using the following databases: CAPES Periodic Portal; Cochrane Library; Google Scholar; Lilacs; PEDro; PubMed; SciELO; Scopus and Web of Science (Table I). Grey literature was also searched via the Catalogue of Theses and Dissertations of CAPES; the Grey Literature Report; Open Grey; and Penn Libraries. The reference lists of all the primary studies were manually searched for additional relevant studies.

When using Pubmed the search strategy used the following MeSH terms: athletes; athletes/medical; athletes/sports; athletes amateurs; athletes care sports; athletes elite; athletes physical activity; athletes population; plaque index; gingival bleeding; dental calculus; tooth loss; gingivitis; inflammation; dental mobility; periodontal bleeding index; probing depth; bleeding on probing; plaque control; oral hygiene; periodontal health; clinical attachment level; oral health and preventive dentistry; oral health/education; oral health; oral hygiene; toothbrushing frequency; interdental cleaning; oral home care; oral health promotion and any changes in the routine of physical activities.

The data extraction started with dividing the keywords and adjusting them for each specific database. For example, in PubMed we used MeSH (medical subject heading), and in Lilacs we used DeCS (health science descriptors). The search strategy was not solely restricted to the key-words subject; entry terms were added in Medline, such as text words, synonyms, acronyms, related words, spelling variations, previous indexing or derivations of the subject, which contributed to the efficacy of the strategy.

Risk of bias

The search and the quality assessments of the selected trials were carried out by two independent reviewers SJJ and LSJ. During the data selection and quality assessment, any disagreements between the reviewers were resolved through discussion and, if needed, consultation with a third reviewer SFA.

Three evaluations were performed. First, we checked if the selected articles complied with the STROBE guidelines. Then, we evaluated the quality of the articles by using the Newcastle Ottawa Scale and Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Heart, Lung and Blood Institute, National Institute of Health, USA).

During the analysis of the studies regarding STROBE, if the recommendations from the guidelines were followed completely the study was represented as “+” in the topic; if the recommendations were only partially followed than it was represented as “+–”; and if the recommendations were not followed at all than it was represented as “–”. Consequently, studies with more “+–” and “–” did not follow the STROBE guidelines.

The Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies was adjusted and the questions that involved follow-up were removed because this systematic review analysed cross-sectional studies. Therefore, questions 6-10, and 12-13 were not included in this quality assessment. Each question could be answered with either “yes”, “no”, “cannot determine” (CD), “not applicable” (NA) or “not reported” (NR). If the answer was “no”, “cannot determine” or “not reported” the risk of bias increased.

The Newcastle-Ottawa Scale was also adjusted, and the questions that involved follow-up and control groups were removed because this study reviewed cross-sectional studies only. In the selection domain, if the sample size was justified it was

graded 1 point, if not 0; if the sample was homogenous it was graded 1 point, if not 0; and if the data was obtained from structured questionnaire or clinical evaluation it was graded 1 point, if it was from non-structured questionnaire it was graded 0. In the outcome domain, if the data was assessed by clinical evaluation, it was graded 1 point; if it was assessed by self-report it was graded 0 point.

The quality rating for each analysis could be either “poor” (0-50%), “fair” (51-70%) or “good” (71-100%).

Results

Study selection

The search was conducted in June 2018 by two reviewers. The following 2386 records were identified through searching the databases: 200 articles from Google Scholar; 117 from Lilacs; 18 from PEDro; 519 from CAPES Periodic Portal; 764 from PubMed; 27 from Scielo; 370 from Scopus; 303 from Web of Science; six from Cochrane Library; and 62 from Grey Literature. During the database search, articles identified through the database searching that were related to the PECO question were hand-searched; therefore, an additional 64 titles were screened. After removing the duplicates, which was carried out with the support of Endnote Studies software, as well as the articles without the outcomes evaluated in this systematic review, 49 articles remained for full-text assessment for eligibility. Eleven articles were included for the quality analysis (Figure 1).

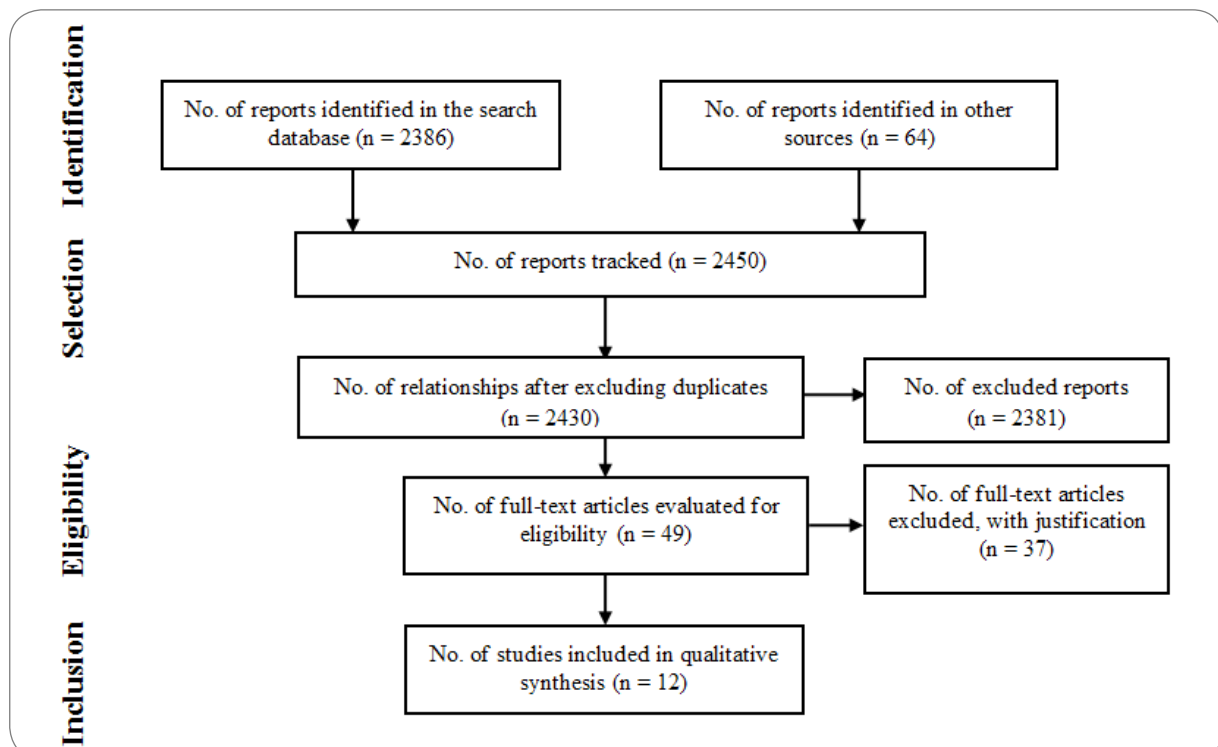


Figure 1 - Flow diagram of literature searches and selection, according to the PRISMA statement. Study characteristics

The articles were mostly from Brazil (45%) and were published from 2011-2018. The influence of oral health on physical performance was mostly evaluated from questionnaires; only in three studies was this evaluation not self-reported, and in the latter three studies, the data were analysed from clinical evaluations. Soccer was the most frequent sport in which the influence of oral health on physical activities was evaluated (Table 1).

Table I - Characteristics of the studies.

Author	Sport	Study type	Sample	Data sources	Influence of oral health in physical performance
Oliveira RS et al., 2007 [10]	Canoeing Handball	Cross-sectional	Canoeing: n=17 Handball: n=20	Structured questionnaire	Canoeing 33.33% Handball 87.5%
Gay-Scoda C et al., 2011 [11]	Football	Cross-sectional	n=30	Clinical examination and interviews	Plaque index (p=0.022) showed statistically significant correlation with intrinsic injuries, and with Gingival Index showed statistically significant correlations (p=0.022 and p=0.032) to muscle injuries
Souza BC et al., 2012 [12]	Soccer	Longitudinal Observational	n=15	Clinical evaluation	Showed correlation between periodontal inflammation and serum level of creatinin kinase
Needleman I et al., 2013 [13]	Athletes from London 2012 Olympic Games	Cross-sectional	n=278	Clinical evaluation and Questionnaire	18%
Nascimento BL et al., 2015 [14]	Triathlon	Cross-sectional	n=254	Structured questionnaire	38.6%
Solleved H et al., 2015 [15]	Soccer	Cross-sectional	n=215	Structured questionnaire	When there were two or more types of oral health problems there were higher odds of having repeated exercise associated muscle cramps, muscle or tendon reinjury and multiple types of reinjury (odds ratio ranging from 2.48 to 3.40)
Alshail F et al., 2016 [16]	Soccer	Cross-sectional	n=27	Clinical evaluation and Structured questionnaire	Increased bleeding on probing and probing pocket depth were associated with increased serum creatinin kinase levels in young soccer players (p<0.01)
Chantaramane A et al., 2016 [17]	Soccer	Cross-sectional	n=25	Clinical evaluation and Questionnaire	18%
Needleman I et al., 2016 [18]	Football	Cross-sectional	n=187	Clinical evaluation and Questionnaire	6.9%
Alves, DCB et al., 2017 [19]	Soccer Basketball	Cross-sectional	Soccer: n=42 Basketball: n=40	Semi-structured questionnaire	Soccer: 73.8% Basketball: 40%
Gallagher J., 2018 [8]	UK elite athletes from different sports	Cross-sectional	n=352	Clinical evaluation and Questionnaire	32.0%

Table III - Compliance of the studies included in the qualitative analysis with the result domain of the Strobe guidelines.

Result Domain	Participants	Descriptive data	Outcome	Main Results	TOTAL (%)
Oliveira, RS et al, 2007	+	+-	+	-	63%
Gay-Scoda C et al, 2011	-	-	+	-	25%
Souza BC et al, 2012	+-	+-	+	-	50%
Needleman I et al, 2013	+	+-	+	+-	75%
Nascimento BL et al, 2015	-	+-	+-	-	25%
Solleved H et al, 2015	+	+-	+	-	63%
Alshail F et al, 2016	-	+-	+	-	38%
Chantaramanee A et al, 2016	+-	+-	+	-	50%
Needleman I et al, 2016	+	+	+	+-	88%
Alves, DCB et al, 2017	-	+-	+	+-	50%
Gallagher J, 2018	+	+	+	+-	88%
Galvão, AM et al, 2018	-	+-	+	-	38%

Table IV - Quality assessment tool for observational cohort and cross-sectional studies.

Criteria	1	2	3	4	5	11	14	TOTAL (%)
Oliveira, RS et al, 2007	Yes	Yes	NR	Yes	No	Yes	No	57%
Gay-Scoda C et al, 2011	Yes	No	NR	NR	No	Yes	No	29%
Souza BC et al, 2012	Yes	Yes	NR	Yes	No	Yes	No	57%
Needleman I et al, 2013	Yes	Yes	NR	Yes	No	Yes	No	57%
Nascimento BL et al, 2015	No	Yes	NR	NR	No	Yes	No	29%
Solleved H et al, 2015	Yes	Yes	Yes	Yes	No	Yes	No	71%
Alshail F et al, 2016	Yes	No	NR	NR	No	Yes	No	29%
Chantaramanee A et al, 2016	Yes	Yes	NR	NR	No	Yes	No	43%
Needleman I et al, 2016	Yes	Yes	Yes	NR	No	Yes	No	57%
Alves, DCB et al, 2017	Yes	Yes	NR	NR	No	Yes	Yes	57%
Gallagher J, 2018	Yes	Yes	Yes	Yes	No	Yes	No	71%
Galvão, AM et al, 2018	No	Yes	NR	NR	No	Yes	No	29%

1- Was the research question or objective in this paper clearly stated? 2- Was the study population clearly specified and defined? 3- Was the participation rate of eligible persons at least 50%? 4- Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? 5- Was a sample size justification, power description, or variance and effect estimates provided? 11- Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? 14- Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)? NR- not reported.

Table V - Newcastle-Ottawa Scale or assessing the quality of nonrandomised studies.

Newcastle-Ottawa Scale	Selection			Outcome	Total (%)
	Representativeness	Homogeneity	Exposure	Evaluation	
Oliveira, RS et al, 2007	0	1	1	0	50%
Gay-Scoda C et al, 2011	0	0	1	1	50%
Souza BC et al, 2012	0	1	1	1	75%
Needleman I et al, 2013	0	1	1	0	50%
Nascimento BL et al, 2015	0	0	1	0	25%
Solleved H et al, 2015	1	1	1	0	75%
Alshail F et al, 2016	0	0	1	1	50%
Chantaramanee A et al, 2016	0	0	1	1	50%
Needleman I et al, 2016	1	0	1	1	75%
Alves, DCB et al, 2017	0	0	1	0	25%
Gallagher J, 2018	1	1	1	1	100%
Galvão, AM et al, 2018	0	0	1	1	50%

Results of individual studies

All studies showed an association between oral health and physical activities; however, this association was assessed by questionnaires in most studies. Among the observed and self-reported changes were the modifications of the sports routine suffered. The influence by self-assessment ranged from 7-88%.

Discussion

The main outcome was that all the studies reported the influence of oral health conditions on difficulties in developing training routines and competitions. The data source from most studies were questionnaires [8,13-22], therefore the results were obtained by self-report answers from the athletes. One limitation of this review is that the results were self-assessed, however, the biggest issue was due to the fact that the questionnaires used were not validated, generating a lack of standardization and an increased risk of bias since each study applies its own questionnaire. The best suggestion is the conduct of clinical trials that perform the treatment of these conditions associated with physical performance evaluation tests.

Other way to obtain more reliable data could be by the evaluation of oral clinical parameters associated with physical parameters of performance. Three studies tried to that, by assessing periodontal clinical parameters with muscle injuries or serum creatin kinase levels, these studies work with the physiological microlesions that occur with the physical activity itself, suggesting an important potential action of the oral health condition on the muscular inflammatory reaction [11,12,16]. Gay-Escoda et al. [11] observed a statistically significant correlation between plaque index and probing pocket depth with muscle injuries (p<0.05). Souza et al. [12] found that depth of probing and bleeding probing were associated with changes in serum creatin kinase levels during training. Alshail et al. [16] found that soccer players with periodontal complication exhibited raised serum creatin kinase levels compared to those without this disease.

There are some animal studies that have found a relationship between oral health and changes in muscle recovery [23], which justifies their inclusion. The data suggested that the association between the pro-inflammatory state induced by periodontal disease and exercise load may play an important negative role in muscle hypertrophy. Another study conducted in animals found that a group that was with immobilized, and with periodontal disease, presented greater degeneration of muscle tissue and increased inflammatory cells compared to other groups. This was due to decreased capillaries and increased connective tissue, which may be indicative of the fact that muscle recovery may be affected by problems of oral origin such as periodontal disease [24]. Hence, periodontal disease may also be a risk factor for a decrease in functional performance of the musculature, since the elevation of pro-inflammatory systemic cytokines can modify the muscular metabolism, leading to the loss of mass and decrease in strength, which is an important factor of physical performance [25].

There are other factors which are important to consider, such as the fact that professional athletes are constantly exposed to maximum stress and recovery situations, which may consequently impact on athlete's activities.

Most of the studies included in this review were performed in Brazil. There was also a higher percentage of studies regarding soccer players. Which can be explained by the fact that it is one of the sports with a greater number of athletes and also due to the huge popularity of soccer, which is the most practiced sport worldwide [26]. The sample size of the studies also revealed a lack of standardization, knowing the specific characteristics of each study; we noticed a high rate of sample variation from 15 to 352 athletes, which may indicate a limitation for these observational studies. This can be explained because most samples are convenience samples due to the difficulty of working with athlete patients, considering that the interventions cannot interfere with the training routine. However, more important than the standardization of the sample size, would be to do follow-ups in these athletes, before and after dental treatment to evaluate in the same population if the oral health really impacts on physical performance.

A systematic review prior to the present study showed four studies assessed this association in which 5 to 18% of the athletes reported negative impact of poor oral health or dental trauma and changes in the development of sports activities [6]. Their methodological quality analysis, Newcastle-Ottawa Scale adjusted, was mostly poor, which was also observed in this review.

Conclusion

Oral health influences in the development of the sportsman's routine, which may impair his adaptation to training of athletes. We suggest that further studies should be conducted with qualitative and quantitative variables to better measure this influence.

Potential conflict of interest

No conflicts of interest with potential potential for this article have been reported.

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Academic link

There is no link between this study and graduate programs.

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Authors' contributions

Conception and design of the research: Santos FA, Souza JJ. Data collection: Souza JJ, Leite JS, Bahls R, Grande RS, Lopes AL. Data Analysis and interpretation: Souza JJ, Leite JS. Obtaining financing: Souza JJ. Writing of the manuscript: Souza JJ, Leite JS, Souza BC, Santos FA. Critical review of the manuscript for important intellectual content: Souza BC and Santos FA.

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