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Validation of a Risk Matrix about the Athlete's Oral Health by Analyzing Behavioral and Nutritional Habits

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Abstract: The study proposal was to build a risk matrix on oral health, by analyzing the behavioral and nutritional habits of these individuals and perform your validation. A literature review was carried out to identify risk factors for the oral diseases. The interviewees were 40 volunteer individuals, athletes, professionals or amateurs, or practitioners of physical activity. The validation process consisted of the following steps: 1. Validity of the content; 2. Verbal understanding; 3. Comparison and correlation of the questionnaire test. The Content Validity Coefficients (CVC), the Content Validity Indexes (CVI) and the Kappa correlation coefficients were calculated for each item. In the phase of assessment of verbal comprehension by volunteers, the final CVC for clarity and understanding was 0.869 and 0.854, respectively. Kappa values varied between 0.5 and 0.667. Cronbach's alpha for each component was calculated, resulting in a cariogenic diet (α = 0.989), acid sports drinks (α = 0.964), oral hygiene (α = 0.963) and dental services (α = 0.980). The definition of this oral profile, in conjunction with an athlete's individual needs, can define treatment and prevention programs, including education in oral health.

Keywords: Dentistry, Dental Clinics, Athletes, Oral Health

Introduction

Regular sports practice is related to better physical results and decreased major mortality risk factors. In addition, sports engagement is related to better health outcomes and increased life expectancy (Frese *et al*., 2018). Conversely, oral heath became a rising concern to amateur and professional athletes, as there seems to be a consensus that most athletes have poor oral health, similarly to people with low socioeconomic status (Needleman *et al*., 2014).

Dental problems can be detrimental to sports performance, especially in athletes with an intense training routine and who perform frequently. In addition to situations involving severe pain or discomfort compatible with acute infections, the athlete is also subject to chronic infectious-inflammatory diseases of periodontal tissues, dental fractures due to trauma, orofacial fractures, loss of tooth structure due to chemical erosion, cavities and temporomandibular joint disorders (Ashley *et al*., 2015). These conditions may directly interfere in training adaptation, such as the case of infectious-inflammatory diseases and pain. Thus, an athlete's oral health condition must be considered as a potential impact factor for the success of training and competitions (Needleman *et al*., 2014).

Dietary and behavioral habits are among the main risk factors associated with oral health problems in athletes, whereas the most prevalent oral diseases are dental caries and periodontitis, which present different etiology (Touger-Decker and van Loveren, 2003). Therefore, considering the particularities that comprise an athlete's routine and lifestyle to reach specific goals in sports practice, it is important to establish clinical care protocols able to detect specific individual characteristics that may influence oral health, while also ensuring appropriate nutritional support. Thus, the objective of the study was to review the literature on athletes' oral health problems, propose a risk matrix on oral health, by analyzing the behavioral and nutritional habits of these individuals and perform your validation. This tool can be used as an aid in patient's risk diagnosis and improve the choice of specific treatments.

Methods

Ethical Considerations

The project was approved by the Human Research Ethics Committee. Participants were informed about all stages of the research, the recognition of the minimum risks to the volunteer's health, the option to withdraw from participating in the study at any time, as well as the confidentiality of personal data. The volunteers signed an Informed Consent, as determined by the current legislation. This research is in line with Resolution 466/12 of the National Health Council and the Declaration of Helsinki.

Sample

The sample was composed of two distinct groups: Evaluators and interviewees. The evaluators were 3 dental surgeons invited voluntarily, who were trained and instructed on the operation and application of risk matrices. The interviewees were 40 volunteer individuals, athletes, professionals or amateurs, or practitioners of physical activity. The sample was calculated using the EPI Info software version 7.2 (EPI Info, Center for Disease Control, Atlanta, Georgia, 2017), based on a linear correlation coefficient of 0.947 (Table 1), which resulted from the responses obtained by two evaluators (senior evaluator and test evaluator), through a pre-evaluation (N = 5), with a 95% confidence interval, probability of type I error (α) of 5% and test power of 80%. 10% were included as an estimate of sample loss. All interviews, instructions and evaluations were carried out in the senior appraiser's office, at pre-defined times with the participants.

Construction of Risk Matrices

Initially, a search was performed in the PubMed database between January and February 2020. There was no restriction on the year of publication. The search for articles was carried out using the following combinations of terms: Nutrition, athlete, oral health, caries, dental erosion, periodontal disease, oral hygiene. After an analysis of the title and the available abstract, articles that did not deal with the proposed topic, that were not published in English, or that did not provide the full text were excluded. The search was conducted considering the relationship between nutrition and oral health problems. Studies approaching Paralympic sports were not included, due to specific interfering factors such as motor skills and pharmacological agents prescription. At the end of the analysis, 36 papers were selected for reading and to assist in the construction of risk matrices. Table 2 indicates the issues related to the outcomes of the main oral diseases, indicating the selected risk factor, component, domain, construct and category for the construction of the instrument.

Risk matrices are management tools used to measure the risk of certain events occurring, enabling qualitative risk classification and assists in planning individualized actions. Thus, this ensures better intervention for each case, according to the athlete's profile and routine. For the construction of qualitative risk analysis matrices, several risk factors for oral diseases with a significant impact for athletes were used: Cariogenic diet, intake of acidic drinks, oral hygiene habits and access to dental services. Each factor was scaled, individually, according to its degree and risk. The established risks are based on data already known from the literature, for oral diseases (Olczak-Kowalczyk *et al*., 2016; Head *et al*., 2017; Hong *et al*., 2018; Obregón-Rodríguez *et al*., 2019; Baishya *et al*., 2019). The results resulted in scores that were converted into recommendations in a scoring matrix. Risk matrices were constructed following the sequence shown in.

The characterization of oral diseases in the athlete was based on literature prevalence data that indicate that the proportion of athletes affected by these conditions were dental caries (15-75%), moderate-to-severe periodontitis (up to 15%) and dental erosion (36-85%) (Needleman *et al*., 2014; Ashley *et al*., 2015). The disease incidence was generally not clearly differentiated by socioeconomic status; however, poor oral health appears to affect athletes, regardless of the country of origin. Needleman *et al*. (2014) Oral health has risk factors that are associated with health behaviors such as beliefs, education, access to preventive programs and personal care. We do not have many studies that address these factors in sport, but we know that awareness of the risk of oral disease is low among athletes, increasing the prevalence of these conditions (Needleman *et al*., 2014; Frese *et al*., 2018).

Oral health has consistently been shown to be poor with a high treatment need for athletes. This may be associated with risk factors for oral diseases, which are present in the athlete's routine, especially oral hygiene after eating and using foods with high carbohydrate content frequently. These are nutritional challenges from frequent carbohydrate intake and acidic sports drinks and poor health behaviors and lack of health promotion and preventive support (Needleman *et al*., 2014). For this reason, factors such as hygiene habits and access to health services were included in the construction of the risk matrix.

Validation of the Risk Matrix

The validation process consisted of the following steps: 1. the validity of the content between the judges; 2. Verbal understanding of volunteers; 3. Comparison and correlation of the questionnaire test. To validate the content, considering clarity and relevance, three experienced dentistry professors were invited to form a committee, which evaluated the questions built by each

matrix. This evaluation was carried out with the aid of a Likert scale, graded from 1 to 5 with the following denominations: Very nuclear, not overly clear, nuclear, clear and very clear, for the criterion of clarity and very irrelevant, not overly relevant, irrelevant, relevant and very relevant, for relevance. After the evaluations, the Content Validity Coefficients (CVC), the Content Validity Indexes (CVI) and the Kappa correlation coefficients were calculated for each item (Table 3). Adjustment needs were made before the analysis of verbal comprehension.

The verbal comprehension stage of the volunteers was carried out with a preliminary study, considering clarity and understanding. This evaluation counted with the participation of 10 interviewees, who analyzed each item of the matrix with the aid of a Likert scale, graded from 1 to 5 with the following denominations: Very nuclear, not overly clear, nuclear, clear and very clear, for the criterion of clarity and very misunderstood, not very understood, misunderstood, understood, very understood, for understanding. After the evaluations, the Content Validity Coefficients (CVC), the Content Validity Indexes (CVI) and the Kappa correlation coefficients were also calculated for each item (Table 4). The volunteers pointed out the main doubts regarding the instructions, questions and answer options, or any other aspect that was confused during the application of the matrices.

The final stage of the validation of risk matrices was carried out with the participation of three evaluators, dental surgeons and 40 respondents. These participants were randomly selected in three groups. Each group was interviewed by 1 different evaluator, with an interval of at least one week, until all evaluators applied the risk matrices to all participants. Before the beginning of the interviews, the senior evaluator performed a previous data collection, for later comparison. Analyzes were performed using the mean and standard deviation of responses and the linear correlation coefficient between the senior appraiser and the other appraisers. Also, Cronbach's alpha was calculated for each component, to estimate the confidence of the responses of the instrument or its domain (Table 5).

Table 1: Comparison and correlation of the questionnaire pre-evaluation

Risk Matrix criteria	Senior evaluator Mean ± SD	Test evaluator Mean ± SD	CC
Cariogenic diet	2.4±1.140	2.4±1.140	1.000
Acid sports drinks	2±0.707	1.6±0.894	0.790
Oral hygiene	2±0.707	2±0.707	1.000
Dental services	2±1.224	2±1.224	1.000
		CC	0.947

CC: Linear Correlation Coefficient. N = 5. Interpretation of CC: 0-0.3: Negligible correlation; 0.31-0.5: Weak correlation; 0.51-0.7: Moderate correlation; 0.71-0.9: Strong correlation; >0.9: Very strong correlation (Mukaka, 2012)

Table 2: Issues related to the risk outcomes of the main oral diseases, based on dietary and behavioral habits

Matrix	Risk factor	Component	Domain	Construct	Category
1	Cariogenic diet	Ingestion of cariogenic foods	Quantity and frequency of consumption of cariogenic foods	Phasic demineralization and remineralisation of dental hard tissues	Dietary habit
2	Acid sports drinks	Consumption of acidic drinks	Quantity and frequency of consumption of acidic drinks	Demineralization of dental hard tissues	Dietary habit
3	Oral hygiene	Oral hygiene habits	Quality and frequency of oral hygiene	Biofilm control	Behavioral habit
4	Dental services	Access to dental care	Frequency of access to dental care and need	Oral health	Behavioral habit

Table 3: Content validity among the judges

	Clarity							Relevance						
	Agreement	Kappa	CVI	Mean	CVC_i	Pe	CVC_f	Agreement	Kappa	CVI	Mean	CVC_i	Pe	CVC_f
Question 1 - frequency of consumption of cariogenic food.	100%	1.0	1	4.00	0.80	0.037	0.763	66.6%	0.5	1	4.66	0.93	0.037	0.893
Question 2 - Frequency of consumption of acidic drinks.	66.6%	0.5	1	4.33	0.86	0.037	0.823	100%	1.0	1	5.00	1.00	0.037	0.963
Question 3 - Frequency of oral hygiene.	100%	1.0	1	4.00	0.80	0.037	0.763	66.6%	0.5	1	4.66	0.93	0.037	0.893
Question 4 - Frequency of	100%	1.0	1	4.00	0.80	0.037	0.763	66.6%	0.5	1	4.33	0.86	0.037	0.823
Possibility of using dental services per year.			$CVC_{t\ clarity}$				0.778			$CVC_{t\ relevance}$				0.893

CVCi: Initial Content Validity Coefficient for each item; Pe: Error; CVCf: Finale Content Validity Coefficient; CVCt: Total Content Validity Coefficient; CVI: Content Validity Index; Kappa: Kappa correlation coefficient. N = 3. Classification of the level of agreement by the Kappa coefficient: <0 there is no agreement; 0-0.2: Minimal agreement; 0.21-0.4: Reasonable agreement; 0.41-0.6: Moderate agreement; 0.61-0.8: Substantial agreement; 0.81-1.0: Perfect agreement (Landis and Koch, 1977). The cut-off point adopted to determine satisfactory levels for language clarity and relevance was CVCf ≥0.70 for each item and CVCt ≥0.70 for the instrument in general (Cassepp-Borges *et al*., 2010)

Table 4: Verbal understanding of volunteers preliminary study

	Clarity							Understanding						
	Agreement	Kappa	CVI	Mean	CVC_i	Pe	CVC_f	Agreement	Kappa	CVI	Mean	CVC_i	Pe	CVC_f
Question 1 - Frequency of consumption of cariogenic food.	80%	0.667	0.9	4	0.80	10^{-10}	0.799	80%	0.667	1.0	4.2	0.84	10^{-10}	0.839
Question 2 - Frequency of consumption of acidic drinks.	70%	0.500	1	4.3	0.86	10^{-10}	0.859	70%	0.500	1.0	4.7	0.94	10^{-10}	0.939
Question 3 - Frequency of oral hygiene.	70%	0.500	1	4.3	0.86	10^{-10}	0.859	80%	0.667	1.0	4.2	0.84	10^{-10}	0.839
Question 4 - Frequency of possibility of using dental services per year.	80%	0.667	1	4.8	0.96	10^{-10}	0.959	80%	0.667	0.9	4.0	0.80	10^{-10}	0.799
			$CVC_{t\ clarity}$				0.869			$CVC_{t\ Understanding}$				0.854

CVCi: Initial Content Validity Coefficient for each item; Pe: Error; CVCf: Finale Content Validity Coefficient; CVCt: Total Content Validity Coefficient; CVI: Content Validity Index; Kappa: Kappa correlation coefficient. N = 10. Classification of the level of agreement by the Kappa coefficient: <0 there is no agreement; 0-0.2: Minimal agreement; 0.21-0.4: Reasonable agreement; 0.41-0.6: Moderate ag reement; 0.61-0.8: Substantial agreement; 0.81-1.0: Perfect agreement (Landis and Koch, 1977). The cut-off point adopted to determine satisfactory levels for language clarity and relevance was CVCf ≥0.70 for each item and CVCt ≥0.70 for the instrument in general (Cassepp-Borges *et al*., 2010)

Table 5: Comparison and correlation of the questionnaire test

	Senior evaluator	Evaluator 1		Evaluator 2		Evaluator 3		
Risk Matrix criteria	Mean ± SD	CC	Mean ± SD	CC	Mean ± SD	CC	Mean ± SD	Cronbach's alpha
Cariogenic Diet	2±0.694	1.000	2±0.694	0.964	2.033±0.668	0.967	1.966±0.718	0.989
Acid Sports Drinks	1.9±0.758	1.000	1.9±0.758	0.949	1.966±0.808	0.876	1.966±0.668	0.964
Oral Hygiene	2.2±0.714	0.939	2.266±0.739	0.939	2.266±0.739	0.865	2.266±0.691	0.963
Dental Services	2.666±0.922	0.959	2.666±0.922	0.943	2.766±0.858	0.980	2.633±0.927	0.980

CC: Linear Correlation Coefficient in relation to the senior evaluator. N = 38. Interpretation of CC: 0-0.3: Negligible correlation; 0.31-0.5: Weak correlation; 0.51-0.7: Moderate correlation; 0.71-0.9: Strong correlation; >0.9: Very strong correlation (Mukaka, 2012). Cronbach's alpha reliability: Very low (α≤0.30); low (0.30 <α<0.60); moderate (0.60 <α<0.75); high (0.75<α≤0.90) and very high (α>0.90) (Gottems *et al*., 2018)

Analysis

All resulting data were tabulated for the analysis. Microsoft Excel® version 2010 software (Microsoft Corp) was used for calculating the linear Correlation Coefficients (CC), Content Validity Coefficients (CVC), Content Validity Indexes (CVI), Kappa correlation coefficients and Cronbach's alpha (Divisi *et al*., 2017).

Results

The instrument consisted of four components that vary in their domain concerning quantity and frequency, quality and frequency and access and need and its realization is very succinct. Individual risk matrices were prepared, according to the cariogenic diet (Fig. 1), acid drink intake (Fig. 2), oral hygiene habits (Fig. 3) and access to dental services (Fig. 4). The individual evaluation with the aid of each matrix results in a score indicated in Fig. 5, followed by its orientation.

During the content validity phase, the teacher's committee members suggested the inclusion of a brief initial explanation, with instructions on how to apply the risk matrix (figure's description). There was also a suggestion to replace the expression "low-sticky foods" with "foods with little adherence", used in the matrix corresponding to the risk factor, cariogenic diet. The final CVC for clarity and relevance was 0.778 and 0.893, respectively. The cut-off point adopted to determine satisfaction levels for this assessment was CVC ≥0.70. Kappa values varied between 0.5 and 1, indicating a moderate to perfect agreement (Table 3).

In the phase of assessment of verbal comprehension by volunteers, there was no need for clarification and, therefore, the matrix did not need to be reassessed. In this step, the final CVC for clarity and understanding was 0.869 and 0.854, respectively. The cut-off point adopted to determine satisfaction levels for this assessment was also CVC ≥0.70. Kappa values varied between 0.5 and 0.667, indicating a moderate to the substantial agreement (Table 4).

The comparison and correlation of the questionnaire test, carried out in the third phase of validation, had the participation of 38 (30.4±7.11 age) interviewees. Two participants did not complete the interviews, however, the sample calculation was performed with an estimate of losses and this fact had no significant impact on the results. This stage of the analysis showed reliability in the reproduction of the interviews between the evaluators over the evaluation weeks. The linear Correlation Coefficient (CC), analyzed by the senior appraiser, varied between 0.865 and 1, indicating a moderate to very strong correlation agreement and also suggesting good temporal stability or external reliability. Cronbach's alpha for each component was calculated as a measure of internal consistency or reliability among the evaluators, resulting in the cariogenic diet (α = 0.989), acid sports drinks (α = 0.964), oral hygiene (α = 0.963) and dental services (α = 0.980) (Table 5).

Discussion

The studies show that increased intake of cariogenic foods, sports nutrition products and sports drinks can contribute to the increased risk of oral problems such as dental erosion, caries and periodontal conditions; especially when accompanied by poor hygiene or restricted access to dental services. Based on this, this study created and validated a risk identification method for the oral health of the athlete patient, considering the most prevalent dental diseases in this population. Besides, the developed risk matrix may also serve as a research tool and for standardizing the clinical assessments performed.

Athletes are exposed to several different risk factors for oral diseases. Considering specific nutritional particularities, this population is susceptible to an important cariogenic challenge, since the consumption of a diet rich in carbohydrates and sugars is frequent, especially in the form of pastes and gels (Gallagher *et al*., 2019). A plethora of evidence indicates that the effects of a cariogenic diet in overall health may not be counterbalanced by the protective induced by the use of fluorides (Broad and Rye, 2015; Frese *et al*., 2018).

The cariogenic potential associated with sports nutrition practices during specific training periods or throughout competitions affects the oral flora, significantly affecting the quality and quantities of specific microorganisms. For example, Streptococcus spp, the main bacterium associated with the appearance of carious lesions, is abundantly present in the oral flora of athletes (Minty *et al*., 2018; Murtaza *et al*., 2019). Ultimately, these detrimental effects on oral health could compromise sports performance (Murtaza *et al*., 2019).

Therefore, to ensure sports performance while minimizing potential risks, integrating information regarding dental health with a balanced and healthy nutritional orientation is vital (Studen-Pavlovich *et al*., 2000; Needleman *et al*., 2018). Thus, based on the nutritional characteristics of the athletes and the risk factors for oral diseases, especially dental caries, a risk matrix for a cariogenic diet in sports nutrition was built Fig. 1, which assesses the risk of the disease according to frequency and intake of cariogenic foods. The purpose of this matrix was to establish guidance on the patient's risk level, according to specific criteria, allowing the dentist to carry out individualized clinical planning.

Current literature indicates that athletes have worse oral health and this may be associated with their behavioral and dietary peculiarities, which could lead to decreased performance associated with a cariogenic diet (Azodo and Osazuwa, 2013; Ostrowska *et al*., 2016). The second risk matrix considers the frequency of sports drinks consumption, (which are acidic drinks) and specific precautions following consumption Fig. 2. This practice is quite common in sports, particularly among athletes who do not usually perform appropriate nutritional monitoring. Although there are specific recommendations for the use of this type of drink, the commercial appeal is still a factor influencing nutrition choices in this population (Morgan *et al*., 2016).

Ingestion of these drinks has cariogenic potential, associated with a reduction of the pH of the oral environment, demineralizing dental tissues and increasing the process of chemical erosion (Coombes, 2005). Sports drinks were developed to improve hydration and performance of athletes, albeit containing relatively high amounts of sugars, salt and citric acid, which are risk factors for poor oral health (Mathew *et al*., 2002; Noble *et al*., 2011). The frequent consumption of these products associated with poor oral health practices is common in athletes (Sirimaharaj *et al*., 2002).

Oral hygiene is an important risk factor for diseases of the oral cavity, which is directly related to individual perception of health and behavioral habits (Anttonen *et al*., 2014). It is well described that athletes often present poor oral health condition associated with poor oral hygiene, which potentiates the risks for oral diseases associated with specific dietary habits since we can observe a significant prevalence of periodontal diseases, which can have an impact on sports performance, as already reported (Gallagher *et al*., 2018). The biofilm is the primary etiologic agent in periodontal diseases. These are one of the most common chronic inflammatory diseases in the world and there is emerging interest in the link between oral health and other clinics condition (Lönn *et al*., 2018).

Appropriate oral health is vital to overall health and quality of life, while also influencing several factors which could be responsible for the appearance of several diseases, including systemic inflammatory responses and impaired muscle metabolism (Cullinan and Seymour, 2013; de Souza *et al*., 2020). Thus, oral hygiene is fundamental for decreasing the development of dental pathologies and possible complications that can compromise the athlete. Figure 3 presents the risk matrix for oral hygiene and also associates exposure to fluorides. The control of plaque and access to fluoride is the most expressive methods for maintaining dental structure (Frese *et al*., 2018).

It should be noted that in all the risk factors mentioned above, they may increase the systemic inflammation of the athlete. Inflammatory mediators such as Tumor Necrosis Factor-alpha (TNFα) and Interleukin-6 (IL-6) are important mediators of catabolic responses such as muscle protein loss and consequently, in performance reduce (Durham *et al*., 2009). Inflammation, which is characterized by increases in macrophage infiltration and levels of inflammatory cytokines/chemokines (e.g., TNFα;

Monocyte Chemoattractant Protein 1, MCP-1), is associated with this muscle atrophy (Valerio *et al*., 2006; Varma *et al*., 2009).

After the initial analysis using the previous matrices, it is possible to establish a risk score for oral diseases, estimating basic care guidelines Fig. 5. Since athletes are at potential risk due to their routines, an appropriate assessment of oral health may reduce the risk of oral pain, inflammation and infection and, thus, minimizing the use of medications or days of departure from training (Bryant *et al*., 2011; Needleman *et al*., 2013; Frese *et al*., 2015).

Cariogenic diet		Amount of food intake with high sugar content:			
		Low	Moderate	High	Very high
Frequency of consumption of cariogenic food. (days/week)	≤1	Low = 1	Low = 1	High = 3	High = 3
	2	Low = 1	Moderate = 2	High = 3	Very high = 4
	3-4	Low = 1	Moderate = 2	High = 3	Very high = 4
	>4	Moderate = 2	Moderate = 2	Very high = 4	Very high = 4
Risk for oral diseases and description of factors					
Low	Ingestion of solid food, following WHO recommendations, not exceeding 10% of the daily energy consumption, or 50 g per day.				
Moderate	Ingestion of foods with little teeth adherence, exceeding 10% of the daily energy consumption, or up to 100g per day.				
High	Ingestion of foods with moderate teeth adherence, exceeding 10% of the daily energy consumption, or up to 100g per day.				
Very high	Ingestion of foods with moderate and high teeth adherence, exceeding 10% of the daily energy consumption and above 100g per day.				

Fig. 1: Risk Matrix for cariogenic diet in sports nutrition. To use this matrix, one should first ask the weekly frequency of consumption of cariogenic foods (sweets, candies, chocolates, stuffed cookies, chocolates, homemade sweets, desserts and the like, sugared drinks, soft drinks). This information must be marked according to the indication of each line (≤1, 2, 3-4 and >4). Then, the average frequency of cariogenic food consumption based on sugar content (50 g per day, up to 100g per day and above 100g per day) should be estimated. This information will indicate the corresponding column

Acid sports drinks		Supervision, care and intake of drinks with low pH			
		Low	Moderate	High	Very high
Frequency of consumption of acidic drinks. (days/week)	≤1	Low = 1	Low = 1	High = 3	High = 3
	2	Low = 1	Moderate = 2	High = 3	Very high = 4
	3-4	Low = 1	Moderate = 2	High = 3	Very high = 4
	>4	Moderate = 2	Moderate = 2	Very high = 4	Very high = 4
Risk for oral diseases and description of factors					
Low	Rare intake of acid drinks of intake followed by mouth rinse after consumption.				
Moderate	Consumption under nutritional supervision and usually rinses the mouth after consumption (not immediately).				
High	Consumption without nutritional supervision but usually rinses the mouth after consumption (not immediately).				
Very high	Consumption without nutritional supervision and without washing the mouth after consumption (not immediately).				

Fig. 2: Risk Matrix for sports drinks. To use this matrix, one should first ask the weekly frequency of consumption of sports drinks (repositories, isotonic, hypertonic and hypotonic drinks). This information must be marked according to the indication of each line (≤1, 2, 3-4 and >4). Then, risk-related conduct must be marked (if this consumption is being prescribed by the nutritionist and if the individual performs a mouth rinse after ingestion). This information will indicate the corresponding column

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Oral hygiene		Oral hygiene conditions and methods			
		Low	Moderate	High	Very high
Frequency of oral hygiene. (daily)	>4	Low = 1	Low = 1	High = 3	High = 3
	3-4	Low = 1	Moderate = 2	High = 3	Very high = 4
	2	Low = 1	Moderate = 2	High = 3	Very high = 4
	≤1	Moderate = 2	Moderate = 2	Very high = 4	Very high = 4
Risk for oral diseases and description of factors					
Low	Performing oral hygiene following meals, using toothbrush and fluoride toothpaste. Daily flossing and access to fluoridated water.				
Moderate	Not performing oral hygiene following every meal, but uses a toothbrush and fluoride toothpaste. Flossing every other day and access to fluoridated water.				
High	Not performing oral hygiene following every meal, but uses a toothbrush and fluoride toothpaste. Not flossing and without access to fluoridated water.				
Very high	Failure to perform oral hygiene after all meals and without access to fluorine.				

Fig. 3: Risk Matrix for oral hygiene. To use this matrix, one must first ask what is the daily frequency of oral hygiene performed. This information must be marked according to the indication of each line (>4, 3-4, 2, ≤1). Then, hygiene procedures (after meals, using a brush and fluoride toothpaste, dental floss and if the individual has access to fluoridated water) should be marked. This information will indicate the corresponding column

Dental services		Access to dental services and treatments			
		Low	Moderate	High	Very high
Frequency of possibility of using dental services. (yearly)	>4	Low = 1	Low = 1	High = 3	High = 3
	3-4	Low = 1	Moderate = 2	High = 3	Very high = 4
	2	Low = 1	Moderate = 2	High = 3	Very high = 4
	≤1	Moderate = 2	Moderate = 2	Very high = 4	Very high = 4
Risk for oral diseases and description of factors					
Low	Full access to dental services and treatments and often uses it, even without an apparent need.				
Moderate	Full access to dental services and treatment, but uses it only with the need or in an emergency situation due to pain.				
High	Full access to dental services and treatment, but without using it, even with apparent need.				
Very high	Restricted access to dental services and treatments.				

Fig. 4: Risk matrix for dental services. To use this matrix, one must first ask how often to access dental services annually. This information must be marked according to the indication of each line (>4, 3-4, 2, ≤1). Then, one should ask in what situation does the individual seek this service (periodic reviews, elective treatments, emergencies). This information will indicate the corresponding column

Risk score matrix and recommendations	
Low 4 points	Half-yearly dental consultations for revision and clinical care when necessary.
Moderate >4 to ≤8 points	Quarterly-yearly dental consultations for revision, with reinforcement on oral hygiene guidance and clinical care when necessary, aiming a score of 4 points.
High >8 to ≤12 points	Bimonthly dental consultations for revision, with reinforcement on the guidance of oral hygiene and clinical care of needs, aiming a score of 4 points. Assess the need for fluorotherapy therapy.
Very high >12 to ≤16 points	Monthly dental consultations for revision, with reinforcement on the guidance of oral hygiene and clinical care of needs, aiming a score of 4 points. Assess the need for fluorotherapy therapy.

Fig. 5: Risk score matrix and recommendations. The sum of the matrix results provides a score that will indicate the individual's estimated risk for oral diseases. In each category (low, moderate, high and very high) there is a recommendation, which can be followed, to help control the patient

Conclusion

An adequate athlete's oral examination as a routine would allow the dental surgeon to determine basic oral health, hygiene quality and the overall susceptibility to risk factors for oral diseases. The definition of this oral profile, together with the individual needs of the athlete, can optimize treatment and prevention programs, including education in oral health. Based on this examination, the dentist can assist the sports nutritionist in making decisions and applying nutritional guidelines. Furthermore, such an examination allows decision-making with the fitness coach, assisting in exercise planning considering oral health status, which can affect performance. This instrument can be used as an aid in the diagnosis of the risk profile for odontogenic diseases in athletes. Future studies in sports dentistry can bring benefits to the oral health of athletes.

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Ethics

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

Author's Contributions

Bárbara Capitanio de Souza and Bruno Costa Teixeira: Study conception and design; Acquisition of data; Analysis and interpretation of data.

Randhall Bruce Carteri and André Luiz Lopes: Drafting of manuscript; Critical revision.

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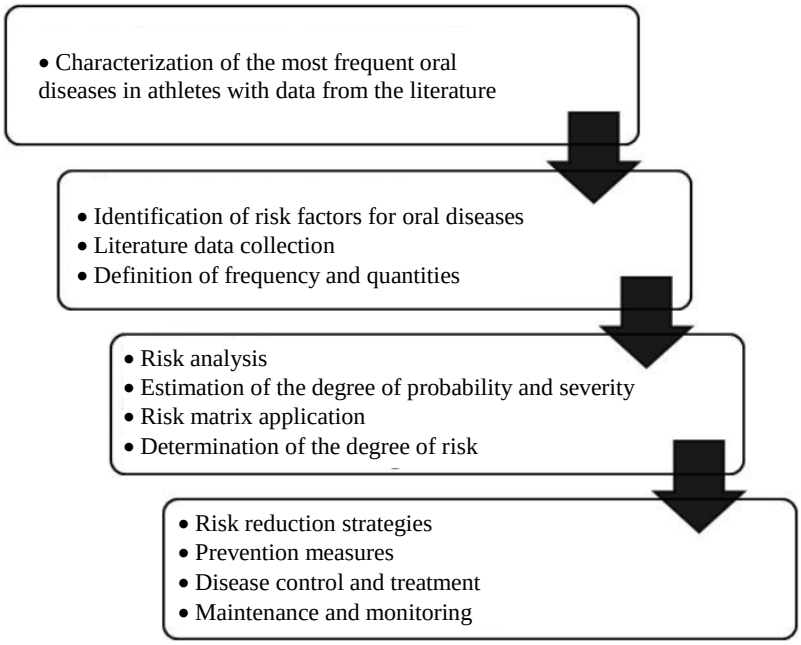
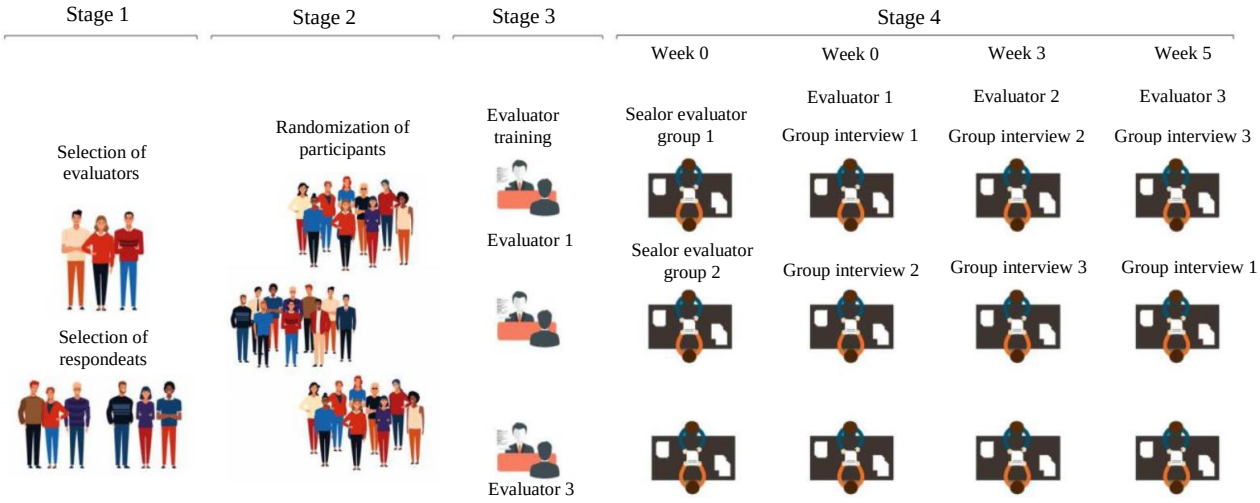
Supplementary Material



Supplementary File 1: Organization chart for the construction of risk matrices



Supplementary File 2: Representation of the final stage of validation of risk matrices. Stage 1: Selection of evaluators and interviewees; Stage 2: Sample randomization; Stage 3: Training of evaluators; Stage 4: Application of risk matrices