Overreaching: a risk factor for periodontal disease?

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• Conflicts of interest: none declared.

ABSTRACT
Objective: To identify the effects of overreaching on the susceptibility to develop periodontal diseases. **Material and Methods:** search for scientific articles on the PubMed database. The search strategy used the term “overreaching” with the Boolean operator “and”, and the keywords: effects, immunological, diagnosis. The descriptor “periodontal disease and risk factor” was also used. The studies selected were analyzed and the studies that did not cover the proposed subject were excluded. **Results:** periodontal diseases involve a multi-factorial etiology. Although the presence of microbiological pathogens is an important factor for the development of the diseases, other factors have also been highly correlated with their prevalence. The dysfunction of the immune function is more pronounced when the exercise is continuous, prolonged and moderately intense, condition that occurs in overreaching. There is a possibility that the combined effects of changes in immunological parameters may compromise the response to some diseases, such as periodontal diseases. The destruction of the periodontal tissues is a final consequence of the immune response from the host, which can vary in overreaching. **Conclusion:** overreaching may be responsible for alterations in the immune system of the athlete. Diseases that present a common inflammatory profile may suffer additional modulations because of this process, leaving these individuals under a higher risk.

Keywords: Oral health; Physical education and training; Periodontal diseases.

Introduction

Periodontal diseases are infectious and inflammatory diseases that affect hard and soft tissues around the teeth.1 They are characterized by the destruction of the connective tissue and periodontal bone support after an inflammatory response from the host, secondary to the bacterial infection.2 The microbial challenge can lead to an imbalance in the disease process, modifying the size and severity of the immunoinflammatory response, which may also be modulated by environmental, genetic and individual factors.3,4 Periodontal diseases have effects beyond the ones on the oral tissues and they have been linked to a condition of systemic inflammation, resulting in increased risk of subsequent chronic diseases such as cardiovascular diseases, diabetes mellitus, low birth weight infants, rheumatoid arthritis, metabolic syndrome, and nowadays, cancer.5 Although this relation has been reported in many publications, the nature of such a link is still little understood.6 On the other hand, periodontal diseases involve multi-factorial etiology. Although the presence of microbiological pathogens is an important factor for the development of diseases, lifestyle factors such as smoking, diet and oral hygiene have also been highly correlated with the prevalence of periodontitis.7 Periodontal diseases are infectious and inflammatory, and as such, they are subject to modulations of the immune system. Currently, the idea that the susceptibility to these diseases may be associated with different factors is widely accepted, which is emphasized by the fact that some people are more prone to periodontal diseases.8 The changes that can occur in the immune response are partially responsible for impact on the susceptibility and severity of the disease, a better understanding of this relation can contribute to the understanding of the pathogenesis of the periodontal disease and on the control of risk factors in individuals of higher risk.5

Athletes who make great efforts to achieve performance levels within their modality seem to present high prevalence of oral diseases.9 This condition may be associated to changes of parameters of the immune system, arising from the intense practice of sports. The increase in the intensity and amount of training are undertaken by athletes to improve their physical performance. However, when the balance between the appropriate training stress and adequate recovery is interrupted, acute fatigue may result in a negative overcompensation, known as functional overreaching (F-OR).10 The prolonging of a state of low performance associated to other stress factors increases the loss of performance and prolongs the recovery state, also involving an inadequate response to the excessive exercise that could result in different physiological disturbances, known as non-functional overreaching (NF-OR). The evolution of this condition can affect the neurological, immune, and endocrine functioning of an athlete and is related to the development of overtraining syndrome (OTS).11

Prolonged episodes of strenuous exercise cause a temporary depression of various aspects of the immune function. The dysfunction of the immune function after exercising is more pronounced when the exercise is continuous, prolonged, of moderate to high intensity and without proper diet.12 Thus, it is possible that the combined effects of changes in immunological parameters can compromise response to some diseases, such as in the periodontal diseases. Therefore, understanding the etiological factors and the patho-
genesis of the periodontal disease is important to better understand the associated risk factors. Thus, the objective of this study was to identify the effects of overreaching on the susceptibility to develop periodontal diseases.

**Material and Methods**

A search for scientific articles on the Pubmed database was performed to achieve this objective. The search strategy used the term “overreaching” with the Boolean operator “and”, and the keywords: effects, immunological, diagnosis. The descriptor “periodontal disease and risk factor” was also used. The studies selected were analyzed and the studies that did not cover the proposed subject were excluded (Figure 1).

![Selection of scientific articles on the Pubmed database](image)

**Figure 1. Description of the selection of articles**

**Literature Review**

**Modifiable Risk Factors for Periodontal Diseases**

Risk factors are particularities of individuals that may put them at greater risk of contracting a disease. They are considered as characteristics, behavior or exposure with an association to a certain disease; however, this relation is not necessarily of causal nature since it does not directly determine the onset or the progression of the disease. To be considered as a risk factor for periodontal diseases, the factor must be associated with the disease and responsible for the development of an adaptive immune response on the body and its elimination or suppression should result in the remission of the condition. By analyzing the criteria mentioned in literature, we noted that periodontal diseases have risk factors reported as systemic and local to be considered.

Modifiable risk factors include characteristics of the local microbiota, quality of the oral biofilm, presence of plaque retention factors, dental calculus, dental restorations and occlusal and anatomical factors. The oral microbiota is the most explored factor in studies involving the etiopathogenesis of periodontal diseases among the ones presented; however, although the presence of pathogenic microorganisms is a factor that causes this condition, it is not enough to cause periodontal diseases. The oral microbiota contributes to the development of periodontal diseases by interfering in the microbial homeostasis of the host, and not because of simple development of a few pathogens.

Susceptibility to periodontal diseases and other inflammatory diseases seems to change in response to interactions of risk factors during the lives of individuals. Many modifiable systemic risk factors contribute to the increase in systemic inflammatory markers and modify the genetic regulation through a variety of biological mechanisms. Periodontal diseases are related to common modifiable risk factors, such as smoking, stress and depression, alcohol, obesity, diabetes, metabolic syndrome, osteoporosis, behavioral factors, among others. Currently, there is significant evidence that smoking and diabetes are major factors not only to the development of periodontal diseases, but also to the severity and progression of diseases. The inflammatory profile common to the conditions seems to be the main factor of synergism, being responsible for the overlap of the risks.

**Non-Modifiable Risk Factors for Periodontal Diseases**

Non-modifiable risk factors, such as age, sex and ethnicity are involved in the prevalence and severity of periodontal disease. Periodontal diseases are not universal because there is a variation of existence and severity within the population that presents susceptibility. The risk of illness is dynamic and changes in response to complex interactions of different characteristics. Understanding the risk factors is essential for clinical practice; therefore, identifying these factors helps guiding the patients for the prevention and treatment.

Literature points the age of the individual as an important factor in the prevalence and severity of periodontal diseases. Adults present a higher prevalence of the disease when compared to younger populations; however, there is no definitive response to this relation, if there is an individual effect on the existence of periodontal diseases or it is a consequence of the cumulative characteristics of the disease. When we consider the sex factor, we observed a greater distribution of the disease among men in relation to women. The reasons for this difference between sexes is not well explained, but it can be attributed to hygiene care and other habits such as smoking. When the prevalence of periodontal diseases is assessed in relation to different ethnic groups a discrepancy among different results is observed, creating a difficulty to establish a causal relationship between the factors with certainty. There is possibility of genetic variations affecting this correlation. Additionally, other risk factors may affect
periodontal diseases among populations.\textsuperscript{17,22}

Additionally, some authors also point to other risk factors for periodontal diseases, such as socioeconomic status, educational level and genetic factors.\textsuperscript{2,17} Data from the studies indicate that the socioeconomic status and the educational level seem to relate to the presence of periodontal diseases; periodontal tissues from people in higher economic and educational levels present better health.\textsuperscript{2,23} Current studies have shown an increased risk of periodontal diseases with variations in the genes related to inflammatory response. A study indicates that genetic polymorphisms of inflammatory factors may influence the development or progression of periodontal diseases.\textsuperscript{24} Furthermore, genetic risk factors are associated with the presence and severity of the disease, as the risk of periodontal diseases seems to be consistent with elements of heritable susceptibility.

**Functional Overreaching**

The increase in the intensity and amount of training is usually performed to enhance physical performance. The intensified training may result in a decline in performance; however, if adequate recovery periods are provided, an effect of overcompensation may occur, resulting in an improvement in performance when compared to the initial values.\textsuperscript{10-12} Based on the principles of sports training, F-OR can be understood as the accumulation of training stress and other factors that result in a temporary decrease of the performance levels. This state of low performance levels can last from a few days to two weeks and a process of overcompensation occurs after this.\textsuperscript{10} The mechanisms that involve the emergence of overreaching are diverse and depend on the relation between training and an adequate recovery period, besides the existence or control of other additional stress factors.\textsuperscript{25,26}

F-OR is often intentionally promoted by periods of intense training with the objective of stimulating a temporary decrease of performance levels followed by an induced overcompensation of performance. However, evidences supporting a maximized training response after F-OR are not fully clarified yet.\textsuperscript{27} Lack of appropriate control of the F-OR stage may result in a stagnation or decline in performance, increasing the duration of the physical recovery period and inducing NF-OR. Additionally, biochemical, immunological and physiological alterations may be presented by the athlete, with the possibility of developing other health problems.\textsuperscript{28}

**Non-Functional Overreaching**

The development of NF-OR is related to the persistence of the period of intense training. Increased levels of performance drop associated to psychological and hormonal disorders, mood changes, weight loss and sleep disorders can be observed in this condition, and the recovery may happen within a few weeks or months.\textsuperscript{29} The effectiveness of the physical training depends on physiological factors and parameters of the athletes, on the workload and on the individual susceptibility to tolerate fatigue. Depending on the workload applied, different responses to training can be induced.\textsuperscript{29} The excessive physical stress imposed by training can result in an inflammation powerful enough to induce subsequent responses, such as those involving the catabolic processes.

Infections and respiratory diseases are complaints that affect the athletes, and the occurrence of these diseases is particularly high during periods of intense training or competition. Exercise triggers the simultaneous increase of antagonistic inflammatory mediators. Disorders in the production profile of cytokines and defense cells may occur as a response to NF-OR, increasing the susceptibility to an infection.\textsuperscript{11} The intensity and the amount of training during NF-OR may be responsible for changes in the immune function, such as the change in the phagocytic activity of defense cells, reduced production of immunoglobulin A and increased oxidative stress.\textsuperscript{29} The NF-OR state can lead to OTS which presents more diffuse characteristics, negatively affecting multiple systems and having a much slower recovery process.

**Overtraining**

OTS can be characterized as a neuroendocrine disorder that occurs in the hypothalamic-pituitary axis due to the imbalance between the intensity of the exercise performed and the responsiveness of the system. Significant reduction of physical performance accompanied by very important physiological, psychological and biochemical changes occur during this condition.\textsuperscript{11} OTS can also be associated to situations of systemic inflammation and subsequent effects on the central nervous system, including mood swings and central fatigue. The recovery of the athlete in OTS is slower and can take weeks or months.\textsuperscript{10}

OTS can be classified into two categories. The sympathetic form is characterized by the increase in activity of the sympathetic nervous system, which causes basic changes of the body functions and facilitates the motor response to acute stress or physical activity. It can be influenced by the emotional state of the athlete and by factors not related to training. The parasympathetic form is characterized by the predominance of the parasympathetic tone during rest and exercise, and it is observed more frequently in endurance athletes.\textsuperscript{30-32} The capacity of adaptation, physiological characteristics, the volume of the intense training and the total amount of internal and external stress factors will determine the greater vulnerability of some athletes to develop OTS.\textsuperscript{10}
Discussion

Overreaching as a Risk Factor for Periodontal Diseases

Periodontal diseases are common oral diseases worldwide and are an important public health concern because of the substantial treatment cost. They are characterized by the inflammation and destruction of the tissues of teeth support, being the main cause of tooth loss. Periodontal diseases present infectious and inflammatory characteristics, as they are subject to the variations and modulations of the immune system as well as conditions that can modify the response of the defense of the body. The immune response plays an important role in the pathogenesis of various diseases and their systemic complications, in addition to specific functions during physiologic conditions. Despite its infectious etiology, the destruction of periodontal tissues is a consequence end of the immune response of the host.

Different physiologic conditions can modulate the degree of systemic immune response by controlling the production profile of defense cells and immunological mediators, who work at the interface of inflammatory processes, such as those that occur in periodontal diseases. The regulation of the expression of enzymes and proteins that act on periodontal inflammatory response is well established, as well as the stimulation, migration and stoppage of immune cells, exacerbation and resolution of the inflammatory responses by complement processing, cytokines and other bioactive molecules. Exercise can have positive and negative effects on immune function and susceptibility to diseases. Physical activity of moderate to high intensity can cause immune changes, being responsible for a transient immunodepression commonly observed after acute and chronic or exhaustive exercise.

Both the number and the functional capacity of the defense cells can be lessened by repeated episodes of intense exercise, such as during NF-OR. The reason probably is related to increased levels of stress hormones during exercise. Additionally, the concentration of glucotamine is important for the function of certain cells of the immune system, it has also been suggested as a possible cause of immunodepression associated to intense training. Also, during exercise, an increase in the production of reactive oxygen species can happen and some cellular functions can be impaired by an excess of free radicals. Reduced levels of immunoglobulin and salivary antimicrobial proteins can also be found during overreaching.

Immune cell functions are temporarily impaired following acute episodes of intense or continuous exercise, and athletes involved in this type of training seem to be more susceptible to infections; in addition, there seems to be a difference in the prevalence of these diseases in athletes, taking more time for recovery. This is important for the athlete patient, because even minor infections can result in drops of exercise performance and capability to sustain the intensity of practices. The physiological conditions that involve overreaching feature a median temporal characteristic, and sometimes it limits the natural evolution of some diseases. However, the high prevalence of periodontal diseases in this population must be considered; an episode of major evolution of diseases and risk of acute conditions related to periodontal diseases can occur under these conditions.

Conclusion

The physiological condition caused by the physical stress from intense training, such as those involving overreaching, may be responsible for changes in the immune system of an athlete. In these situations, diseases that present a common inflammatory profile may suffer additional modulations because of this process, leaving these individuals under a higher risk. Considering this biological plausibility between the two conditions as possible, further research for the clarification of this relation is important, since there is little literature about it.

References


Mini Curriculum
1. Bárbara Capitanio de Souza – DDS and MSc.