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Evaluation of salivary pH behavior in athletes and its relationship with periodontal disease - a pilot study

Avaliação do comportamento do pH salivar em atletas e sua relação com a doença periodontal – um estudo piloto

Evaluación del comportamiento del pH salival en atletas y su relación con la enfermedad periodontal – un estudio piloto

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Abstract
An athlete needs to have their overall health in optimal condition to compete at the highest level, and oral health is essential for such condition. It is known that periodontal disease is highly prevalent in the population, and acidic salivary pH directly influences oral health conditions, potentially leading to various oral problems. This study aimed to assess the behavior of salivary pH in athletes with active periodontal disease and after its remission. The selected volunteers with periodontal disease underwent oral hygiene instruction and basic periodontal therapy and were reevaluated after 30 days. Periodontal markers were used through Basic Periodontal Examination to determine the presence and progression/regression of periodontal disease. Saliva samples were also collected at the initial appointment and during the follow-up visits for salivary pH comparison. The results showed initial oral acidity that moved towards neutrality after treatment. The Friedman test (analysis of variance for repeated measures by ranking) was used. The non-parametric test for differences between repeated measures yielded a Chi-Square value of 16.647, considered statistically significant ($p < 0.001$). The presente study concludes that periodontal disease in high-performance athletes influences salivary pH behavior.
Keywords: Athletes; pH; Periodontal disease; Sports; Saliva.

Resumo
Um atleta precisa estar com sua saúde geral em ótimas condições para competir no mais alto nível e a saúde oral é essencial para tal condição. Sabe-se que a doença periodontal é altamente prevalente na população, bem como um pH salivar ácido influi diretamente nas condições de saúde bucal, podendo acarretar diversos problemas orais. Este trabalho teve como objetivo verificar o comportamento do pH salivar em atletas com doença periodontal ativa e após

sua remissão. Os voluntários selecionados com Doença Periodontal, foram submetidos a instrução de higiene oral e terapia periodontal básica e reavaliados após 30 dias. Os parâmetros utilizados foram marcadores periodontais através de Exame Periodontal Básico para determinar a presença e a progressão/regressão da doença periodontal. Também foram coletadas amostras de saliva na consulta inicial e nos retornos de reavaliação, para comparação de pH salivar. Os resultados mostraram uma acidez bucal na consulta inicial, mas que caminhou em direção a neutralidade após o tratamento. Foi utilizado o teste de Friedman (Análise de variância de medidas repetidas, por ranqueamento). O teste não-paramétrico de diferenças entre medidas repetidas foi conduzido em que se obteve um valor de Qui-Quadrado de 16.647, considerado estatisticamente significante ($p < 0,001$). O presente estudo conclui que a Doença Periodontal em atletas de alta performance influi no comportamento do pH da saliva.
Palavras-chave: Atletas; pH; Doença periodontal; Esporte; Saliva.

Resumen
Un atleta necesita tener su salud general en condiciones óptimas para competir al más alto nivel, y la salud oral es esencial para tal condición. Se sabe que la enfermedad periodontal es altamente prevalente en la población, y un pH salival ácido influye directamente en las condiciones de salud bucal, lo que puede ocasionar diversos problemas bucales. Este estudio tuvo como objetivo verificar el comportamiento del pH salival en atletas con enfermedad periodontal activa y después de su remisión. Los voluntarios seleccionados con enfermedad periodontal fueron sometidos a instrucción de higiene oral y terapia periodontal básica y fueron reevaluados después de 30 días. Se utilizaron marcadores periodontales a través del Examen Periodontal Básico para determinar la presencia y la progresión/regresión de la enfermedad periodontal. También se recolectaron muestras de saliva en la consulta inicial y en las visitas de seguimiento para comparar el pH salival. Los resultados mostraron acidez oral en la consulta inicial, pero que se dirigió hacia la neutralidad después del tratamiento. Se utilizó la prueba de Friedman (análisis de varianza para medidas repetidas por clasificación). La prueba no paramétrica para diferencias entre medidas repetidas arrojó un valor de Chi-Cuadrado de 16.647, considerado estadísticamente significativo ($p < 0,001$). El presente estudio concluye que la enfermedad periodontal en atletas de alto rendimiento influye en el comportamiento del pH salival.
Palabras clave: Atletas; pH; Enfermedad periodontal; Deporte; Saliva.

1. Introduction

An athlete is expected to be in excellent health condition. To compete at the highest level, athletes need to be well-prepared, fit, and healthy, and oral health is crucial for overall health and well-being. Previous studies have indicated an association between oral health problems and negative impacts on performance in elite athletes (Gallagher et al., 2018).

Oral health is directly linked to the oral pH level, where a more acidic pH indicates poorer oral health quality in individuals (Bretas et al., 2008). An acidic oral pH can lead to compromised dental and supporting structures, mucous membranes, and tongue, and may also affect occlusion, nutrition quality, causing dentin hypersensitivity, non-carious cervical lesions, pain, and impairing concentration and athletic performance in those who suffer from such conditions (Ferradans et al., 2020; Mirim et al., 2016).

Considering that periodontal disease is highly prevalent in the population (Botelho et al., 2021) and is described as an inflammatory disease in the tooth-supporting tissues caused by a group of microorganisms, leading to continuous destruction of the periodontal ligament along with alveolar bone loss, pocket formation, gingival recession, or both (Koppolu et al., 2022), its diagnosis and treatment are essential to maintaining good oral health and, consequently, overall health due to the systemic risks involved (Oliveira et al., 2015; Teixeira et al., 2021).

Although sports are undoubtedly healthy and a positive habit in the lives of young and adult individuals (Pereira et al., 2021), their practice can be considered a risk factor, among athletes from different sports modalities, for the occurrence of oral diseases (Castilho et al., 2022; Maffei et al., 2022; Tripodi et al., 2021). Their occurrence is related to variations involving ecological factors of the oral cavity such as salivary pH, flow rate, buffering capacity, among others (Tripodi et al., 2021).

The knowledge regarding the relationship between physical exercise, periodontal disease, and salivary pH alteration is still limited in the literature. Therefore, the aim of the present study was to evaluate the behavior of salivary pH after the treatment and regression of periodontal disease in athletes.

2. Methodology

This study was submitted to the Research Ethics Committee of the Faculty of Dentistry at the University of São Paulo (FOUSP) and was approved under the number CAEE 56711022.9.0000.0075.

Thirteen athletes and parathletes of both sexes, aged over 18 years, were selected at the Sports Dentistry Specialization Clinic of the Faculty of Dentistry, University of São Paulo (FOUSP). All participants were informed about the details, including the number of sessions, procedures, risks, and discomforts involved. After agreeing to participate in the research, they signed an informed consent form.

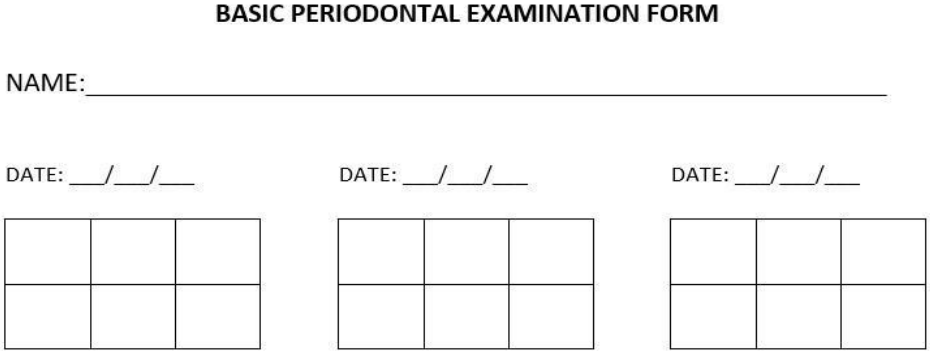
The selected athletes and parathletes participated in various sports modalities, including Rugby, Long Jump, Athletics 100m, 400m, and 1,500m sprints, 400m Hurdles, Wheelchair Moto Cross (WCMX), Blind Soccer and Sitting Volleyball.

The procedures were divided into three stages: 1) Initial Consultation (Pre): During this stage, anamnesis, periodontal clinical examination for participant selection in the study, signing of the informed consent form, and salivary collection were performed. No clinical intervention or oral hygiene instruction was provided during this consultation to avoid interference with the subsequent control consultation and prevent any potential impact on the participant's periodontal health; 2) First Return Consultation (Control): This stage occurred 30 days after the initial consultation. Saliva was collected before any intervention, and oral hygiene instruction and periodontal intervention were carried out, respectively; 3) Second Return Consultation (Post): This stage occurred 30 days after the control consultation. Saliva was collected again, and a new periodontal clinical examination was performed to detect any progression/regression of Periodontal Disease (PD).

The BPE index (Basic Periodontal Examination) (Gallagher et al., 2018; Lindhe et al., 2005; Dietrich et al., 2019) was used in the periodontal examination to diagnose the presence or absence of PD. The BPE index includes the following markers: Score 0 - Periodontal Pocket depth equal to or less than 3mm, no bleeding on probing, and no presence of calculus; Score 1 - Periodontal Pocket depth equal to or less than 3mm, positive bleeding on probing, and no presence of calculus; Score 2 - Periodontal Pocket depth equal to or less than 3mm, positive bleeding on probing, with the presence of supra and/or subgingival calculus; Score 3 - Periodontal Pocket depth between 3 and 5mm, positive bleeding on probing, with the presence of supra and/or subgingival calculus; Score 4 - Periodontal Pocket depth equal to or greater than 6mm, positive bleeding on probing, with the presence of supra and/or subgingival calculus.

In the periodontal chart, only the worst score per evaluated sextant was recorded. Among them, individuals who presented BPE indices different from 0 were selected (see Figure 1).

Figure 1 - Basic Periodontal Examination Form**.**



Source: Authors.

In Figure 1, the basic periodontal examination form is presented, indicating the 3 collection moments. All indices were recorded on their respective dates.

Salivary samples were collected in disposable cups, with the patient fasting for at least 2 hours, between 8 and 9 am in all stages of the study. Patients were asked to dispense saliva into the disposable container, in a stimulated manner, until it reached approximately 5ml.

Oral hygiene instructions were provided meticulously, explaining brushing and flossing techniques, as well as the frequency of performing them. This step is considered extremely important in the treatment, as it allows participants to maintain oral hygiene control for the 30 days following the treatment and, consequently, contribute to the regression of periodontal disease.

The periodontal interventions performed included supra-gingival and sub-gingival scaling, using a Dabi Atlante ultrasonic device and Hu-Friedy Gracey curettes (5-6, 7-8, 11-12, and 13-14).

Salivary pH analysis was conducted using colorimetric strips (Barbosa et al., 2008) from the Merck brand, with a range of 1 to 14, without decimal places. Immediately following the saliva collection, the strip was immersed in the saliva-collecting container, and after complete coloration, the saliva was discarded and the marked pH value was recorded as the final pH for each collection (Figure 2 and Figure 3). All the described steps were performed by a single operator to avoid calibration biases between evaluators that could influence the results.

Figure 2 - Colorimetric strip immersed.

Source: Authors.

In Figure 2, the colorimetric strip can be observed immersed in a saliva sample collected in a disposable container. Within a few seconds, the color corresponding to their respective pH levels could be observed.

Figure 3 - Colorimetric strips (Merck) and their corresponding color graduations.

Source: Authors.

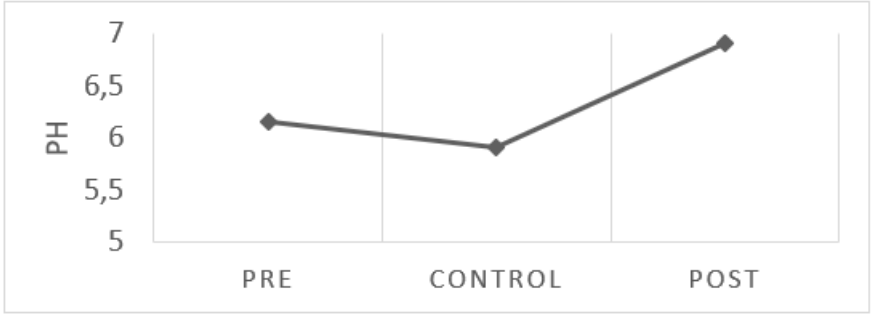
In Figure 3, there is an image of colorimetric strips from the Merck brand and their respective color graduations for comparison and pH analysis after collection and immersion in saliva. The strips, after submersion and reaching their final coloration, were compared with the graduations present on the model to determinate the pH value.

3. Results

From the sample of 13 individuals, 1 was lost, resulting in a total of 12 tested individuals. Among the researched athletes, the BPE score ranged from 2 to 3 at the initial consultation, and all regressed to score 0 after treatment, indicating that the performed interventions were sufficient for regression of active periodontal disease. The ages ranged from 22 to 54 years, with a majority being male (n=9) and female (n=3). The average training load was 17.5 hours per week. The average pH at the initial consultation (pre) was 6.15, at the control point 5.91, and post-treatment 6.91.

To test the differences in pH between the 3 time points (pre, control, and post), the Friedman test (Analysis of variance by ranks) was used. The non-parametric test of differences between repeated measures yielded a Chi-Square value of 16.647, which was considered statistically significant ($p < 0.001$). The Tukey post-hoc test used for multiple mean comparisons indicated statistically significant differences in pH between the "post" moment compared to both the "pre" and "control" moments (Figure 4).

Figure 4 - Graph depicting the evolution of salivar pH.



Source: Authors.

In Figure 4, the graph shows the evolution of salivary pH at the evaluated time points. The pre and control indices are very close, reaching a certain level of acidity, unlike the post, which indicates a trend towards pH neutralization.

4. Discussion

This study aimed to assess the behavior of salivary pH associated with the regression of periodontal disease in athletes. The results showed an elevation in salivary pH towards neutrality after the provided periodontal treatment, which aligns with the findings of Ferradans et al. (2020), who demonstrated an association between oral hygiene status and salivary pH in elite athletes. Athletes with poorer oral hygiene had lower salivary pH levels, and due to the repeated sessions of anaerobic metabolism during training, athletes with inadequate oral hygiene may be more susceptible to oral and systemic diseases caused by the formation of oral biofilm. These changes could not only compromise their oral health but also affect their performance.

All the participants in the study had some level of periodontal disease, consistent with the findings of Opazo-García et al. (2021), who reported a high prevalence of periodontal disease in athletes participating in the Lima 2019 Pan American Games.

A positive relationship was observed between acidic salivary pH and training load, where athletes with higher weekly training hours showed higher salivary acidity. Athletes with lower weekly training loads had lower salivary acidity in the presence of periodontal disease and were more likely to achieve neutrality after disease treatment compared to athletes with higher training loads. These results have been observed in previous studies by Mirim et al., (2016), and Ferradans et al., (2020), which demonstrated that high-intensity exercise leads to changes in salivary pH and lactate levels, resulting in decreased pH and increased salivary lactate concentration after exercise. Additionally, the findings suggested that oral hygiene levels may influence salivary pH and lactate responses, with less pronounced responses for those with good oral hygiene compared to those with poor oral hygiene.

No differences in pH behavior were observed based on gender, age, or type of sport practiced. This indicates that regardless of gender, sport type, or age, professional athletes require constant dental monitoring to minimize the chances of physical performance decline, as stated by Araújo et al. (2021); Brancher et al. (2021); Gallagher et al. (2018); Oliveira et al. (2015); Opazo-García et al. (2021).

All participating athletes reported consuming isotonic beverages or dietary supplements at least once a day. Considering that acidic oral pH can lead to tooth erosion and subsequent dentin sensitivity, causing pain and influencing athletic performance, athletes can be considered a high-risk group for such conditions. According to Berard et al., 2021, the consumption of isotonic drinks with flavoring agents, particularly citric acid, can remove calcium from enamel and saliva, reducing the buffering capacity and enhancing dental erosion. Salivary pH around 7 is considered critical, and when it reaches 5.5 or less, enamel demineralization begins. Drinks with a pH below this value potentiate dental erosion, making athletes consuming such sports drinks more susceptible to dental problems. Berard et al., 2020, also showed that acidic drinks adhere differently to dental structures, and a longer exposure time of the drink to the teeth increases the risk of corrosion. The inability of saliva to displace the drink's film formed on the dental surface further reduces its remineralization capacity. Additionally, some dietary supplements widely consumed by athletes may contribute to dental erosion due to the demineralization of hydroxyapatite, resulting in enamel surface loss.

It was also observed that despite the more alkaline composition of dental calculus present in periodontal disease (Patel et al., 2016), gingival inflammation (Koppolu et al., 2022), and the presence of salivary lactate in inadequate oral hygiene (Ferradans et al., 2020) are more influential in salivary acidity. Thus, all methods of neutralizing salivary pH, including oral hygiene and periodontal treatment, should be mandatory for this population.

5. Conclusion

In conclusion, periodontal disease in high-performance athletes can influence salivary pH behavior. In the presence of periodontal disease, higher salivary acidity was observed, and with its regression achieved through oral hygiene guidance, biofilm control, and basic periodontal treatment, salivary pH returned to neutral levels.

As a final note, since this study is a pilot study, it is believed that further research in this area should be designed and conducted to explore salivary pH behavior concerning periodontal disease and its possible association with salivary lactate or sports drinks.

Potential conflict of interest

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

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