Prevalence of barodontalgia in military pilots of the Brazilian Air Force

Prevalência de barodontalgia em pilotos militares da Força Aérea Brasileira

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ABSTRACT
Introduction: Barodontalgia refers to the painful condition affecting previously asymptomatic teeth and periodontal tissues, caused by changes in atmospheric pressure during flight. This study aimed to evaluate the prevalence of barodontalgia in Brazilian Air Force (FAB) pilots. Materials and Methods: An exploratory study was carried out, with a convenience sample, made up of military pilots, regardless of age group and type of aircraft, using a structured questionnaire and descriptive analysis of the data. Results: 141 pilots
participated; men; 37.3 ± 3.6 years; 40.6% were transport pilots, 14.1% fighter, 9.4% rotary wing, and 35.8% Instruction/Demonstration. The prevalence of barodontalgia was 12.8% (18 occurrences). Three missions were interrupted. Regarding knowledge of barodontalgia, 56 (39.7%) reported regular knowledge and 21 (15%) declared they had no knowledge on the subject. Conclusions: It is concluded that the prevalence of barodontalgia in Brazilian military pilots is higher than the values reported by some air forces of developed countries, already indicating the need for a more in-depth look at the oral health of FAB military personnel.

Keywords: barotrauma, atmospheric pressure, toothache, oral health.

RESUMO
Introdução: Barodontalgia refere-se à condição dolorosa que afeta dentes e tecidos periodontais previamente assintomáticos, causada por alterações na pressão atmosférica durante o voo. Este estudo teve como objetivo avaliar a prevalência de barodontalgia em pilotos da Força Aérea Brasileira (FAB). Materiais e Métodos: Foi realizado um estudo exploratório, com amostra de conveniência, composta por pilotos militares, independente da faixa etária e tipo de aeronave, utilizando questionário estruturado e análise descritiva dos dados. Resultados: Participaram 141 pilotos; homens; 37,3±3,6 anos; 40,6% eram pilotos de transporte, 14,1% de caça, 9,4% de asa rotativa e 35,8% de Instrução/Demonstração. A prevalência de barodontalgia foi de 12,8% (18 ocorrências). Três missões foram interrompidas. Quanto ao conhecimento sobre barodontalgia, 56 (39,7%) relataram conhecimento regular e 21 (15%) declararam não ter conhecimento sobre o assunto. Conclusões: Conclui-se que a prevalência de barodontalgia em pilotos militares brasileiros é superior aos valores relatados por algumas forças aéreas de países desenvolvidos, já indicando a necessidade de um olhar mais aprofundado sobre a saúde bucal dos militares da FAB.

Palavras-chave: barotrauma, pressão atmosférica, dor de dente, saúde bucal.

RESUMEN
Introducción: La barodontalgia se refiere a una condición dolorosa que afecta dientes y tejidos periodontales previamente asintomáticos, causada por cambios en la presión atmosférica durante el vuelo. Este estudio tuvo como objetivo evaluar la prevalencia de barodontalgia en pilotos de la Fuerza Aérea Brasileña (FAB). Materiales y Métodos: Se realizó un estudio exploratorio, con una muestra por conveniencia, compuesta por pilotos militares, independientemente de grupo de edad y tipo de aeronave, mediante un cuestionario estructurado y análisis de datos descriptivos. Resultados: Participaron 141 pilotos; hombres; 37,3±3,6 años; El 40,6% eran pilotos de transporte, el 14,1% de caza, el 9,4% de alas giratorias y el 35,8% de instrucción/demostración. La prevalencia de barodontalgia fue del 12,8% (18 ocurrencias). Tres misiones fueron interrumpidas. En cuanto al conocimiento sobre barodontalgia, 56 (39,7%) reportaron conocimiento regular y 21 (15%) declararon no tener conocimiento
sobre el tema. Conclusiones: Se concluye que la prevalencia de barodontalgia en pilotos militares brasileños es superior a los valores reportados por algunas fuerzas aéreas en países desarrollados, indicando ya la necesidad de una mirada más profunda a la salud bucal del personal militar de la FAB.

**Palabras clave:** barotrauma, presión atmosférica, dolor de muelas, salud bucal.

1 INTRODUCTION

Currently, there is a progressive increase in the number of commercial aviation flights, transporting more passengers and crew, with a consequent increase in the occurrence of diseases related to this type of transport (de Oliveira et al., 2023).

Military pilots are also subject to injuries during flights, with risks to organs and systems, making them considered a different class of individuals (Baldini et al., 2013).

Commercial flights expose people to small variations in atmospheric pressure but for relatively long periods. Military pilots of high-performance aircraft face rapid changes in pressure and intense acceleration forces and, among the problems they are subject to, is the occurrence of barodontalgia.

Barodontalgia can be defined as acute pain in a previously asymptomatic dental element, caused by changes in atmospheric pressure (Zadik, 2009b). During aerial activities or diving, the dental pulp may not be able to adapt to pressure variations, which, in combination with other factors, can result in intense pain, capable of leading to loss of consciousness (al Khawalde et al., 2016).

The diagnostic classification for barodontalgia, proposed by Ferjentsik and Aker (Ferjentsik; Aker, 1982), is based on the main complaint and symptoms presented by the patient, including the type of pain, together with clinical and radiographic findings, such as cavities and deep or inadequate restorations. These elements indicate a pre-existing subclinical pathology, and it is crucial to identify it before starting the appropriate and, consequently, effective treatment for the case.
Most of the knowledge about barodontalgia was acquired from studies with pilots and military crews in the 1940s (Zadik, 2009a). In military environments, activities can take place in extreme conditions, encompassing physical, physiological and emotional challenges. Military pilots in particular are constantly subjected to situations that can generate intense physical and psychological stress. These situations include abrupt temperature changes, variations in atmospheric pressure and the need to withstand, during aerial maneuvers, rates of gravitational force (G force) equivalent to nine times the force of gravity (Morais, 2022).

These circumstances can result in acute and unexpected dental discomfort, triggered by a variety of dental conditions and inappropriate dental procedures, leading to an experience where the pain can be unbearable.

During flight, barodontalgia typically occurs at altitudes greater than 3,000 feet, affecting approximately 11% of aircrew (Kollmann, 1993) with an occurrence rate of five episodes per 1,000 flight hours per year in military pilots (Zadik, 2010). The weighted incidence of barodontalgia during flight is similar to the incidence reported in the first half of the 20th century (9.5%), despite the decrease in atmospheric compression inside cabins, the high quality of dental care and advances in oral health in the second half of that century (Zadik, 2010).

The constant increase in speed and altitude reached by military aircraft means that pilots are subject to rapid pressure changes and intense acceleration forces (Stoetzer et al., 2012), contributing to the increased incidence of barodontalgia. The pain can appear both during takeoff and during landing, and may or may not persist after these events and, in some situations, cause premature interruption of the flight (Cruz et al., 2016).

Modern aircraft, such as the recently acquired F-39 Gripen by the Brazilian Air Force (FAB), which reach altitudes of 16,000 meters and speeds of 2,400 kilometers per hour, require maximum levels of attention and cognition from pilots. Therefore, an episode of barodontalgia on an aircraft of this size can compromise human-machine interaction and lead to errors and fatal accidents.
Despite advances in dentistry over the last 60 years, information about the occurrence and treatment of barodontalgia is still scarce. There are few studies in the specialized literature that report the frequency of this condition in pilots and military crews (Marceliano-Alves et al., 2012). In the context of Brazilian military pilots, to date, there are no studies that have investigated this issue.

Knowing the prevalence of barodontalgia among military pilots will make it possible to improve oral health services, through the adoption of preventive measures to ensure efficient and safe operational health. This is especially important given that they are professionals who face intense operational demands.

Given the above, this work aimed to verify the prevalence of barodontalgia in FAB pilots and compare the results with specialized literature.

2 METHODOLOGY

Exploratory, descriptive, and observational study, with pilots who were attending the Aeronautical Command and General Staff School (ECEMAR), regardless of age group, type of aircraft flown and squadron of affiliation.

Participation was voluntary, by signing an Informed Consent Form (ICF).

Data were collected through the application of a structured questionnaire, prepared by the researchers, with questions designed to characterize the sample such as gender, age, experience as a pilot (in years), squadron affiliation and military rank. Additionally, the questionnaire included questions about the occurrence of barodontalgia, the type of aircraft flown during this phenomenon, the possible need to interrupt the mission, the type of aerial activity carried out at the time of occurrence of barodontalgia and the military’s level of knowledge on the subject.

The content of the questions in the aforementioned instrument was planned to preserve the pilots’ anonymity as much as possible, thus ensuring the greatest possible veracity of the information provided.
The data were stored in Excel spreadsheets for later descriptive analysis of the data.

The research was approved by the Human Research Ethics Committee of the Hospital de Força Aérea do Galeão – HFAG (CAAE 03425518.9.0000.5250; N. 6.144.211), strictly observing the precepts of the Declaration of Helsinki ("World Medical Association Declaration of Helsinki", 2013).

3 RESULTS

A total of 141 pilots participated in the study, all male, with an average age of 37.3 ± 3.6 years (ranging between 32 and 45 years). Experience as a pilot ranged from 10 to 27 years, with an average of 17.7 ± 4.0 years. Regarding military rank, 73 (51.8%) were captains, 35 (24.8%) were majors and 33 (23.4%) were lieutenant colonels.

Among the 106 pilots who identified their squadrons, 43 (40.6%) belonged to transport squadrons, 15 (14.2%) fighter squadrons, 10 (9.4%) rotary-wing squadrons, and 38 (35.8%) instruction/demonstration/aircraft defense squadrons.

The prevalence of barodontalgia was 12.8%, with 18 occurrences. Of these, three (16.7%) caused the mission to be interrupted. The aircraft piloted, when the flight was interrupted, were fighter, transport, and helicopter.

The occurrences of barodontalgia occurred in the following aerial missions: Air Superiority – carried out basically by fighters, with four occurrences (22.2%); Combat Support – (search and rescue; logistical transport), carried out by cargo and transport aircraft, with six occurrences (33.3%); Other Missions (air instruction and special transport), with eight occurrences (44.5%).

Among the pilots who reported the problem, 16 (88.9%) sought dental treatment.

Regarding the level of knowledge about barodontalgia, two subjects (1.4%) mentioned having excellent knowledge; 36 (25.5%) stated they had good knowledge; 56 (39.7%) reported regular knowledge and 21 (15%) declared they
did not know the subject. Non-respondents totaled 26 participants (18.4%). Of the three pilots who interrupted flights, the fighter pilot reported good knowledge, and the regular helicopter and the transport pilot reported no knowledge of the subject.

4 DISCUSSION

The prevalence of barodontalgia among Brazilian military pilots was 12.8%, a value higher than that reported in some studies conducted in developed countries.

In research involving French military pilots, the rate of this condition was just 6.6% (Laval-Meunier et al., 2013). Similarly Zadik et al. (Zadik; Chapnik; Goldstein, 2007) observed barodontalgia experience values in Israeli pilots that ranged from 7%, 8% and 9%. Gonzalez Santiago et al. (Gonzalez Santiago; Martinez-Sahuquillo Marquez; Bullón-Fernández, 2004) mentioned a prevalence of 2.63% among Spanish military airmen, but highlighted that this number is probably lower than the real one, as some pilots choose not to report “minor barotraumatic accidents” to prevent their careers from being compromised. In this sense, the prevalence reported in studies may be underestimated, due to these professionals' fear of being removed from flying, as piloting hours are important requirements for functional progression.

However, similar and higher prevalence rates were found than those of the present study. Al Khawalde et al. (Al Khawalde et al., 2016), in a study with 305 pilots from the Jordanian Air Force, found that 10.49% of the sample experienced barodontalgia at least once during their flight activities, and Rai et al. (Rai et al., 2010) obtained 20.6% occurrences of barodontalgia among 304 Indian military pilots. Al-Hajri and Almadi (Al-Hajri; Almadi, 2006) observed that 49.6% of military pilots, in a sample of 135 individuals from Saudi Arabia and Kuwait, reported positive responses about barodontalgia. High prevalence was also observed in the study conducted by Topbas et al. (Topbaş et al., 2024) who, analyzing 526 pilots from Turkey, found a total prevalence of barodontalgia of 55%, considering
both civilian and military pilots. Specifically among military pilots, the prevalence was even higher, reaching 71%, with 181 of the 255 pilots assessed being affected.

Discrepancies in the prevalence rates of barodontalgia were also documented in the review conducted by Zadik (Zadik, 2010) who gathered data from several air forces, including Spain, Saudi Arabia, Kuwait, Israel and Turkey. The differences in the reported prevalence of barodontalgia are considerable and can be attributed to relatively small sample groups, variations in the oral health conditions of participants from each country, as well as frequency and exposure to extreme flight conditions, such as rapid maneuvers with sudden changes in pressure.

Therefore, such variations in barodontalgia prevalence values can be explained by numerous factors related to the context of each country, including specific flight conditions, cultural differences in oral hygiene habits and dietary patterns, as well as socioeconomic disparities that impact access to health services, dental care, and the oral health of the population. Regarding this last aspect, among the factors attributed to the improvement of the oral health conditions of a population are the fluoridation of the water supply, the incorporation of fluoride in toothpaste, the expansion of access to preventive practices, the improvement of human development indicators and the implementation of national policies aimed at oral health (Corassa et al., 2022). Furthermore, the way an individual perceives their oral health can be influenced by a variety of factors, both subjective and objective. These include your beliefs, sociodemographic profile, aesthetic and professional needs, as well as your personal experiences with oral problems, such as pain, tooth loss and chewing difficulties (Bidinotto et al., 2017).

As mentioned, the increase in the number of passengers, crew and pilots is accompanied by a growing concern about health risks during flights, particularly dental problems such as barodontalgia. Therefore, dentists must be fully informed about these conditions, as they play a fundamental role in preventing these problems. These professionals can reduce the risk of complications during the
flight by educating patients about necessary precautions and emphasizing the importance of maintaining good oral health.

Therefore, military dentists must be up to date on the subject to provide airmen with the best dental treatment possible and make them aware of the dangers associated with dental problems at higher altitudes.

However, it is worrying to note the lack of knowledge about Aeronautical Dentistry among postgraduate students and dental professionals, as evidenced by a study carried out by Shetty et al. (Shetty et al., 2020). In a sample of 170 participants from a private dental clinic, it was found that 61.8% were not familiar with the term “aviation dentistry”.

Therefore, the occurrence of barodontalgia is probably influenced by the intersection of population and individual characteristics and the dental services offered in each country, each contributing a different weight to the problem.

Pilots' knowledge of the problem also plays an important role in preventing barodontalgia from occurring during a flight. In the present study, it was found that 54.7% of participants (77 individuals) mentioned having regular knowledge or no knowledge of this subject. This data is relevant because when pilots are aware of the problem and its implications, they can implement effective individual prophylactic measures. However, in the study by Topbas et al. (Topbaş et al., 2024), it was observed that pilots who had barodontalgia had greater knowledge about the condition and made more frequent visits to the dentist. The authors suggest that pilots with poorer oral hygiene may have been more affected by toothache during the flight, resulting in greater awareness about barodontalgia. On the other hand, those who did not experience such a problem mentioned having less knowledge and fewer visits to the dentist, which probably indicates better oral hygiene.

Thus, it can be inferred that experiencing the problem, added to the knowledge about barodontalgia acquired during dental consultations, can serve as a protective factor against future events of this condition. It is worth noting that the present study did not aim to estimate the extent to which this knowledge influenced the reported occurrences.
Although rare, barodontalgia is recognized as a potential cause of vertigo and sudden disability in air travelers, representing a serious risk to the safety of flight operations (Aggarwal et al., 2023). The studies analyzed demonstrated that pain can appear at altitudes ranging from three thousand to twenty-five thousand feet and may disappear during the descent or persist for three days or more afterward, as reported in research involving Spanish military pilots (Gonzalez Santiago; Martinez-Sahuquillo Marquez; Bullón-Fernández, 2004). The authors highlight that the altitude at which pain begins and ends may vary, making it impossible to establish a pattern for this condition. Furthermore, they observed that, in eight of the thirteen cases, the pain did not disappear after landing, indicating that the dental pulp was irreversibly affected and that, even after the onset of pain due to altitude, the pathological process continued to develop despite normal pressure conditions.

In general terms, the literature reports the occurrence of barodontalgia varying between 0.7% and 2% in the 1940s and 0.3% in the 1960s (Sahu et al., 2020). Despite the relatively low prevalence, in the Second World War it was the fifth most common physiological disorder reported by American pilots during the flight, and the third main cause of early landings (Bayar et al., 2023).

It is important to highlight that a distinction must be made between real flight conditions and simulations in altitude chambers, since barodontalgia is more prevalent in the first situation (Laval-Meunier et al., 2013). Studies in hypobaric chambers, carried out in the sixties, revealed rates between 0.23% and 0.3% in US Air Force cadets, and 0.26% in tests carried out in Germany in the eighties (Bayar et al., 2023).

Another important aspect refers to the type of aircraft flown when the problem occurred. No significant differences were found in the incidences of barodontalgia among Israeli pilots operating helicopters, semi-compressed fighter aircraft and compressed transport aircraft (8%, 9% and 7%, respectively), suggesting that aircraft type does not exert a relevant influence on the prevalence of the condition (Zadik; Chapnik; Goldstein, 2007). Differently, prevalence rates of barodontalgia were observed to be more common in pressurized aircraft (such
as fighters and transports), compared to non-pressurized ones (such as helicopters), with 7.3% and 3.2%, respectively. This is because the standard pressure inside the cabin of a fighter aircraft is compatible with significantly higher altitudes (8,000 to 18,000 feet or 2,438 to 5,486 meters), a value much higher than the pressure found in non-pressurized aircraft in routine use (Nakdimon; Zadik, 2019). In our study, the occurrence of the problem seemed to be distributed evenly among the types of aircraft if we consider the air missions “Air superiority” and “Combat support” as being carried out by pressurized aircraft and “Other missions” with a predominance of unpressurized aircraft. These different findings highlight the importance of also considering the type of aircraft and its pressurization characteristics when assessing the risk of barodontalgia in pilots.

Some studies have researched the occurrence of barodontalgia in military crews, providing valuable insights into the prevalence and factors associated with this condition. For example, research conducted by Zadik et al. (Zadik; Chapnik; Goldstein, 2007) analyzed 331 Israeli Air Force crew members, of which 27 (8.2%) reported at least one barodontalgia event. This study highlighted that the incidence of barodontalgia was similar among fighter (6.5%), transport (6.6%) and helicopter (8.6%) crew. Another study, conducted by Sipahi et al. (Sipahi et al., 2007) investigated flight crews from four air bases of the Turkish Air Force between 2002 and 2006. A prevalence of barodontalgia of 0.3% was reported, noting that these professionals were exposed to this condition in three out of every 1,000 military flights. A systematic review conducted by Nakdimon and Zadik 26, to verify the rate of barodontalgia in military and civilian divers and air crews, revealed rates of 5.4% of this disorder in military crew members. Although our study population was only pilots, considering the occurrence of barodontalgia in military crews is also important, as their members can also be affected, which can also lead to flight interruption.

Barodontalgia is associated with a variety of factors. Although the pressure gradient is an important contributing factor to its occurrence, it is essential to identify other aspects to properly diagnose this condition. According to Zadik (Zadik, 2010), the diagnosis of barodontalgia requires the presence of
pathologies in the oral tissues or paranasal sinuses. Furthermore, behavioral aspects, such as bruxism, can play an important role in this context. This highlights the importance of collaboration between trained professionals, such as dentists and doctors, who have the necessary knowledge to detect these aspects.

Another relevant fact that deserves to be highlighted is that research that uses questionnaires and requires the identification of the soldier can lead to underestimated results. This is due to military pilots' fear of reporting health problems that could result in their removal from flight schedules. If this happens, a pilot may remain for an indefinite period without performing his main function, in addition to being obliged to carry out actions that lead to the resolution of the problem encountered (Nakdimon; Zadik, 2019).

This study presents some limitations related to information collection, which may have compromised the accuracy and reliability of the data obtained. One of these limitations refers to the use of a single instrument, in this case, an unvalidated questionnaire. Reading the articles showed that each researcher prepared their questionnaire, according to specific interests, as no mention of a validated questionnaire to investigate barodontalgia was found in the literature. Therefore, information about the validity and repeatability of these instruments cannot be discussed. Despite important advantages, such as low cost and speed in obtaining data, questionnaires are subjective methods and, therefore, more susceptible to errors.

Furthermore, there is the issue of pilots' reluctance to reveal health problems due to fear of being removed from flying. Regardless of the quality of the data collection instrument and the efforts to establish an environment of reliability to encourage sincerity in responses, it must be considered that the respondent processes a set of knowledge and prejudices about the study (and the researcher), organizing their answers as they see fit. It is also important to consider information-hiding strategies on the part of the respondent, who may consider certain information as threatening or disqualifying for themselves or the group (Almeida; Prandini, 2002) resulting in underreporting of barodontalgia cases. In the study by Topbas et al. (Topbaş et al., 2024), a questionnaire was
sent via email to the pilots. Probably, the high prevalence of barodontalgia found may have resulted from the feeling of privacy offered by this form of data collection, as the researcher is not present, allowing for more honest answers.

Furthermore, the fact that it is a convenience sample, made up only of pilots who were taking a command course, may introduce sampling bias, limiting the generalization of the results to the population of Brazilian pilots in general.

Despite the difficulties mentioned, it is important to highlight some strengths of this research. Firstly, the pioneering nature of the study stands out, being the first to investigate the prevalence of barodontalgia in Brazilian military pilots. Given the lack of information about this phenomenon among FAB pilots, this exploratory research was crucial to expand knowledge on the subject and provide an initial overview of the problem in the institution. Furthermore, by better understanding the research object, the results will serve to guide future, more detailed, prospective research, in addition to involving a greater number of pilots aiming at the external validity of the research.

The prevalence found also indicates the need for a closer look at the oral health of military personnel, showing the importance of implementing more effective preventive measures through the FAB health system.

From a knowledge point of view, this research meets the interests and strategic needs of the institution, based on the premises of national defense, and also to a segment of the academic community that researches and produces intellectually for a specific segment: the military environment interested in performance biopsychosocial of the military combatant.

Finally, it is important to mention that, in the context of military operations, the presence of barodontalgia can lead to significant costs due to the interruption of ongoing operations, as verified in this study. This implies a waste of direct and indirect resources, and also a negative impact on military reputation. In mission execution or actual combat situations, this interruption can have important implications, including the loss of tactical advantage, compromising the success of the operation and fatal accidents.
5 CONCLUSION

It is concluded that the prevalence of barodontalgia in Brazilian military pilots is higher than the values reported by the air forces of some developed countries.

This highlights the need for special attention from health services, focusing on implementing appropriate preventive and support measures. Such measures are essential to ensure the operational health and effective performance of air missions.
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