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Relationship between cervical posture and class III malocclusion: a literature review

Relationship between cervical posture and class III malocclusion: A Literature Review

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Palabras claves:
maloclusión de clase III, posición de las vértebras cervicales, postura cervical, diagnóstico ortodóncico, tratamiento.

Resumen

Introducción: la maloclusión de clase III es una deformidad maxilomandibular que tiene gran relevancia en el área de ortodoncia debido a su impacto en la función y estética del paciente. **Objetivo**: investigar la relación entre la posición de las vértebras cervicales y la maloclusión de clase III, así como su implicación en el diagnóstico y tratamiento. Se realizó una revisión sistemática de la literatura científica utilizando bases de datos especializadas y seleccionando estudios relevantes que abordaran esta relación. El tipo de investigación fue descriptivo y analítico, con un enfoque en la revisión bibliográfica. **Resultados:** Existe asociaciones significativas entre la posición de las vértebras cervicales y la maloclusión de clase III en varios estudios, aunque no se estableció una conexión conclusiva**. Conclusión**: La postura cervical juega un papel relevante en la etiología y manejo de la maloclusión de clase III, subrayando la importancia de una evaluación integral en el enfoque terapéutico de estos pacientes. **Área de estudio general:** Odontología. **Área de estudio específica:** Ortodoncia. **Tipo de estudio:** Artículos originales

Keywords:
Class III malocclusion, position of cervical vertebrae, cervical posture, orthodontic diagnosis, treatment.

Abstract

Introduction:class III malocclusion is a maxillomandibular deformity relevant in orthodontics due to its impact on patient function and aesthetics. Objective: To investigate the relationship between the position of cervical vertebrae and Class III malocclusion and its implication in diagnosis and treatment. A systematic scientific literature review was conducted using specialized databases, selecting relevant studies addressing this relationship. It was a descriptive and analytical research, focusing on a literature review. Results: Significant relationships exist between the position of cervical vertebrae and Class III malocclusion in various studies, although a conclusive connection was not established. Conclusion: Cervical posture plays a relevant role in classifying and managing Class III malocclusion, emphasizing the importance of comprehensive evaluation in the therapeutic approach for these patients.

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Introduction

Skeletal class III malocclusion, a condition characterized by protrusion of the mandible in relation to the upper jaw, has been the subject of constant interest and study in dentistry, particularly orthodontics.(1)As research in the field of oral health progresses, it has become evident that this malocclusion affects both masticatory function and facial aesthetics and is influenced by a series of complex and multifaceted factors.(2)One of these factors, which has gained relevance in the scientific literature in recent decades, is the position of the cervical vertebrae in relation to class III malocclusion.(23).

The relationship between the position of the cervical vertebrae and class III malocclusion has aroused great interest among dentistry and orthodontics professionals, as it could provide clues about fundamental aspects of the etiology, diagnosis and treatment of this condition.(4, 5). Despite abundant research in both fields, the precise connection between cervical vertebral alignment and Class III malocclusion has not yet been conclusively established.(5,6).

Understanding the relationship between cervical vertebral position and Class III malocclusion could not only have important implications for the diagnosis and treatment of this condition, but also for the development of more effective and personalized therapeutic approaches.(7). While the relationship between cervical vertebral position and Class III malocclusion is an evolving area of research, several underlying mechanisms have been proposed that could be involved.(8.9). One of the key factors in this relationship is the influence of head and neck posture on jaw position and dental occlusion.(10,11). Abnormal alignment of the cervical vertebrae can alter the posture of the head, which in turn could affect the position of the jaw.(10, 12).

Furthermore, it has been suggested that alterations in cervical posture may influence the development of the facial and masticatory muscles, which could contribute to Class III malocclusion. Neck muscles such as the sternocleidomastoid and scalenes work in conjunction with masticatory and facial muscles such as the masseter and temporalis to maintain proper jaw function and optimal cervical posture. Any imbalance in the function of these muscles could have a significant impact on the position of the jaw and therefore on malocclusion.(13).

It is important to note that Class III malocclusion is a complex and multifactorial condition that may be the result of the interaction of genetic, environmental and functional factors.(14)The position of the cervical vertebrae is just one of many factors that could contribute to its development.(15).

Understanding the relationship between cervical vertebral position and Class III malocclusion has significant clinical implications. If cervical posture is confirmed to

influence malocclusion, this could lead to more accurate diagnostic approaches and more effective treatment strategies.(16)Orthodontists and maxillofacial surgeons may consider cervical posture assessment as an integral part of their treatment approach.(17).

The relationship between the position of the cervical vertebrae and class III malocclusion is a complex topic that has intrigued the scientific and professional community of oral health for years. Although progress has been made in understanding this relationship, there are still questions to be answered.(18,19)Continued research in this field is essential to improve the diagnosis and treatment of Class III malocclusion, which could have a significant impact on the quality of life of patients suffering from this condition.

This literature review aims to analyze and synthesize the scientific evidence available to date on the relationship between the position of the cervical vertebrae and class III malocclusion.(20)Through a comprehensive review of relevant studies, research and findings, we seek not only to explore the possible correlation between these two elements, but also to better understand the underlying mechanisms that could be involved in the etiology of Class III malocclusion.(21).

This review aims to be a significant contribution to current knowledge on the subject, offering a more complete and updated view of this complex condition and its relationship with the cervical spine.(22)The aim of this bibliographical study is to collect and analyse the available scientific evidence on the relationship between the position of the cervical vertebrae and class III malocclusion. The aim is to examine the most relevant clinical and experimental studies that address this topic, evaluating the methodological quality of the research and summarising the results obtained.

Methodology

This research is of a descriptive documentary type, where an exhaustive search was carried out in scientific databases, such as PubMed, Scopus, Google Academic, Taylor and Francis, Redalyc, Scielo. Keywords obtained from relevant Medical Subject Headings (MeSH) were used, which were "position of cervical vertebrae", "class III malocclusion" and "cervical-occlusal relationship", to identify relevant studies, limiting the search to articles published in Spanish or English.

Search strategy:

Relevant data from the selected studies were collected, including information about the author, year of publication, study objective, sample characteristics, methodology used, main results and conclusions. These data were organized in a table or database for further analysis.

A critical evaluation of the information obtained was carried out and a thematic analysis of the data extracted from the included studies was then carried out, identifying common findings, trends and discrepancies between the studies. The information was synthesized in a clear and concise manner, focusing on the relationship between the position of the cervical vertebrae and class III malocclusion.

Finally, a detailed report was written, including a description of the selected studies, the results obtained, the main conclusions and the clinical implications. The report was supported with appropriate citations and bibliographical references to ensure the validity and reliability of the findings, focusing on the new relationship between the position of the cervical vertebrae and class III malocclusion.

The search for information on the relationship between the position of the cervical vertebrae and class III malocclusion was carried out electronically in various digital databases, such as PubMed, Scopus, Google Academic, Taylor and Francis, Redalyc, SciELO. The search covered from January 2015 to September 2024, in English and Spanish.

The search strategy was based on relevant key terms, such as "cervical vertebrae position", "class III malocclusion" and "cervical-occlusal relationship", using controlled and indexed words for each database and combining them with the Boolean operator AND (see Table 1).

Table 1. Search strategy

Database	Search Strategy	Unfiltered Results
PUBMED	position AND vertebrae AND cervical AND cervical AND malocclusion AND class III	21
SCOPUS	position AND vertebrae AND cervical AND cervical AND malocclusion AND class III	3
GOOGLE ACADEMIC	position AND vertebrae AND cervical AND cervical AND malocclusion AND class III	1710
Taylor and Francis	position AND vertebrae AND cervical AND cervical AND malocclusion AND class III	115
Redalyc	position AND vertebrae AND cervical AND class III malocclusion	20
Scielo	position AND vertebrae AND cervical AND class III malocclusion	1

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For the selection of studies of interest, the following inclusion and exclusion criteria were applied:

Inclusion Criteria:

- Clinical and experimental studies investigating the relationship between the position of the cervical vertebrae and class III malocclusion.
- Articles in English or Spanish with clear results and conclusions.
- Articles from the last 5 years, from January 2019 to September 2024.

Exclusion Criteria:

- Book chapters.
- Expert opinion.
- Clinical cases of asymptomatic patients.
- Articles that present a conflict of interest in the study.

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Results

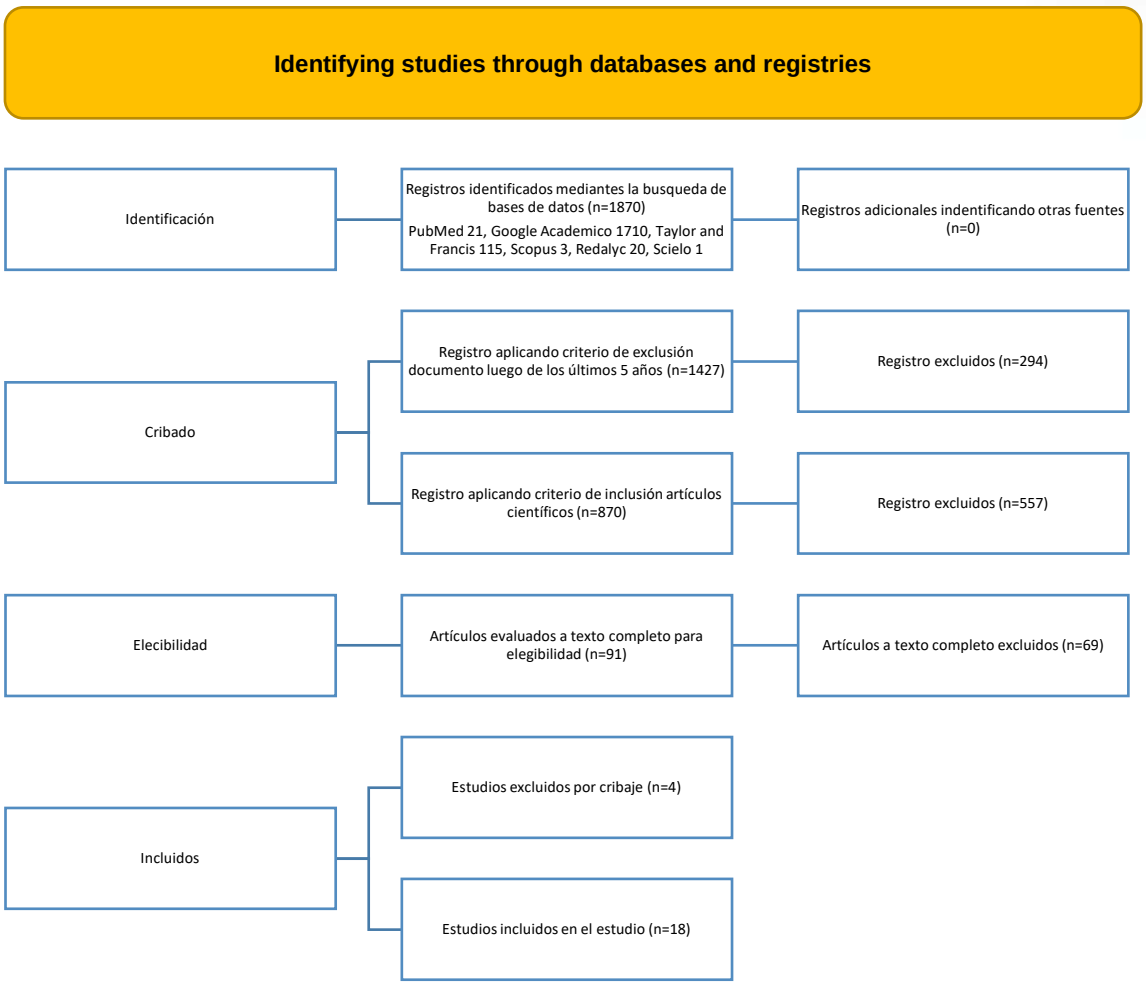

Figure1. *Article Search Flowchart*

A total of 1870 articles were identified through exhaustive searches in scientific databases such as Google Academic, SciELO, PubMed, Scopus, Redalyc and Web of Science. After applying inclusion and exclusion criteria, 18 clinical and experimental studies that met the predefined criteria were selected to investigate the relationship between the position of the cervical vertebrae and class III malocclusion. A table or database was created detailing the relevant information of the selected studies, including author, year of publication, objective of the study, characteristics of the sample, methodology used and main findings. This compilation allowed a detailed analysis of the existing literature on the subject.

A Class III malocclusion is characterized by an abnormal position of the jaws and teeth, where the mandible protrudes beyond the upper jaw. This can lead to a significant

discrepancy between the upper and lower teeth, causing functional and aesthetic problems. In addition, this malocclusion can influence the oral musculature, with some muscles becoming more active or tense to compensate for the incorrect position of the teeth and jaws. For example, the masseter muscle and the temporalis muscle, which are primarily responsible for chewing, might be more active in an attempt to correct dental alignment. Also, the buccinator muscle, which helps with sucking and positioning food inside the mouth, needs to adapt due to malocclusion. As for the cervical vertebrae, normal posture is affected by malocclusion, as the position of the jaw and the alignment of the teeth can influence the alignment of the cervical spine, potentially generating additional muscle tension and vertebral misalignments. It is important to address this malocclusion not only for aesthetic reasons, but also for its potential impact on the patient's function and overall health.

However, it is essential to take into account the limitations of these studies, such as the cross-sectional nature of some analyses and the diversity in the study samples. Longitudinal and larger research is required to corroborate and better understand these relationships, also considering other factors such as genetics, growth and environment.(23). Despite these limitations, the results offer valuable information that may impact the understanding and clinical approach to skeletal malocclusions and their relationship to vertebral position.(24).

The comparative study between patients with class III skeletal malocclusion and adults with normal occlusion revealed significant differences in the morphology of the cervical vertebrae.(25). A higher incidence of cervical vertebral body fusion was observed in the skeletal class III malocclusion group compared to the normal occlusion group. In addition, cervical spine deviations were more frequent in the malocclusion group ($p<0.001$), indicating a possible association between vertebral fusion and class III malocclusion.(20).

Regarding the evaluation of cervical posture in different sagittal skeletal malocclusions, the results showed significant differences in cervical posture between different sagittal skeletal malocclusions. Subjects with Class III skeletal malocclusion presented a significantly straighter cervical spine compared to Class I individuals.(2). Furthermore, a weak but significant correlation was found between cervical curvature and sagittal mandibular relations, suggesting a possible association between cervical posture and sagittal malocclusions.(26).

Cervical angulation is measured by assessing the curvature of the spine at the neck relative to a horizontal reference line, typically using radiographs (2). Cervical lordosis is the natural inward curvature of the spine at the neck, whereas kyphosis is an abnormal outward curvature. The inverse relationship between cervical angulation and mandibular length suggests that greater cervical angulation may be associated with shorter

mandibular length in women with Class III malocclusion, indicating a possible connection between cervical lordosis and mandibular position. Furthermore, the positive correlation between anterior cranial base and maximum length suggests a possible morphological adaptation between the cranial base and the mandible.(27,28).

In this context, it is known that there are associations between the morphology of the cervical spine, craniofacial morphology and head posture in pre-orthodontic children with excess horizontal maxillary projection.(29). Cervical spine morphology abnormalities were found to be significantly associated with increased horizontal maxillary projection, mandibular retrognathia, increased mandibular inclination, and extended head posture.(30).

Additionally, clinical evidence has been found on the relationship between the position of the cervical vertebrae and class III malocclusion, which is varied and often presents mixed results.(31)Some studies have found a significant correlation between abnormal cervical position and the presence of class III malocclusions, while others have found no clear associations.(10, 32).

The results obtained in these studies suggest an association between the morphology and position of the cervical vertebrae with various skeletal malocclusions. The presence of vertebral fusion, cervical deviations and changes in cervical lordosis showed significant correlations with different types of malocclusions, especially with Class III malocclusion.(33, 34)This suggests a possible link between the position of the cervical vertebrae and the development of skeletal malocclusions, although the exact nature of this relationship remains complex and needs further exploration.

The associations found between cervical and craniofacial morphology in several study groups indicate the interrelationship between cervical structure, jaw position and head posture.(29)These findings underline the importance of considering the cervical spine as a potentially influential component in the etiology and development of skeletal malocclusions.(30).

Discussion

Association between cervical spine morphology and Class III malocclusion, the results of Hedayati et al. (2011) (32) andArntse &Sonnesen(2011)(25)suggest a significant association between cervical spine morphology and Class III malocclusion. In the patient groups with mandibular overjet and Class III malocclusion, D'Attilio et al. (2005) (33) and Arntsen &Sonnesen(2011) (25) report more frequent cervical spine abnormalities, such as fusions and posterior arch deficiencies, compared to control groups with neutral occlusion and normal craniofacial morphology.

These findings support the hypothesis that Class III malocclusion might be associated with alterations in cervical morphology, including vertebral fusions and deficiencies. In addition,D'Attilio et al. (2005) (33) and Sandoval et al. (2021) (16) report thatthe absence of significant differences in the distribution of cervical anomalies between Class I, II and III malocclusions that Class III malocclusions are not exclusively associated with certain specific types of cervical anomalies, but rather with a general tendency towards altered cervical morphology.

Relationship between cervical posture and different skeletal classes Hedayati et al. (2023) (32), the study investigating cervical posture in different skeletal classes (Class I, II, and III) found significant differences in cervical angulation between groups. Children with Class III malocclusion presented less cervical lordosis compared to Class I and Class II subjects. Furthermore, Class II subjects were observed to show greater head extension relative to the spine, possibly due to the straightness in the lower part of their spine compared to Class I and III subjects.

These results highlight the potential influence of skeletal morphology on cervical posture, showing that different skeletal classes are associated with findings collected from multiple studies provide substantial evidence of Al-Somairi et al., 2023 (14) suggesting an association between cervical morphology and skeletal malocclusions, particularly Class III malocclusion. The presence of vertebral fusions and deficiencies in the groups with Class III malocclusions and prominent mandible supports the hypothesis of a connection between cervical morphology and the development of specific skeletal malocclusions.

Despite existing research such as Nooari et al. (2020)(15), further studies are still required to fully understand the relationship between cervical vertebral position and Class III malocclusion. Murrieta et al. (2013) (34) mention that longitudinal research and controlled studies are needed to more comprehensively evaluate the underlying mechanisms and clinical implications of this relationship. In addition, the role of genetics and other factors in the etiology of Class III malocclusion should continue to be investigated.

Regarding the assessment of cervical posture in Class III malocclusions, studies showed significant differences in cervical posture between Class III and Class I and II malocclusions. It was observed that participants in studies by Murrieta et al. (2013) (34) and Sandoval et al. (2021) (9) mentioned that with Class III malocclusion they had a more forward cervical posture and tended to tilt their head more compared to those in Class I and II. In addition, an association was found between mandibular ramus rotation and cervical lordosis, especially in Class II individuals.(34).

Sandoval et al. (2021) (9) mention that the analysis of differences in craniofacial morphology and cervical spine, studies that compared craniofacial morphology and cervical spine between European and Asian populations with Class III malocclusion showed significant differences in maxillary inclination and the shape of the posterior cranial fossa between the groups. Sambatarro et al. (2020) (12) mention that the morphology of the cervical spine and the dimensions of the atlas have been observed to be significantly related to craniofacial characteristics, growth prediction signs and sagittal relationship of the mandible.

The findings indicate a clear association between craniofacial morphology and cervical posture in Class III malocclusions. In this sense, Nascimiento (35) indicates that the maxillary inclination and the shape of the posterior cranial fossa differ between European and Asian populations with Class III, suggesting ethnic variations in craniofacial morphology and its relationship with the cervical spine.(35).

Significant differences in cervical posture were observed between adolescents with different skeletal classes. Cervical curvature was associated with the ANB angle and the C0-C1 distance, being different between the groups. Cervical posture appears to be strongly associated with sagittal posture and the vertical structure of the face.(39).

In the study on cervical vertebral anomalies (CVAs) in Class I, II and III malocclusions, a frequency of 13.2% was observed for CVAs in the Turkish population. However, no statistically significant correlation was found between CVAs and Class I, II and III malocclusions.(10,46)Furthermore, no significant gender relationship was identified in the distribution of CVAs.(10,37)

Significant differences in the position and orientation of the hyoid bone were identified between Class I, II and III malocclusions. Alma (38) and Sandoval 2021 (49) speaks of the anteroposterior position of the hyoid bone varied significantly between the classes of malocclusion, being more anterior in Class III and more posterior in Class II.(9.38). However,García et al., (2012) and Sandoval et al., (2021) mention that the vertical position of the hyoid bone did not show significant differences between the malocclusion classes.

The study using geometric methods showed differences in craniofacial and cervical morphology between Class II and III. Differences were identified in maxillary protrusion, mandibular retrusion, anterior cranial base rotation, and a smaller and more forward cervical spine in Class II compared to Class III. (9.38)

The results collected from multiple studies show the association between craniofacial morphology, cervical posture and Class I, II and III malocclusions.

Cervical posture Samudio (40) talks about the relationship with the sagittal and vertical position of the face, suggesting that the cervical spine can be influenced by the craniofacial structure. However, the specific association between cervical vertebral anomalies and malocclusions seems not to be so evident, at least in the Turkish population studied, where no significant correlations were found.(40).

Overall, these studies provide a deeper understanding of the interrelationship between craniofacial morphology, cervical posture and different skeletal malocclusions, which may be useful for orthodontic and orthognathic treatment planning in clinical practice. (40)

Conclusions

- Despite existing research, further studies are still required to fully understand the relationship between cervical vertebral position and Class III malocclusion.(15)Longitudinal research and controlled studies are needed to more comprehensively evaluate the underlying mechanisms and clinical implications of this relationship.(34)Furthermore, the role of genetics and other factors in the etiology of Class III malocclusion remains a matter of further investigation.
- Comprehensive analysis of multiple investigations has revealed an intrinsic relationship between craniofacial structure, cervical posture and malocclusions. Detailed studies have shown that differences in the configuration of the mandible and maxilla have a significant influence on the morphology of the cervical spine. The relationship between craniofacial morphology and cervical posture is revealed as a key component to understanding malocclusions.
- Marked variations in cervical posture were observed between the different Malocclusion Classes (Class I, II and III). The position of the mandible and maxilla showed notable differences, suggesting their impact on the configuration and position of the cervical spine. Furthermore, the position and orientation of the hyoid bone showed significant variations between these Malocclusion Classes, which could be crucial in orthodontic and orthognathic treatment planning.
- Despite the identification of cervical vertebral anomalies in some patients with malocclusion, no consistent correlations were found in all the populations studied. This indicates the possible existence of genetic and ethnic variability in this relationship, underlining the need for a broader and more specific analysis of different ethnic and genetic groups.
- These findings could also have important implications for clinical practice, especially in the field of orthodontics and orthognathic surgery. Understanding the complex craniofacial-cervical relationship could be crucial for planning and implementing successful treatments, highlighting the importance of a

multidisciplinary assessment that integrates orthodontics, maxillofacial orthopedics and attention to cervical posture.

- Despite these advances, further longitudinal and larger-scale studies are required to confirm these associations and better understand the underlying mechanisms between cervical morphology and skeletal malocclusions.(41). These future investigations may provide additional information to improve diagnostic and treatment approaches in orthodontics and dentistry.
- In summary, the relationship between craniofacial structure, cervical posture and malocclusions is a fascinating and complex field that requires a thorough and multidisciplinary evaluation to better understand their interconnection and its application in clinical practice, with the ultimate goal of improving patient outcomes and quality of life.
- Furthermore, the relationship between different skeletal classes and cervical posture indicates that facial skeletal structure may have a direct impact on cervical morphology and head posture. These findings highlight the importance of considering the cervical spine as a key component in the evaluation and treatment of skeletal malocclusions, especially Class III.
- Furthermore, cervical morphology, including vertebral anomalies, is found to be closely linked to craniofacial morphology and growth prediction signs, suggesting the importance of considering the cervical spine in the evaluation and treatment of Class III malocclusions.(36).
- The development of a predictive equation for mandibular growth potential based on cervical measurements(30)offers a promising avenue for predicting mandibular growth in Class III malocclusions, which could have important implications for clinical management and treatment planning.
- Taken together, these findings highlight the complex interrelationship between craniofacial morphology, cervical posture, and the development of Class III malocclusions, opening avenues for future research and potential clinical applications for more precise and personalized treatment planning.(37,38).

Conflict of interest

The authors of this literature review, Evelyn Guiracocha, Yamanua León and Isabel Cabrera, declare that they have no conflict of interest that could influence the objectivity or impartiality of this work. They have no financial or personal relationships with organizations or entities that could have an interest in the results presented in this article. In addition, they have not received funding or support from any company or institution that may have an interest in the subject matter discussed in this work.

Authors' contribution statement

Author 1: It has contributed with a thorough review of the relevant scientific literature, contextualizing and adequately justifying the study. The most recent advances in the field have been taken into account, which has allowed establishing a solid theoretical framework.

Author 2: Participation in the interpretation of data and in the development of conclusions.

Author 3: Review and correction of the writing of the manuscript and the tables that have been carried out, guaranteeing precision and clarity in the presentation of the results.

In summary, the contribution of Yamanua León and Isabel Cabrera in this scientific article has been fundamental for the development and successful completion of the study. The efforts have allowed us to advance in the knowledge of the subject and provide new perspectives for future research in this field.

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