Systematic Review

Stomatognathic System Changes in Obese Patients Undergoing Bariatric Surgery: A Systematic Review

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Abstract: Background: Obesity is a multifactorial chronic disease involving multiple organs, devices, and systems and involving important changes in the stomatognathic system, such as in the orofacial muscles, temporomandibular joint, cheeks, nose, jaw, maxilla, oral cavity, lips, teeth, tongue, hard/soft palate, larynx, and pharynx. Patients with obesity indicated for bariatric surgery reportedly presented with abnormalities in the structures and function of the stomatognathic apparatus. This occurs through the accumulation of adipose tissue in the oral cavity and pharyngeal and laryngeal regions. Therefore, this systematic review aimed to elucidate the changes occurring in the stomatognathic system of patients with obesity after undergoing bariatric surgery. Method: Information was searched based on the equations developed with the descriptors obtained in DECS and MESH using the PRISMA methodology. Studies published between 2010 and October 2021 in databases including PubMed, ProQuest, Scielo, Dialnet, EBSCO, and Springer Link were considered. Results: Eighty articles met the inclusion criteria after evaluating the articles, thereby allowing for the determination of the morphophysiological correlation of the stomatognathic system with the population studied. At the morphological or structural level, changes were observed in the face, nose, cheeks, maxilla, jaw, lips, oral cavity, teeth, tongue, palate, temporomandibular joint, neck, muscles, head, shoulders, larynx, and pharynx. At the morphological level, the main changes occurred in, and the most information was obtained from, the labial structures, teeth, muscles, pharynx, and larynx. Physiological changes were in breathing, phonation, chewing, and swallowing, thereby revealing the imbalance in basic and vital functions. Conclusions: Analyzing the changes and structures of obese patients and candidates for bariatric surgery revealed that, in the preoperative period, the evidence is clear owing to the presence of a wide range of information. However, the information is more limited regarding the postoperative period; thus, further research focusing on characterization of the system postoperatively is warranted.

Keywords: obesity; bariatric surgery; stomatognathic system; physiology

1. Introduction

The stomatognathic system is an integrated and coordinated morpho-functional unit comprising skeletal, muscular, angiologic, nervous, glandular, and dental structures organized around the occipto-atloidal, atlantoaxial, cervical vertebral, temporomandibular, dento-dental in occlusion, and dentoalveolar joints, which are organically ligated and functionally related to the digestive, respiratory, phonological, and facial aesthetic expression systems. Consequently, this system is associated with the senses of taste, touch, balance, and orientation. It intervenes in functions of suction, oral digestion (mastication,
salivation, tasting, and degradation of carbohydrates), swallowing, verbal communication (phonological modulation, articulation of sounds, speech, and whistles), oral sexuality (smiling, laughing, orofacial gesticulation, and kissing, among other aesthetic-affective manifestations), alternate breathing, and vital defense (coughing, expectorating, sneezing, yawning, sighing, and exhalation and vomiting), which are considered essential for an individual's survival [1].

Obesity has become a 21st century problem, as well as one of the fastest growing health problems worldwide [2,3]. Currently, it is one of the most important and concerning public health conditions, which is why it has become a priority [4]. According to the Center for Disease Control and Prevention, obesity is defined as “weight above what is adequate or considered healthy given the height of each subject”. Concurrently, it defines it as a chronic disease requiring timely medical care, thereby limiting the activities of daily living. Its main characteristic is excessive accumulation of body fat that has harmful effects on health. However, it is considered a treatable disease [3,5,6].

According to statistics from the World Health Organization (WHO), in 2005, 1.6 billion people aged > 15 years were classified as overweight and 400 million were classified as obese [7]. Currently, there are approximately 1200 million people in the world with problems related to overweight and obesity [8]. This constitutes evidence of high levels of prevalence of the disease, which affects approximately 23% of the adult population of Latin America and the Caribbean, or ~140 million people [9]. However, the Colombian Ministry of Health and Social Protection (MinSalud) estimates that the prevalence of overweight people in Colombia is approximately 56.4% and, thus, it is considered a public health problem for the country. Based on data provided by the same entity, it is predicted that, by the year 2030, 1 out of 2 adults will be obese, and 1 in 4 adults will have severe obesity [10,11]. However, obesity is a preventable disease, and it can be addressed through multidisciplinary intervention, which includes allowing the interaction of several professionals during treatment, involving diet, physical exercise, and pharmacological treatment [12]. However, the combination of eating, sports, and medicinal habits is sometimes not effective or successful. Therefore, patients resort to extreme alternatives, such as bariatric surgery, since it provides an effective solution to the problem in order to reduce food intake and nutrient absorption. This is despite the fact that the procedure includes invasive surgical intervention in the digestive system [2,13]. It is necessary to clarify that not everyone is an ideal candidate for the procedure, even though bariatric surgery is a reliable method for long-term weight loss. Candidates must at least be adults, with a body mass index (BMI) ≥ 40 kg/m² or with a BMI between 35 and 39.9 kg/m² and a severe associated comorbidity [12,13].

Historically, bariatric surgery emerged in the United States in the 1950s. It was the pioneering country in the American continent, followed by Brazil, the second country in the world to perform more bariatric surgeries, with approximately 80,000 surgeries per year [4,14]. For this approach, it must be highlighted that a suitable bariatric technique must primarily be very safe; i.e., with a morbidity of <10% and a mortality of <1%. Second, such a technique must be able to cause the loss of at least 50% of the additional weight, which must be maintained for a period of approximately 5 years, thereby improving the patient’s quality of life. It should be noted that there are three techniques for performing these interventions (malabsorptive, restrictive, and mixed) [15]. The restrictive technique consists of reducing the capacity of the stomach and preventing the passage of food. However, over time, this technique forces patients to undergo a reintervention. The malabsorptive technique reduces the capacity of the stomach by half, producing crossover with the intestine, so that there is a malabsorption of nutrients from food, forcing the patient into restrictive control after surgery. The mixed technique has a restrictive and somewhat malabsorptive character, which allows it to be a well-tolerated procedure, without the patient presenting long-term complications or requiring reintervention [16]. Another technique used to address this problem is sleeve gastrectomy (SG) (the malabsorptive type), and it has been the most
commonly performed technique in the world, and in Colombia, since 2004, followed by the Roux-en-Y gastric bypass (RYGB) (the mixed type) [17].

In conclusion, it is important to highlight that, despite the many benefits of making use of this procedure, there are also various changes and anomalies in the structures and functioning of the different systems, including the stomatognathic system [18,19]. The literature and the investigated studies make it clear that these anomalies severely compromise the entire stomatognathic system due to the accumulation of adipose tissue in the oral cavity and in the pharyngeal and laryngeal regions [19], with the adiposity of these regions being the etiology responsible for the changes in these large and important structures of the patient, thus compromising morphology and physiology [20]. Considering the arguments and findings previously revealed, the following research question arises: how are the stomatognathic systems of obese patients, and those of obese patients with bariatric surgery, characterized?

2. Materials and Methods

This review was performed following the parameters proposed by the PRISMA methodology. For this, the databases were identified, and thesauruses were defined in the search for information. The studies were also selected based on inclusion and exclusion criteria that facilitated the assessment of the studies’ quality and reliability and that, eventually, allowed answering the research question posed [21–23].

The PICO tool was used to construct the research question. This tool was employed owing to the fact that it is used to improve the specificity and conceptual clarity of the clinical problems to be studied, as well as to perform searches with greater quality and precision, which allows for the collection of pertinent and accurate data to answer the problem question [24,25].

2.1. Research Question

In accordance with the theme established for the research, the components of the PICO strategy shown in Table 1 were established, resulting in the following research question: how are the stomatognathic systems of obese patients, and those of obese patients with bariatric surgery, characterized?

Table 1. Research Question.

| Component          | Description                                                                 |
|--------------------|-----------------------------------------------------------------------------|
| P: Patient or problem of interest (Population) | Obese patient and post-bariatric surgery                                   |
| I: Intervention    | Assessment of the stomatognathic system                                     |
| C: Comparison      | Stomatognathic system                                                       |
| O: Outcome         | Alterations or changes in anatomical and functional structures              |

2.1.1. Inclusion Criteria

1. Overweight subjects, those with obesity or morbid obesity, or those who had undergone bariatric surgery
2. A publication time window of 10 years;
3. Articles focused on the evaluation of aspects related to the distal airways, upper airways, lower airways, stomatognathic system (morphology and physiology), respiratory system, masticatory system, and swallowing mechanics;
4. Studies conducted with humans;
5. Full-text articles;
6. Free-access articles and current DOIs.
2.1.2. Exclusion Criteria

1. Articles with DOIs that were not current within the databases for download;
2. Research with a time window of >10 years;
3. Articles that were not related to human beings;
4. Grey literature, such as theses, white books, research and project reports, annual or activity reports, conference proceedings, preprints, working papers, newsletters, technical reports, recommendations and technical standards, patents, technical notes, data and statistics, presentations, field notes, laboratory research books, abstracts, academic courseware, lecture notes, and evaluations, were excluded.

2.2. Sources of Information

The key terms were selected from the Descriptors in Health Sciences (DECS) and the Medical Subject Headings (MESH) (see Table 2).

| Source | Keyword                | Related Terms                                                                 |
|--------|------------------------|-------------------------------------------------------------------------------|
| DECS   | Distal airways         | No records found                                                              |
| MESH   | Distal airways         | No records found                                                              |
| DECS   | Obesity                | No records found                                                              |
| MESH   | Obesity                | Morbid obesity, excess adipose tissue, abnormal weight gain                   |
| DECS   | Overweight             | No records found                                                              |
| MESH   | Overweight             | Excess weight, increased body fat, increased adipose tissue                   |
| DECS   | Bariatric surgery      | No records found                                                              |
| MESH   | Bariatric surgery      | Weight reduction, metabolic surgery, bariatric surgical procedure, stomach stapling, gastroenterostomy, gastric bypass, gastroplasty, jejunoileal bypass, lobectomy, lipoabdominoplasty |
| DECS   | Upper respiratory tract| No records found                                                              |
| MESH   | Upper respiratory tract| Respiratory system, respiratory tract, upper respiratory tract               |
| DECS   | Lower respiratory tract| No records found                                                              |
| MESH   | Lower respiratory tract| No records found                                                              |
| DECS   | Respiratory system     | No records found                                                              |
| MESH   | Respiratory system     | Airways, respiratory function                                                 |
| DECS   | Masticatory system     | No records found                                                              |
| MESH   | Masticatory system     | Stomatognathic system                                                         |
| DECS   | Masticatory apparatus  | No records found                                                              |
| MESH   | Masticatory apparatus  | No records found                                                              |
| DECS   | Masticatory dynamic    | No records found                                                              |
| MESH   | Masticatory dynamic    | No records found                                                              |
| DECS   | Swallowing disorder    | No records found                                                              |
| MESH   | Swallowing disorder    | Swallowing disorder, difficulty swallowing, dysphagia                       |
| DECS   | Swallowing reflex      | No records found                                                              |
| MESH   | Swallowing reflex      | No records found                                                              |
| DECS   | Swallowing physiology  | No records found                                                              |
| MESH   | Swallowing physiology  | No records found                                                              |
Table 2. Cont.

| Source | Keyword                                      | Related Terms                                      |
|--------|----------------------------------------------|----------------------------------------------------|
| DECS   | Swallowing biomechanics                      | No records found                                   |
| MESH   | Swallowing biomechanics                      | No records found                                   |
| DECS   | Dysphagia                                    | Swallowing disorder, neuromuscular disorder, or    |
| MESH   | Dysphagia                                    | mechanical obstruction                             |
| DECS   | Aspiration                                   | Pneumonia, respiratory aspiration                 |
| MESH   | Aspiration                                   |                                                    |
| DECS   | Myofunctional disorder                       | No records found                                   |
| MESH   | Myofunctional disorder                       | No records found                                   |
| DECS   | Orofacial disorder                           | No records found                                   |
| MESH   | Orofacial disorder                           | No records found                                   |
| DECS   | Swallowing                                   | No records found                                   |
| MESH   | Swallowing                                   | Swallow                                           |
| DECS   | Masticatory alteration                       | No records found                                   |
| MESH   | Masticatory alteration                       | No records found                                   |
| DECS   | Orofacial motor skills                       | No records found                                   |
| MESH   | Orofacial motor skills                       | No records found                                   |
| DECS   | Myofunctional therapy                        | No records found                                   |
| MESH   | Myofunctional therapy                        | Orofacial myotherapy, orofacial myologies          |
| DECS   | Stomatognathic system                        | No records found                                   |
| MESH   | Stomatognathic system                        | No records found                                   |
| DECS   | Breathing                                    | No records found                                   |
| MESH   | Breathing                                    | Breath work                                        |
| DECS   | Suction                                      | No records found                                   |
| MESH   | Suction                                      | No records found                                   |
| DECS   | Speech                                       | No records found                                   |
| MESH   | Speech                                       | Verbal communication                               |
| DECS   | Phonation                                    | No records found                                   |
| MESH   | Phonation                                    | Sound production                                   |
| DECS   | Chewing                                      | No records found                                   |
| MESH   | Chewing                                      | No records found                                   |

Source: Information obtained from DECS and MESH.

2.2.1. Search Strategies

A search strategy was developed with the aid of trained institutional professional librarians from la Universidad Simón Bolívar, Colombia, and la Universidad de Pamplona, Colombia.

Subsequently, the search equations were designed with the terms found. These equations were created using the logical operators AND/OR/NOT and symbols such as ‘’ and (). The information search was conducted in PubMed, ProQuest, Scielo, Dialnet, EBSCO, and Springer Link in the English language (see Table 3).
Table 3. Search equations.

| Database                          | Search Algorithm                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------------|
| PubMed, ProQuest, Scielo, Dialnet, EBSCO, and Springer Link | (“Bariatric Surgery”) AND (“Disorders”) AND (“Myofunctional”)                     |
|                                   | (“Bariatric Surgery”) AND (“Disorders”) AND (“Myofunctional” OR “Orofacial”) OR (“Disorder Physiology”) AND (“Obesity”) |
|                                   | (“Alteration”) AND (“Masticatory System”) AND (“bariatric surgery” OR “Obese”)     |
|                                   | (“Deglutition”) AND (“bariatric surgery” OR “Obese”)                               |
|                                   | (“Orofacial Motor Skills”) AND (“Physiology”)                                      |
|                                   | (“Myofunctional Therapy” OR “Stomatognathic System”) AND (“Physiology”)            |
|                                   | (“Orofacial”) AND (“Disorder”) AND (“bariatric surgery”) AND (“Respiration” OR “Suction” OR “Swallowing” OR “Speech” OR “Phonation”) |
|                                   | (“Orofacial” OR “Bariatric Surgery”) AND (“Breathing”)                             |
|                                   | (“Orofacial”) AND (“Disorder”) AND (“Bariatric Surgery”) AND (“Suction”)           |
|                                   | (“Disorder”) AND (“Bariatric Surgery”) AND (“Swallowing”)                          |
|                                   | (“Bariatric Surgery”) AND (“Speech”)                                               |
|                                   | (“Disorder”) AND (“Bariatric Surgery”) AND (“Phonation”)                           |
|                                   | (“Orofacial”).AND (“Disorder”) AND (“Obesity”) AND (“Breathing”)                    |
|                                   | (“Orofacial”) AND (“Disorder”) AND (“Obesity”) AND (“Suction”)                     |
|                                   | (“Orofacial”) AND (“Obesity”) AND (“Swallowing”)                                   |
|                                   | (“Orofacial”) AND (“Disorder”) AND (“Obesity”) AND (“Speech”)                      |
|                                   | (“Distal Airways”) AND (“Obesity”)                                                 |
|                                   | (“Distal Airways”) AND (“Overweight”)                                              |
|                                   | (“Distal Airways”) AND (“Obesity”) AND (“Bariatric Surgery”)                        |
|                                   | (“Distal Airways”) AND (“Overweight”) AND (“Bariatric Surgery”)                    |
|                                   | (“Upper Airways”) AND (“Obesity”)                                                  |
|                                   | (“Upper Respiratory Tract”) AND (“Overweight”)                                     |
|                                   | (“Upper Airway”) AND (“Overweight”) AND (“Bariatric Surgery”)                      |
|                                   | (“Lower Respiratory Tract”) AND (“Obesity”)                                        |
|                                   | (“Lower Respiratory”) AND (“Overweight”)                                           |
|                                   | (“Lower Respiratory Tract”) AND (“Obesity”) AND (“Bariatric Surgery”)               |
|                                   | (“Respiratory System”) AND (“Obesity”)                                             |
|                                   | (“Masticatory System”) AND (“Obesity”)                                             |
|                                   | (“Masticatory Apparatus”) AND (“Obesity”)                                           |
|                                   | (“Masticatory Dynamics”) AND (“Obesity”)                                            |
|                                   | (“Swallowing Disorder”) AND (“Obesity”)                                             |
|                                   | (“Swallowing Reflex”) AND (“Obesity”)                                               |
|                                   | (“Swallowing Physiology”) AND (“Obesity”)                                            |
|                                   | (“Swallowing Biomechanics”) AND (“Obesity”)                                         |
|                                   | (“Dysphagia”) AND (“Obesity”)                                                       |
|                                   | (“Aspiration”) AND (“Obesity”)                                                      |
2.2.2. Characteristics of the Studies

Initially, the interventions and the respective descriptions of the treatment therapy were classified. Likewise, these interventions were compared from the perspective of the control and experimental groups—based on the characteristics of the therapies—including the model, the technique (if applicable), whether they involved group or individual interventions, the characteristics of the sessions (number of sessions and frequency and duration of each session), the effectiveness and benefit of therapies, the intervention protocol, randomization, and the characteristics of the participants.

Additionally, the characteristics of the therapists and evaluators of the results, the follow-up in time after the interventions, and the findings of the studies were identified. In cases of missing or unclear data, emails were sent requesting the additional information.

2.3. Selection and Analysis

Initially, a preliminary selection of studies based on a review of inclusion criteria, population characteristics, type of study, and year was taken into consideration. Subsequently, a registration table was filled out independently in Excel, prepared by the authors, in which the key elements of each of the selected studies were specified. The process used in the identification, screening, eligibility, and inclusion of articles is briefly described, following the structure proposed by the PRISMA statement [26].

3. Results

The eligibility criteria were determined following the order established in the methodology by developing each of the phases of the PRISMA flowchart (Figure 1).

![Figure 1. PRISM diagram.](image)

3.1. Identification Phase

The search was performed in the databases PubMed, ProQuest, Scielo, Dialnet, EBSCO, and Springer Link, according to the crosses of variables constructed from DECS and MESH keywords. Then, the following filters were applied: type of document, time window, full or duplicate text, articles without access, and non-compliance with criteria. Finally, articles were selected to obtain the final sample of 80 articles that were used in this investigation (See Table 4).
### Table 4. Filters applied.

| Database  | Total Articles | Type of Document | Period | Incomplete and/or Duplicate Texts | No Access | Non-Compliance with Criteria | Selected Articles |
|-----------|----------------|------------------|--------|-----------------------------------|-----------|-------------------------------|-------------------|
| PUBMED    | 460,295        | 29,752           | 330,324| 79,016                            | 20,345    | 832                           | 26                |
| PROQUEST  | 580,424        | 259,904          | 18,580 | 18,667                            | 24,348    | 258,901                       | 24                |
| SCIELO    | 330            | 120              | 36     | 32                                | 15        | 111                           | 16                |
| DIALNET   | 356            | 43               | 43     | 1                                 | 0         | 266                           | 3                 |
| EBSCO     | 16,405         | 5280             | 4012   | 3                                 | 0         | 7105                          | 5                 |
| SPRINGER  | 11,314         | 4555             | 3868   | 530                               | 2300      | 55                            | 6                 |
| TOTAL     | 1,069,124      | 299,654          | 356,863| 98,249                            | 47,008    | 267,270                       | 80                |

### 3.2. Selection and Elimination Phase

The initial selection of the research articles was carried out through the preliminary reading of the titles, summaries, and, later, the introduction, allowing the identification of the most relevant articles regarding the subject under investigation, with a total of 80 selected articles. The results for each variable crossing in English are listed below (see Table 5) for the six PubMed, ProQuest, Scielo, Dialnet, EBSCO, and Springer Link databases.

| Match/Database                          | PUBMED | PROQUEST | SCIELO | DIALNET | EBSCO | SPRINGER LINK |
|----------------------------------------|--------|----------|--------|---------|-------|---------------|
| Obesity + Bariatric Surgery            | 7      | 8        | 3      | 1       | 1     | 1             |
| Obesity + Stomatognathic System        | 6      | 6        | 5      | 2       | 1     | 2             |
| Obesity + Physiology                   | 9      | 6        | 8      | 0       | 3     | 3             |
| Obesity + Upper Airway                 | 2      | 2        | 0      | 0       | 0     | 0             |
| Obesity + Lower Airway                 | 2      | 2        | 0      | 0       | 0     | 0             |
| **Total**                              | **26** | **24**   | **16** | **3**   | **5** | **6**         |

In the first search, 17 crosses were made in English between the different variables, resulting in 26 articles from PubMed, 24 from ProQuest, 16 from Scielo, 3 from Dialnet, 5 from EBSCO, and 6 from Springer Link, for a total of 80 items.

### 3.3. Inclusion Phase

The selection proceeded after reading the titles and the summaries of the articles, and they were analyzed in their entirety with a complete read-through, applying criteria that allowed a selection that, thus, made it possible to obtain those that clearly answered the question posed initially. The selection corresponded to a final sample of 80 articles (See Table 6).

| N | Database | Title                                                                 | Author                                    | Year | URL                                                                 |
|---|----------|-----------------------------------------------------------------------|--------------------------------------------|------|----------------------------------------------------------------------|
| 1 | DIALNET  | Standardized care plan in bariatric surgery [27]                      | Mesa García, C; Muñoz Del Castillo, M.     | 2016 | [https://dialnet-unirioja-es.unipamplona.basesdedatosproxy.com/servlet/articulo?codigo=7801587](https://dialnet-unirioja-es.unipamplona.basesdedatosproxy.com/servlet/articulo?codigo=7801587) (accessed on 23 November 2021) |
| 2 | DIALNET  | Formulation of criteria to record tongue position in patients with atypical swallowing [28] | Pachon Salem, L. E.                       | 2016 | [https://dialnet.unirioja.es/descarga/articulo/6045809.pdf](https://dialnet.unirioja.es/descarga/articulo/6045809.pdf) (accessed on 23 November 2021) |
| 3 | DIALNET  | Structural and Functional Alterations of the Stomatognathic System: Speech-Language Management [29] | Pérez Serey, J; Hernández Mosquera, C; Fuenzalida Cabezas, R. | 2021 | [https://arete.ibero.edu.co/article/view/art.17105](https://arete.ibero.edu.co/article/view/art.17105) (accessed on 23 November 2021) |
| N  | Database   | Title                                                                 | Author                                                                                           | Year | URL                                                                 |
|----|------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|------|----------------------------------------------------------------------|
| 4  | EBSCO      | Myofunctional and electromyographic characteristics of obese adolescent children [30] | Bolzan Berlese, D; Copetti, F; Maciel Weimann, A; Fantinel Ferreira, P; Bonfanti Haeffner, L. | 2013 | https://web-s-ebscohost-com.ezproxy.uniminuto.edu/ehost/detail/detail?vid=0&sid=9dc4c2db-fcfd-47f0-a413-8bf76cd36e2c%40redis&bdata=Jmxhbmc92XMc20TZT1aG9zdf1saXZJlnjXj3BIPXNpG%3d#AN=90594980&dID=a9h (accessed on 04 December 2021) |
| 5  | EBSCO      | Pulmonary Function and Obesity [31]                                   | Carpio, C., Santiago, A., García De Lorenzo, A; Álvarez-Sala, R                                  | 2014 | https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112014001200009 (accessed on 04 December 2021) |
| 6  | EBSCO      | Characterization of sleep disorders, snoring, and alterations of the stomatognathic system of obese candidates for bariatric surgery [20] | Mores, R; Delgado, S. E; Martins, N. F; Anderle, P; Da Silva Longaray, C; Pasqualeto, V. M; Batista Berbert, M. C. | 2017 | http://www.rbone.com.br/index.php/rbone/article/view/447 (accessed on 04 December 2021) |
| 7  | EBSCO      | Maximum phonation time in people with obesity not undergoing or undergoing bariatric surgery [11] | Fonseca, A; Salgado, W; Dantas, R.                                                               | 2019 | https://www.hindawi.com/journals/jobe/2019/5903621/ (accessed on 04 December 2021) |
| 8  | EBSCO      | Obesity, bariatric surgery, and the impact on oral health: A review of the literature [32] | Mosquim, V; Aparecido Foratori, J. G; Saory Hissano, W; Wang, L; Sales Peres, S.                  | 2019 | https://pesquisa.bvsalud.org/portal/resource/pt/biblio-1051047 (accessed on 04 December 2021) |
| 9  | PROQUEST   | Impaired swallowing reflex in patients with obstructive sleep apnea syndrome [33] | Teramoto, S; Sudo, E; Matsuse, T; Ohga, E.                                                     | 1999 | https://www.proquest.com/docview/2004986309/5EDD348C9AAE606PQ/73?accountid=48797&forcedol=true (accessed on 17 December 2021) |
| 10 | PROQUEST   | The stomatognathic system and body scheme [1]                           | Barreto, J. F.                                                                                 | 1999 | https://www.redalyc.org/pdf/283/28330405.pdf (accessed on 17 December 2021) |
| 11 | PROQUEST   | Obesity and the lungs: 2 - Obesity and sleep-disordered breathing [34] | Crummy, F; Piper, A. J; Naughton, M. T.                                                        | 2008 | https://www.proquest.com/docview/1781775154/FFC0B0206C8B14725PQ/73?accountid=48797&forcedol=true&forcedol=true (accessed on 17 December 2021) |
| 12 | PROQUEST   | The effect of dental status on changes in chewing in obese patients after bariatric surgery [35] | Godlewski, A. E; Veyrune, J; Ciangura, C; Chaussain, C.                                      | 2011 | https://www.proquest.com/docview/1306252769/9EDE348C9AAE606PQ/47?accountid=48797&forcedol=true (accessed on 17 December 2021) |
| 13 | PROQUEST   | Habitual snoring and atopic status: Correlations with respiratory function and tooth occlusion [36] | Zicari, A. M; Marzo, G; Ruggiano, A; Celani, C; Carbone, M. P.                              | 2012 | https://www.proquest.com/docview/1197719038/8A8EC372DDBF43DPQ/9 (accessed on 17 December 2021) |
| 14 | PROQUEST   | Impairment of the distal airway in normally reactive obese women [37] | Marin, G; Gamez, A. S; Molinari, N; Kacimi, D; Vachier, I.                                      | 2013 | https://www.proquest.com/docview/1434621519/2E1B5ED485B4119PQ/4?accountid=48797? (accessed on 17 December 2021) |
| 15 | PROQUEST   | Airway dysfunction in obesity: The response to voluntary restoration of end-expiratory lung volume [38] | Oppenheimer, Beno W; Berger, Kenneth I; Segal, Leopoldo N; Stabile, A; Coles, K.                 | 2014 | https://www.proquest.com/docview/1494399689/2E1B5ED485B4119PQ/2?accountid=48797 (accessed on 17 December 2021) |
| 16 | PROQUEST   | Perioperative respiratory care in obese patients undergoing bariatric surgery: Implications for clinical practice [39] | Pouwels, S; Smeenk, F. W; Manschot, L; Lascaris, B; Nienhuijs, S; Bouwman, R A; Buise, M. P. | 2016 | https://www.sciencedirect.com/science/article/pii/S0954611611601287 (accessed on 17 December 2021) |
| 17 | PROQUEST   | Therapeutic strategies for the management of dry mouth with emphasis on electrostimulation as a treatment option [40] | Tulek, A; Mulic, A; Hogset, M; Utheim, T. P; Sehic, A.                                       | 2021 | https://www.hindawi.com/journals/jid/2021/6043488/ (accessed on 17 December 2021) |
Table 6. Cont.

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### Table 6. Cont.

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| 37 | PUBMED     | The stomatognathic system [51]                                       | Mizraji, M; Freese, A. M; Bianchi, R.                                | 2012 | https://pesquisa.bvsalud.org/portal/resource/pt/lil-706324 (accessed on 13 January 2022) |
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| 61 | SCIELO   | Masticatory profile of morbidly obese subjects undergoing gastroplasty [69]                   | Marques Gonçalves, R. D. F; Zimberg Chehter, E.                                               | 2012 | https://www.scielo.br/j/reefa/c/a/cDMcdK4TtTSWhQepLR6pzzD/?lang=pt     |
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| 63 | SCIELO   | Binge eating disorder [71]                                                                     | Marques Gonçalves, R. D; Zimberg Chehter, E.                                                 | 2016 | https://www.scielo.br/j/rcefac/a/crM36KrQZBYR3W5d4RtrTfm/?lang=en       |
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| 65 | SCIELO   | Chewing and swallowing in obese children and adolescents [19]                                 | Souza, N. C. D; Ferreira Guedes, Z. C.                                                       | 2016 | https://www.scielo.br/j/rcefac/a/HypwyzNNyb9tHVPvSnRX9mJ/?lang=pt        |
| 66 | SCIELO   | Speech therapy intervention in morbidly obese patients undergoing the Fobi-Capella gastroplasty method [72] | Marques Gonçalves, R. D; Zimberg, E.                                                         | 2016 | https://www.scielo.br/j/abcd/a/a/crM36KrQZBYR3W5d4RtrTfm/?lang=en       |
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| 68 | SCIELO   | Physiology of exercise in orofacial motricity: Knowledge of the subject [74]                   | Xavier Torres, G. M; Hernández Alvez, C.                                                     | 2019 | https://www.scielo.br/j/rcefa/a/dpdp39WnSLkbj5D3hvhq7p/?lang=en         |
| 69 | SCIELO   | Chewing and swallowing in obese individuals referred for bariatric surgery/gastroplasty: A pilot study [18] | Andrade Rocha, A. C; Oliveirea De Souza, N; Davison Mangilli Toni, C. | 2019 | https://www.scielo.br/j/abcd/a/a/crM36KrQZBYR3W5d4RtrTfm/?lang=en       |
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| 71 | SCIELO   | Contributions of emotional overload, emotion dysregulation, and impulsivity to eating patterns in obese patients with binging eating disorder who seek bariatric surgery [15] | Benzerouk, F; Djerda, Z; Bertin, E; Barrière, S; Gierski, F; Kaladjian, A.                    | 2020 | https://www.mdpi.com/2072-6643/12/10/3099                              |
| 72 | SCIELO   | Alimentary and bariatric surgery: Social representations of obese individuals [76]            | Silva Gebara, T; Mocelin Polli, G; Wanderbrooke, A. C.                                      | 2021 | https://www.scielo.br/j/pcc/a/a/6XkTNs9MYqSIKkGn3V15c/abstract?format=html&lang=en |
| 73 | SCIELO   | Functional esophageal disorders in the preoperative evaluation of bariatric surgery [77]      | Oliveira Lemme, E; Cerqueira Alvariz, A; Cotta Pereira, G.                                    | 2021 | https://www.scielo.br/j/ag/a/a/Wh3kSvtxqCQY7WRnZHFpDg/abstract/?lang=pt |
Table 6. Cont.

| N  | Database   | Title                                                                                      | Author(s)                                                                 | Year | URL                                      |
|----|------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|------|------------------------------------------|
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| 75 | SPRINGER   | Obesity: Systemic and pulmonary complications, biochemical abnormalities, and impaired lung function [79] | Mafort, T. T; Rufino, R; Costa, C. H; Lopes, A. J.                     | 2016 | https://mrmjournal.biomedcentral.com/articles/10.1186/s40248-016-0066-z (accessed on 02 February 2022) |
| 76 | SPRINGER   | Obstructive sleep apnea and lung function in severely obese patients prior to and after bariatric surgery: A randomized clinical trial [80] | Aguiar, I. C; Freitas, W. R; Santos, I. R; Apostolico, N; Nacif, S. R; Urbano, J. J; Oliveira, L. V. | 2014 | https://mrmjournal.biomedcentral.com/articles/10.1186/2049-6958-9-43 (accessed on 02 February 2022) |
| 77 | SPRINGER   | Can myofunctional therapy increase tongue tone and reduce symptoms in children with sleep-disordered breathing? [81] | Villa, M. P; Evangelisti, M; Martella, S; Barreto, M; Del Pozzo, M. | 2017 | https://link.springer.com/article/10.1007/s11325-017-1489-2 (accessed on 02 February 2022) |
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| 79 | SPRINGER   | Silent gastroesophageal reflux disease in morbidly obese patients prior to primary metabolic surgery [83] | Kristo, I; Paireder, M; Jomrich, G; Felsenreich, D. M; Fischer, M; Hennerbichler, F. P; Schoppmann, S. F | 2020 | https://link.springer.com/article/10.1007/s11695-020-04959-6 (accessed on 02 February 2022) |
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Table 7 shows the characterization of the stomatognathic system from its morphological changes.

Table 7. Characterization of the stomatognathic system (morphological changes).

| Obese Patient | Structure | Post-Bariatric Patient |
|---------------|-----------|------------------------|
| Facial asymmetry with greater size in the middle and lower third of the face [18,30] | Face | Theoretical information not evidenced |
| Asymmetry in lip corners in normal position and in smile [65,70] | Nose | Theoretical information not evidenced |
| Flattened and narrow nostrils (turbinate hypertrophy) [30,36,52] | Cheeks | Theoretical information not evidenced |
| Deviated septum [34] | Maxillary | Theoretical information not evidenced |
| Tension with slight drop [18,70] | | |
| Hypertonia [18] | | |
| Hypotonia [30,54] | | |
| Dysfunction for inflating, retracting, and sucking [18] | | |
| Atretic [30] | | |
Table 7. Cont.

| Obese Patient                                                                 | Structure                      | Post-Bariatric Patient                                                                 |
|------------------------------------------------------------------------------|--------------------------------|--------------------------------------------------------------------------------------------|
| • Impaired mobility [18,47]                                                    | Mandible                      | Theoretical information not evidenced                                                     |
| • Clockwise rotation of the mandibular angle [30]                             |                                |                                                                                           |
| • Contraction during swallowing [18]                                          |                                |                                                                                           |
| • Dysfunction when protruding, retracting, and lateralizing on both sides [18]|                                |                                                                                           |
| • Decreased tone [30,54,69,70]                                                |                                |                                                                                           |
| • Without lip seal [30,54]                                                    |                                |                                                                                           |
| • Short upper lip and functioning hiccups [30]                                 |                                |                                                                                           |
| • Thick lower lip [15,29]                                                     |                                |                                                                                           |
| • Dryness [30]                                                                |                                |                                                                                           |

- **Mallampati scale with Class III (only the soft palate and uvula are visualized) and Class IV (only the hard palate is visualized) results [20]**
- **Dental caries [32]**
- **Open bite [30]**
- **Protrusion of upper teeth [66]**
- **Erosion, attrition, abrasion, and fraction [58]**
- **Loss of teeth [54]**

**Oral cavity**
- **Mallampati scale with Class III and IV on the Mallampati scale [20]**
- **Dental caries and dental erosion due to recurrent acidity in the oral cavity, with a higher prevalence in patients undergoing a Roux-en-Y gastric bypass [58]**

**Teeth**
- **Increased periodontal disease and hypersensitivity [2]**

**Tongue**
- **Abnormal position (lowered or low) [18,20,70]**
- **Volume increase [18,20]**
- **Decreased tone (hypotonia) [30,54,69]**
- **Increased tone (hypertonia) [52,69]**
- **Difficulty performing praxis or movements [30,69]**
- **Tongue covered or interposed anteriorly between the dental arches [35,54]**

**Palate**
- **Presence of noise [18]**
- **Increased length of the soft palate [52]**

**Temporomandibular articulation**
- **Presence of mental muscle tension during swallowing [18]**
- **Presence of reduced tone in temporalsis muscle [70]**
- **Hypotonic orofacial musculature [30]**
- **Mental muscle hyperfunction [30]**
- **Excessive contraction of the orbicularis oris muscle [54]**

**Muscles**
- **Left leaning posture in hyperextension [70]**
- **Hyperflexion [18]**
- **Right shoulder higher than left [70]**

**Head**
- **Narrowing due to accumulation of fat in the respiratory tract [20]**
- **Thickening of the lateral walls with little possibility of seeing the posterior pharyngeal wall [11,20,52]**
- **Mechanical obstruction of the nasopharynx (adenotonsillar hypertrophy) [36]**
- **Pharyngeal collapse [81]**

**Larynx and pharynx**
- **Theoretical information not evidenced**

Table 8 presents the characterization of the stomatognathic system from its physiological changes.
Table 8. Characterization of the stomatognathic system (physiological changes).

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Respiratory disorder with hypoventilation [13,57,62] | • Significant reduction in obstructive sleep apnea-hypopnea index >50% and -20 events per hour [13] |
| • Obstructive sleep apnea [13,18,20,40,57,61,69,81] | • Mild respiratory disturbances [57] |
| • Oral respiration [18,30,36] | • Presence of obstructive sleep apnea syndrome [57] |
| • Reduced olfactory ability due to chronic nasal obstruction [68] | • Adult respiratory distress syndrome (ARDS) [57] |
| • Respiratory failure due to collapse of the upper airway [42,53] | |
| • Decrease in the fundamental frequency due to obstruction of the air flow [52] | |
| • Diaphragmatic dysfunction [59] | |
| • Difficulty in phonorespiratory coordination [52] | |
| • Presence of snoring [36] | |
| • Presence of moderate dyspnea [12] | |
| • Hypoxia [57] | |
| • Oxygen desaturation [57] | |
| • Reduced functional residual capacity [61] | |

Respiration

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Escape during the emission of phonemes [70] | No significant improvement in MPT or maximum phonation time [11] |
| • Impaired spontaneous speech due to mandibular deviation [70] | |
| • Short maximum phonation time [11] | |
| • Altered voice quality (strangled, hoarse, and gasping) [11,79] | |
| • Presence of hoarseness, murmurs, vocal instability, altered nervousness, and brilliance; in addition, strangulation of the voice at the end of the emission [11] | |
| • Vocal fatigue with voice failure [37,52] | |
| • Phonatory dysfunction due to dehydrated mucosa [40,56] | |

Phonation

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Dental alterations [2] | Mastication Persistence of masticatory dysfunction |
| • Lack of bite force [18] | |
| • Chronic and mild unilateral preference [18,19,44] | |
| • Dehydrated mucosa [60] | |
| • No presence of grinding phase [18] | |
| • Hypotonicity of the lips and tongue [19] | |
| • Rapid masticatory pattern [70,72] | |
| • Taste reduction [80] | |
| • Alternate bilateral chewing [30] | |
| • Altered saliva production [40] | |

Masticatory dysfunction due to:

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Tension of facial muscles and altered posture [18] | Swallowing Sensation of choking or stagnation [18,70] |
| • At the level of consistencies, 50% alteration in solids and 25% alteration in liquids [18] | • Gastroesophageal reflux [2,18,70] after sleeve gastrectomy [83] |
| • Dehydrated mucosa [40] | • Binge eating disorder [43,71] |
| • Adapted swallowing [30] | • Acid reflux is increased in patients undergoing sleeve gastrectomy (SG) and decreased in patients undergoing Roux-en-Y gastric bypass (RYGB) [64] |
| • Low swallowing efficiency due to repeated swallowing of the bolus [18] | |
| • Hypotonicity of the lips and tongue [20] | |
| • Neural deterioration [83] | |
| • Multiple swallows due to cheek hypotonicity [19] | |
| • Difficulty in oral propulsion due to pharyngeal, nasal, or palatal obstruction [30] | |
| • Presence of food residues in the cavity [19,70] | |
| • Presence of large food bolus [70,72] | |
| • Gastroesophageal reflux [44,81,83] | |
| • Oropharyngeal dysphagia [64] | |
| • Esophagitis [83] | |
| • Swallowing dysfunction due to dehydrated mucosa [40] | |
| • Binge eating disorder [43,71] | |
| • Alteration in sense of taste and sensitivity of oral mucosa [77] | |
| • Nutcracker esophageal dysphagia [81] | |

Swallowing dysfunction due to:

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Hypotonicity in cheeks [18] | Suction Theoretical information not evidenced |
| • Impaired mouth breathing [30] | |
| • Absence of lip seal with interposition of the tongue [54] | |

Mastication

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Dental alterations [2] | Persistence of masticatory dysfunction |
| • Lack of bite force [18] | |
| • Chronic and mild unilateral preference [18,19,44] | |
| • Dehydrated mucosa [60] | |
| • No presence of grinding phase [18] | |
| • Hypotonicity of the lips and tongue [19] | |
| • Rapid masticatory pattern [70,72] | |
| • Taste reduction [80] | |
| • Alternate bilateral chewing [30] | |
| • Altered saliva production [40] | |

Suction

| Obese Patient | Function | Post-Bariatric Patient |
|---------------|----------|------------------------|
| • Hypotonicity in cheeks [18] | |
| • Impaired mouth breathing [30] | |
| • Absence of lip seal with interposition of the tongue [54] | |

Theoretical information not evidenced
4. Discussion

The stomatognathic system (SS) is also called the masticatory apparatus (MA), and the word “stomatognathic” originates from the Greek “stoma” (mouth) and “gnathos” (jaw). The stomatognathic system refers to structures that are anatomically and functionally linked [51] to processes related to vital functions, such as breathing, sucking, chewing, and swallowing, and social functions, such as phonation and articulation [78], and these are integrated by different structures that allow the development of each function in a harmonious and balanced way [38,41]. First, there are bony structures, such as the skull, facial bones, hyoid bone, larynx, maxilla, mandible, and bony palate. There are also muscular structures, such as the muscles for mastication and facial expression and the muscles of the tongue, soft palate, pharynx, and neck, as well as other structures, such as the head, nose, oral cavity, teeth, and shoulders [29].

Based on the above, any change or alteration in any of the bodily structures can lead to its imbalance and this will simultaneously have an effect on the performance of its functions, thereby generating a negative influence on people’s daily lives [48]. Currently, studies demonstrate that obesity is the etiology of these structural and physiological changes, given that obese patients present excessive accumulations of adipose tissue in regions that have direct effects [19,75]. To reduce the dysfunctions associated with obesity, these patients undergo surgical interventions, including bariatric surgery, which appears to have a positive impact. However, if a patient does not receive an intervention for existing alterations, the alterations reportedly persist and even worsen [39,50].

Within the investigated databases, it is possible to provide details on the characterization of the SSs of patients with obesity and post-bariatric surgery. In terms of the facial features, patients with obesity may present an asymmetry, with differences in measurements of the middle and lower thirds of the face [18,30], as well as in the corners of the lips in the habitual position and when the subjects smile [70]. A flattened nose, with a possible deviated septum and turbinate hypertrophy caused by the narrowing of the nostrils, may trigger these patients to become oral breathers and affect other SS functions [36,52]. Hypotonic cheeks, with slight sagging on one side and dysfunction in performing requested exercises, such as inflating, retracting, and sucking, may also be present [18]. However, other authors state that the cheek hypertonia of the patients included in their studies was attributable to continuous food intake, an argument contradicted by theory, as it has been determined that obese patients do not perform the chewing phase correctly and have preferences to swallow food whole [30,54].

Atretic maxilla is evidenced when the hard palate is arched or vaulted and the soft palate, for its part, is increased in length and reduced in mobility, as well as being characterized by mobility alterations in the mandible, with rotation of the mandibular angle [34], and repercussions related to the presence of noises from the temporomandibular joint. Lips show the presence of dryness and are contracted during the swallowing process. In the usual state, they do not present a lip seal, their tone is decreased [54,72], and they exhibit dysfunction when performing requested praxias (protruding, retracting, and lateralizing to both sides) [18]. The upper lip, for its part, is short and hypo-functional, and the lower lip is observed to have great volume [30].

Regarding the oral cavity, a study based on the Mallampati scale—which is useful for analyzing air obstructions that prevent its passage from the nose and mouth to the lower respiratory tract—reported that the results obtained by these patients were Class III (indicating visualization of only the soft palate and uvula) and Class IV (indicating visualization only of the hard palate) [20], states that may indicate the appearance of obstructive sleep apnea [34]. Authors emphasize that the results of this scale in the case of a post-bariatric patient will remain unchanged, since such changes only depend on the gradual loss and reduction of the BMI, as structures such as the larynx and pharynx in obese patients are affected through the accumulation of fat in the respiratory tract, thickening and narrowing the lateral walls and obstructing the nasopharyngeal mechanics (adenotonsillar hypertrophy), which is why pharyngeal collapse can occur [20,36,81].
Dental wear is the gradual loss of tooth substance without the involvement of the caries process or interference from the action of microorganisms or trauma. Changes in lifestyle, diet, and behavior play a fundamental role in this process. Patients with obesity usually consume unhealthy diets and, therefore, have an oral profile including loss of teeth [54], erosion, attrition, abrasion, and dental fraction [58], as well as other characteristics independent of their diet, such as dental caries, periodontitis [2,32,66], open bite, and upper teeth protrusion [30]. Patients undergoing RYGB present recurrent acidity in the oral cavity compared to those undergoing SG, affecting dental erosion, periodontal disease, and hypersensitivity [2,58].

The orofacial muscles are crucial for the performance of stomatognathic functions that are relevant to health and quality of life. Therefore, for example, problems may arise in chewing and in the manipulation and propulsion of the food bolus during swallowing if performance is affected [74]. In the case of patients with obesity, their musculatures will be perceived as hypotonic with hyperfunction of the mentalis muscle and tension during swallowing [30], excessive contraction of the orbicularis oris [54], and hypotonicity of the temporalis muscle [70]. Regarding the musculature of the tongue, some studies register an increased tone [52,70]; however, most studies agree that it is hypotonic [30,54,72]. In addition, an increase in volume and an abnormal position, called “cloaked or low tongue”, or sometimes interposed between the dental arches [18,20,54], can be observed.

Finally, structures such as the head, neck, and shoulders are also highlighted within the information obtained from the studies, since functional harmony between them is necessary to ensure that each of the functions involved in the SS is correctly developed. When patients with obesity accumulate fat, the circumference of their neck increases, which is considered an anthropometric predictor of the severity of obstructive sleep apnea syndrome and of a possible collapse of the upper airway [42,52]. In addition, these patients adopt a head tilt and hyperflexion posture, with one shoulder more inclined relative to the other [30].

Undoubtedly, the results obtained reflect a broad characterization of the functions of the SS in obesity. Before bariatric surgery, patients with obesity suffer from respiratory disorders, such as alveolar hypoventilation and obstructive sleep apnea [63], apnea being a condition that has been reported on multiple occasions with a wide variety of evidence in scientific articles [13,18,20,44,57,60,82]. The respiratory mode of obese patients is oral because of the numerous structural changes; a chronic nasal obstruction is possibly maintained, thereby leading to attempts to restore the function that is vital for the patient’s survival and, consequently, affecting physiological breathing [18,36]. Likewise, there is an insufficient ability to perceive odors from the environment [30]. In addition to this, the collapse in the structures that make up the upper airway [42] may lead to respiratory failure and other lung diseases, such as asthma [20]. When there is an obstruction of the flow of air coming from the pulmonary complex, the vibration of the vocal folds and the number of times per second in which they must vibrate are affected, which is known as a decreased fundamental frequency. Phonorespiratory incoordination occurs because of poor air support as a result of affected lung capacity, which leads to alterations in vocal mechanics [52].

Episodes of snoring are frequent and are the result of limitations related to and increases in respiratory effort, causing hypoventilation or slow breathing and generating sleep interruption, also known as apnea [36]. Likewise, patients experience moderate dyspnea or a feeling of shortness of breath [44], which can, in extreme circumstances, trigger hypoxia, decreased oxygen supply to various tissues, or low desaturation [57] and reduced residual lung capacity. This indicates inadequate chest expansion and can, therefore, affect normal respiratory function [76]. Obstructive sleep apnea persists even after bariatric surgery; however, the development of adult respiratory distress syndrome is also possible [61]. In contrast, some bibliographic bases show the existence of a significant reduction in the rate of obstructive sleep apnea and hypopnea by ≥50% and of nocturnal episodes to <20 events per hour, which can be characterized as adequate or within a range of possible normality [57].
In the phonatory field, one study reports, through a speech evaluation, an air leak during the emission of phonemes, with mandibular deviation during spontaneous speech [70], as well as a short maximum phonation time, justified because ventilatory pressures are lower than expected during inspiration and expiration, causing a reduction in respiratory muscle strength, lung capacity, and respiratory reserve volume [11]. Obese patients present with fatigue and phonatory dysfunction because of the dehydration of the mucosa of the area, generating altered vocal qualities (strangled, hoarse, and gasping voice), the presence of murmurs, vocal instability, nervousness, and prosodic alteration of speech or vocal brightness [52]. However, these patients do not report significant improvements in the maximum phonation time after undergoing the surgical procedure [11].

The masticatory patterns of patients with obesity undergoing bariatric surgery are strongly affected. The characteristics are maintained before and after bariatric surgery, which means that the masticatory dysfunction does not change and is persistent. This dysfunction is caused by dental alterations, the cause of which is, theoretically, the high level of recurrent acidity in the oral cavity, which causes caries, erosion, or loss of teeth and dental hypersensitivity [2], as well as, simultaneously, a weak bite force. There is also a chronic unilateral preference [18,73] and mild mucosa in the dehydrated area [40], without a crushing phase, according to the food bolus [18], and hypotonicity, or low muscle tone, in the lips and tongue [28]. Chewing speed is also affected [69,70], and some patients show the ability to taste outside the normal parameters or decreased ability to taste [30] and low production of saliva or hyposalivation, which leads to difficulty in moistening and macerating food adequately and satisfactorily [40].

The swallowing function of patients with obesity, like the other vital functions, is also affected owing to the tension in the facial muscles and the abnormal position of the tongue during chewing (hooded or lowered tongue). The information that suggests that obese patients swallow repeatedly or abnormally is new, with alterations of 50% for swallowing solid consistencies and 25% for swallowing liquid consistencies [18]. The mucosa that converges in the process of swallowing food is dehydrated [4]. The swallowing pattern is classified as having low efficiency because of repeated swallowing of the bolus or multiple swallows [18]. These changes make it difficult to propel the food orally, in addition to the existence of pharyngeal, nasal, or palatal obstructions [30]. Patients may also show food residues in the oral cavity [70], a large food bolus construct [27,31], gastroesophageal reflux disease [32,44,83], and oropharyngeal dysphagia (OFD) [55], a symptom that refers to the difficulty in forming or moving the food bolus toward the pharyngeal wall or toward the esophagus and which is concurrently related to difficulty in oral propulsion. OFD causes alterations in safety (possible aspiration pneumonia) and efficacy (dehydration and malnutrition), thereby increasing the morbidity and mortality of individuals experiencing this condition and, consequently, deteriorating their quality of life [46,73]. Other features of the swallowing function in obese patients include esophagitis or inflammation, which damages the duct that extends from the throat to the stomach [83], and binge eating disorder or compulsive behavior through binge eating, where the main characteristic is loss of control over what is eaten [43,71]. The swallowing reflex is well coordinated with breathing patterns in normal humans. However, patients with obstructive sleep apnea syndrome may have a swallowing disorder that reflects abnormal nerve and muscle function in the suprathyrlnx [34].

Furthermore, the observation that patients with obesity have a nutcracker-shaped esophagus is frequently related to an anomaly or to hypercontractile motor disorder with characteristically high amplitude waves in the distal esophagus—the main symptoms being chest pain and dysphagia [81]. All the abovementioned alterations are categorized under the terms “swallowing dysfunction” and “adapted swallowing”. Theory defines adapted or atypical swallowing as an alteration in the oral phase of swallowing that is characterized by the inadequate position of the tongue and other structures of the oral cavity and that appears when there is an alteration in the form and function of the same. This altered pattern is observed when the structures of the oral cavity have to
adapt as a consequence of a structural or functional alteration [60]. Sensations of choking or stagnation [18], gastroesophageal reflux [2,18], and binge eating disorder [43,71] are alterations that, according to theory, continue to present even after the postoperative period, which indicates that swallowing dysfunction persists after bariatric surgery.

In addition, the reviewed studies show the mechanical effects of obesity on pulmonary physiology and the function of adipose tissue, this latter being an endocrine organ that produces systemic inflammation and affects central respiratory control [49]. Patients with morbid obesity show increased total, airway, peripheral, and tissue system resistance, even though they do not show limitations in expiratory flow or reduced respiratory muscle strength [63]. The already mentioned mechanical effects on the respiratory system can trigger dyspnea, wheezing, and cough, thereby becoming a morbidity of the respiratory system [47]. Major respiratory complications of obesity are considered to include increased ventilatory demand, increased effort in breathing, respiratory muscle inefficiency, and decreased respiratory compliance [48].

Changes in respiratory system compliance and lung volumes can negatively affect pulmonary gas exchange and lead to upper airway obstruction and sleep-disordered breathing. Therefore, the perioperative period should be carefully observed [82]. Among other things, decreased functional residual capacity, decreased expiratory reserve volume, decreased compliance, and increased resistance of the respiratory system imply breathing with low lung volume, promoting airway closure in dependent lung zones with consequent abnormalities in gas exchange, even though the capacity of the lungs to diffuse carbon monoxide is normal or increased [83].

Obesity is characterized by increased systemic and pulmonary blood volume (pulmonary vascular congestion). The concomitant abnormal diffusion of the alveolar membrane suggests subclinical interstitial edema. In this setting, functional abnormalities should encompass the entire distal lung, including the airways [38]. These abnormalities are caused by the reduction in lung volume at rest; however, airway inflammation, vascular congestion, and/or concomitant intrinsic airway disease may occur [41]. A study of obese women demonstrated that the airways are characterized by hyperreactivity. Bronchial hyperreactivity is an exaggerated response of the bronchial mucosa and is the cause of bronchospasm. Some of the agents that can trigger bronchial hyperreactivity are respiratory infections, substances present in the environment, such as pollen or smoke, and certain drugs [72].

Global dysfunction of the distal lung (alveolar membrane and distal airways) is associated with pulmonary vascular congestion and failure to reach the high-output state of obesity. Pulmonary vascular congestion and consequent fluid transudation and/or alterations in alveolar-capillary membrane structure can be considered as often unrecognized causes of airway dysfunction in obesity [41].

One study describes the phenotype of pulmonary dysfunction in obesity as reduced functional residual capacity (FRC) with airway narrowing, distal respiratory dysfunction, and bronchodilator response [38]. The repercussions of obesity on respiratory function are associated, above all, with the restrictive alteration caused by excess adipose tissue. Increased fat in the chest and abdomen can shift the elastic equilibrium point between the chest and lungs, thereby reducing FRC [42]. Obesity also significantly interferes with respiratory function by decreasing lung volume, particularly expiratory reserve volume, and FRC [84].

For this reason, bariatric surgery effectively reduces neck and waist circumference, increases peak ventilatory pressures, improves sleep architecture, and reduces sleep-disordered breathing, specifically obstructive sleep apnea, in patients with severe obesity [80].

5. Conclusions

There are compromises that negatively affect the harmonious and joint form of the morphological and physiological unit that is the stomatognathic system (SS) in patients with obesity, which are due to an imbalance caused by the concentrated accumulation of
adipose tissue characteristic of a BMI ≥ 40 kg/m² or between 35 and 39.9 kg/m² above that established for normality according to an individual’s height.

Breathing, chewing, and swallowing are the functions of the stomatognathic system in patients with obesity that provided the most information during the evidence search process. Most of the articles investigated coincided in specific information, which allowed the broad characterization of each of these functions and, in the same way, of those structural alterations that play a significant role in said functions. The most cited were lip dysfunction; cloaked tongue, or lingual and cheek hypotonia; lip hypotonia with no lip seal; the presence of periodontitis; dysfunction in the width and height of the hard palate; and, finally, thickening of the lateral walls of the pharynx.

Swallowing dysfunctions caused by gastroesophageal reflux may vary according to the bariatric procedure performed. If the patient undergoes RYGB, acid reflux will decrease, given the implications of the procedure, unlike if they undergo SG, which favors an increase in acid reflux in these patients and, simultaneously, the alteration of the stomatognathic system (SS) at the morphological level.

The information evidenced within the literature reflects the need to develop and implement multidisciplinary work with obese patients before and after they undergo bariatric surgery, given that the alterations of the stomatognathic system, if not treated in the preoperative period, may persist and even worse, thereby negatively impacting these patients’ quality of life.

After performing an exhaustive search on the stomatognathic system in patients with obesity before and after surgery and analyzing all the information obtained on the structural and functional alterations of this system, we noted that there is ample and clear evidence regarding the condition of obese patients who are candidates for bariatric surgery. However, when considering post-bariatric patients in relation to the stomatognathic system, the information changes and shows great limitations. Certainly, in this case, the data obtained were scarce.

It is evident how interest in bariatric surgery has grown in recent years. The number of bariatric surgeons has been progressively increasing, along with the number of patients undergoing these surgeries, which highlights considerable positive impacts on weight loss, metabolic control, and self-esteem, among others. However, many other diseases in obese patients that compromise this population’s quality of life, such as those of the SS, have been forgotten, and there is a lack of knowledge about the advantages of this surgery for the SS.

Considering the abovementioned information, the greatest contribution of this review would be to arouse interest in the evaluation of patients with obesity before and after surgery beyond weight control. A comprehensive and multidisciplinary evaluation should be performed that includes breathing, chewing, and swallowing as basic functions to be analyzed, thereby allowing patients to have a great opportunity to improve their quality of life.

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