Systematic Review Article

Evaluation of quality of life after orthognathic surgery in obstructive sleep apnea syndrome: a systematic review

Inês Francisco[a]; Raquel Travassos[b]; Anabela Baptista Paula[c]; Bárbara Oliveiros[d]; Filipa Marques[e]; Madalena Prata Ribeiro[e]; Mariana McEvoy[f]; Mariana Santos[f]; Catarina Oliveira[f]; Carlos Miguel Marto[g]; Eunice Carrilho[c]; Catarina Nunes[b]; Francisco Vale[a]

ABSTRACT

Objectives: To develop a systematic review of patient perspectives on the treatment of obstructive sleep apnea syndrome (OSAS) after undergoing orthognathic advancement surgery.

Materials and Methods: This systematic review adhered to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines, and Patient, Intervention, Comparison, and Outcome (PICO) methodology was employed to formulate the research question. A literature search was performed using the following databases: Cochrane Library (Trials), PubMed via MEDLINE, Embase, and Web of Science (all databases). The Newcastle-Ottawa Scale was used to assess quality of the studies.

Results: Initially, 1407 articles were retrieved from diverse databases, and these were subjected to initial scrutiny. Subsequently, 17 articles were selected for thorough quality analysis and 6 studies for quantitative analysis. Most studies were classified as good quality. Maxillomandibular advancement surgery appeared to enhance patient satisfaction in cases of moderate to severe adult OSAS.

Conclusions: Maxillomandibular advancement surgery significantly improves patients' subjective overall quality of life, improving by 6.36 points in questionnaire ratings and demonstrating long-term stability. (*Angle Orthod*. 2025;95:104–125.)

KEY WORDS: OSA; Orthognathic surgery; Quality of life; Orthodontics

[a] Professor, Institute of Orthodontics; and Coimbra Institute for Clinical and Biomedical Research (iCBR), Area of Environment Genetics and Oncobiology (CIMAGO); and Laboratory for Evidence-Based Sciences and Precision Dentistry; and Clinical Academic Center of Coimbra (CACC); and Centre for Mechanical Engineering, Materials and Processes (CEMMPRE), Advanced Production and Intelligent Systems (ARISE), Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal.

[b] Guest Assistant, Institute of Orthodontics; and Coimbra Institute for Clinical and Biomedical Research (iCBR), Area of Environment Genetics and Oncobiology (CIMAGO); and Laboratory for Evidence-Based Sciences and Precision Dentistry; and Clinical Academic Center of Coimbra (CACC); and Centre for Mechanical Engineering, Materials and Processes (CEMMPRE), Advanced Production and Intelligent Systems (ARISE), Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal.

[c] Professor, Institute of Orthodontics; and Coimbra Institute for Clinical and Biomedical Research (iCBR), Area of Environment Genetics and Oncobiology (CIMAGO); and Institute of Integrated Clinical Practice; and Laboratory for Evidence-Based Sciences and Precision Dentistry; and Clinical Academic Center of Coimbra (CACC); and Centre for Mechanical Engineering, Materials and Processes (CEMMPRE), Advanced Production and Intelligent Systems (ARISE), Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal.

[d] Professor, Coimbra Institute for Clinical and Biomedical Research (iCBR), Area of Environment Genetics and Oncobiology (CIMAGO); and Centre for Innovative Biomedicine and Biotechnology (CIBB); and Clinical Academic Center of Coimbra (CACC); and Laboratory of Biostatistics and Medical Informatics; and Laboratory for Evidence-Based Sciences and Precision Dentistry, University of Coimbra, Coimbra, Portugal.

[e] Guest Assistant, Institute of Orthodontics, Faculty of Medicine, University of Coimbra, Coimbra, Portugal.

[f] Postgraduate Student, Institute of Orthodontics, Faculty of Medicine, University of Coimbra, Coimbra, Portugal.

[g] Guest Assistant. Coimbra Institute for Clinical and Biomedical Research (iCBR), Area of Environment Genetics and Oncobiology (CIMAGO); and Institute of Integrated Clinical Practice; Institute of Experimental Pathology; and Laboratory for Evidence-Based Sciences and Precision Dentistry; and Clinical Academic Center of Coimbra (CACC); and Centre for Mechanical Engineering, Materials and Processes (CEMMPRE), Advanced Production and Intelligent Systems (ARISE), Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal.

Corresponding author: Dr Inês Francisco, Orthodontics, Faculty of Medicine, University of Coimbra, Av. Bissaya Barreto, Bloco de Celas, Coimbra 3000-075, Portugal
(e-mail: ines70.francisco@gmail.com)

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INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) has an incidence ranging from 5% to 25% in adults, and it is more commonly observed in men (2–4%) than in women (1–2%).[1–7] OSAS is defined according to the number of abnormal respiratory events that occur per hour of sleep. Apneas are pauses in breathing of at least 10 seconds, and hypopneas are characterized by a reduction in air volume, accompanied by a decline of up to more than 4% in blood oxygen saturation, lasting more than 10 seconds. A patient is diagnosed with apnea when at least five such episodes occur per hour.[4,5,8,9] At night, the most frequent and obvious symptom is snoring. Breathing difficulties can lead to several awakenings during the night.[2,4,8,10–12] During the day, OSAS patients often complain of headaches, tiredness, difficulty in concentrating, memory loss, stress, and moodiness. These complaints tend to worsen throughout the day.[2,4,6,7,9,11,13,14]

There are two main risk factors for the development of OSAS: low upper airway volume or the presence of constriction that leads to increased airflow resistance. Thus, OSAS is related to predisposing anatomical factors such as craniofacial anomalies, macroglossia, hypotonia of the soft tissues of the oropharynx, tongue base retro position, mandibular hypoplasia, and maxillary retro position/retrusion.[1] The reduction in jaw length may have repercussions on the oropharyngeal dimensions between the soft palate and the tongue and between the soft palate and the pharyngeal wall.[2,4,8] This phenomenon is explained by the fact that the soft palate is enlarged by about 20%, further reducing the efficiency of the airway. Despite tongue size being normal, its functional space is reduced due to the decreased length of the mandible, which forces it to recede into the pharynx.[2,4]

OSAS can predispose to several cardiovascular and metabolic implications, which are believed to be due to a lower saturation of hemoglobin levels during sleep, resulting in neurocognitive impairment and, subsequently, a lower quality of life (QOL).[1,5] Nocturnal hypoxemia occurs whenever there are episodes of apnea, and if these episodes are prolonged, they may result in hypertension and heart problems. Cardiac arrhythmia, nocturnal angina, and myocardial ischemia can also occur, the latter potentially resulting in an acute myocardial infarction.[2,7–11]

The gold-standard nonsurgical treatment technique for individuals with OSAS is continuous positive airway pressure (CPAP). This treatment is shown to be effective in reducing symptoms and consequently improving the patient's overall QOL. However, despite being an effective technique, it heavily relies on patient cooperation.[6,7] For this reason, orthognathic surgery for maxillomandibular advancement of approximately 10 mm provides an alternative to the use of CPAP in cases of moderate to severe OSAS.[5,10,11,15–17] This surgery promotes an increase in airway dimensions, reducing potential airway collapse during sleep.[9,10,14,16–18] Authors of previous studies assessing the satisfaction of OSAS patients after undergoing orthognathic advancement surgery reported that most were satisfied with the outcomes.[9] However, unsatisfactory results regarding facial esthetics have also been reported, even if they achieved airway improvement.[6,11,15] Understanding the patient's perspective when choosing the treatment is key to providing more personalized and effective health care, ensuring that his or her needs, preferences, and concerns are considered throughout the therapeutic process. This study aimed at investigating and evaluating the available evidence regarding QOL after surgical treatment in OSAS management.

MATERIALS AND METHODS

Protocol Registration

The protocol was registered in PROSPEPO (CRD42023448337). The review was carried out according to preferred reporting items for systematic reviews and meta-analysis (PRISMA) criteria.

PICO Question

The Patient, Intervention, Comparison, and Outcome (PICO) question was chosen considering the patient's perspective, namely, expectations and satisfaction in QOL after orthognathic surgery. The PICO question was: "In patients with OSAS, does orthognathic surgery increase the quality of life?"

The outcome assessed was the patient's perspective (QOL, satisfaction, side effects, and experience with treatment).

Database Search Protocol

For this systematic review, a search was made in several databases including Medline (PubMed), Web of Science all databases, Embase, and Cochrane. Table 1 describes the search keys used, when conducted on July 3, 2023.

Beyond these databases, search of the gray literature was also done on the Websites: OpenGrey Europe (https://opengrey.eu, accessed on March 10, 2023) and ProQuest (https://www.proquest.com, accessed on July 3, 2023).

Analysis of Eligibility Criteria

The chosen inclusion criteria comprised randomized clinical trials, retrospective and prospective cohort studies, cross-sectional studies, and case-control studies

Table 1. Search Keys of Several Databases

Databases	Search Keys
PubMed via MedLine	("Sleep Apnea Syndromes"[Mesh] OR "Sleep Apnea*" OR "Apnea Syndrome, Sleep" OR "Apnea Syndromes, Sleep" OR "Sleep Hypopnea*" OR "Hypopnea, Sleep" OR "Hypopneas, Sleep" OR "Apnea, Sleep" OR "Apneas, Sleep" OR "Hypersomnia with Periodic Respiration" OR "Sleep-Disordered Breathing" OR "Breathing, Sleep-Disorder*" OR "Sleep Disordered Breathing" OR "Sleep-Disorder Breathing" OR "Sleep Disorder Breathing" OR "OSA" OR "OSAS") AND ("Orthognathic Surgery"[Mesh] OR "Orthognathic Surger*" OR "Surgery, Orthognathic" OR "Surgeries, Orthognathic" OR "Orthognathic Surgical Procedures"[Mesh] OR "Orthognathic Surgical Procedure*" OR "Procedure, Orthognathic Surgical" OR "Procedures, Orthognathic Surgical" OR "Surgical Procedure, Orthognathic" OR "Surgical Procedures, Orthognathic" OR "Jaw Surger*" OR "Surgeries, Jaw" OR "Surgery, Jaw" OR "Maxillo-Mandibular Surger*" OR "Maxillo Mandibular Surger*" OR "Surgeries, Maxillo-Mandibular" OR "Surgery, Maxillo-Mandibular" OR "Surgeries, Maxillofacial Orthognathic" OR "Surgery, Maxillofacial Orthognathic") Filters. Language EN, SP, FR, PT
Web of Science all databases	("Sleep Apnea*" OR "Apnea Syndrome, Sleep" OR "Apnea Syndromes, Sleep" OR "Sleep Hypopnea*" OR "Hypopnea, Sleep" OR "Hypopneas, Sleep" OR "Apnea, Sleep" OR "Apneas, Sleep" OR "Hypersomnia with Periodic Respiration" OR "Sleep-Disordered Breathing" OR "Breathing, Sleep-Disordered" OR "Sleep Disordered Breathing" OR "OSA" OR "OSAS") AND ("Orthognathic Surger*" OR "Surgery, Orthognathic" OR "Surgeries, Orthognathic" OR "Orthognathic Surgical Procedure*" OR "Procedure, Orthognathic Surgical" OR "Procedures, Orthognathic Surgical" OR "Surgical Procedure, Orthognathic" OR "Surgical Procedures, Orthognathic" OR "Jaw Surger*" OR "Surgeries, Jaw" OR "Surgery, Jaw" OR "Maxillo-Mandibular Surger*" OR "Maxillo Mandibular Surger*" OR "Surgeries, Maxillo-Mandibular" OR "Surgery, Maxillo-Mandibular" OR "Surgeries, Maxillofacial Orthognathic" OR "Surgery, Maxillofacial Orthognathic") (Topic) and English or French or Spanish or Portuguese (Languages) and Review Article or Abstract or Meeting or Letter or Editorial Material or Patent or Book (Exclude—Document Types) Filters. Language EN, SP, FR, PT
Embase	('sleep apnea*':ti,ab,kw OR 'apnea syndrome, sleep':ti,ab,kw OR 'apnea syndromes, sleep':ti,ab,kw OR 'sleep hypopnea*':ti,ab,kw OR 'hypopnea, sleep':ti,ab,kw OR 'hypopneas, sleep':ti,ab,kw OR 'apnea, sleep':ti,ab,kw OR 'apneas, sleep':ti,ab,kw OR 'hypersomnia with periodic respiration':ti,ab,kw OR 'sleep disordered breathing'/exp OR 'sleep-disordered breathing':ti,ab,kw OR 'breathing, sleep disordered':ti,ab,kw OR osa:ti,ab,kw OR osas:ti,ab,kw) AND ('orthognathic surgery'/exp OR 'orthognathic surger*':ti,ab,kw OR 'surgery, orthognathic':ti,ab,kw OR 'surgeries, orthognathic':ti,ab,kw OR 'orthognathic surgical procedure*':ti,ab,kw OR 'procedure, orthognathic surgical':ti,ab,kw OR 'procedures, orthognathic surgical':ti,ab,kw OR 'surgical procedure, orthognathic':ti,ab,kw OR 'surgical procedures, orthognathic':ti,ab,kw OR 'jaw surger*':ti,ab,kw OR 'surgeries, jaw':ti,ab,kw OR 'surgery, jaw':ti,ab,kw OR 'maxillomandibular surger*':ti,ab,kw OR 'maxillo mandibular surger*':ti,ab,kw OR 'surgeries, maxillo-mandibular':ti,ab,kw OR 'surgery, maxillo-mandibular':ti,ab,kw OR 'maxillofacial orthognathic surger*':ti,ab,kw OR 'orthognathic surgeries, maxillofacial':ti,ab,kw OR 'orthognathic surgery, maxillofacial':ti,ab,kw OR 'surgeries, maxillofacial orthognathic':ti,ab,kw OR 'surgery, maxillofacial orthognathic':ti,ab,kw) AND ([english]/lim OR [french]/lim OR [portuguese]/lim OR [spanish]/lim) AND ([article]/lim OR [article in press]/lim OR [data papers]/lim OR [letter]/lim) Filters. Language EN, SP, FR, PT

Cochrane	ID	Search	Hits
	#1	MeSH descriptor: [Sleep Apnea Syndromes] explode all trees	3389
	#2	"sleep apnea"	8129
	#3	"sleep apneas"	111
	#4	"apnea syndrome, sleep"	14
	#5	"apnea syndromes, sleep"	869
	#6	"sleep hypopnea"	0
	#7	"sleep hypopneas"	1
	#8	"hypopnea, sleep"	7
	#9	"hypopneas, sleep"	0
	#10	"apnea, sleep"	412
	#11	"apneas, sleep"	3
	#12	hypersomnia with periodic respiration	0
	#13	"sleep-disordered breathing"	3381
	#14	"breathing, sleep-disordered"	4
	#15	"sleep disordered breathing"	3381
	#16	OSA	3950
	#17	OSAS	709
	#18	MeSH descriptor: [Orthognathic Surgery] explode all trees	64

Table 1. Continued

Cochrane	ID	Search	Hits
	#19	"orthognathic surgery"	601
	#20	"orthognathic surgeries"	29
	#21	"surgery, orthognathic"	40
	#22	"surgeries, orthognathic"	0
	#23	MeSH descriptor: [Orthognathic Surgical Procedures] explode all trees	279
	#24	"orthognathic surgical procedure"	5
	#25	"orthognathic surgical procedures"	199
	#26	"procedure, orthognathic surgical"	0
	#27	"procedures, orthognathic surgical"	8
	#28	"surgical procedure, orthognathic"	0
	#29	"surgical procedures, orthognathic"	7
	#30	"jaw surgery"	65
	#31	"jaw surgeries"	4
	#32	"surgeries, jaw"	2
	#33	"surgery, jaw"	11
	#34	"maxillo-mandibular surgery"	0
	#35	"maxillo-mandibular surgeries"	0
	#36	"maxillo mandibular surgery"	0
	#37	"maxillo mandibular surgeries"	0
	#38	"surgeries, maxillo-mandibular"	0
	#39	"surgery, maxillo-mandibular"	0
	#40	"maxillofacial orthognathic surgery"	1
	#41	"maxillofacial orthognathic surgeries"	0
	#42	"orthognathic surgeries, maxillofacial"	0
	#43	"orthognathic surgery, maxillofacial"	3
	#44	"surgeries, maxillofacial orthognathic"	0
	#45	"surgery, maxillofacial orthognathic"	0
	#46	(#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17) AND (#18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45)	

involving patients with OSAS patients undergoing orthognathic surgery. The studies included were required to report patient perceptions regarding QOL, satisfaction, experience with treatment, and side effects.

Umbrella reviews, systematic reviews, case series studies, case reports, editorials, conference abstracts, book chapters, guidelines, protocols, and opinion papers were excluded from the analysis. Studies including patients with systematic diseases, known genetic syndromes, and participants without an OSAS diagnosis were also excluded.

Study Selection

Two researchers (M.M. and C.O.) were tasked with selecting articles based on predefined inclusion and exclusion criteria. In cases where there was a difference of opinion, a third investigator (C.N.) reviewed the articles in question. The initial assessment of studies involved screening titles and abstracts. Articles that met the inclusion criteria underwent a comprehensive full-text reading.

Data Collection and Synthesis of Results

The included studies underwent thorough examination, and the following information was extracted: author and year of publication, sample size, sex distribution, mean age of patients, type of orthognathic surgery (unilateral or bilateral), parameters assessed, evaluation instruments used, key findings, conclusions drawn, and additional observations.

The findings derived from the selected papers were presented through a combination of narrative and tabular formats, aligning with the PICO question. To report the results, an approach inspired by the work of other researchers in the field was followed.

Risk of Bias Assessment of Included Studies

The Newcastle-Ottawa Scale was used to assess the quality of the cohort studies and was employed by two independent reviewers (I.F. and R.T.). The methodological quality score for both study types was calculated

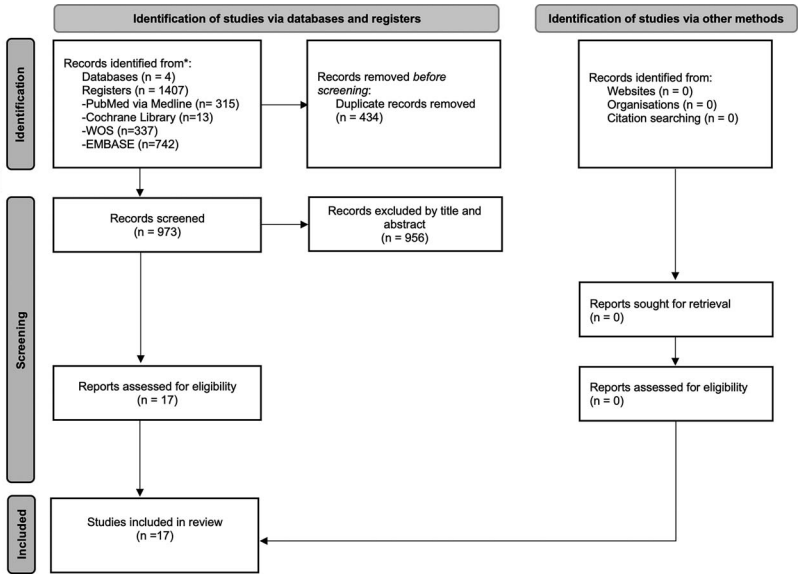

Figure 1. Preferred reporting items for systematic reviews and meta-analysis (PRISMA) flowchart diagram.

based on three domains: selection (0–4 points), comparability (0–2 points), and outcome (0–3 points). The reviewers answered a series of multiple-choice questions for each domain based on their reading and understanding of each study. Within the selection and exposure domains, a maximum of one point could be awarded for each numbered item, while a maximum of two points could be awarded for comparability. Therefore, the scores ranged from 1 to a maximum of 9 points.

Statistical Analysis

Meta-analysis was performed using a random effects model for paired differences after evaluating heterogeneity between studies through the Higgins and Thompson I^2 and presented in a forest plot. Publication bias was visually accessed through the funnel plot and its absence confirmed by the Egger test. Analysis was conducted in R version 4.2.1 using the package metaphor, and it was evaluated at a 5% significance level.

RESULTS

Study Selection

From the eligibility processes, 1407 articles were initially found, none of which had cross-references. After removing duplicates, 973 articles were analyzed by title and abstract, resulting in 17 articles to be read in full (Figure 1). Of the 17 articles included in this systematic review, 17 were evaluated qualitatively, and 6 were subjected to quantitative evaluation.

Characteristics of the Included Studies

The studies included were published between 2004 and 2023, with 10 of the 17 included being published in 2020 or more recently. Study samples ranged from 10 to 210 individuals, obtaining a total sample of n = 690 with an average age of 45.8 years. In all studies, more men than women were included, except for one study in which authors did not mention patient sex.[5]

The most commonly referred instruments were Epworth Sleepiness Scale (ESS; n = 9), 36-Item Short Form Survey (SF-36; n = 4), Functional Outcomes of Sleep (n = 3), Ottawa Sleep Apnea (n = 2), and Rustemever's (n = 2). The most evaluated outcomes were sleep quality, daytime function, facial esthetics, dental function, and emotional health. Follow-up of the included studies ranged from 2 months to 20 years, with authors of only one study not reporting this information.[15] Authors of most studies evaluated patient QOL by examining improvements in function, with the most commonly reported outcomes including sleep quality, daytime performance, dental function, and emotional health. Of these variables, the ones that reported the most improvement were sleep quality (average 4.02) and daytime performance (average 3.7). Patients with OSAS did not show significant differences in masticatory function before and after surgery. Authors of studies that evaluated the Apnea-Hypopnea Index (AHI) observed a significant reduction, with at least 1° of severity being reduced. Authors of six of the included articles also considered esthetic evaluation of orthognathic surgery to treat OSAS. Most patients reported that the facial changes brought about by orthognathic surgery improved their overall facial appearance, namely, facial rejuvenation, smile appearance, and nasal

Table 2. Characteristics of Included Studies in the Qualitative Analysis[a]

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Cillo et al.,[19] 2020	Retrospective cohort	27	59.1 ± 11.7 y	M = 15, F = 12	OSA-Q
Cillo and Dattilo,[20] 2020	Retrospective cohort	27	59.8 y	M = 15, F = 12	7-point VAS

* statistically significant value; [a] AHI indicates Apnea-Hypopnea Index; BAI, Beck Anxiety Inventory; BDI, Beck Depression Index; BMI, body mass index; CAD/CAM, computer-aided design/computer-aided manufacturing; CI, confidence interval; CPAP, continuous positive airway pressure; ESS, Epworth Sleepiness Scale; FOSQ, Functional Outcomes of Sleep Questionnaire; ISI, Insomnia Severity Index; MMA, maxillo-mandibular advancement; NR, not reported; NS, not statistically significant; OSA, obstructive sleep apnea; OSA-Q, Ottawa Sleep Apnea Questionnaire; PSG, polysomnography; PSQI, Pittsburgh Sleep Quality Index; QOL, quality of life; REM, rapid eye movement; RDI, Respiratory Disturbance Index; SCHNOS-C, Standardized Cosmesis and Health Nasal Outcomes Survey-cosmesis domain; SCHNOS-O, Standardized Cosmesis and Health Nasal Outcomes Survey-obstruction domain; SF-36, 36-Item Short Form Survey; VAS, visual analog scale; VAS-C, Visual Analogue Scale for Concentration; VAS-F, Visual Analogue Scale for Fatigue.

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA	12.7 ± 3.8 y	Overall QOL	Subjective responses to sleep quality, daytime function, physical health, mental and emotional health, and sexual health.	Outcomes with statistical differences: Sleep quality: 3.69 ± 1.03 ($P < .01$); functional desires: 3.89 ± 1.24 ($P < .01$); personal satisfaction: 3.39 ±1.42 ($P < .05$). Outcomes without statistical differences: Daytime function: average 3.42 ± 0.97; physical health: average 3.28 ± 1.05; emotional health: average 3.21 ± 0.78; sexual desires: average 2.78 ± 0.60; dental function: average 2.65 ± 1.16. Overall QOL: 3.25 ± 1.56 ($P < .05$).	MMA for OSA provided significant improvement in overall patient QOL as well as personal satisfaction, sleep quality, and functional outcomes at very long-term follow-up.
MMA	12.7 ± 3.8 y	Subjective assessment of perioral neurosensory deficit intensity	Subjective assessment of specific oral functional behaviors: chewing, swallowing food and fluids, smiling, spitting, kissing, eating, and speaking.	(1) Subjective oral functional behavior assessment: Most subjects (85%) reported no to minimal difficulty with the oral functional behaviors ($P < .05$), namely, chewing, swallowing food, swallowing, smiling, spitting, kissing, eating, drooling, and speaking. (2) Subjective neurosensory assessment: Most subjects (85%) reported mild to no overall mean perioral neurosensory intensity deficit. (3) Correlation between subjective assessments of neurosensory intensity deficits and oral functional behaviors: Statistically significant moderate to strong positive correlations were found between the subjective oral functional behaviors and perioral neurosensory deficit intensity for chewing (r = 0.74), kissing (r = 0.50), eating (r = 0.80), speaking (r = 0.81), and drooling (r = 0.67).	Strong positive correlations between the subjective decreased perioral neurosensory deficit intensity and decreased oral function behavior difficulty suggest that the return of perioral neurosensation might contribute to the return of oral functional behavior.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Dattilo and Drooger,[21] 2004	Prospective cohort study	57	47.2 y	M = 43, F = 14	RDI, ESS
Rossi et al.,[9] 2022	Retrospective clinical study	18	44.39 ± 9.43 y	M = 17, F = 1	Rustemeyer's questionnaire. Postoperative: Quality-of-life domains of the OSA-18 questionnaire
Rossi et al.,[17] 2022	Retrospective clinical study	61 (OSA: n = 21; Class II: n = 12; Class III: n = 28)	34.75 ± 11.33 y	M = 33, F = 29	SF-36 questionnaire, Rustemeyer's questionnaire

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
Phase I: Hyoid suspension, palatal surgery, and/or genioglossus advancement. Phase II: MMA	≥8 wk	Objective changes using the RDI); subjective changes using the ESS.		Functional outcomes (RDI and ESS): (1) Phase I surgery: 80% success rate; (2) Phase II: >95% success rate. Improvement in ESS scores and excessive daytime sleepiness seems to parallel the improvement in OSS scores in patients undergoing surgical correction of OSA.	Both procedures are effective in treating OSA. MMA appears to be more effective in treating OSA.
MMA	32.64 ± 21.91 mo	Overall satisfaction and QOL	Results of the CAD/CAM and traditional surgery were compared.	(1) Rustemeyer's questionnaire: Postoperative satisfaction: 79.72 ± 9.96% (Group A: 81.5 ± 11%; Group B: 76.9 ± 8.9%); patient satisfaction was not significantly different in CAD/CAM patients when compared to traditional surgery (P = .32). (2) Postoperative QOL questionnaire: Improvement after surgery but no significant difference between the two groups; slightly significant (P = .04) reduction of the BMI in the postop period (from 29.06 ± 4.53 to 27.65 ± 3.45).	Maxillomandibular advancement surgery seems to be beneficial in terms of patients' satisfaction in severe adult OSAS patients
MMA	65.47 ± 26.36 mo	Patients' satisfaction and QOL		(1) Rustemeyer: Overall postoperative satisfaction score was 84.92 ± 14.72%; satisfaction with facial aesthetics: statistically significant differences (P = 0.035); satisfaction with chewing function: no difference (P = .028), but significant difference in non-OSA patients. (2) SF-36 student t-test results: Emotional well-being 0.002*; general health 0.003*; health transition 0.009*; physical functioning 0.03; role limitations due to physical health < 0.001*; role limitations due to emotional problems <0.001*; energy/fatigue < 0.001*; social functioning < 0.001*; bodily pain 0.331.	Satisfaction for facial aesthetics and chewing function for OSA patients did not change much when preoperative and postoperative values were compared.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Boyd et al.,[10] 2019	Prospective multicenter cohort study	30	45.9 ± 9.8 y	M = 19, F = 11	ESS, SF-36, FOSQ
Butterfield et al.,[22] 2016	Retrospective cohort study	22	45.9 ± 11.6 y	M = 19, F = 3	OSA-Q
Chintalapudi et al.,[15] 2020	Prospective cohort study	210	38.2 ± 14.0 y	M = 104, F = 106	Survey of the lay public. Each preoperative and postoperative image was accompanied by 7-point Likert scales rating 6 emotional expressions and 6 personality traits.

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA	7.2 ± 2.0 mo	ESS, SF-36, FOSQ	Changes in general QOL: SF-36	(1) ESS: Mean score: decreasing from 13.3 to 4.9 ($P < .001$); difference: −8.5 ± 5.7; 95% CI = −10.54, −6.46. (2) FOSQ: Mean score: increased from 14.1 to 18.3 ($P < .001$); difference: 4.1 ±2.8; 95% CI = 3.10, 5.10. (3) SF-36: Improvement in general QOL, as each of the functional domains of the survey. (4) AHI: Mean score: decreasing from 39.6 to 7.9 events per hour ($P < .001$).	MMA is a very effective and safe treatment for OSA, consistently resulting in major improvements in sleepiness, QOL, sleep-disordered breathing, and neurocognitive performance, along with a decrease in cardiovascular risk factors such as blood pressure.
MMA	2–61 mo	Change in the QOL detected (OSA-Q)	Change in the AHI	QOL questionnaire: Overall mean: increased QOL: 3.98 ±0.35); sleep quality: 4.35 ±0.63; daytime function: 4.13 ±0.46; physical health: 4.19 ±0.45; mental and emotional health: 4.02 ± 0.55; sexual health (3.78 ± 0.62). All categories were improved postoperatively ($P < .001$).	MMA for OSA significantly improves patient's subjective overall QOL, with few MMA-related side effects.
MMA	NR	Changes in emotional and personality traits	Change in the AHI	Evaluation of facial expressions: Association between MMA surgery and emotional perception (Wilks $\lambda = 0.89$; $F_{6,203} = 4.23$; $P < .01$); no association between personality perception and MMA (Wilks $\lambda = 0.95$; $F_{6,185} = 1.73$; $P = .12$); after surgery, patients are less sad (−0.59; $P < .01$) and less disgusted (−0.54; $P < .01$).	MMA was accompanied by favorable changes in the lay perceptions of emotional but not personality traits.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Martin et al.,[23] 2022	Cohort	10	49.9 y	M = 7, F = 3	5-point Likert scale, ESS, 10-point Likert scale
Pottel et al.,[24] 2019	Retrospective study	12	43.5 y	M = 10, F = 2	OSAS questionnaire, ESS
Goodday et al.,[5] 2016	Retrospective cohort study	13	38.6 ± 8.4 y	NR	ESS, postoperative questionnaire carried out at least 6 mo after surgery

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA	2 mo	Psychosocial and functional domains as well as patient satisfaction	NR	(1) ESS: Improved from 15.1 to 4.3 (P = 0.0005); 90% of patients reported an improvement in snoring and sleepiness after 1 wk; all patients reported improvements in all the psychosocial and functional domains. (2) Aesthetic evaluation: Only half of the patients reported improvements, with no significant differences. (3) Overall QOL: Improved from 2.8 to 8.1, with a high rate of around 90% of patients.	MMA is a highly effective treatment in selected patients with OSAS who cannot tolerate CPAP. All patients favored surgery over CPAP in terms of symptom control.
MMA	14–20 y	Overall quality of life	Change in AHI	ESS: Median score at long-term: 5 (range, 1–13); headache: median 4 (range, 0–4); blood pressure: median 1 (range, 0–5); daytime sleepiness: median v4 (range, 1–5); concentration: median 2 (range, 1–5); insomnia: median 3 (range, 0–5); nycturia: median 5 (range, 4–5); snoring: median 4 (range, 3–5); sexual relationship: median 0.5 (range, 0–3).	MMA surgery is a safe and effective alternative to CPAP in the long-term treatment of OSAS patients.
MMA	Mean: 21 mo	Objective data: AHI gathered from PSGs performed before and a minimum of 6 mo after surgery in the same lab.	Subjective assessment of the presence of snoring, witnessed apneas, use of CPAP, and general satisfaction.	(1) AHI: pre 117.9 $\pm$ 9.2 and post 16.1 $\pm$ 26.2. (2) ESS: pre 12.9 $\pm$ 5.5 (P = .004) and post 5.0 $\pm$ 4.1. (3) BMI: pre 38.8 $\pm$ 10.9 and post 37.3 $\pm$ 8.0. (4) Snoring: pre 9 and post 2. (5) Apneas: pre and post 1. (6) Daytime sleepiness: pre 9 and post 2. (7) CPAP: pre 6 and post 1. 8 patients reported favorable change after MMA, and 9 patients considered the surgery worthwhile.	MMA can be a highly successful surgery that eliminates the use of CPAP, improving subjective outcomes and the AHI.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Lin et al.,[25] 2020	Cohort study	53	35.66 ± 11.66 y	M = 40, F = 13	ESS, PSQI, ISI, BAI, BDI, SF-36
Ruiter et al.,[26] 2020	Cohort study	41	55 ± 10 y	M = 35, F = 20	EQ-5D-3L, FOSQ, VAS

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA	Before, 1 and 2 y after treatment	Long-term outcomes of MMA, using PSG, as well as questionnaires and neurocognitive function tests.	Long-term complications of MMA and discussed about facial esthetic issue for Far East Asians	(1) AHI: 34.78 ± 26.01 (pre), 3.61 ± 2.79 (post 1 y), 7.43 ± 6.70 (post 2 y), decreased arousal index ($P < .001$), decreased snore index ($P = .035$), decreased systolic pressure ($P = .022$) and increased stage N2 sleep. (2) PSQI global score: 8.71 ± 3.71 (pre), 5.86 ± 2.41 (post 1 y), 6.55 ± 3.20; $P = .001$ (post 2 y). (3) ISI total: 12.79 ± 6.12 (pre), 8.78 ± 7.00 (post 1 y), 10.73 ± 6.26 (post 2 y). (4) BAI: 6.09 ± 7.81 (pre), 4.57 ± 6.02 (post 1 y), 4.55 ± 7.69; $P = .672$ (post 2 y). (5) BDI: 11.88 ± 10.04 (pre), 9.70 ± 10.13 (post 1 y), 112.87 ± 12.08; $P = .123$ (post 2 y). (6) ESS:10.78 ± 5.00 (pre), 9.47 ± 5.21 (post 1 y), 10.24 ± 5.14 $P = .137$ (post 2 y).	MMA is a clinically effective treatment for patients with moderate to severe OSA as demonstrated by significant long-term decrease in AHI and improvement in neurocognitive testing.
MMA	After MMA surgery	Overall QOL	Changes in facial esthetics	(1) AHI: 54 ± 22 (pre) and 18 ± 17 (post). (2) EQ-5D-3L showed a lower overall score. (3) ESS: 6.3 ± 5.4; $P = .102$ (post). (4) FOSQ: 16.0 ± 3.3 $P = .003$ (post). In this OSA patient population, the satisfaction after MMA surgery was correlated with the outcome of the ESS, FOSQ, and EQ-VAS: −0.368 ($P = .027$), 0.620 ($P < .001$), and 0.537 ($P < .001$), respectively. The EQ-VAS showed a correlation with the ESS and FOSQ: 0.326 ($P = .043$) and 0.599 ($P < .001$), respectively.	Patients generally reported no significant alteration in their perceived facial esthetics before or after the MMA procedure. If postoperative esthetics were negatively perceived by the patient, MMA was considered a surgical failure.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
González et al.,[27] 2020	Retrospective cohort study	25	46.68 y	M = 23, F = 2	SF-36, "Do you consider your esthetic change to be positive after surgery?" "Do you consider your facial profile to be more youthful after surgery?"
Beranger et al.,[28] 2017	Retrospective study	23	45.7 y	M = 15, F = 8	ESS, subjective evaluation of changes in facial aesthetics (slimmer and younger appearance) and changes in the smile, as seen by themselves and their friends.
Boyd et al.,[29] 2015	Cohort study	30	50.5 ± 9.6 y	M = 24, F = 6	ESS, FOSQ

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA	At least 9 mo after surgery	Facial esthetics and QOL	NR	(1) QOL questionnaire (SF-36): Improve significantly, obtaining a mean of 48.86 ± 13.19 (pre) and 71.74 ± 14.39 (post); mean difference of −22.87 ± 10.55. (2) Aesthetic evaluation: 88% considered that their esthetic outcome had been positive; 52% considered having a more youthful profile.	Results presented using the FS-36 survey should be considered for monitoring the response to treatment in OSAS patients. MMA is a clinically effective treatment.
MMA	At least 6 mo after surgery	Facial esthetics and QOL	Morphological modifications to bone and soft tissue following surgery on preoperative and postoperative lateral cephalograms.	(1) QOL questionnaire (ESS): 4.1 (post) (2) Aesthetic evaluation: 14 subjects (60.8%) considered that they were improved or significantly improved. The impressions of family and friends were identical to those of the patients. 11 patients (47.8%) considered their smile improved or significantly improved. (3) Overall satisfaction with the procedure: Very satisfied: 13 (56.5%); satisfied: 8 (34.8%); dissatisfied: 1 (4.3%); very dissatisfied: 1 (4.3%).	MMA for the treatment of OSA obtained a high satisfaction, with 91% overall satisfaction and 78.2% of patients who observed no negative effects on their facial appearance.
MMA	At a minimum of 2 y after surgery	AHI	Blood pressure ESS, FOSQ	(1) AHI: 49 ± 20 (pre); 10.9 ± 15; $P < .0001$ (long-term). (2) ESS: 12.1 ± 4.9 (pre); 6.0 ± 3.9; $P < .01$(long-term). (3) %REM sleep score: 10.3 ± 9.4 (pre); 16.6 ± 7.5; $P < .05$ (long-term). (4) FOSQ: 12.6 ± 3.6 (pre); 17.3 ± 2.4; $P < .05$ (long-term). (5) Blood pressure: 1306.0 ± 13.0 (pre); 133.0 ± 13.0; $P > .05$ (long-term).	MMA is a clinically effective long-term treatment for patients with moderate to severe OSA, with significant improvements in QOL.

Table 2. Continued

Author/Year	Study Design	Sample Size	Mean Age of Patients	Sex	Instruments (Questionnaires)
Abdelwahab et al.,[18] 2023	Prospective cohort	31	38 ± 11 y	M = 28, F = 3	Standardized Cosmesis and Health Nasal Outcomes Survey, VAS for nasal function and cosmesis, ESS

cosmetics. These changes promote alterations in lay perceptions of emotions. Authors of all studies reported that maxillomandibular advancement surgery for OSAS provided significant improvement in overall patient QOL as well as personal satisfaction, sleep quality, and functional outcomes at very long-term follow-up. It should be noted that improving perioral neurosensation contributes to the recovery of oral functional behavior. Table 2 shows a summary of the characteristics of the included studies.

Synthesis of the Best Evidence

Considering the results of the quantitative assessment, the selected papers showed a high heterogeneity between studies ($I^2 = 74.36\%$), so a random effects model was applied, observing a mean effect of 6.36 ± 1.33 with statistical significance ($P < .001$; Figure 2). One study had a smaller effect than what was expected, creating heterogeneity.[25] Despite this fact, according to Egger's test, no publication bias was found (the effect size reported by the authors of the studies did not depend on their precision: $b = 1.33$; $P = .139$). Therefore, the results were clinically significant, demonstrating that maxillomandibular advancement surgery significantly improves overall subjective QOL for patients.

Risk of Bias

The quality assessment of the included studies is summarized in Table 3. Most studies were classified as good quality (≥7 points) except for two studies that were classified as fair.[15,17] It was observed that all studies had three or four stars in the selection domain, one or two stars in comparability, and two or three stars in the outcome/exposure domain. Of the studies considered to be of good quality, six had the minimum score in this category,[15,17] and three studies had a maximum score of nine.[10,29,30]

DISCUSSION

OSAS is a respiratory disease that interferes with the QOL of patients. The aim of this review was to assess the impact of surgical treatment for OSAS on QOL. The results obtained showed that this treatment provided a significant improvement in overall QOL as well as in personal satisfaction, sleep quality, and functional results in very long-term follow-up.

The prevalence of obstructive sleep apnea varies according to sex and age, being more common in men and increasing with age. At 63.4% vs 36.6%, males exhibit a higher prevalence than females, as described in the literature. Physiological differences between the sexes, such as anatomy and physiology of the upper airway, may be indicative of these differences. Obesity and hormonal differences may also explain the sex difference; however, the exact mechanisms remain unknown.[19,31–34] Additionally, the severity of OSAS increases with age and is more prevalent after the age of 50.[33,35] According to results of the present study, the age of patients with OSAS ranged from 34.75 ± 11.33 to 59.8 years. As described by Gabbay and Lavie,[34] the average age of OSAS patients is 51.12 ± 13.01. Also, it should be noted that, in females, there is a linear increase in the AHI with increasing age, while in males, there is a sharp increase from the age of 20 to 40, and after this age, a linear increase is maintained.[34]

From the patient's perspective, QOL can be assessed through several outcomes related to function, mental

Table 2. Extended

Type of Surgery	Follow-Up	Primary Outcomes	Secondary Outcomes	Results	Conclusions
MMA with the nasal modification	64 d	Function (obstruction), cosmesis	Daytime sleepiness	(1) SCHNOS-O: Improved from 44.38 ± 26.21 to 19.03 ± 4.75 ($P < .001$). (2) SCHNOS-C: Improved from 13.95 ± 19.32 to 5.27 ± 8.93 ($P = .029$). (3) VAS-F: Improved from 4.22 ± 2.61 to 1.07 ± 1.79 ($P < .001$). (4) VAS-C: Improved from 6.81 ± 2.39 to 8.52 ± 1.39 ($P < .001$). (5) Daytime sleepiness: Improved from 9.41 ± 6.11 to 3.26 ± 3.03 ($P < .001$).	The patients' perception of nasal obstruction and appearance improved.

health, sleep quality, esthetics, and postoperative condition. Functional outcomes evaluate daily productivity, activity levels, mobility, chewing, phonation, swallowing, and sexual life quality. Sleep quality is assessed through issues like insomnia, daytime sleepiness, nocturnal diuresis, and snoring. Esthetic outcomes focus on facial changes from orthognathic surgery, while mental health outcomes address well-being, emotional status, mood, anxiety, and depression. Finally, postoperative condition is evaluated based on recovery experiences such as pain or discomfort. Currently, several questionnaires for assessing QOL in OSAS patients exist, such as the ESS, QOL/Functional Outcomes of Sleep Questionnaire (FOSQ), Patient-Reported Outcome Measures (PROMS), Rustemeyer's, Ottawa Sleep Apnea Questionnaire (OSA-Q), European Quality of Life-5D (EQ-5D). These are recognized as an important means of assessing the impact of OSAS symptoms and, in addition, comparing the presurgical and postsurgical status of maxillomandibular advancement.[9,10,13,17,19,21,22,29,30] Of the various questionnaires analyzed, the most widely used was the ESS. This consists of a subjective assessment that evaluates the degree of daytime sleepiness.[36,37] Walker et al.[38] analyzed the clinical usefulness of this questionnaire, demonstrating the results obtained were reliable compared with other means of clinical assessment such as polysomnography. However, some authors identified some disadvantages in this questionnaire, namely, inconsistencies in the results after repeating the test, measurements of different variables between populations, as well as the sensitivity of negative results.[39–41]

Walia et al.[42–44] stated in their study that both the EQ-5D and the FOSQ are valid instruments for measuring QOL, with one being more global and the other being a more specific measure of sleep quality, respectively. Chasens et al.,[45] Rey de Castro et al.,[46] and Weaver et al.[47] described a self-reported measurement of functional status through which it is possible to understand how sleep-related problems interfere with everyday activities, and therefore, the FOSQ was developed and validated to capture patient experiences comprehensively. On the other hand, the EQ-5D questionnaire was developed to describe and assess health-related QOL, rather than just a specific disease, to complement other existing assessment measures.[48,49]

Rustemeyer et al.[50] developed a questionnaire consisting of 14 questions asked during the first year after surgery to evaluate the negative effects of the postoperative period (edema and pain). This questionnaire aims at assessing both the factors that affect patient satisfaction and expectations after undergoing orthognathic surgery. Thus, it was concluded that the factors that contributed most to patient satisfaction were the improvement in masticatory function and facial esthetics. Rustemeyer et al.[50] also cited other questionnaires regarding the QOL of a patient with OSAS with the aim of assessing sleep quality, daytime sleepiness, energy levels, daily activities, mood, sexual activity, social outcome, and daily productivity, referring to satisfaction comparing situations before and after orthognathic surgery; significant improvements were reported in QOL in general and sleep quality in particular.[19,20,22,23,27,30,31]

OSAS is a disease with a multifactorial etiology, which presents a potential risk for the development of other pathologies, such as alterations in the nervous system, inflammatory responses, oxidative stress, endothelial dysfunction, and a prothrombotic state, increasing the risk of cardiovascular diseases.[51] Additionally, sleep

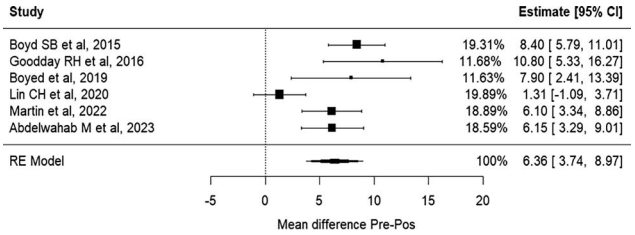

Figure 2. Forest plot of quantitative analysis.

deprivation is related to symptoms of anxiety and depression and, consequently, to a worse educational outlook and QOL.[52] QOL and patient satisfaction are increasingly important in the field of clinical health, and it is important to guarantee patients a better QOL when choosing the most suitable therapeutic options.[53,54]

The dual benefit of improved functionality and enhanced appearance often results in high satisfaction rates, as patients experience both health benefits and psychological gains. However, a small percentage of patients are dissatisfied. This dissatisfaction is not usually associated with surgical complications but with other factors, such as an undesired esthetic result, functional reasons, and unfulfilled psychosocial expectations.[55] In this sense, it is particularly important to assess the existence of psychological difficulties, namely, the presence of body dysmorphic disorder (BDD), to design a treatment plan adapted to each patient. This pathology involves a distorted perception of body image and is characterized by an exaggerated preoccupation with an imagined anomaly in physical appearance or with a minimal bodily defect present.[56] A study carried out by Vulink et al.[57] in 2008 revealed that 10% of patients undergoing orthognathic surgery met the criteria for BDD and, according to Phillips et al.,[58] the presence of BDD was related to lower satisfaction with the results.[59]

Patient satisfaction after orthognathic surgery tends to increase over time as recovery progresses and the esthetic and functional benefits become more evident. Initially, patients may experience discomfort and swelling, which can temporarily affect their QOL and perception of the results. Authors of studies have indicated that overall satisfaction with the surgery is high, with many patients also experiencing improvements in self-esteem and psychological well-being. In the long term, these factors contribute to a positive perception of the surgical results, highlighting the importance of adequate follow-up and support during the recovery process.[60,61] Patients undergoing orthognathic surgery who experience psychological distress before the procedure generally report a greater recovery burden and face more challenges with symptoms, social and self-related concerns, and general health during the first 1 or 2 months postsurgery.[62] Authors of the studies included in this analysis conducted postsurgical follow-ups after 2 months, which may help minimize the initial negative assessments. Most patients reported overall satisfaction with the treatment, noting significant improvements in oral function, facial esthetics, and respiratory issues.

This study had some limitations, one of which was that it only included retrospective and prospective studies, and no randomized controlled trial studies, which could contribute to a greater risk of bias, as those studies included did not all have a homogeneous sample.

Table 3. Risk of Bias

	Items								
	Selection				Comparability	Outcome			
Studies	1	2	3	4	1	1	2	3	Score
Cillo et al.,[19] 2020	*	*	*	*	**	**	*		9
Cillo and Dattilo,[20] 2020	*	*	*	*	**	*	*		8
Dattilo and Drooger,[21] 2004		*	*	*	**	*	*	*	8
Rossi et al.,[9] 2022		*	*	*	**	*	*	*	8
Rossi et al.,[17] 2022		*	*	*	*	*	*		6
Boyd et al.,[10] 2019	*	*	*	*	**	*	*	*	9
Butterfield et al.,[22] 2016		*	*	*	**	*	*	*	8
Martin et al.,[23] 2022		*	*	*	**	*	*	*	8
Pottel et al.,[24] 2019		*	*	*	**	*	*	*	8
Goodday et al.,[5] 2016		*	*	*	**	*	*	*	8
Lin et al.,[25] 2020		*	*	*	**	*	*		7
Ruiter et al.,[26] 2023		*	*	*	**	*	*		7
González et al.,[27] 2022		*	*	*	**	*	*	*	8
Beranger et al.,[28] 2017		*	*	*	**	*	*		7
Boyd et al.,[29] 2015	*	*	*	*	**	*	*	*	9
Abdelwahab et al.,[18] 2023		*	*	*	**	*		*	7
Chintalapudi et al.,[15] 2020		*	*	*	*	*	*		6

Additionally, according to the COMET Initiative, which seeks to facilitate the development and application of a set of outcomes in various medical fields, there is an agreed minimum set of outcomes that should be measured and reported in all clinical trials of a specific disease or test population. This set presents seven main outcomes, including the impact of esthetic self-perception, alignment and/or occlusion, skeletal relationship, stability, patient-related compliance, breakage, and adverse effects on teeth or tooth-supporting structures. When evaluating these questionnaires, not all of these parameters were considered. Nevertheless, the results showed that, in general, patients with OSAS, after undergoing orthognathic surgery for mandibular advancement and/or maxillomandibular advancement, show improvements in QOL.

CONCLUSIONS

- Maxillomandibular advancement surgery significantly improves patients' subjective overall QOL, improving by 6.36 points in questionnaire ratings and demonstrating long-term stability.

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