REVIEW

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Long-Term Quality-of-Life Outcomes After Endoscopic Resection of Sinonasal and Skull Base Tumours: A Systematic Review and Meta-Analysis

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Abstract

Introduction: The present meta-analysis and systematic review aims to address the gap by examining long-term quality-of-life outcomes following endoscopic resection of sinonasal and skull base tumours. **Materials and procedures:** We searched databases such as PubMed, Scopus, Embase, and Google Scholar for research publications published between 2005 and 2024, following the PRISMA guidelines. R software was used to perform the meta-analysis, and Cochrane's ROB 2.0 tool was employed to assess the risk of bias in the included studies. The I^2 statistic was used to evaluate heterogeneity. A funnel plot, along with Egger's regression test, was used to assess publication bias. **Results:** The meta-analysis showed that quality of life (QOL) typically declined shortly after surgery, with a statistically significant worsening indicated by the SNOT-22 score (standardized mean difference [SMD] 0.49; 95% CI: 0.01 to 0.96) and a non-significant change on the ASBQ score (SMD -2.72; 95% CI: -10.93 to 5.49). However, results from the SNOT-20 score suggested a non-significant immediate improvement (SMD -4.70; 95% CI: -23.95 to 14.55). In the long term, patients experienced a clear and statistically significant overall improvement in QOL ($p < 0.01$), reflected by reductions in SNOT-22 (SMD -0.23; 95% CI: -0.61 to 0.14) and SNOT-20 scores (SMD -5.46; 95% CI: -26.93 to 16.02), alongside an increase in ASBQ scores (SMD 0.77; 95% CI: -2.18 to 3.71). **Conclusion:** Endoscopic resection of sinonasal and skull base tumours significantly improves postoperative sinonasal quality-of-life (QOL) symptoms. Although symptoms may temporarily worsen during the perioperative period, most patients generally return to baseline QOL in the long term.

Keywords: Sinonasal- Anterior Skull base surgery- HRQOL- minimally invasive

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Introduction

With an annual incidence rate of roughly 0.55 incidences per 100,000 population, sinonasal cancers are extremely uncommon [1]. Treatment usually comprises surgical excision followed by radiotherapy (RT) or chemoradiotherapy (CRT), except for early-stage tumours [2].

In carefully chosen situations, endoscopic tumour resection has become the gold standard for surgical management of sinonasal and base of the skull tumours, whereas historically open techniques were initially employed [3].

As the paradigm turns towards long-term surveillance for disease recurrence, comprehending the quality of life (QOL) for sinonasal tumours and pertinent determinants becomes more crucial than ever [4].

By enabling dynamic visualisation from a wide panorama to a close-up view and the capacity to "look around corners," the endoscopic technique to the anterior base of the skull revolutionised skull base surgery [5] and expanded the operative boundaries of pituitary surgery [6]. Direct anatomical access to numerous intracranial and paranasal sinus lesions is another significant benefit of the endoscopic endonasal approach. This approach also avoids the aftermath of a skin incision, facial bone flap or craniotomy, and brain retraction that are unavoidable with traditional neurosurgical incisions, which leads to a reduction in discomfort, complications, morbidity, and mortality as well as, indirectly, shorter hospital stays and management expenses [7].

There are still significant gaps in our knowledge of how the endoscopic approach affects patient quality of life (QOL), even though surgical outcomes and complication

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profiles are comparable, if not improved [8-15], between more recent endoscopic techniques and conventional open and combined open and endoscopic approaches.

The present meta-analysis and systematic review aim to fill the gap by finding long-term quality-of-life outcomes after endoscopic resection of sinonasal and skull base tumours.

Materials and Methods

The research was recorded in the PROSPERO (CRD42024539204). This research was conducted in accordance with the PRISMA guidelines for systematic reviews and meta-analysis [16].

Eligibility criteria

Inclusion Criteria: The researchers incorporated trials into their study that met the following conditions: (a) they had to be either RCTs or controlled clinical studies in the English language; (b) the participants must have been adult patients or survivors of all types of sinonasal mass or anterior skull base mass both benign and malignant treated with minimally invasive endoscopic resection; (c) the study had to compare quality of life before and after surgery in long term follow up period;

Exclusion Criteria: (a) Research focusing on individuals with end-stage diseases, hospice patients, or studies in which a long-term follow-up period of at least more than 3 months was not considered were eliminated. (b) Articles older than 15 years of publication (before the year 2011) were also excluded. (c) Observational studies were not included.

Information sources

We searched databases like PubMed, Scopus, Embase, and the Cochrane database for research publications published between 2011 and 2025, using the PRISMA guidelines.

Search strategy

Various search terms were used to search the English language articles between the years 2011 and 2025 in databases which included ‘‘Health-related quality of life’’, “HRQOL”, ‘‘Quality of Life’’, ‘‘QOL’’, ‘‘SNOT-22’’, ‘‘SNOT-20’’, ‘‘ASBQ’’, ‘‘Sinonasal mass’’, ‘‘Anterior skull base mass”, “nasal mass”, “Randomized control trials”, “minimally invasive resection” and “endoscopic resection”. To find further papers, we also looked through the bibliographies of pertinent articles.

Selection process

Each author independently evaluated the eligibility of each study after they were located in the databases. If the writers had any discrepancies, they thoroughly discussed them to resolve them.

Data collection process

The eligibility of each study was determined using the titles and abstracts. Next, the authors reviewed complete trial texts deemed potentially eligible to confirm their eligibility (see Figure 1). Paired reviewers assessed the eligibility of each trial and gathered information on the trial’s characteristics and the impact of the intervention on outcomes. Disputes among reviewers were resolved through consensus or by bringing in a third reviewer. To obtain any needed details or clear up confusion, the authors contacted the original trial author.

Data items

The first researcher’s name, publication year, country, size of the sample, mean age, and key findings were extracted from the retrieved publications using a standardized form (Table 1).

Study risk of bias assessment

The Risk of Bias tool 2.0, created by Cochrane, was employed for assessing the quality of randomized controlled trials. The quality is assessed using five areas: (1) Risk of Bias in Randomization Process; (2) Risk of Bias in Deviations from Intended Interventions; (3) Risk of Bias in Missing Outcome Data; (4) Risk of Bias in Measurement Process; and (5) Risk of Bias in Reporting Process.

Effect measures

Patient self-reported outcomes involved a change in standardized mean difference with 95% confidence intervals before and after minimally invasive endoscopic resection of sinonasal and skull base tumours measuring overall health-related quality of life through Sinonasal outcome test scores, SNOT-22, and SNOT-20 along with Anterior Skull Base Questionnaire (ASBQ) scores. I2 values were used to evaluate heterogeneity.

Synthesis methods

Trial data that showed no significant clinical differences were combined in a meta-analysis when appropriate. The authors combined all studies in a random-effects meta-analysis using R software version 4.3.0 to calculate the standardized mean difference (SMD) and 95% confidence interval (CI) of the intervention effect estimate. A meta-analysis was conducted for each type of measurement and long-term follow-up time frame, as the trial results were reported in the form of a change in score from baseline to follow-up data.

Reporting bias assessment

Funnel plots were made to express publication bias.

Results

Study selection

After applying the keywords, a total of 532 items were identified; out of these, 236 articles were removed due to being duplicates. Due to not being in English, 73 articles were removed. The 193 articles that didn’t fit the requirements for inclusion were removed. 92 studies did not have an abstract, while 182 studies were too old, so not included in the research. Following thorough consideration and review, the authors selected 18 articles deemed appropriate for the meta-analysis. Figure 1 shows the PRISMA flow diagram that illustrates the detailed

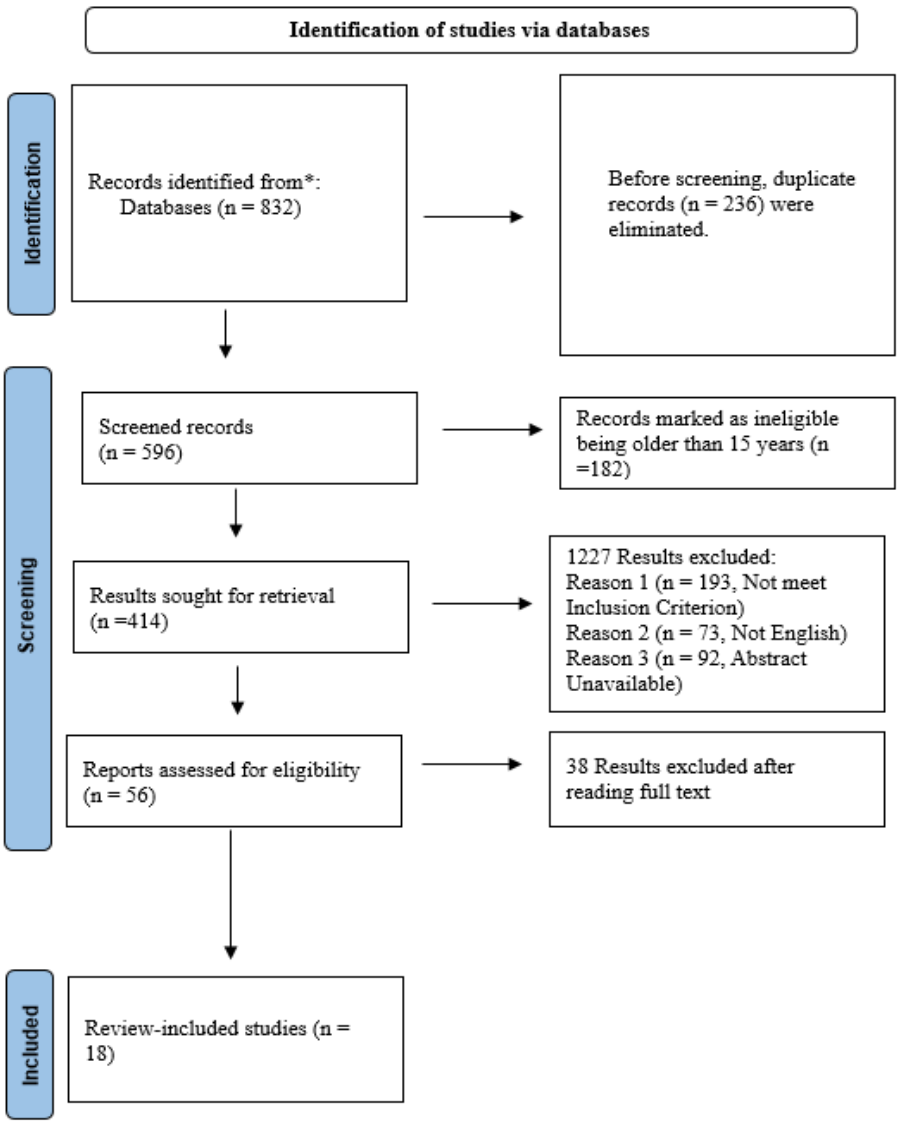


Figure 1. PRISMA Flow Diagram

selection procedure.

Study characteristics

In the meta-analyses, 2119 individuals treated with minimally invasive endoscopic resection of sinonasal and skull base tumours were evaluated in 18 randomized control trials. Most of the research was conducted in the USA of America (n=9). On the other hand, the remaining studies took place in China (n= 1), Canada (n= 1), South Korea (n= 1), Czech Republic (n= 1), Brazil (n= 1), Australia (n= 1), Netherlands (n= 1), Israel (n= 1), and Italy (n= 1). The papers from 2012 and 2025 were the oldest and newest, respectively. The quality of all papers was assessed following Cochrane's ROB 2.0 guidelines, with papers being categorized as either "Low", "Medium" or "High" quality. Table 1 provides the details of the studies that are included in the list.

Risk of bias in studies

In most instances, all 18 studies were found to have a minimal risk of bias, as Figure 2 illustrates. There was a low level of bias overall.

Results of syntheses and individual studies

In the forest plots, the standardized mean difference (SMD) for each study is represented by a black square, while the horizontal line extending through it indicates the 95% confidence interval. The diamond symbol illustrates the pooled overall effect of endoscopic resection on quality of life in patients with sinonasal and skull base tumors.

As depicted in Figure 3, quality of life decreased in the immediate postoperative period, with a pooled SMD of 0.49 (95% CI: 0.01 to 0.96) based on the SNOT-22 score and -2.72 (95% CI: -10.93 to 5.49) based on the ASBQ score. Conversely, the SNOT-20 score showed a non-significant immediate improvement, with an SMD of -4.70 (95% CI: -23.95 to 14.55). Heterogeneity exceeded 50% across all analyses. The short-term decline in quality of life was statistically significant ($p < 0.01$).

As illustrated in Figure 4, patients experienced a long-term improvement in quality of life following surgery. This was demonstrated by decreases in SNOT-22

Table 1. Characteristics of the Study Involved

Author and Year of Publication	Total Sample Size and Country	Mean age (SD/Age Range) in years	Major Findings
Abiri et al, [4]	373, USA	59.9 (13.2)	Despite the fact that patients seem to see long-lasting improvement as early as three months after surgery, the nasal, sleep, and otologic/facial components substantially influence QOL outcomes associated with inverted papilloma excision.
Carmel Neiderman et al. [17]	43, Israel	55.93 (17.6)	The study demonstrated that patients who underwent endoscopic pituitary lesion resection maintained high nasal- and tumour-related quality of life over a 5-year follow-up period.
Castle-Kirszbaum et al. [18]	50, Australia	61.5	Endoscopic endonasal surgery improves overall QOL after a transient 3-week worsening due to the sinonasal morbidity of the approach.
Dolci et al. [19]	30, Brazil	Oct-76	Patients who had pituitary adenoma resection by endoscopic transsphenoidal surgery reported significant improvements in nasal function and all other physical and mental domains on the global and site-specific forms in the sixth post-operative month follow-up, indicating the procedure's safety and effectiveness.
Novak et al. [20]	65, Czech Republic	54.7 (24-79)	The endoscopic endonasal approach in patients with a sellar tumour is a gentle method with minimal effects on sinonasal quality of life over longer than six months.
Li et al. [21]	40, China	50.7 (32-69)	Using validated instruments specific to the location and sinonasal-related QoL showed an overall preservation of postoperative QoL in comparison to preoperative QoL. One effective treatment option for people with recurrent NPC is endoscopic endonasal excision.
Seo et al. [22]	767, South Korea	51.34 (15.73)	Patients treated with the expanded endoscopic endonasal approach had a considerably lower quality of life (QOL) linked to their sinuses than those treated with the endoscopic transsellar technique. The only factor that negatively predicts sinonasal quality of life following endoscopic skull base operations is the insertion of a Naso-septal flap.
Riley et al. [23]	46, USA	49.3 (16.3)	After Naso septal flaps are used for endoscopic anterior base of skull surgery, most patients have an overall improvement in their long-term sinonasal QOL.
Wu et al. [24]	45, Canada	54 (14.6)	Following endoscopic transsphenoidal base of skull surgery, sinus quality of life declined at the 0–1 month follow-up but reached preoperative levels at the 2–4-month mark and stayed there for more than 5 months.
Glicksman et al. [3]	145, USA	Malignant: 58.6, Benign: 51.8	Unlike previously documented studies, this cohort's QoL appears to improve after endoscopic removal of sinonasal tumours and lasts for two years.
Jones et al. [25]	34, USA	56.1 (15.2)	Age <55 was significantly linked to better QOL. ASBQ and SNOT-22 readings before and after surgery were compared in a subgroup of patients. The only score that increased significantly was SNOT-22.
Van Samkar et al. [26]	34, Netherlands	58.9 (40-85)	According to the disease-specific SNOT-22 questionnaire, patients who have endoscopic excision of sinonasal inverted papillomas return to a nearly normal quality of life.
Derousseau et al. [27]	104, USA	Sinonasal cancer: 58.1, Inverted papilloma: 56.4	At one and two years, the long-term impacts of MIER for sinus cancer demonstrated enhanced psychological and sleep scores. Sadly, at none of the time points that were assessed, rhinologic QOL showed a statistically significant improvement. The most significant predictor of QOL for sinonasal malignancy two years following MIER was found to be a history of smoking.
Patel et al. [28]	31, USA	49.3 (17.1)	When compared to preoperative QOL, this report of verified site-specific QOL after an endoscopic operation for craniopharyngiomas demonstrates a significant increase in postoperative maintenance.
Castelnuovo et al. [29]	153, Italy	58.8	Within the first year following radical endoscopic endonasal resection, the patient's quality of life either fully or at least partially recovered.
Harrow et al. [30]	94, USA	55.2 (10.9–89.1)	Overall SNOT-20 scores improve after Minimally Invasive Endoscopic Resection (MIER), with patients with benign tumours and females showing the biggest decrease. A lower enhancement of sinonasal Quality of Life (QOL) following surgery is highly predicted by prior smoking and chemoradiation.
McCoul et al. [31]	85, USA	52.5(20–83)	Endoscopic skull base resection is linked to a final improvement in quality of life connected to the sinuses and has no negative long-term effects. Sinonasal-related QOL deficits are self-limiting and predictable in the short run. Additional data regarding ESBS outcomes can be obtained through prospective evaluation utilising sinonasal-related and specific to the site QOL tools.
Ransom et al. [32]	14, USA	55	Compared to open craniofacial excision, full endoscopic excision of anterior base of skull tumours is oncologically sound and has been shown to increase anecdotal quality of life.

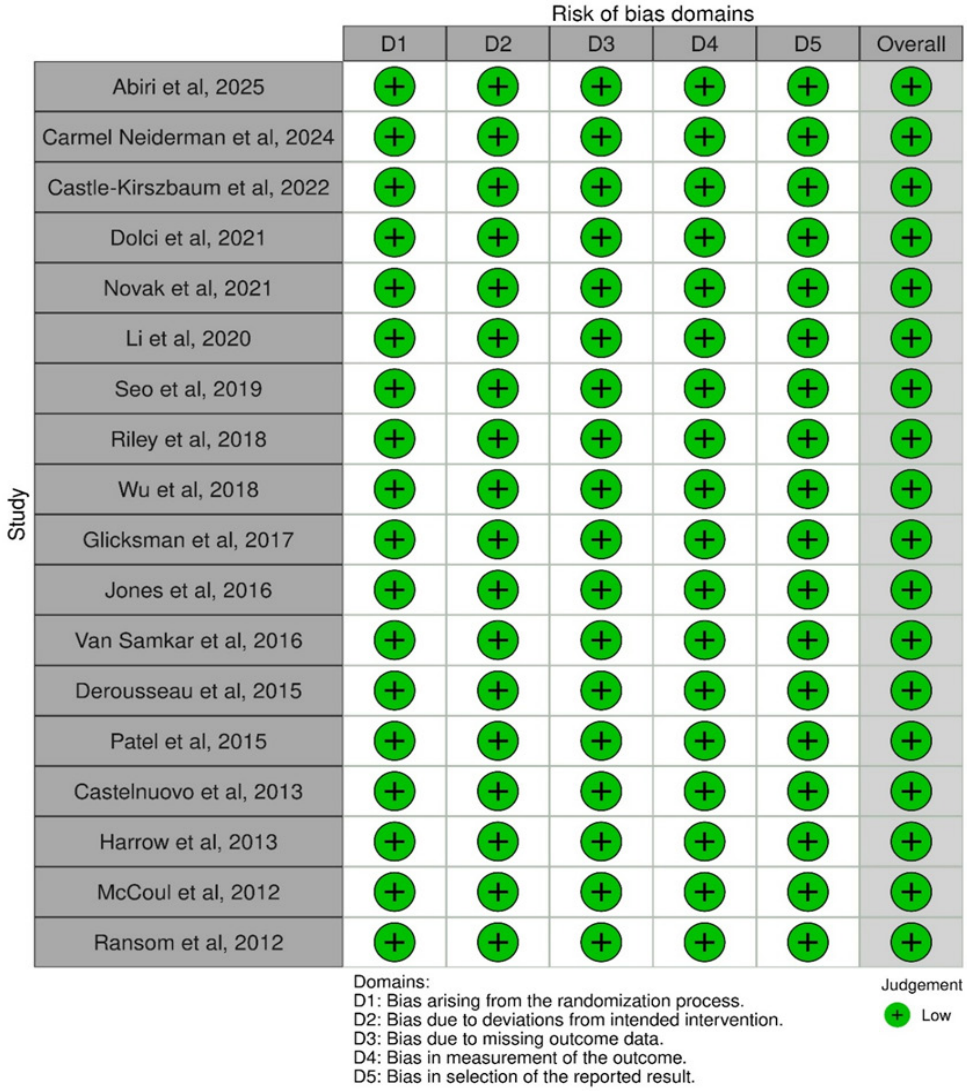


Figure 2. Traffic Plot Showing the Risk of Bias among Studies Involved

and SNOT-20 scores and an increase in ASBQ scores, with pooled standardized mean differences of -0.23 (95% CI: -0.61 to 0.14), -5.46 (95% CI: -26.93 to 16.02, and 0.77 (95% CI: -2.18 to 3.71), respectively. The overall long-term enhancement in quality of life was statistically significant ($p < 0.01$).

Reporting biases and certainty of evidence

Sterne and Egger's funnel plot was utilized to further assess the risk of publication bias [33, 34]. The standard error (SE) is represented on the vertical axis of the funnel plot, while the treatment's impact is displayed on the horizontal axis. The summary estimate obtained from a fixed-effect meta-analysis is shown by the vertical dashed line. For every SE on the vertical axis, two diagonal lines show the (pseudo) 95% confidence intervals (effect ± 1.96 SE) surrounding the summary effect. These demonstrate the predicted distribution of research when selection bias and heterogeneity are absent. 95% of the research should fall inside the funnel that these diagonal lines define if there is no heterogeneity. Publication bias causes the funnel plot to be asymmetrical. Figure 5 displays a funnel plot that illustrates publication bias in the initial impact of endoscopic excision of sinonasal and base of skull cancers on patient quality of life as determined by SNOT-22, SNOT-20, and ASBQ scores. Figure 6 displays a funnel plot that illustrates publication bias in the long-run impact of endoscopic excision of sinonasal and skull base cancers on patient quality of life as determined by SNOT-22, SNOT-20, and ASBQ scores.

Discussion

The endoscopic endonasal approach (EEA) has revolutionized sinonasal tumor and skull base surgery. In this study, we sought to ascertain the long-term impact on sinonasal quality of life outcomes of endoscopic resection using a minimally invasive technique for tumours of the skull base and sinonasal region.

An in-depth examination was conducted to determine how endoscopic resection of sinonasal and skull base tumors impacts the quality of life of individuals long-term after the surgery. The results from 18 articles and 2119 participants indicated a beneficial impact of endoscopic

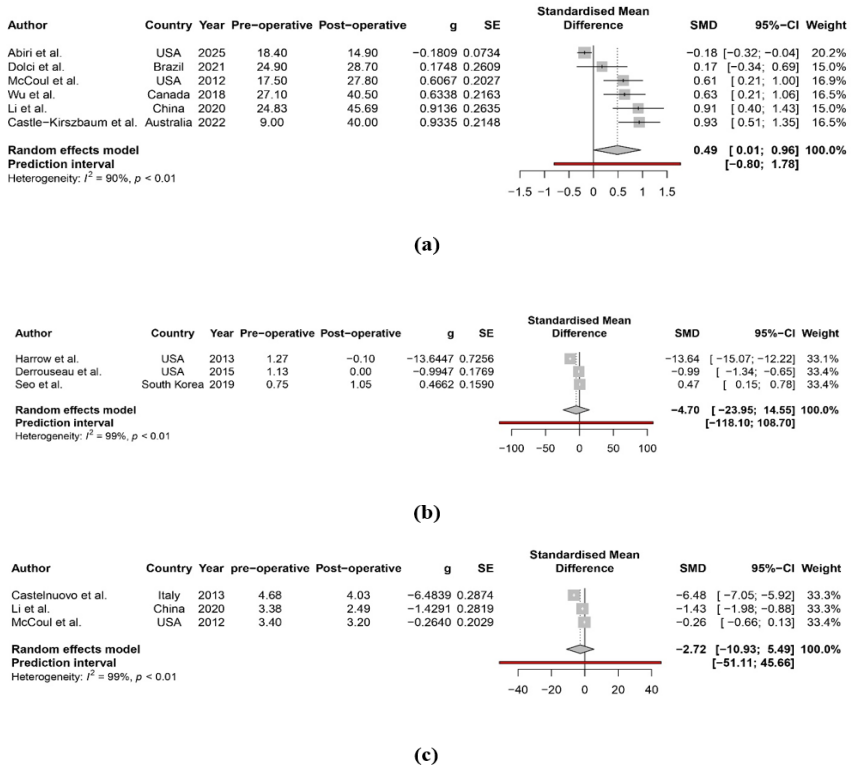


Figure 3. Immediate Effect of Endoscopic Resection of Sinonasal and Skull Base Tumours on Quality of Life of Patients as Measured by Using (a) SNOT-22 scores, (b) SNOT-20 scores, and (c) ASBQ scores

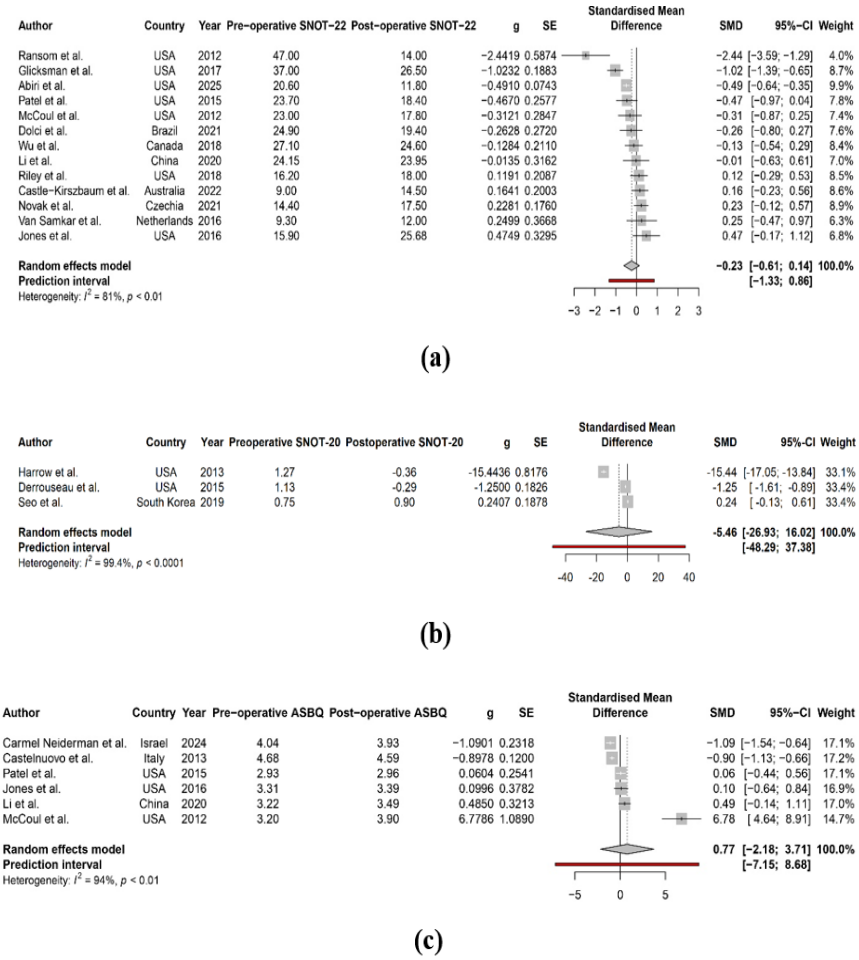
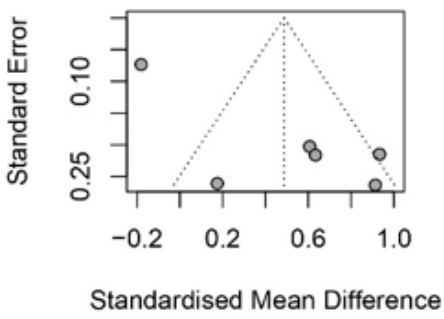


Figure 4. Long-term Effect of Endoscopic Resection of Sinonasal and Skull base Tumours on Quality of Life of Patients as Measured by Using (a) SNOT-22 scores, (b) SNOT-20 scores, and (c) ASBQ scores



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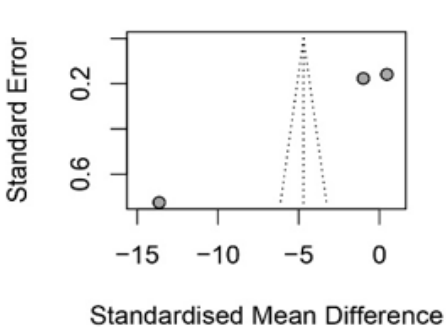

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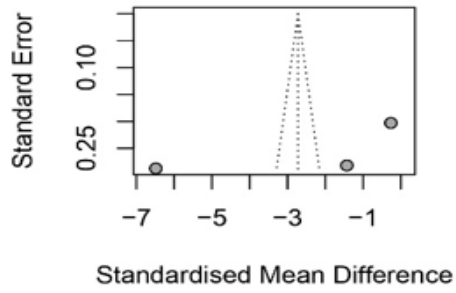
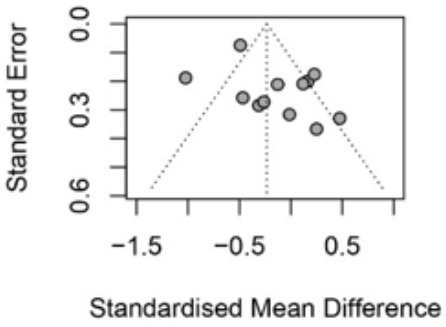
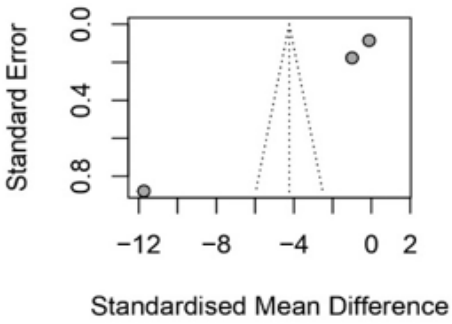


(c)

Figure 5. Funnel Plot Illustrating Publication Bias in the Direct Effects on Patients' Quality of Life of Endoscopic Removal of Sinonasal and base of the Skull Tumours as Measured by Using (a) SNOT-22 scores, (b) SNOT-20 scores, and (c) ASBQ scores



(a)



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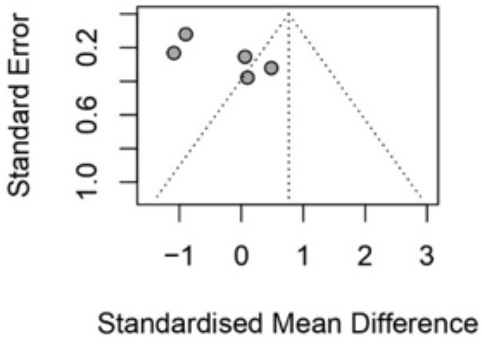

(c)

Figure 6. Funnel Plot Illustrating Publication Bias in the Long-Run Impact on Patients' Quality of Life of Endoscopic Removal of Sinonasal and Skull base Cancers as Measured by Using (a) SNOT-22 scores, (b) SNOT-20 scores, and (c) ASBQ scores

resection on long-term overall health-related quality of life using three types of QOL scales, i.e. SNOT-22, SNOT-20 and ASBQ.

Overall, this study showed that all patients' sinonasal quality of life (QOL) temporarily deteriorated following surgery, but that this was followed by statistically significant gains over the patients' preoperative QOL values.

In a similar meta-analysis conducted by Bhenswala et al. [35] Patients with reduced sinonasal quality of life before to surgery who underwent endoscopic endonasal procedure for skull base diseases showed notable improvements in their quality of life after surgery. Patients having a comparatively normal preoperative sinonasal quality of life did not have any symptoms after surgery.

According to these relatively intuitive results, there appears to be a brief decline in sinonasal quality of life that corresponds with postoperative recovery, followed by a continuous and long-lasting improvement in symptomatology once the surgical site has healed. Within three months of surgery, all patients had restored their preoperative sinonasal status, and from then on, improvements above baseline were made, reaching their peak one year after surgery. ESBS exposes patients to a

number of comorbidities that are specific to the EEA, such nasal crusting, nasal leakage, poor olfaction, and nasal deformities, despite the fact that endoscopic skull base operation is praised for its novelty and maybe better results. Depending on the intricacy of the procedure, almost all patients show postoperative signs of intranasal crusting, with about half of them enduring moderate to serious crusting that may take more than three months to clear [36, 37].

In conclusion, endoscopic resection of sinonasal tumors and skull base tumors significantly improves postoperative sinonasal QOL symptoms. Although there is a temporary worsening of symptoms perioperatively, patients generally achieve baseline QOL in the long term.

Author Contribution Statement

BG, SJ, and KG: the article's conception, design, and typographical logic. BG, RS, and KG: Literature selection and acquisition of data. BG, GD, and AM: analysis and interpretation of data and editing of the article. BG, SJ, and KG: study supervision and revising the article. All authors contributed to the article and approved the submitted version.

Acknowledgements

Ethical permission and study approval

Since it is a meta-analysis and systematic review, no ethical permission was required for the study. PROSPERO, the international Prospective Register of Systematic Reviews, approved this study.

Registering Authority

This study was registered by PROSPERO (CRD42024539204).

Conflicts of Interest

There were no conflicts of interest.

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