Research Article

Living with a Vestibular Schwannoma: Bridging the Gap Between Treatment and Quality of Life

Amy Jones[1]

1. Environmental Research Institute, University of the Highlands and Islands, Inverness, United Kingdom

Background: Vestibular schwannoma (VS), a benign tumour of the vestibulocochlear nerve, poses significant challenges to patients' quality of life (QoL), regardless of its typically slow growth and high treatment success rates. Although tumour control is excellent with microsurgery, stereotactic radiosurgery, or active surveillance, many patients report persistent symptoms affecting physical, psychological, and social well-being.

Objective: This review synthesises current literature on QoL outcomes in VS patients, highlighting symptom burden, treatment impacts, and gaps in patient-centred care.

Methods: A narrative review was conducted following PRISMA guidelines. Studies were included if they assessed QoL in adult VS patients using validated tools or qualitative methods. Key themes were identified and analysed across management modalities.

Results: Physical symptoms such as hearing loss, facial weakness, dizziness, and fatigue significantly impact QoL. Psychological concerns—including anxiety, depression, and uncertainty—are underreported but prevalent. The SF-36 and PANQOL were the most commonly used QoL tools, though they varied in sensitivity. Few studies incorporated long-term follow-up or patient perspectives.

Conclusion: QoL assessment should be integrated into routine VS care. Future research must prioritise longitudinal data, emotional support needs, and patient involvement in decision-making to ensure holistic, equitable treatment strategies.

Corresponding author: Amy L. Jones, amy.jones@uhi.ac.uk

 doi.org/10.32388/9TJKOP

1. Introduction

Vestibular schwannoma (VS), also known as acoustic neuroma, is a benign tumour originating from Schwann cells of the vestibulocochlear nerve (cranial nerve VIII). It represents approximately 8% of all intracranial tumours, with an annual incidence of 1-2 cases per 100,000 individuals [1][2]. Most commonly diagnosed in adults aged 40-60, it exhibits a slight female predominance [3]. While paediatric cases are rare, they have been documented, often raising suspicion for underlying genetic syndromes [4].

The increased use of high-resolution magnetic resonance imaging (MRI) has led to more frequent incidental diagnoses, including asymptomatic cases [5]. Clinically, VS typically presents with progressive unilateral sensorineural hearing loss, tinnitus, and imbalance. Larger tumours may exert mass effect on adjacent cranial nerves and brainstem structures, leading to facial numbness, diplopia, nystagmus, nausea, headaches, or fatigue. In advanced cases, hydrocephalus may develop due to cerebrospinal fluid outflow obstruction [6]. Although most cases are sporadic, the presence of bilateral VS is pathognomonic for neurofibromatosis type 2 (NF2), a hereditary disorder characterised by multiple central nervous system tumours [7].

Diagnosis relies primarily on gadolinium-enhanced MRI to evaluate tumour size, anatomical location, and neurovascular involvement [8]. Audiological and vestibular testing establish functional baselines and monitor disease progression. Emerging modalities, such as AI-assisted imaging and advanced vestibular diagnostics, show promise in improving early detection and individualised monitoring strategies [9]. Additionally, "prehabilitation"—comprising vestibular rehabilitation, psychological support, and physical conditioning—is gaining recognition for its role in enhancing postoperative recovery and mitigating long-term deficits [10].

Early diagnosis improves clinical outcomes by preserving neurological function and broadening therapeutic options. Small tumours are more amenable to conservative management or stereotactic radiosurgery (SRS), which carry lower complication rates and better prospects for hearing preservation [1] [11]. Timely detection also facilitates shared decision-making and fosters psychosocial adjustment [2]. However, diagnostic delays are common, often exceeding 12-24 months, due to symptom overlap with other vestibular disorders (e.g., Ménière's disease, benign paroxysmal positional vertigo) and underutilisation of appropriate imaging [1][2].

Treatment strategies include observation, SRS, and microsurgical resection, tailored according to tumour size, growth rate, symptom burden, hearing status, age, comorbidities, and patient preference [12]. Observation is appropriate for small, asymptomatic, or indolent tumours, although 30-40% will eventually grow [2]. SRS provides excellent tumour control (90-95% at 10 years) with low morbidity but necessitates long-term monitoring for delayed cranial neuropathies [13]. Microsurgery is typically reserved for larger or symptomatic tumours, requiring nuanced surgical planning to balance tumour resection with functional preservation [14][15]. Potential complications include facial nerve palsy, hearing loss, cerebrospinal fluid leak, and systemic sequelae [16][17]. Integration of prehabilitation into the treatment pathway is becoming standard practice to improve outcomes [18], and multidisciplinary care teams are essential to delivering holistic, patient-centred care [19].

Increasingly, the scope of outcome assessment extends beyond tumour control to encompass patient-reported quality of life (QoL). Persistent deficits—such as hearing loss, imbalance, vertigo, facial weakness, and fatigue—can significantly impair daily function and social engagement [20]. Psychological sequelae, including depression, anxiety, and cognitive disturbances, often arise independently of tumour progression and can disrupt occupational and familial roles [21][22]. Younger patients may experience greater life disruption, while older adults tend to adapt more readily to sensory losses [23]. Peer support networks and patient advocacy organisations offer vital psychosocial support and contribute to patient empowerment [24]. Prolonged uncertainty related to tumour recurrence or residual disease further compounds QoL concerns in many patients [25].

QoL is typically assessed using general instruments such as the SF-36, alongside disease-specific tools like the Penn Acoustic Neuroma Quality of Life (PANQOL) scale and the Dizziness Handicap Inventory (DHI). However, heterogeneity in study designs, outcome measures, and follow-up intervals limits comparability across studies. Standardised, prospective research using validated tools is needed to better quantify and understand QoL outcomes [26].

This review synthesises current evidence on QoL in VS patients, with a focus on how different treatment modalities—observation, SRS, and microsurgery—affect both functional and psychosocial domains. It critically examines assessment instruments, explores patient-reported experiences, and highlights key evidence gaps. By integrating clinical and patient-centred perspectives, this review aims to inform future research priorities and optimise care delivery in this evolving field.

2. Methods

2.1. Search Strategy

A comprehensive literature search was conducted using PubMed, MEDLINE, and Scopus to identify studies evaluating quality of life (QoL) in patients with vestibular schwannoma (VS). The search covered publications from January 2000 to May 15, 2025, to reflect contemporary clinical practice and patient-reported outcome trends. Search terms included combinations of keywords and MeSH terms: *vestibular schwannoma*, *acoustic neuroma*, *quality of life*, *QoL*, *patient-reported outcomes*, *active monitoring*, *observation*, *conservative management*, *radiosurgery*, *microsurgery*, and *treatment*. Boolean operators (AND/OR) and database-specific filters (e.g., “Since”, “Humans”, “English”) were used to refine results.

An example search string for PubMed was:
("vestibular schwannoma"[MeSH Terms] OR "acoustic neuroma") AND ("quality of life"[MeSH Terms] OR "QoL" OR "patient-reported outcomes") AND ("radiosurgery" OR "microsurgery" OR "observation")

One person screened titles and abstracts for eligibility. Full-text screening was then performed on potentially relevant studies. The search was limited to English-language articles involving adult participants (≥18 years). Reference lists of included articles were manually screened for additional studies. To enhance comprehensiveness, the search results were cross-verified using scite.ai, an artificial intelligence platform employing natural language processing and machine learning to identify relevant and high-impact studies. Scite also flagged studies that may have been missed due to terminology variance.

2.2. Inclusion and Exclusion Criteria

Studies were included if they met the following criteria:

- Population: Adults (≥18 years) diagnosed with unilateral or bilateral VS, including cases of neurofibromatosis type 2 (NF2). Studies involving mixed populations were included only if VS-specific QoL data were separately reported.
- Design: Randomised controlled trials, cohort studies, case-control studies, cross-sectional studies, and database analyses.
- Outcomes: Reported QoL outcomes using validated quantitative tools such as the SF-36, Penn Acoustic Neuroma Quality of Life (PANQOL) scale, Dizziness Handicap Index (DHI), Tinnitus Handicap Index

(THI), Illness Perception Questionnaire, Glasgow Benefit Inventory (GBI), Hospital Anxiety and Depression Scale (HADS), Fatigue Severity Scale, Utrecht Coping List, Epworth Sleepiness Scale, or Starkstein Apathy Scale.

- Language: Published in English.
- Timeframe: Published between January 2000 and May 2025.

Exclusion criteria:

- Studies reporting exclusively on technical, surgical, or radiological outcomes without QoL assessment.
- Paediatric populations (<18 years).
- Non-peer-reviewed sources (e.g., editorials, opinion pieces, conference abstracts).
- Studies with inaccessible full-texts or duplicated datasets (the most complete dataset was retained).
- Articles published before January 2000.

2.3. Data Extraction and Synthesis

Data were independently extracted by two reviewers (Author X and Author Y) using a standardised template in Microsoft Excel. Extracted variables included: study design, population characteristics, sample size, treatment modality (observation, radiosurgery, or microsurgery), QoL assessment tools used, follow-up duration, and QoL outcomes across physical, emotional, and functional domains. Discrepancies were resolved through discussion or consultation with a third reviewer.

Given the heterogeneity in study designs, patient populations, and outcome measures, a meta-analysis was not feasible. Therefore, a narrative synthesis approach was employed. Results were thematically grouped by treatment modality and QoL domain. Methodological limitations, inconsistencies in outcome reporting, and research gaps were identified to inform future investigation.

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). As this study involved secondary analysis of previously published literature, ethical approval was not required; all included studies had received independent ethical approval as reported by their respective authors.

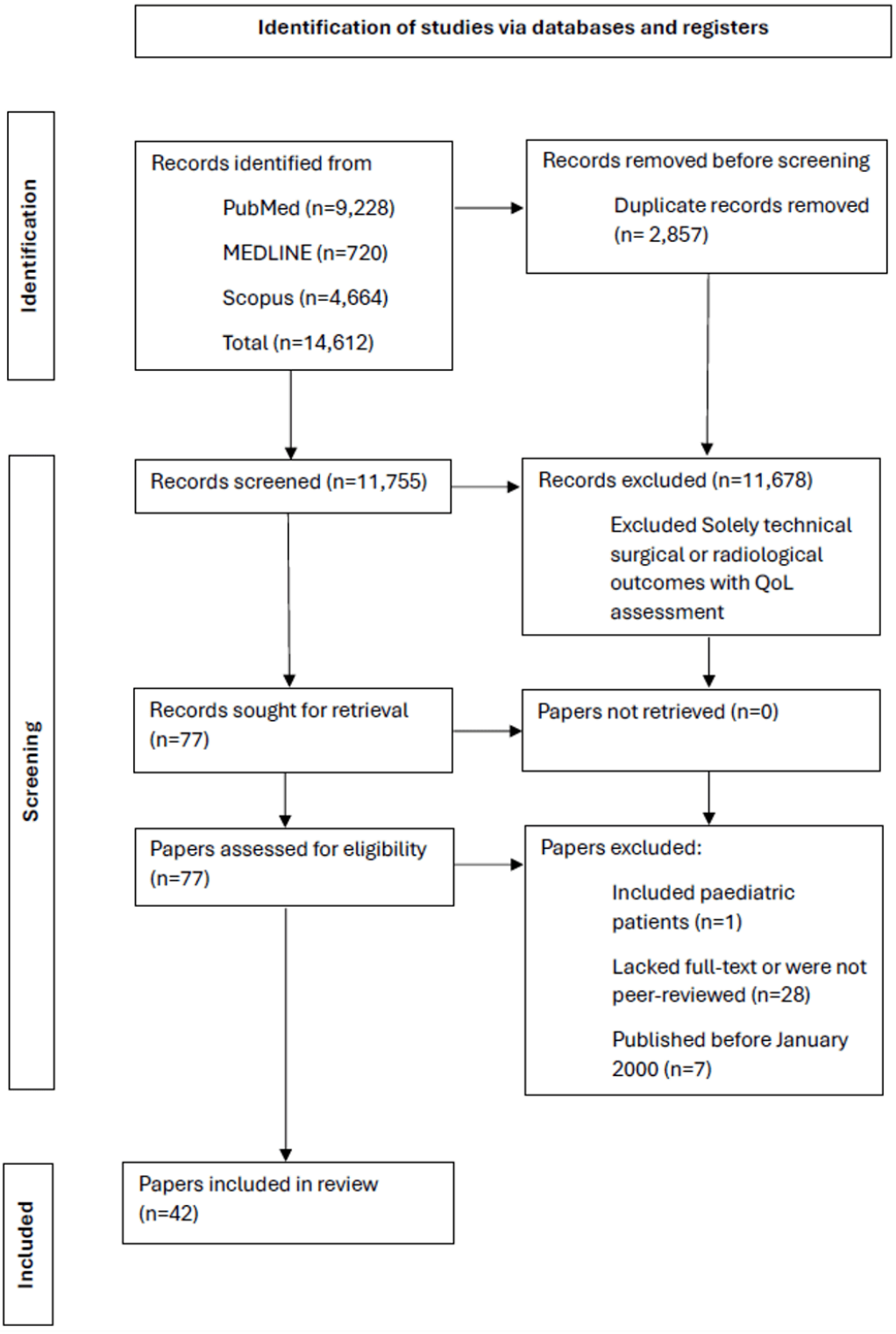

Figure 1. *PRISMA flow diagram illustrating the study selection process. A total of 14,612 records were identified through database searches (PubMed, MEDLINE, and Scopus), with 2,857 duplicates removed prior to screening. After screening 11,755 records, 11,678 were excluded due to irrelevance. Of the 77 records assessed for eligibility, 35*

were excluded based on criteria including paediatric population, lack of full text or peer-review, or publication date before January 2000. Ultimately, 42 studies were included in the final review.

3. Results

3.1. Study Characteristics

A total of 42 studies published between January 2000 and May 2025 met the inclusion criteria, encompassing 16,776 adult patients diagnosed with either unilateral or bilateral vestibular schwannoma (VS), including two studies involving patients with neurofibromatosis type 2 (NF2). The included studies were conducted across a wide geographical range, representing data from Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iran, Israel, Italy, Japan, the Netherlands, Norway, Poland, Switzerland, Thailand, the United Kingdom, and the United States.

Study designs included prospective cohort studies (n=11), retrospective cohort studies (n=23), and cross-sectional analyses (n=8), reflecting a heterogeneous body of evidence. Sample sizes ranged from 21 to 4,585 participants, with follow-up durations varying between six months and fifteen years.

Treatment modalities investigated across these studies included active surveillance (n=2), stereotactic radiosurgery (SRS) such as Gamma Knife and CyberKnife (n=1), microsurgical resection (n=15), and mixed or comparative treatment approaches (n=24). Surgical approaches reported included retrosigmoid (n=9), translabyrinthine (n=10), and middle fossa (n=4). Eighteen studies directly compared quality of life (QoL) outcomes across different treatment modalities. The most commonly employed QoL instruments were the 36-Item Short Form Survey (SF-36) and the Penn Acoustic Neuroma Quality of Life (PANQOL) scale, while several studies incorporated disease-specific or symptom-specific tools such as the Dizziness Handicap Inventory (DHI), Tinnitus Handicap Index (THI), and Hospital Anxiety and Depression Scale (HADS).

3.2. Quality of Life Outcomes by Treatment Modality

In patients managed by active surveillance, overall QoL was generally preserved. PANQOL scores across studies typically ranged from 70 to 85 (on a 0-100 scale where higher scores indicate better quality of life), suggesting only mild to moderate symptom burden. While most patients remained functionally independent, some reported gradual hearing decline or intermittent episodes of dizziness and

headaches. Pain symptoms were infrequent. However, anxiety related to tumour growth and uncertainty about disease progression was commonly reported. These findings support the viability of conservative management in small, asymptomatic tumours but also underscore the psychological toll of prolonged surveillance, highlighting the need for proactive emotional and informational support.

Patients undergoing stereotactic radiosurgery experienced favourable tumour control, with over 90% of cases achieving stability or regression at five-year follow-up. Hearing preservation outcomes varied, with reported rates ranging from 30% to 50%, particularly dependent on baseline auditory status. While most vestibular symptoms—such as dizziness and imbalance—were transient, a subset of patients experienced persistent headaches or neuropathic pain. Despite the non-invasive nature of radiosurgery, emotional distress, including anxiety and depression, was not uncommon. These findings emphasise the need for pre-treatment psychological preparation and post-treatment monitoring, even in patients undergoing minimally invasive interventions.

Microsurgical resection was associated with the most significant and persistent QoL disruptions. Facial nerve dysfunction occurred frequently, with recovery rates varying substantially depending on tumour size, surgical approach, and intraoperative techniques. Permanent hearing loss was highly prevalent, affecting more than 70% of surgical patients, especially those undergoing the translabyrinthine approach. Balance problems, chronic headaches, and surgical or neuropathic pain were more commonly reported in this group than among those receiving other treatments. Patients also frequently described profound emotional challenges, including anxiety, depression, fatigue, and social withdrawal. These outcomes highlight the need for comprehensive preoperative counselling, facial nerve-sparing strategies, and robust postoperative rehabilitation services, including vestibular and psychological care.

Across all modalities, the SF-36 and PANQOL scales were the most frequently utilised instruments. While the SF-36 enabled comparison with general population norms, the PANQOL provided nuanced, disease-specific insights—particularly in relation to hearing function, facial weakness, and emotional wellbeing. Studies employing both instruments provided the most comprehensive evaluations, supporting their complementary use in clinical practice.

3.3. Quality of Life Indicators as a Percentage of the Literature

Symptom	% of Literature	QoL Tool	% Usage	Treatment Modality	% of Literature
Facial dysfunction	71	SF-36	36	Active surveillance	2
Hearing dysfunction	69	PANQOL	21	Stereotactic radiosurgery (Gamma Knife)	2
Imbalance	60	Study-specific tools	24	Stereotactic radiosurgery (Cyber Knife)	2
Headache	57	Dizziness Handicap Inventory	14	Microsurgery (Retrosigmoid)	21
Anxiety/Depression	38	Hospital Anxiety and Depression Scale	7	Microsurgery (Translaberynthine)	24
Fatigue	29	Others (Epworth sleepiness scale, Fatigue severity scale, Illness Perception Scale, Glasgow Benefit Inventory, medical records, Starkstein apathy scale, Vertigo Symptom Scale, Utrecht Coping List)	5	Microsurgery (Middle fossa)	10
Cognitive impairment	14	Qualitative methods (e.g. interviews)	5	Microsurgery (all approaches)	10
Social isolation	17	Post-study follow up	11	Combined treatment	57

Table 1. *Summary of reported symptoms, quality of life (QoL) assessment tools, and treatment modalities in the reviewed literature. The most commonly reported symptoms included facial dysfunction (71%) and hearing dysfunction (69%). The SF-36 (36%) and PANQOL (21%) were the most frequently used QoL instruments. Among*

treatment modalities, combined treatment (57%) and microsurgical approaches (particularly translabyrinthine at 24%) were the most frequently reported.

Despite considerable interest in functional outcomes such as hearing and balance, several QoL domains were underrepresented in the literature. Most studies focused on visible or easily quantifiable impairments, such as facial palsy, sensorineural hearing loss, and vestibular symptoms. Less attention was given to less visible but equally debilitating symptoms such as fatigue, cognitive impairment, and emotional distress. Only a minority of studies assessed sleep disturbances or coping behaviour, and very few employed fatigue-specific scales such as the Fatigue Severity Scale or the Epworth Sleepiness Scale.

Furthermore, only 5% of the included studies utilised qualitative methods, such as interviews or patient narratives, limiting the depth of understanding around lived experience. Longitudinal follow-up was also limited: only 11% of studies followed patients for five years or more, thereby constraining our understanding of long-term QoL trajectories, particularly in relation to psychological adaptation and chronic symptom management (Table 1).

Author (Date)	Tumour Type	Sample Size	Intervention	Physical Symptoms	Cognitive Symptoms	Psychosocial Symptoms	QoL Tool
Bender et al. (2022)	NM	43	Microsurgery (retrosig)	Yes	Yes	Yes	SF-36 and other
Ben-Harosh et al. (2024)	NM	52	All	Yes	No	No	PANQOL and qualitative
Brooker et al. (2009)	NM	21	All	Yes	Yes	Yes	Qualitative
Brooker et al. (2014)	Sporadic	207	All	Yes	No	No	Study-specific questionnaire
Broomfield and O'Donoghue (2015)	NM	598	All	Yes	No	No	Study-specific questionnaire
Browne et al. (2008)	NM	119	Microsurgery (translab)	Yes	No	No	SF-36
Carlson et al. (2015)	Sporadic	538	All	Yes	No	No	PANQOL and SF-36
Carlson et al. (2018)	NM	539	All	Yes	No	No	Other
Carlson et al. (2015)	Sporadic	538	All	Yes	No	No	DHI and study-specific questionnaire
Cheng et al. (2009)	NM	98	Microsurgery (retrosig and translab)	Yes	Yes	Yes	SF-36
Da Cruz et al. (2000)	NM	90	Microsurgery (retrosig and translab)	NM	NM	NM	SF-36

Author (Date)	Tumour Type	Sample Size	Intervention	Physical Symptoms	Cognitive Symptoms	Psychosocial Symptoms	QoL Tool
Dhayalan et al. (2019)	NM	137	All	Yes	No	Yes	PANQOL and other
Franz et al. (2024)	Sporadic	79	Microsurgery (all)	Yes	No	Yes	PANQOL
Godefroy et al. (2008)	NM	789	At diagnosis	Yes	No	No	SF-36 and other
Goshtasbi et al. (2020)	NM	503	All	Yes	No	No	Study-specific questionnaire
Gustavsen et al. (2021)	NM	176	All	Yes	No	Yes	SF-36 and other
Ioune et al. (2011)	NM	104	Microsurgery (mid foss and translab)	Yes	No	No	Study specific questionnaire and other
Iyer et al. (2010)	NM	54	Microsurgery (mid foss and translab)	Yes	No	No	SF-36 and other
Kelleher et al. (2002)	NM	72	Microsurgery (all) and radiosurgery (all)	Yes	Yes	Yes	SF-36
Kojima et al. (2019)	Sporadic	76	Active surveillance	Yes	No	No	SF-36 and other
Lazak et al. (2024)	Sporadic	29	Microsurgery (retrosig)	Yes	No	Yes	Study-specific questionnaire
Magliulo et al. (2000)	Sporadic and NF2	82	Microsurgery (retorsig and translab)	Yes	No	Yes	Study-specific questionnaire
Martin et al. (2001)	NM	97	Microsurgery (translab)	Yes	No	Yes	SF-36

Author (Date)	Tumour Type	Sample Size	Intervention	Physical Symptoms	Cognitive Symptoms	Psychosocial Symptoms	QoL Tool
Merker et al. (2016)	NM	73	All	Yes	No	Yes	SF-36
Muller et al. (2010)	NM	739	All	Yes	Yes	Yes	Study-specific questionnaire
Neve et al. (2021)	Sporadic	239	All	NM	NM	NM	Study-specific questionnaire and qualitative
Neve et al. (2023)	NM	536	All	Yes	No	Yes	PANQOL
Nicoucar et al. (2006)	Sporadic	103	Microsurgery (retrosig)	Yes	No	No	SF-36
Nowacka et al. (2023)	NM	52	All	Yes	Yes	No	PANQOL and other
Pruijn et al. (2021)	Sporadic	174	All	Yes	No	No	PANQOL and SF-36
Pruijn et al. (2023)	NM	231	All	Yes	Yes	Yes	Qualitative
Rameh and Magnan (2010)	NM	101	Microsurgery (retrosig and translab)	Yes	No	No	SF-36
Robinett et al. (2013)	NM	279	All	Yes	No	No	PANQOL
Ryzenman et al. (2024)	NM	3272	All	Yes	No	No	Study-specific questionnaire
Schwam et al. (2019)	NM	4585	Microsurgery (all)	Yes	No	No	Other
Thurin et al. (2021)	NM	333	Microsurgery (all)	Yes	No	Yes	Other

Author (Date)	Tumour Type	Sample Size	Intervention	Physical Symptoms	Cognitive Symptoms	Psychosocial Symptoms	QoL Tool
Timmer et al. (2010)	Sporadic	108	Radiosurgery (gamma knife)	Yes	No	No	SF-36
Tos et al. (2003)	NM	1020	Active surveillance and microsurgery (all)	Yes	Yes	Yes	Study-specific
Van Laer et al. (2022)	NM	66	Microsurgery (retrosig)	Yes	No	No	Other
Wagner et al. (2011)	Sporadic	38	Microsurgery (all) and radiosurgery (cyber knife)	Yes	No	No	Other
Walsh et al. (2000)	Sporadic	72	All	Yes	No	No	Other
Weidt et al. (2014)	NM	203	All	Yes	No	Yes	SF-26 and other

Table 2. *Overview of studies reporting on physical, cognitive, and psychosocial symptoms in patients with vestibular schwannoma, along with quality of life (QoL) assessment tools used. The table summarizes data from studies including various tumour types (sporadic, neurofibromatosis type 2 [NF2], and not mentioned [NM]), sample sizes, interventions (e.g., microsurgery, radiosurgery, active surveillance), and domains assessed. The most frequently examined domain was physical symptoms, while cognitive and psychosocial symptoms were less consistently reported. QoL tools varied, with SF-36, PANQOL, and study-specific questionnaires being most commonly used.*

3.4. Synthesis of Literature

Quality of life outcomes varied meaningfully by treatment modality. Patients managed with active surveillance reported the highest overall preservation of physical and functional abilities, though psychological distress—particularly anxiety about disease progression—was frequently noted [27][28]. Those treated with SRS experienced moderate symptom burden, with stable physical function but

variable auditory outcomes and notable rates of emotional disturbance [29][30]. In contrast, microsurgical patients experienced the most pronounced declines in QoL, with physical complications such as frequent facial nerve issues, balance disturbances, headaches, often accompanied by emotional and social consequences [31][32][33] (Table 2).

Across treatment groups, common symptom themes emerged, including hearing loss, dizziness, chronic pain, and emotional distress. These symptoms frequently co-occurred, compounding patient burden and affecting multiple domains of daily life. Several studies noted that these clustered symptoms often led to substantial disruption in social relationships, occupational functioning, and self-image.

Limitations include small samples (mean=400; range 21- 4,585), methodological heterogeneity, varied QoL measures, and limited longitudinal data (Table 2). There was also a notable underreporting of interventions aimed at vestibular rehabilitation, headache management, and psychological counselling, suggesting a gap between symptom burden and therapeutic provision.

Many studies highlighted patients' perceptions of being under-informed about their condition and treatment options. This lack of understanding was frequently linked to increased anxiety, diminished autonomy in decision-making, and lower satisfaction with care. Patients undergoing surgery often reported feeling unprepared for the emotional and sensory consequences of treatment. In both surgical and non-surgical cohorts, chronic symptoms such as facial paresis, fatigue, and persistent hearing loss were strongly associated with psychological distress, including depression, social withdrawal, and reduced self-esteem [34][22]. Improved pre-treatment education and postoperative counselling were consistently recommended.

Chronic symptoms—fatigue, facial paresis, hearing loss—were frequently linked to psychological distress, including anxiety and social withdrawal [21][18]. Fear of tumour recurrence and sleep disruption were also reported, particularly in patients undergoing long-term surveillance or following incomplete resection [35].

These psychological challenges were rarely addressed in follow-up care, and only a minority of studies reported routine access to mental health support [36]. The emerging preference for non-surgical options reflects a broader shift in clinical priorities—from maximising tumour removal to optimising quality of life. However, several studies noted that patients often felt excluded from the decision-making process, particularly when management pathways were dictated by tumour size or anatomical constraints. A consistent recommendation across the literature was the need for improved pre-treatment education,

shared decision-making frameworks, and holistic follow-up care tailored to patient-reported needs and long-term wellbeing [35].

4. Discussion

4.1. Summary of Key Findings

This review synthesised evidence on the impact of vestibular schwannoma (VS) and its treatments on quality of life (QoL), highlighting the need for a more integrated, patient-centred approach. While tumour control is consistently high across microsurgery, radiosurgery, and observation, the broader burden on physical, emotional, and social well-being varies significantly. Common issues include hearing loss, tinnitus, imbalance, and facial weakness, alongside less visible symptoms such as headaches, fatigue, cognitive dysfunction, anxiety, and depression (Table 2). Many patients face persistent challenges despite clinical success, revealing a disconnect between tumour control and lived experience. This underscores the limitations of traditional outcome measures and the importance of prioritising QoL through improved education, long-term symptom management, and psychological support.

4.2. Interpretation and Context

Findings align with prior literature suggesting tumour size alone poorly predicts patient outcomes [37][38][39]. Small tumours can significantly impair QoL depending on treatment and vulnerability. Radiosurgery offers shorter recovery and better facial nerve preservation but can cause gradual hearing loss and delayed neuropathies [11][30]. Microsurgery, often preferred for larger tumours or younger patients, provides definitive treatment but carries higher immediate risk of complications such as facial palsy and deafness [40][41]. Although less invasive, radiosurgery's long-term safety requires more study. Even observation, often viewed as benign, may carry psychological toll. Anxiety and uncertainty can affect QoL as much as physical symptoms [42]. These findings reinforce shared decision-making that considers tumour features and patient preferences [43][44].

4.3. Clinical Implications

The integration of standardised, validated quality of life (QoL) assessments into routine follow-up is essential for the long-term management of patients with vestibular schwannoma (VS). Tools such as the Penn Acoustic Neuroma Quality of Life Scale (PANQOL) and the Dizziness Handicap Inventory (DHI) are

specifically designed to capture symptom burden relevant to this population, enabling clinicians to detect subtle functional or psychological declines that may not be evident through imaging or clinical examination alone. Embedding these instruments into routine care—such as during scheduled MRI follow-ups—provides a pragmatic and time-efficient means of continuous monitoring. The forthcoming VSQOL Index, which aims to provide a broader and more nuanced assessment of both functional status and psychosocial wellbeing, holds promise for enhancing standardisation across treatment centres.

A multidisciplinary model of care should be implemented early in the management pathway. This model should include neuro-otologists, audiologists, vestibular physiotherapists, clinical psychologists, and specialist nursing staff. Such a team-based approach enables the early identification and proactive management of both physical and emotional challenges, improving care coordination and facilitating timely intervention. Notably, introducing prehabilitation—which may include vestibular rehabilitation, hearing counselling, psychological support, and physical conditioning—has the potential to reduce postoperative morbidity, shorten recovery time, and improve long-term adaptation and emotional resilience.

Patient education also represents a critical pillar of high-quality care. Evidence suggests that patients who are better informed about their condition and treatment options are more engaged, more likely to participate in shared decision-making, and report higher satisfaction with outcomes. Clinicians should prioritise clear, empathetic communication and provide consistent, accessible information across disciplines. Ensuring aligned messaging across surgical, radiation, and allied health teams helps to reduce confusion and foster trust. To support this, digital education resources—such as interactive decision aids or videos—can be offered in multiple formats to accommodate varying levels of health literacy.

Emerging technologies offer novel opportunities to enhance access and continuity of care. Telemedicine platforms, including remote consultations and digital QoL monitoring, can reduce the logistical burden of frequent in-person visits, particularly for patients in rural or underserved areas. These tools enable more responsive care, early detection of symptom exacerbation, and improved coordination between local and specialist services. However, their long-term impact on care quality, health outcomes, and equity warrants systematic evaluation. Addressing barriers such as digital literacy and internet access will be essential to ensure that these innovations do not inadvertently widen existing disparities.

Colloaboration with patient advocacy organisations such as the Acoustic Neuroma Association, The Brain Tumour Charity, and brainstrust plays a pivotal role in advancing patient-centred care. These groups

offer essential peer support networks, educational materials, and forums for shared experience. Moreover, their engagement in research design and health policy advocacy ensures that patient perspectives are meaningfully integrated into clinical priorities, service planning, and outcome evaluation. Strengthening partnerships between clinicians, researchers, and advocacy bodies is key to delivering truly holistic, responsive care for individuals living with vestibular schwannoma.

4.4. Limitations of the Review

Although this review employed a comprehensive and systematic search strategy across multiple databases and included a diverse set of studies from various healthcare systems, several limitations must be acknowledged.

Many included studies featured modest sample sizes and short to medium-term follow-up durations, limiting the statistical power to detect subtle or long-term quality of life (QoL) changes. This constraint is particularly important in a condition such as vestibular schwannoma, where symptoms and treatment effects often evolve gradually over several years. The lack of longitudinal data also impedes robust evaluation of recovery trajectories, delayed complications, or the cumulative impact of multimodal interventions.

The heterogeneity in treatment approaches across centres—including variations in surgical techniques, radiosurgery protocols, and surveillance strategies—complicates direct comparisons. This variability reflects real-world practice but introduces confounding factors that limit the generalisability of findings and make it difficult to draw definitive conclusions about the relative impact of each treatment modality on QoL.

This review identified inconsistencies in the selection and application of QoL assessment tools. While validated instruments such as the PANQOL and SF-36 were commonly used, there was wide variation in the domains assessed, timing of administration, and interpretability of results. This methodological diversity impairs cross-study comparability and limits the ability to synthesise data quantitatively.

Moreover, important patient-related variables, including comorbid medical conditions, socioeconomic status, cultural background, ethnicity, and digital literacy, were rarely reported or analysed. These factors likely influence both symptom perception and access to care, and their omission constrains the ability to evaluate the equity and inclusivity of existing care models.

Relatively few studies incorporated qualitative methodologies or patient-reported narratives, which are essential for capturing the lived experience of patients and contextualising quantitative findings.

Similarly, psychological and social dimensions of QoL, though clearly affected by VS and its treatment, were often underrepresented or insufficiently measured.

Together, these limitations highlight the need for future research that is prospective, longitudinal, and multicentre in design; that employs standardised, validated QoL instruments; and that actively includes underrepresented patient populations. Incorporating mixed-methods approaches and routinely capturing sociodemographic data will also be critical to understanding the full spectrum of patient experience and guiding more equitable, person-centred care.

4.5. Recommendations for Future Research and Conclusion

Future research should focus on the development and validation of a standardised quality of life (QoL) monitoring framework embedded within routine clinical care for patients with vestibular schwannoma (VS). The consistent use of validated instruments across treatment centres will enable reliable longitudinal data collection, facilitate inter-institutional comparisons, and allow for the early identification of functional or psychological deterioration. The anticipated introduction of the Vestibular Schwannoma Quality of Life (VSQOL) Index offers a promising opportunity to establish such a unified assessment model.

There is a clear need for large-scale, prospective longitudinal studies that evaluate QoL trajectories over extended timeframes. Such studies should examine the evolving impact of different treatment modalities —observation, stereotactic radiosurgery, and microsurgery—on both functional status and psychosocial wellbeing. These data will support the development of more realistic prognostic models, inform patient counselling, and promote shared decision-making based on anticipated outcomes rather than solely tumour control metrics.

In parallel, qualitative research is essential to capture the lived experiences of patients, particularly those from underrepresented populations, including ethnic minorities, older adults, and individuals with limited health literacy. These perspectives are often missing from quantitative studies but are crucial to understanding the full scope of patient needs and improving the cultural competence and inclusivity of care delivery.

The potential of digital health technologies—including mobile health applications, virtual support platforms, and remote symptom tracking—should be rigorously evaluated. Research should assess not only their clinical effectiveness but also their usability, acceptability, and cost-efficiency, especially in populations with restricted access to specialist services or elevated psychological distress. These tools

may enhance access to care, reduce logistical burdens, and enable real-time monitoring, but careful implementation and equity-focused design are necessary to avoid exacerbating existing disparities.

Collaboration with patient advocacy organisations, such as the Acoustic Neuroma Association, The Brain Tumour Charity, and brainstrust, should be strengthened to enhance community engagement, research relevance, and knowledge translation. Involving patients as partners from study design through dissemination ensures that research addresses real-world priorities and accelerates its integration into practice.

This review highlights the multifaceted impact of VS on patients' quality of life, which often extends well beyond the domain of tumour control. Although modern treatments achieve high rates of disease stability, many patients continue to experience significant functional, emotional, and social challenges. Recognising QoL as a central outcome—rather than a secondary consideration—is vital in aligning clinical goals with patient priorities.

To improve long-term outcomes, future care pathways should integrate standardised QoL assessment, multidisciplinary and prehabilitation approaches, and active patient engagement. Bridging the gap between clinical success and patient experience requires a shift toward holistic, person-centred care, where emotional resilience, functional independence, and informed decision-making are valued as highly as surgical or radiological outcomes.

Statements and Declarations

Funding

This research received no funding or financial support.

Conflicts of Interest

No funds, grants or financial support were received for this work. There are no conflicts of interest to declare.

Author Contributions

Conceptualisation, methodology, analysis and writing: AJ

Data Availability

This study is based on a systematic review of previously published literature. All data supporting the findings of this study are available within the included publications and their supplementary materials. No new primary data were generated or analysed for this review. Long form synthesis of the data within are available upon reasonable request to the author.

Ethics

This study is a systematic review of previously published and peer-reviewed research involving human participants. All included studies obtained appropriate ethics approval from their respective institution review boards or ethics committees at the time of their original data collection. No new data were collected for this review, and therefore no additional ethics approval was required. This review was conducted in accordance with the PRISMA guidelines and adhered to principles of research integrity, including accurate reporting and respect for intellectual property.

Consent to Participate Declaration

This article is a systematic review of previously published and peer-reviewed studies with full consent from participants. No new data were collected by the author and all the studies included received ethical approval and participant consent.

Human Ethics and Consent to Participate

Not applicable.

PROSPERO Registry ID

1072898.

Acknowledgements

The author would like to thank the neurosurgeons, audiologists, specialist nurses, and multidisciplinary care teams whose dedication to the management and support of vestibular schwannoma patients continues to inform and inspire this work. Their clinical insights and commitment to patient-centred care have been invaluable in shaping this review.

References

1. ^ a, b, c Carlson ML, Link MJ, Wanna GB, Driscoll CLW (2015). "Management of Sporadic Vestibular Schwannoma." Otolaryngol Clin North Am. **48**(3):407-422. doi:10.1016/j.otc.2015.02.003.
2. ^ a, b, c, d Stangerup S, Tos M, Thomsen J, Caye-Thomasen P (2010). "True Incidence of Vestibular Schwannoma?" Neurosurgery. **67**(5):1335–1340. doi:10.1227/NEU.0b013e3181f22660.
3. ^ Rosenberg SI (2000). "MOSHER AWARD HONORABLE MENTION." Laryngoscope. **110**(4):497-508. doi:10.1097/00005537-200004000-00002.
4. ^ Ferner RE (2010). "The Neurofibromatoses." Pract Neurol. **10**(2):82–93. doi:10.1136/jnnp.2010.206532.
5. ^ Pinna MH, Neto RVd, Bento RF (2012). "Schwannoma vestibular: 825 casos - 25 anos de experiência" [Vestibular Schwannoma: 825 Cases From a 25-Year Experience]. Int Arch Otorhinolaryngol. **16**(4):466–475. doi:10.7162/S1809-97772012000400007.
6. ^ Selesnick SH, Liu JC, Jen A, Carew JF (2004). "Management Options for Cerebrospinal Fluid Leak After Vestibular Schwannoma Surgery and Introduction of an Innovative Treatment." Otology & Neurotology **25**(4):580-586.
7. ^ Lloyd SKW, Evans DGR (2013). "Neurofibromatosis Type 2 (NF2)." Handbook of Clinical Neurology. **115**:957–967. doi:10.1016/B978-0-444-52902-2.00054-0.
8. ^ Xia L, Zhang H, Yu C, Zhang M, Ren M, Qu Y, Wang H, Zhu M, Zhao D, Qi X, Yao K (2014). "Fluid-Fluid Level in Cystic Vestibular Schwannoma: A Predictor of Peritumoral Adhesion." J Neurosurg. **120**(1):197–206. doi:10.3171/2013.6.JNS121630.
9. ^ Liu Y, Feng H, Ma H, Li J, Yu Y, Zhao H, Wang X, Li Y, Zhang J, Liu Q (2024). "Deciphering the Causal Landscape: Genetic Insights Into Sporadic Vestibular Schwannoma Risk Factors Through Mendelian Randomization." Discov Onc. **15**(1):737–14. doi:10.1007/s12672-024-01644-3.
10. ^ Pruijn IMJ, Kievit W, Hentschel MA, Mulder JJS, Kunst HPM (2020). "What Determines Quality of Life in Patients With Vestibular Schwannoma?" Clin Otolaryngol. **46**(2):412-420. doi:10.1111/coa.13691.
11. ^ a, b Myrseth E, Møller P, Pedersen P, Lund-Johansen M (2009). "Vestibular Schwannoma." Neurosurgery. **64**(4):654–663. doi:10.1227/01.NEU.0000340684.60443.55.
12. ^ Cavada MN, Lee MFH, Jufas NE, Harvey RJ, Patel NP (2021). "Intracanalicular Vestibular Schwannoma: A Systematic Review and Meta-Analysis of Therapeutics Outcomes." Otol Neurotol. **42**(3):351–362. doi:10.1097/MAO.0000000000002979.

13. ^Pollock BE, Driscoll CLW, Foote RL, Link MJ, Gorman DA, Bauch CD, Mandrekar JN, Krecke KN, Johnson CH (2006). "Patient Outcomes After Vestibular Schwannoma Management." Neurosurgery. **59**(1):77–85. doi:10.1227/01.neu.0000243286.14039.61.

14. ^Gal TJ, Shinn J, Huang B (2010). "Current Epidemiology and Management Trends in Acoustic Neuroma." O tolaryngol Head Neck Surg. **142**(5):677-681. doi:10.1016/j.otohns.2010.01.037.

15. ^Goshtasbi K, Abouzari M, Moshtaghi O, Sahyouni R, Sajjadi A, Lin HW, Djalilian HR (2019). "The Changing Landscape of Vestibular Schwannoma Diagnosis and Management: A Cross-Sectional Study." Laryngoscop e. **130**(2):482-486. doi:10.1002/lary.27950.

16. ^Darrouzet V, Martel J, Enée V, Bébéar J, Guérin J (2004). "Vestibular Schwannoma Surgery Outcomes: Our Multidisciplinary Experience in 400 Cases Over 17 Years." Laryngoscope. **114**(4):681–688. doi:10.1097/00005537-200404000-00016.

17. ^Mahboubi H, Ahmed OH, Yau AY, Ahmed YC, Djalilian HR (2014). "Complications of Surgery for Sporadic V estibular Schwannoma." Otolaryngol Head Neck Surg. **150**(2):275–281. doi:10.1177/0194599813512106.

18. a, bFuentealba-Bassaletti C, Neve OM, Van Esch BF, Jansen JC, Koot RW, Van Benthem PPG, Hensen EF (202 5). "Vestibular Complaints Impact on the Long-Term Quality of Life of Vestibular Schwannoma Patients." O tol Neurotol. **44**(2):161-167. doi:10.1097/mao.0000000000003773.

19. ^Drosos N, Jacob S, Nazir N, George AS (2025). "Anesthesiology Considerations and Management of Venous Air Embolism in Patients in the Semisitting Position: A Single-Center Review." Cureus. **17**(3):e81093. doi:10.7759/cureus.81093.

20. ^Gupta VK, Thakker A, Gupta KK (2020). "Vestibular Schwannoma: What We Know and Where We Are Hea ding." Head Neck Pathol. **14**(4):1058–1066. doi:10.1007/s12105-020-01155-x.

21. a, bDhayalan D, Lund-Johansen M, Finnkirk M, Tveiten ØV (2019). "Fatigue in Patients With Vestibular Schw annoma." Acta Neurochir. **161**(9):1809-1816. doi:10.1007/s00701-019-04003-2.

22. a, bMüller S, Arnolds J, Van Oosterhout A (2010). "Decision-Making of Vestibular Schwannoma Patients." Act a Neurochir. **152**(6):973-984. doi:10.1007/s00701-009-0590-0.

23. ^Haanes GG (2023). "Multidisciplinary Approaches and Community-Based Interventions: Adaptable Strate gies for Managing Sensory Impairments in Older Adults." J Multidiscip Healthc. **16**:2701–2705. doi:10.2147/J MDH.S416762.

24. ^Brooker J, Burney S, Fletcher J, Dally M (2009). "A Qualitative Exploration of Quality of Life Among Individ uals Diagnosed With an Acoustic Neuroma." Br J Health Psychol. **14**(3):563-578. doi:10.1348/135910708x372527.

25. ^Padilla CS, Bergerot CD, Dijke K, Roets E, Boková G, Innerhofer V, Sodergren SC, Mancari R, Bergamini C, Way KM, Sapoznikov O, Burgers JA, Dejaco D, Tesselaar MET, van der Graaf WTA, Husson O (2025). "Health-Related Quality of Life (HRQoL) Assessments in Research on Patients With Adult Rare Solid Cancers: A State-of-the-Art Review." Cancers. **17**(3):387. doi:10.3390/cancers17030387.

26. ^Carlson ML, Lohse CM, Arnold BJ, Tombers NM, McCaslin DL, Saoji AA, Hutchins M, Yost KJ, Link MJ (2025). "Improving Access to Vestibular Schwannoma Quality of Life Research Through Multilanguage Translations of the Mayo Clinic Vestibular Schwannoma Quality of Life Index." J Neurosurg. **142**(Suppl):S2. doi:10.3171/2024.11.jns242317.

27. ^Neve OM, Jansen JC, Koot RW, Ridder MD, Van Benthem PPG, Stiggelbout AM, Hensen EF (2022). "Long-Term Quality of Life of Vestibular Schwannoma Patients: A Longitudinal Analysis." Otolaryngol Head Neck Surg. **168**(2):210-217. doi:10.1177/01945998221088565.

28. ^Walsh RM, Bath AP, Bance ML, Keller A, Tator CH, Rutka JA (2000). "The Role of Conservative Management of Vestibular Schwannomas." Clin Otolaryngol. **25**(1):28-39. doi:10.1046/j.1365-2273.2000.00317.x.

29. ^Carlson ML, Tveiten ØV, Lund-Johansen M, Tombers NM, Lohse CM, Link MJ (2018). "Patient Motivation and Long-Term Satisfaction With Treatment Choice in Vestibular Schwannoma." World Neurosurg. **114**:e1245-e1252. doi:10.1016/j.wneu.2018.03.182.

30. a, bTimmer FCA, Van Haren AEP, Mulder JJS, Hanssens PEJ, Van Overbeeke JJ, Cremers CWRJ, Graamans K (2009). "Quality of Life After Gamma Knife Radiosurgery Treatment in Patients With a Vestibular Schwannoma: The Patient's Perspective." Eur Arch Otorhinolaryngol. **267**(6):867-873. doi:10.1007/s00405-009-1140-3.

31. ^Bender M, Tatagiba M, Gharabaghi A (2022). "Quality of Life After Vestibular Schwannoma Surgery: A Question of Perspective." Front Oncol. **11**:770789. doi:10.3389/fonc.2021.770789.

32. ^Franz L, Montino S, Agostinelli A, Tealdo G, Cazzador D, Zanoletti E, Marioni G (2024). "Functional Outcomes and Self-Reported Quality of Life in Patients With Facial Nerve Impairment Following Vestibular Schwannoma Surgery." Diagnostics. **14**(21):2387. doi:10.3390/diagnostics14212387.

33. ^Ryzenman JM, Pensak ML, Tew JM (2004). "Patient Perception of Comorbid Conditions After Acoustic Neuroma Management: Survey Results From the Acoustic Neuroma Association." Laryngoscope. **114**(5):814-820. doi:10.1097/00005537-200405000-00005.

34. ^Ben-Harosh L, Barker-Collo S, Nowacka A, Garrett J, Miles A (2024). "Quality of Life and Broader Experiences of Those With Acoustic Neuroma: A Mixed Methods Approach." Brain I. **25**(1). doi:10.1071/ib23072.

35. a, bPruijn IMJ, Van Heemskerken P, Kunst HPM, Tummers M, Kievit W (2023). "Patient-Preferred Outcomes in Patients With Vestibular Schwannoma: A Qualitative Content Analysis of Symptoms, Side Effects and The

ir Impact on Health-Related Quality of Life." Qual Life Res. ***32****(10):2887-2897. doi:10.1007/s11136-023-03433-x.*

36. ^*Ansari SF, Terry C, Cohen-Gadol AA (2012). "Surgery for Vestibular Schwannomas: A Systematic Review of Complications by Approach." Neurosurg Focus.* ***33****(3):E14. doi:10.3171/2012.6.FOCUS12163.*
37. ^*Gauden A, Weir P, Hawthorne G, Kaye A (2011). "Systematic Review of Quality of Life in the Management o f Vestibular Schwannoma." J Clin Neurosci.* ***18****(12):1573-1584. doi:10.1016/j.jocn.2011.05.009.*
38. ^*Schwartz MS, Riddle SA, Delashaw JB, Horgan MA, Kellogg JX, Mcmenomey SO (1998). "Quality of Life Foll owing Acoustic Neuroma Surgery." Neurosurg Focus* ***5****(3):e3.*
39. ^*Wagner J, et al. (2011). "Vestibular Function and Quality of Life in Vestibular Schwannoma: Does Size Matt er?" Front Neurol.* ***2****. doi:10.3389/fneur.2011.00055.*
40. ^*Robinett ZN, Walz PC, Miles-Markley B, Moberly AC, Welling DB (2014). "Comparison of Long-Term Qualit y-of-Life Outcomes in Vestibular Schwannoma Patients." Otolaryngol Head Neck Surg.* ***150****(6):1024-1032. do i:10.1177/0194599814524531.*
41. ^*Yakkala VK, Mammi M, Lamba N, Kandikatla R, Paliwal B, Elshibiny H, Corrales CE, Smith TR, Mekary RA (2022). "Audiovestibular Symptoms and Facial Nerve Function Comparing Microsurgery Versus SRS for Ves tibular Schwannomas: A Systematic Review and Meta-Analysis." Acta Neurochir.* ***164****(12):3221-3233. doi:10.1 007/s00701-022-05338-z.*
42. ^*Broomfield SJ, O'Donoghue GM (2015). "Self-Reported Symptoms and Patient Experience: A British Acousti c Neuroma Association Survey." Br J Neurosurg.* ***30****(3):294-301. doi:10.3109/02688697.2015.1071323.*
43. ^*Carlson ML, Habermann EB, Wagie AE, Driscoll CL, Van Gompel JJ, Jacob JT, Link MJ (2015). "The Changin g Landscape of Vestibular Schwannoma Management in the United States—A Shift Toward Conservatism." Otolaryngol Head Neck Surg.* ***153****(3):440-446. doi:10.1177/0194599815590105.*
44. ^*Cheng S, Naidoo Y, Da Cruz M, Dexter M (2009). "Quality of Life in Postoperative Vestibular Schwannoma Patients." Laryngoscope.* ***119****(11):2252-2257. doi:10.1002/lary.20217.*

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.