Original article

The quality of life of patients with vestibular schwannoma assessed using cross-cultural adapted and validated PANQOL and Mayo VSQOL questionnaires in comparison

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Introduction: Vestibular schwannoma (VS) adversely affects patients' functional status and quality of life (QoL). Disease-specific questionnaires, such as PANQOL and Mayo VSQOL, provide a more sensitive assessment of disease progression and treatment outcomes compared with general instruments. Modern microsurgical techniques aim to preserve facial and cochlear nerve function, which directly influences postoperative QoL.

Objective: To evaluate the QoL of patients with VS using the Ukrainian versions of PANQOL and Mayo VSQOL questionnaires and to validate them according to COSMIN standards.

Materials and methods: The prospective study included 190 patients with VS, divided into three groups: Group I (n=64) — traditional microsurgery (2001–2016); Group II (n=57) — modern microsurgical techniques (2017–2024); Group III (n=69) — observation ("wait-and-scan"). QoL was assessed using PANQOL, Mayo VSQOL, SF-36, QLQ-C30, and BN20 questionnaires. Correlation analysis was performed; statistical significance was set at $p<0.05$.

Results: Mayo VSQOL scores were significantly higher in Group II compared with Group I in the domains of balance (+33.3%), tinnitus/pain (+36.4%), emotional well-being (+43.1%), memory (+58.4%), and total score (+32.2%). Comparison with Group III also confirmed the advantage of surgical treatment, particularly in emotional well-being and memory (+44.3%). PANQOL demonstrated the greatest improvement in the "Face" domain (+35.6%), while changes in other domains were not statistically significant. Significant correlations were found between PANQOL and Mayo VSQOL results with SF-36, QLQ-C30, and BN20, confirming their validity. Internal consistency was high (PANQOL α=0.75–0.93 preoperatively; α=0.81–0.90 postoperatively; Mayo α=0.763–0.938 preoperatively; α=0.858–0.937 postoperatively). Test–retest reliability (ICC) ranged from 0.60–0.91 for PANQOL and 0.778–0.953 for Mayo. Mayo VSQOL demonstrated higher responsiveness to clinical changes (Cohen's d=2.11; SRM=1.74) compared with PANQOL (Cohen's d=0.87; SRM=0.75).

Conclusions: PANQOL and Mayo VSQOL are reliable instruments for assessing QoL in patients with VS. Mayo VSQOL demonstrated higher sensitivity, while PANQOL showed stable correlation with general QoL scales. The use of modern microsurgical techniques substantially improves postoperative QoL in VS patients.

Keywords: *vestibular schwannoma; quality of life; PANQOL; Mayo VSQOL; treatment outcomes*

Background

Over the past three decades, the diagnosis and treatment of sporadic vestibular schwannomas (VS) have changed significantly. Widespread magnetic resonance imaging (MRI) availability has increased the detection of incidental tumors, while radiosurgery and the "wait-and-scan" strategy have been increasingly used for small, clinically inactive lesions. These changes shifted the focus from purely morphological and neurosurgical endpoints (resection completeness, survival) to broader concepts of "treatment success," including functional outcomes and patient-reported QoL [1–6].

In VS clinical studies general questionnaires such as SF-36, EORTC QLQ-C30 have long been used. They effectively assess general health but poorly capture VS-specific problems such as hearing loss, tinnitus, balance disorders, anxiety, or social/occupational impacts [5, 7-10]. Over the last 15 years, there has been growing interest in validating disease-specific scales: PANQOL (Penn Acoustic Neuroma QoL) and the newer Mayo VSQOL Index. These scales correlate better with clinical symptoms and provide sensitive criteria for comparing treatment strategies [1–3, 7–11].

PANQOL was developed and validated specifically for patients with acoustic/vestibular schwannomas. It

has good psychometric properties including internal consistency, test-retest reliability and demonstrated correlation with clinical indicators. Translations into Italian, Spanish, Hindi, and other languages have confirmed its stability across cultures, making it suitable for multicenter and long-term cohort studies [3, 9, 12-16].

Mayo VSQOL is a newer 40-item tool designed for a comprehensive assessment of VS impact and treatment on QoL, including employment, treatment satisfaction, and side effects. Initial validation showed excellent psychometric properties and the ability to detect differences between treatment groups. However, further independent validation and comparative studies with PANQOL and general instruments are needed [2, 4, 7].

Recent studies comparing PANQOL and Mayo VSQOL, as well as their correlation with general scales (QLQ-C30/BN20, SF-36), show that disease-specific instruments are more sensitive to VS-related symptoms including hearing, balance, face and emotional state. General scales correlate with overall QoL but may "smooth out" differences between treatment strategies. Using both disease-specific and general tools provides the most complete assessment of the overall and symptom-specific impact of VS and its treatment [1, 2, 4, 5, 7–11, 17].

Prospective studies using PANQOL have tracked QoL dynamics in patients undergoing different strategies including observation, radiosurgery, microsurgery. Differences in disease-specific QoL between strategies are often minimal in the long term, while early postoperative periods show more pronounced differences [4, 18-22]. Modern microsurgery with intraoperative neuromonitoring and nerve-sparing techniques can achieve favorable long-term functional outcomes and improve certain QoL domains. However, results must be interpreted in the context of patient age, tumor size, preoperative hearing status, comorbidities, and individual expectations [5, 17, 23].

Ukrainian data show later diagnosis with a predominance of large tumors (Koos grades III–IV), affecting treatment choice and functional outcomes [1]. Ukrainian versions of PANQOL and Mayo VSQOL questionnaires have undergone cross-cultural adaptation, pilot testing, with most items demonstrating good comprehensibility (<1% required clarification) [1]. However, multi-center registries and long-term follow-up (>5 years) are necessary to evaluate outcomes and treatment impact on QoL patients with VS in Ukraine [1, 2, 5, 17].

Despite the use of PANQOL and Mayo VSQOL, several questions remain open: standardized translation and cross-cultural adaptation and validation, optimal combination of specific and general instruments in routine practice, determination of clinically meaningful minimal changes for each questionnaire, commonly agreed and accepted criteria of VS surgical removal radicality as well as the impact of socioeconomic and professional factors on subjective quality of life. Therefore, large-scale prospective studies are needed to determine which strategies provide better long-term quality of life in different patient subgroups. In this context, the cross-cultural adaptation, validation and comparative use of PANQOL and Mayo VSQOL are particularly important for developing optimal treatment strategies and enhancing patient-centered care in Ukraine and wherever [2, 4, 10, 15, 17].

The cross-cultural adaptation and validation PANQOL and Mayo VSQOL in Ukraine and comparing them with QLQ-C30/BN20 and SF-36 is not only a methodological need but also clinically relevant: only localized, sensitive instruments allow treatment strategies to be adjusted according to patient priorities such as hearing preservation, facial nerve function, balance, return to work, etc.) and justify choices between early microsurgery, observation, or primary radiosurgery within a specific social-medical context [1, 2, 5, 17, 18, 23]. The present study combines cross-cultural adaptation and validation with analysis of clinical outcomes using contemporary microsurgical techniques and aims to provide evidence to optimize local treatment protocols and improve QoL for patients with VS in Ukraine [1].

Materials and methods
Study participants
A total of 373 patients with VS were under dynamic observation at the Kolomyichenko Institute of Otolaryngology, National Academy of Medical Sciences of Ukraine. The present study was conducted at the Subtentorial Neuro-oncology Department of the Romodanov Neurosurgery Institute and included patients treated or followed between 2001 and 2024.

Quality-of-life (QoL) assessment was completed in 190 patients. Patients were evaluated during inpatient treatment, outpatient follow-up visits, telephone interviews, as well as postal or electronic surveys. Postoperative QoL assessment was performed no earlier than 6 months after surgery.

Inclusion criteria
Patients were eligible for inclusion if they met all of the following criteria:
- unilateral sporadic vestibular schwannoma;
- preoperative MRI or contrast-enhanced CT confirming the diagnosis;
- histopathological verification (for surgically treated patients);
- age ≥ 18 years;
- written informed consent;
- completed PANQOL and/or Mayo VSQOL questionnaires.

Exclusion criteria
Patients were excluded from the study if they had:
- neurofibromatosis type II;
- absence of imaging or histopathological confirmation of vestibular schwannoma;
- incomplete questionnaire data;
- Bell's palsy during follow-up;
- age < 18 years.

Group characteristics
Based on treatment strategy and time period, patients were divided into three groups:

Group I – 64 patients who underwent microsurgical removal of VS using conventional microsurgical techniques between 2001 and 2016;

Group II – 57 patients treated with updated contemporary microsurgical techniques between 2017 and 2024;

Group III – 69 patients managed using a "wait-and-scan" observation strategy without surgical intervention.

The mean follow-up duration was 159.44 months (median 136 months) in Group I and 49.52 months (median 60 months) in Group II.

The follow-up period in Group III ranged from 6 months to 18 years.

Response rates were as follows: Group I – PANQOL (61 patients), Mayo VSQOL (64 patients), BN20/QLQ-C30/SF-36 (64 patients); Group II – PANQOL (57 patients), Mayo VSQOL (56 patients), BN20/QLQ-C30/SF-36 (57 patients); Group III – PANQOL and Mayo VSQOL (69 patients), BN20/QLQ-C30/SF-36 (44 patients).

Comparative analysis of the domains "Hearing," "Balance," "Pain," and "Face" between PANQOL and Mayo VSQOL was performed across the three groups, along with analyses of BN20, QLQ-C30, and SF-36 scores between Groups I–II and II–III. Comparative analysis between Groups I and III was not performed because outdated surgical techniques were associated with different indications for surgery, levels of functional risk, and standards for outcome assessment.

Study design

This study employed a retrospective comparative cohort design and was aimed at assessing quality of life in patients with VS using both disease-specific and generic QoL instruments.

The study combined cross-cultural adaptation and validation of the Ukrainian versions of the PANQOL and Mayo VSQOL questionnaires with a comparative analysis of QoL outcomes according to the selected treatment strategy: conventional microsurgery, contemporary microsurgical techniques, or active surveillance using a "wait-and-scan" approach.

In addition, patients completed the EORTC QLQ-C30, EORTC QLQ-BN20, and SF-36 questionnaires. Comparative analyses were performed between Groups I and II and between Groups II and III, with evaluation of specific functional domains (hearing, balance, pain, facial nerve function) as well as overall composite QoL scores.

Cross-cultural adaptation and validation of the PANQOL and Mayo VSQOL [1] questionnaires were conducted in accordance with international recommendations and COSMIN guidelines [24, 25]. Official permission for the translation and use of the Mayo VSQOL questionnaire in Ukraine was obtained from the developers of the original instrument.

Statistical analysis

Statistical analysis was performed using the Deducer package (Java GUI for R, GNU license) [26]. Continuous variables were analyzed using descriptive statistics. Differences were considered statistically significant at $p < 0.05$.

Internal consistency of questionnaire domains was assessed using Cronbach's α. Test–retest reliability was evaluated using the intraclass correlation coefficient (ICC) based on paired observations with an interval of 2–14 days. Responsiveness to clinically meaningful changes was assessed using Effect Size (Cohen's d) and Standardized Response Mean (SRM).

Postoperative hearing outcomes were classified according to the Gardner–Robertson hearing scale [27]. Facial nerve function was evaluated using the House–Brackmann grading system. Correlation and regression analyses were applied to assess the relationships between disease-specific and general QoL instruments.

Results
Adaptation and validation of questionnaires

A standardized multi-step cross-cultural adaptation and validation of the PANQOL and Mayo VSQOL questionnaires was conducted in accordance with international guidelines [24, 25, 28]. Three neurosurgeons independently translated the scale into Ukrainian. A professional Ukrainian philologist from Taras Shevchenko National University of Kyiv compiled three texts into one. The back translation was performed by two native English speakers residing in Canada and the United Kingdom. The reconciled version was subsequently reviewed by a linguist and a methodology expert from Taras Shevchenko National University of Kyiv. Pilot testing in 30 patients confirmed high comprehensibility, with less than 1% of items requiring clarification. The back-translated version demonstrated 96% semantic equivalence with the originals, meeting the recommended validation criteria [28]. The final Ukrainian version of the Mayo VSQOL questionnaire was approved by the original developers, Carlson ML and Lohse CM, and accepted as the official localized version [1].

To assess QoL in Ukrainian patients with VS and validate the PANQOL and Mayo VSQOL scales, a study was conducted using PANQOL, Mayo VSQOL Index, BN20, QLQ-C30, and SF-36 questionnaires (**Tables 1-7**). The observation period spanned 2001–2024 and included patients treated at the Subtentorial Neuro-oncology Department, as well as outpatients followed in the Ear Microsurgery and Oto-neurosurgery Department of the Kolomyichenko Institute of Otolaryngology after diagnosis verification. Patients with tumor progression (increase in VS size to T3 according to Hannover classification or higher on follow-up imaging) were referred for surgical treatment at the Neurosurgery Institute.

A total of 1,183 statistical cards and 829 medical records from the Institutes archive was reviewed. For the survey, 244 patients were possible to reach, and fully completed questionnaires were received from 190 individuals. Comparative analysis of QoL measures using validated scales (PANQOL, Mayo VSQOL, BN20, QLQ-C30, SF-36) revealed significant differences between the three study groups (see **Tables 1–7**).

A total of 373 patients were under dynamic observation at the Kolomyichenko Otolaryngology Institute of the National Academy of Medical Sciences of Ukraine, of whom 110 (29.5%) subsequently underwent surgical removal of VS due to symptom progression or a progressive disease course, and 24 (6.4%) received radiotherapy (RT). QoL data were obtained for 10 patients who remained under "wait-and-scan" management. Patients who underwent surgery following "wait-and-scan," either in our department or at the Kolomyichenko Institute, were evaluated according to the department where the surgery was performed.

Comparative analysis of Groups I and II

According to the PANQOL scale, patients in Group II showed improvement across all domains compared to Group I, except for the "Anxiety" domain. The most pronounced positive changes were observed in the following domains: Pain, which increased from 42.2 to 50.4 (+19.5%, mean comparison criterion 0.905); Facial function, from 45.1 to 61.1 (+35.6%, 1.968); Overall health, from 45.7 to 52.9 (+15.7%, 1.222); and the Total

Table 1. Correlation between Groups I, II, and III according to the PANQOL and Mayo VSQOL scales with the BN20 and QLQ-C30 scales, as well as correlation between QLQ-C30 and BN20

	Correlation of Group I on the PANQOL and Mayo scales with the BN20 and QLQ-C30 scales, and correlation between QLQ-C30 and BN20		
	Parameter	**Parameter**	**Correlation coefficient**
1	PANQOL total score	QLQ C30	0,635
2	PANQOL total score	BN20	0,635
3	Mayo total score	QLQ C30	-0,126
4	Mayo total score	BN20	-0,133
5	QLQ C30	BN20	0,816
	Correlation of Group II scores on the PANQOL and Mayo scales with the BN20 and QLQ-C30 scales		
1	PANQOL total score	QLQ C30	0,596
2	PANQOL total score	BN20	0,629
3	Mayo total score	QLQ C30	0,586
4	Mayo total score	BN20	0,501
	Correlation of Group III scores on the PANQOL and Mayo scales with the BN20 and QLQ-C30 scales		
1	PANQOL total score	QLQ C30	0,663
2	PANQOL total score	BN20	0,743
3	Mayo total score	QLQ C30	0,155
4	Mayo total score	BN20	0,093

Table 2. Comparison of Groups I and II based on the PANQOL scale

№	Parameter	Divergence Coefficient	Mean Value Group I	Mean Value Group II	Increase of Group II over I, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs I
1	Hearing	0,118	46	49,7	8%	0,582	+
2	Balance	0,089	48,4	50,3	4%	0,259	+
3	Anxiety	0,145	63,2	62,6	-1%	-0,085	-
4	Energy	0,161	48,4	49,6	2,3%	0,165	+
5	Pain	0,197	42,2	50,4	19,5%	0,905	+
6	Face	0,292	45,1	61,1	35,6%	1,968	+
7	Overall Health	0,146	45,7	52,9	15,7%	1,222	+
8	Total Score	0,174	48,4	53,8	11,1%	0,964	+

Table 3. Comparison of Groups I and II based on the Mayo VSQOL

№	Parameter	Divergence Coefficient	Mean Value Group I	Mean Value Group II	Increase of Group II over I, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs I
1	Domain I (Hearing problems)	0,19	49	57,1	16,5%	1,09	+
2	Domain II (Dizziness and balance disorders)	0,35	46,7	62,3	33,3%	1,872	+
3	Domain III (Pain, discomfort, and ear noise)	0,397	46,7	65,8	36,4%	2,191	+
4	Domain IV (Face or eye problems)	0,128	50,3	55	9,4%	0,668	+
5	Domain V (Impact on physical, emotional, and social well-being)	0,35	47,8	68,4	43,1%	2,532	+
6	Domain VI (Cognitive and memory difficulties)	0,432	43,3	68,5	58,4%	2,858	+
7	Domain VII (Satisfaction or regret)	0,19	47,9	49	2,2%	0,126	+
8	Domains I–VI (average)	0,652	47,3	62,5	32,2%	2,243	+

Table 4. Comparison of Group I and II according to the QLQ-C30, BN20 and SF-36

№	Parameter	Divergence Coefficient	Mean Value Group I	Mean Value Group II	Increase of Group II over I, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs I
1	QLQ C30	0,19	65,5	72	9,9%	1,252	+
2	BN20	0,208	67	72,5	8,1%	1,027	+
3	Overall Physical Health Score (SF-36)	0,353	31	34,2	10,3%	0,958	+
4	Overall Mental Health Score (SF-36)	0,261	47,6	49,7	4,4%	0,435	+
5	SF-36 Total score	0,359	39,3	41,9	6,7%	0,706	+

Table 5. Distribution comparison characteristics of Group II and III based on the PANQOL scale

№	Parameter	Divergence Coefficient	Mean Value Group III	Mean Value Group II	Increase of Group II over III, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs III
1	Hearing	0,224	42,3	49,7	17,4	1,19	+
2	Balance	0,186	48,9	50,3	2,9	0,182	+
3	Anxiety	0,17	56,3	62,6	11,1	0,883	+
4	Energy	0,141	46,9	49,6	5,8	0,388	+
5	Pain	0,114	43,1	50,4	17	0,855	+
6	Face	0,143	66,8	61,1	-8,5	-0,733	-
7	Overall Health	0,158	52,3	52,9	0,6	0,051	+
8	Total Score	0,824	51	53,8	5,6	0,511	+

Table 6. Distribution comparison characteristics of Group II and III based on the MAYO VSQOL scale

№	Parameter	Divergence Coefficient	Mean Value Group III	Mean Value Group II	Increase of Group II over III, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs III
1	Domain I (Hearing problems)	0,203	48,2	57,1	18,6	1,06	+
2	Domain II (Dizziness and balance disorders)	0,276	47,3	62,3	31,5	1,699	+
3	Domain III (Pain, discomfort, and ear noise)	0,231	46,8	63,8	36,2	2,174	+
4	Domain IV (Face or eye problems)	0,175	47,7	55	15,3	0,95	+
5	Domain V (Impact on physical, emotional, and social well-being)	0,328	46	68,4	48,7	2,743	+
6	Domain VI (Cognitive and memory difficulties)	0,32	46,5	68,5	47,5	2,453	+
7	Domain VII (Satisfaction or regret)	0,157	43,6	49	12,5	0,608	+
8	Domains I–VI (average)	0,317	47,2	62,5	32,5	2,142	+

Table 7. Comparison of Group II and III according to the QLQ-C30, BN20 and SF-36

№	Parameter	Divergence Coefficient	Mean Value Group III	Mean Value Group II	Increase of Group II over III, % of Mean	Mean Comparison Criterion	Direction of Shift in Group II vs III
1	QLQ C30	0,187	67,5	72	6,7	0,901	+
2	BN20	0,126	67,5	72,5	7,4	0,916	+
3	Overall Physical Health Score (SF-36)	0,263	30,8	34,2	10,9	1,123	+
4	Overall Mental Health Score (SF-36)	0,172	43,8	49,7	13,4	1,495	+
5	SF-36 Total score	0,19	37,3	41,9	12,3	1,517	+

score, from 48.4 to 53.8 (+11.1%, 0.964). In contrast, the "Anxiety" domain showed a minimal decrease (–1%). Statistically significant improvements (p<0.05) were noted specifically in the domains of Pain, Facial function, Overall health, and the Total score (see **Table 2**).

Assessment using the Mayo VSQOL scale also demonstrated systematic improvement in Group II compared to Group I across all domains. The most notable and statistically significant changes were observed in: Domain I ("Hearing problems"), from 49 to 57.1 (+16.5%, mean comparison criterion 1.09); Domain II ("Dizziness and balance disturbances"), from 46.7 to 62.3 (+33.3%, –1.872); Domain III ("Pain, discomfort, and tinnitus"), from 46.7 to 65.8 (+36.4%, 2.191); Domain V ("Impact on physical, emotional, and social well-being"), from 47.8 to 68.4 (+43.1%, 2.532); Domain VI ("Cognitive difficulties and memory"), from 43.3 to 68.5 (+58.4%, 2.858). Additionally, the mean total score on the Mayo scale significantly increased from 47.3 to 62.5 (+32.2%, 2.243). For these measures, the null hypothesis of equal population means was rejected with p=0.001, confirming the high statistical significance of the results (see **Table 3**).

Comparison of BN20, QLQ-C30, and SF-36 scores showed a consistent shift in Group II toward improvement of QoL relative to Group I. The most pronounced differences were observed for BN20 (from 67 to 72.5, +8.1%, mean comparison criterion 1.027) and QLQ-C30 (from 65.5 to 72, +9.9%, 1.252), with statistically significant results (p<0.05). Regarding SF-36, improvement in overall physical health in Group II nearly reached statistical significance (mean comparison criterion = 0.958, p=0.06), indicating a trend toward a positive effect of the enhanced microsurgical techniques on patients' QoL (see **Table 4**).

Comparative analysis of Groups II and III

QoL assessment in patients with VS using PANQOL, Mayo VSQOL, BN20, QLQ-C30, and SF-36 instruments demonstrated statistically significant improvement in Group II (operated on from 2017) compared to the observation group (Group III).

According to the PANQOL scale (see Table 5), Group II showed improvement in most domains compared to the observation group. The mean score for the Hearing

domain increased from 42.3 to 49.7 (+17.4%), which was statistically significant (mean comparison criterion = 1.19, positive shift). Improvements were also observed in the Balance domain from 48.9 to 50.3 (+2.9%, 0.182), Anxiety from 56.3 to 62.6 (+11.1%, 0.883), Energy from 46.9 to 49.6 (+5.8%, 0.388), Pain from 43.1 to 50.4 (+17%, 0.855), and Overall health from 52.3 to 52.9 (+0.6%, 0.051). The only domain showing a slight decrease was Facial function (from 66.8 to 61.1, –8.5%, –0.733), reflecting the prolonged recovery of facial nerve function, which typically requires more than six months postoperatively. The total PANQOL score increased from 51.0 to 53.8 (+5.6%, 0.511).

Mayo VSQOL analysis (Table 6) also revealed statistically significant improvement in Group II. All domains showed increased mean scores, with significant improvement in six domains: Domain I (Hearing problems) – from 48.2 to 57.1 (+18.6%, mean comparison criterion –1.06); Domain II (Dizziness and balance disturbances) – from 47.3 to 62.3 (+31.5%, 1.699); Domain III (Pain, discomfort, and tinnitus) – from 46.8 to 63.8 (+36.2%, 2.174); Domain V (Impact on physical, emotional, and social well-being) – from 46.0 to 68.4 (+48.7%, 2.743); Domain VI (Cognitive difficulties and memory) – from 46.5 to 68.5 (+47.5%, 2.453); Total Mayo VSQOL score – from 47.2 to 62.5 (+32.5%, 2.142); Domains IV (Facial or eye problems) and VII (Satisfaction or regret) also showed positive trends; however, these changes did not reach statistical significance.

Regarding QLQ-C30, BN20, and SF-36, Group II demonstrated improvement compared to Group III (Table 7). Mean QLQ-C30 scores increased from 67.5 to 72 (+6.7%, mean comparison criterion =0.901), and BN20 scores increased from 67.5 to 72.5 (+7.4%, 0.916). Overall physical health on SF-36 increased from 30.8 to 34.2 (+10.9%, 1.123), mental health from 43.8 to 49.7 (+13.4%, 1.495), and the total SF-36 score from 37.3 to 41.9 (+12.3%, 1.517).

Clinical status evaluation between groups: facial and cochlear nerve function

Facial nerve function was assessed using the House-Brackmann (HB) scale in the early postoperative period, with distribution as follows: Group 1: HB I was observed in 24 patients (5%), II – 30 (6.3%), III – 67 (14.1%),

IV – 102 (21.6%), V – 149 (31.5%), VI – 102 (21.5%); Group 2: HB I was recorded in 132 patients (37.2%), II – 77 (21.7%), III – 95 (26.8%), IV – 37 (10.4%), V – 11 (3.1%), VI – 3 (0.8%) (p<0.001, χ² test).

Intraoperative identification and preservation of the cochlear nerve were not performed in Group 1. In Group 2, such attempts were made in patients with functional hearing preoperatively. Among 93 identified patients, anatomical preservation of the cochlear nerve was achieved in 49 (52.7%). Postoperative hearing outcomes in these patients were classified according to the Gardner–Robertson (GR) scale as follows: GR-I in 21 patients (42.9%), GR-II – 12 (24.5%), GR-III – 16 (32.6%).

Correlation analysis

Correlation analysis showed a moderate to high positive relationship between total PANQOL and Mayo VSQOL scores and QLQ-C30 and BN20 scores in Group II: PANQOL and QLQ-C30 – r = 0.596, PANQOL and BN20 – r = 0.629, Mayo and QLQ-C30 – r = 0.586, Mayo and BN20 – r = 0.501, confirming consistency of QoL assessment across different scales (see ***Table 1***).

Correlation analysis and multiple correlation coefficient assessment were used to compare the consistency of PANQOL and Mayo VSQOL questionnaires with the validated SF-36 scale across the three groups of patients with VS.

Group I: Correlation between PANQOL and physical health – r = 0.651; mental health – r = 0.532; SF-36 total score – r = 0.611. Mayo VSQOL: physical health – r = 0.188; mental health – r = 0.129; SF-36 total score – r = 0.163. Multiple regression: PANQOL (physical health β = 0.623; mental health β = 0.035), Mayo (physical health β = 0.189).

Group II: Correlation between PANQOL and physical health – r = 0.495; mental health – r = 0.397; SF-36 total score – r = 0.503. Mayo VSQOL: physical health – r = 0.477; mental health – r = 0.451; SF-36 total score – r = 0.532. Multiple regression: PANQOL (physical health β = 0.527), Mayo (physical health β = 0.539).

Group III: Correlation between PANQOL and physical health – r = 0.716; mental health – r = 0.613; SF-36 total score – r = 0.748. Mayo VSQOL: physical health – r = 0.208; mental health – r = −0.182; SF-36 total score – r = −0.007. Multiple regression: PANQOL (physical health β = 0.753), Mayo (physical health β = 0.414).

Overall, PANQOL consistently demonstrated moderate to high concordance with SF-36 across all three groups, confirming its ability to reflect both physical and psycho-emotional status of patients. In contrast, Mayo VSQOL showed weak or minimal correlation with SF-36, particularly in Group III, indicating limited sensitivity of this scale for evaluating overall physical and mental health. Multiple regression confirmed that the main predictor of total PANQOL score is physical health, while the contribution of mental health is minimal. For Mayo, the contribution of physical health in regression was significantly lower, consistent with the observed correlation coefficients.

Comparison of corresponding domains between PANQOL and Mayo VSQOL

Analysis of correlations between corresponding domains of the PANQOL and Mayo VSQOL questionnaires in Group II patients revealed only weak positive correlations: Hearing – r = 0.395, Balance – r = 0.405, Pain – r = 0.440, Face – r = 0.470. In Group III, the strength of correlations was even lower: Hearing – r = 0.262, Balance – r = 0.117, Pain – r = 0.181, Face – r = 0.080. These results indicate that direct comparison of individual domains between the two questionnaires has limited clinical significance, as the content and structure of the respective questions partially differ. It is more appropriate to use each questionnaire as an independent tool for assessing the QoL or to compare their total scores, which demonstrates better concordance between the scales.

Test–retest reliability, internal consistency, and responsiveness

The internal consistency of the Ukrainian versions of PANQOL and Mayo VSQOL questionnaires was evaluated using Cronbach's α for each domain in pre- and postoperative samples. The ICC was interpreted according to commonly accepted categories: Cronbach's α < 0.50 – poor/unacceptable reliability; 0.50–0.59 – weak; 0.60–0.69 – moderate/acceptable; 0.70–0.79 – acceptable/satisfactory; 0.80–0.89 – high; ≥ 0.90 – excellent [29].

The preoperative sample for PANQOL included 154 patients. Cronbach's α values ranged from 0.75 to 0.93 across domains I, II, III, V, and VI, indicating acceptable to excellent internal consistency. Domain IV consisted of a single item and was not analyzed. Domain VII showed low consistency (α = 0.38), typical for two-item scales. The overall Cronbach's α for PANQOL in the preoperative sample was 0.91, confirming high internal consistency for the entire scale. Postoperatively (199 patients), domain-specific α values remained stable (0.75–0.90 for domains I, II, III, V, and VI), while domain VII improved slightly (α = 0.48) but remained below the acceptable threshold due to the limited number of items. The overall Cronbach's α after surgery was 0.92, demonstrating stability and reliability of the scale postoperatively (***Table 8***).

The preoperative sample for Mayo VSQOL included 105 patients, with α values ranging from 0.763 to 0.938, indicating high internal consistency. In the postoperative sample (177 patients), the overall Cronbach's α for all 40 items was 0.953, reflecting excellent internal consistency. Domain-specific α values ranged from 0.858 to 0.937, demonstrating high to very high reliability of the measured constructs after surgery (***Table 9***).

Test–retest reliability of the Ukrainian versions of PANQOL and Mayo VSQOL was evaluated to determine the temporal stability of the scales. All domains of PANQOL and Mayo VSQOL are presented as interval scales; therefore, reliability was assessed using the ICC, in accordance with COSMIN recommendations [24,26]. ICC interpretation followed widely accepted categories: <0.50 – poor; 0.50–0.75 – moderate; 0.75–0.90 – good; >0.90 – excellent reliability. The test–retest interval ranged from 2 to 14 days, in line with guidelines.

For PANQOL analysis, 33 paired observations were included. ICC values across domains ranged from 0.60 to 0.91. The highest stability was observed in Domain VI (ICC = 0.91), indicating excellent reliability. Domains II, III, IV, and V demonstrated good to high reliability (ICC = 0.72–0.84). Domains I and VII showed moderate

reliability (ICC = 0.60–0.65), corresponding to an acceptable level according to COSMIN [25, 26]. Overall, all PANQOL domains had ICC > 0.60, indicating sufficient and clinically acceptable stability of the questionnaire during repeated administration (***Table 10***).

For the Mayo VSQOL test–retest analysis, 31 patients were included. ICC values for all domains ranged from 0.778 to 0.953, corresponding to good or excellent reliability according to conventional criteria. The highest stability was observed in Domains II (ICC = 0.942) and III (ICC = 0.953), indicating exceptional reproducibility during repeated completion. Pearson's correlation coefficients were also high (r = 0.872–0.975), further confirming the reliability of results (***Table 11***).

The responsiveness of the Ukrainian versions of the PANQOL and Mayo VSQOL questionnaires was evaluated to determine their ability to detect clinically meaningful postoperative changes. Responsiveness was assessed using two commonly accepted indicators — Effect Size (Cohen's d) and Standardized Response Mean (SRM), calculated based on paired pre- and postoperative observations. The interpretation followed established thresholds: <0.20 — negligible; 0.20–0.49 — small; 0.50–0.79 — moderate; ≥0.80 — large effect.

A total of 30 paired PANQOL patient observations in Group II were analyzed. All PANQOL domains demonstrated improvement after surgery. Cohen's d ranged from 0.52 to 1.09, indicating moderate to large responsiveness. The highest responsiveness was observed in Domain VI (Energy/Vitality) with Cohen's d = 1.09 and SRM = 0.81, reflecting a substantial improvement in overall well-being and functional vitality. The total PANQOL score also showed a large effect (Cohen's d = 0.87; SRM = 0.75), confirming the high sensitivity of the scale in detecting overall changes in quality of life after treatment. Domains I, II, III, V and VII demonstrated moderate responsiveness, whereas Domain IV (Headache) showed the lowest yet still clinically meaningful effect (Cohen's d = 0.52), corresponding to a small–moderate effect (***Table 12***).

For the Mayo VSQOL, 31 paired observations in Group II were included. All domains demonstrated clinically meaningful changes, with Cohen's d values ranging from 0.31 to 2.11. The greatest responsiveness was observed in Domain V, where Cohen's d = 2.11 and SRM = 1.74, indicating an exceptionally large effect. High responsiveness was also demonstrated in domains VI (Cohen's d = 1.33; SRM = 1.36) and VII (Cohen's d = 1.12; SRM = 0.94), reflecting substantial improvements in social functioning, emotional status, and treatment satisfaction. The total Mayo VSQOL score demonstrated a large effect (Cohen's d = 1.17; SRM = 1.11), confirming high overall responsiveness of the scale. Domains I–IV showed small to moderate effects (Cohen's d = 0.31–0.63), which is typical for physical or functional aspects of QoL (***Table 13***).

Table 8. Internal consistency (Cronbach's α) of the PANQOL domains before and after surgery

Domain	Preoperative α	Postoperative α	Interpretation
I. Hearing	0.75	0.75	Acceptable internal consistency at both time points
II. Balance	0.93	0.90	Excellent and consistently high reliability
III. Face	0.79	0.81	Good consistency, no deterioration
IV. Headache	—	—	α not computed (single item domain)
V. Anxiety / Stress	0.81	0.83	Good reliability both pre- and postoperatively
VI. Energy / Vitality	0.87	0.87	Very good and stable reliability
VII. Isolation / Cognition	0.38	0.48	Low (expected for a 2-item domain), slight improvement postoperatively

Table 9. Internal consistency (Cronbach's α) of the MAYO VSQOL domains before and after surgery

Domain	Preoperative α	Postoperative α	Interpretation
I	0.867	0.858	Very good
II	0.931	0.905	Excellent
III	0.873	0.875	Very good
IV	0.763	0.864	Acceptable / good
V	0.938	0.937	Excellent
VI	0.925	0.913	Excellent
VII	0.886	0.894	Very good

Table 10. Test–retest reliability of PANQOL domains (n = 33 paired observations)

PANQOL Domain	ICC	Interpretation
I	0.65	Moderate
II	0.84	High
III	0.75	Good
IV	0.82	High
V	0.72	Good
VI	0.91	Excellent
VII	0.60	Moderate

Table 11. Test–retest reliability of Mayo VSQOL domains (n = 31 paired observations)

Domain	Pearson r	ICC	Interpretation
I	0.896	0.889	Good
II	0.961	0.942	Excellent
III	0.975	0.953	Excellent
IV	0.884	0.858	Good
V	0.872	0.778	Good
VI	0.944	0.860	Good
VII	0.930	0.893	Good

Table 12. Responsiveness of PANQOL domains (n = 30 paired observations)

Domain	Δ (post–pre)	Cohen's d	SRM	Interpretation
I. Hearing	+16.00	0.60	0.55	Moderate effect
II. Balance	+17.17	0.65	0.47	Moderate (d), small–moderate (SRM)
III. Face	+14.67	0.54	0.53	Moderate effect
IV. Headache	+15.00	0.52	0.49	Small–moderate effect
V. Anxiety/Stress	+16.25	0.76	0.59	Moderate–large effect
VI. Energy/Vitality	+24.50	1.09	0.81	Large effect
VII. Isolation/Cognition	+12.50	0.58	0.53	Moderate effect
Total PANQOL	+16.58	0.87	0.75	Large effect

Table 13. Responsiveness of Mayo VSQOL domains (n = 31 paired observations)

Domain	Δ (post–pre)	Cohen's d	SRM	Interpretation
I	+10.17	0.41	0.40	Small–moderate effect
II	+16.82	0.63	0.58	Moderate effect
III	+11.33	0.45	0.37	Small–moderate effect
IV	+7.00	0.31	0.37	Small effect
V	+29.36	2.11	1.74	Very large effect
VI	+22.58	1.33	1.36	Large effect
VII	+18.81	1.12	0.94	Large effect
Total Mayo	+16.58	1.17	1.11	Large effect

Both scales demonstrated adequate ability to detect clinically important postoperative changes; however, their sensitivity profiles differed: PANQOL provided more uniform responsiveness across domains and was particularly sensitive to changes in energy/vitality and overall quality of life. In contrast, Mayo VSQOL showed markedly higher responsiveness in social and emotional domains and in the total score, with Cohen's d exceeding 1.0 in three domains.

Discriminant Validity

The discriminant validity of the Ukrainian versions of PANQOL and Mayo VSQOL was assessed based on their ability to differentiate patients with objectively different clinical outcomes. Patients were stratified according to the extent of tumor resection, facial nerve (FN) function assessed by HB scale in the early postoperative period, and cochlear nerve preservation and hearing outcomes. In Group 1 (traditional microsurgery, 2001–2016), FN function was distributed as follows: HB I – 24 (5%), II – 30 (6.3%), III – 67 (14.1%), IV – 102 (21.6%), V – 149 (31.5%), VI – 102 (21.5%). In Group 2 (modern microsurgical techniques, 2017–2024), significantly better outcomes were observed: HB I – 132 (37.2%), II – 77 (21.7%), III – 95 (26.8%), IV – 37 (10.4%), V – 11 (3.1%), VI – 3 (0.8%) (p < 0.001). Cochlear nerve preservation and postoperative hearing further demonstrated the discriminant ability of the questionnaires. In Group 2, among 93 patients with functional preoperative hearing, the cochlear nerve was anatomically preserved in 49 (52.7%), with postoperative hearing graded as GR-I in 42.9%, GR-II in 24.5%, and GR-III in 32.6%. Cochlear nerve preservation was not performed in Group 1.

Both PANQOL and Mayo VSQOL effectively reflected these clinical differences, confirming the questionnaires' ability to discriminate clinically distinct subgroups and demonstrating adequate discriminant validity.

Discussion

We performed cross-cultural adaptation and validation of the PANQOL and Mayo VSQOL questionnaires for Ukrainian-speaking patients. To the best of our knowledge, for the first time, apart from the authors of Mayo VSQOL, a comparative analysis of these questionnaires and cross-cultural adaptation and validation of the Mayo VSQOL scale was conducted outside the USA.

The study results confirmed that the Ukrainian versions of PANQOL and Mayo VSQOL demonstrate high internal consistency, adequate test–retest reliability, and sensitivity to clinically meaningful postoperative changes. Internal consistency of PANQOL was high across most domains, whereas Domain VII (Isolation/Cognition) showed lower α values due to the limited number of items, which is typical for short domains. Similarly, Mayo VSQOL exhibited high α values in all domains postoperatively, reflecting the reliability of the measured constructs.

Test–retest analysis indicated that both questionnaires were stable upon repeated administration, with ICCs >0.75 in most domains and exceeding 0.90 in some, corresponding to high to excellent reliability.

Responsiveness analysis demonstrated that PANQOL provides a more uniform detection of clinically meaningful changes, particularly in domains related to energy and overall well-being, while Mayo VSQOL showed exceptionally high responsiveness in social–emotional domains and in the total score. For more precise assessment of responsiveness, a larger sample size than 30 patients and a longer postoperative follow-up period may be required. These findings support the practical utility of both scale for evaluating quality of life in patients after microsurgical removal of vestibular schwannoma and highlight different sensitivity profiles, which may inform the choice of tool depending on research or clinical objectives.

In this study, we assessed and compared patients with vestibular schwannomas who underwent surgical treatment or were managed using the "wait-and-scan" strategy. However, for a comprehensive evaluation of the quality of life of all VS patients, it would be also necessary to include groups treated with radiation or combined (surgical and radiation) modalities. Unfortunately, this was not possible due to the lack of feedback from these patient categories, as well as whole amount included into research (244 from 829) largely as a result of the people migration during war in Ukraine.

Our study demonstrated that the PANQOL and Mayo VSQOL questionnaires provide complementary information on the quality of life of patients with VS.

PANQOL showed a stable moderate-to-high correlation with total SF-36, QLQ-C30, and BN20 scores across all three groups, confirming its reliability for comprehensive assessment in both physical and mental health. For example: In Group I, the correlation coefficients were r = 0.635 with QLQ-C30 and r = 0.635 with BN20; In Group II, r = 0.596 with QLQ-C30 and r = 0.629 with BN20; In Group III, r = 0.663 with QLQ-C30 and r = 0.743 with BN20. These data indicate that PANQOL provides consistent and reliable quality-of-life assessment across different patient groups. Mayo VSQOL, on the other hand, showed a moderate correlation with SF-36, QLQ-C30, and BN20 only in Group II (r = 0.586 with QLQ-C30 and r = 0.501 with BN20) but demonstrated higher sensitivity to intergroup differences, particularly when comparing Group I vs. II and Group II vs. III. This suggests that Mayo VSQOL more effectively reflects clinical differences between patients undergoing different treatment modalities, even if its correlation with total SF-36 scores is lower.

Therefore, PANQOL can be used for comprehensive assessment of physical and mental health, whereas Mayo VSQOL is more suitable for sensitive detection of clinical differences between treatment groups. Direct comparisons of corresponding domains showed only weak correlations, indicating that each questionnaire should be used as an independent tool or that only total scores should be compared. Although further investigation is advisable to spend on more material for precise comparison.

Comparative analysis of Groups II and III demonstrated a statistically significant improvement after surgery in several domains. The "Anxiety" domain showed a mild decrease only when comparing Groups I and II, while between Groups II and III it remained

relatively stable, though without statistical significance. In our opinion, this trend may be influenced by the timing of the study in Ukraine during the wartime period (2022–2024).

When comparing Groups II and III, not all patients completed the items within the "Satisfaction or Regret" domain, as some questions were applicable only to individuals who had undergone active treatment (surgery or radiation). Additionally, some patients did not fully understand that the "wait-and-scan" strategy constitutes an independent management approach. Therefore, including this domain for patients managed with the "wait-and-scan" strategy may be methodologically inappropriate unless accompanied by additional clarification regarding this treatment modality.

For comprehensive validation, PANQOL and Mayo VSQOL should be compared to other scales; however, the total number of items in all of these questionnaires including BN20, QLQ-C30, and SF-36 reaches 152. Continuous completion of all instruments takes 20–60 minutes, requiring many patients to take breaks. Fatigue and cognitive load may affect the accuracy of responses and overall perception of questions. Practical experience showed that PANQOL can be self-administered by patients, whereas Mayo VSQOL requires explanations, comfortable conditions, and greater attention to each question. Despite or due to the greater complexity and duration, Mayo VSQOL demonstrates increased sensitivity to intergroup differences compared with other assessment tools, making it effective for detailed evaluation of treatment impact on QoL.

The use of the Mayo VSQOL, developed by Carlson *et al.* (2022) [2], demonstrates a contemporary approach to assessing disease-specific quality of life in patients with VS, taking into account hearing, balance, cognitive impairments, anxiety, and psychosocial adaptation. The authors emphasized high internal consistency (Cronbach's α > 0.80 for most domains), adequate test–retest reliability, and confirmed construct validity of the instrument [2]. In our study, the adapted Ukrainian version demonstrated similar psychometric properties, confirming its effectiveness and validity for use in clinical practice and research in Ukraine. To further enhance the reliability and generalizability of the results, analysis on a larger patient cohort is warranted, considering potential cultural and socio-economic factors that may influence patients' perception of QoL.

Conclusion

1. PANQOL demonstrates a stable moderate-to-high correlation with total SF-36, QLQ-C30, and BN20 scores across all three groups of vestibular schwannoma patients treated by: Group I - traditional microsurgery (2001–2016); Group II – contemporary modern microsurgical techniques (2017–2024); and Group III – observation ("wait and scan"), confirming its adequacy for comprehensive assessment of physical and mental health.

2. Mayo VSQOL shows a moderate correlation with SF-36, QLQ-C30, and BN20 only in Group II, but demonstrates higher sensitivity to intergroup differences, making it effective for detecting clinical differences between patients undergoing different treatment modalities.

3. Direct comparison of corresponding domains between PANQOL and Mayo VSQOL is of limited clinical value; it is more appropriate to compare total scores or treat the questionnaires as independent instruments.

4. PANQOL is convenient for self-administration by patients, whereas Mayo VSQOL requires explanations and a comfortable setting but shows higher sensitivity to differences between treatment groups.

5. Updated microsurgical techniques (2017–2024) provide a statistically significant improvement in quality of life for patients with VS compared with traditional methods and "wait and scan"/observation.

6. The Ukrainian versions of PANQOL and Mayo VSQOL demonstrated high reliability, stability, and sensitivity to clinically meaningful postoperative changes. PANQOL showed more uniform responsiveness across domains, particularly for energy and overall well-being, while Mayo VSQOL was especially sensitive in social–emotional domains and the total score.

7. The Ukrainian versions of PANQOL and Mayo VSQOL demonstrated adequate discriminant validity, effectively distinguishing patients with different facial nerve outcomes, extent of tumor resection, and cochlear nerve preservation. Higher quality-of-life scores were reported in patients with better clinical outcomes, confirming the scale sensitivity to meaningful clinical differences.

8. The cross-cultural adaptation and validation of the PANQOL and Mayo VSQOL questionnaires were successfully completed. However, further statistical analysis on a larger patient cohort is required to confirm their reliability and generalizability.

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