Joint Diseases and Related Surgery

Jt Dis Relat Surg
2026;37(2):501-509

ORIGINAL ARTICLE

Health-related quality of life in patients undergoing surgery for upper extremity bone tumors: A cross-sectional study

Mustafa Çeltik, MD[1], Özlem Orhan, MD[2], Gülsüm Öztürk Emiral, MD[3], Kemal Yücel, MD[2], Hayati Hürol Türkoğlu, MD[2], Coşkun Ulucaköy, MD[2], İsmail Burak Atalay, MD[2]

[1]Department of Orthopedics and Traumatology, İzmir Bakırçay University, İzmir Türkiye
[2]Department of Orthopedics and Traumatology, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Türkiye
[3]Department of Internal Medicine, Division of Public Health, Ankara Yıldırım Beyazıt University Faculty of Medicine, Ankara, Türkiye

Primary malignant bone tumors are rare entities, accounting for approximately 0.2% of all neoplasms.[1,2] Upper extremity tumors, whether malignant (e.g., osteosarcoma, Ewing sarcoma) or benign (e.g., simple bone cysts, enchondromas), typically occur during childhood and early adulthood.[3] The most common presenting complaints in patients with musculoskeletal tumors are pain and restricted range of motion.[4,5] The upper limb plays a central role in activities of daily living, occupational tasks, and social interaction; therefore, surgical interventions in this region may have a greater impact on functional independence than similar procedures in the lower extremity.[6]

Assessment of health-related quality of life (HRQoL) has become an essential component

Received: October 01, 2025
Accepted: January 22, 2026
Published online: March 18, 2026

Correspondence: Coşkun Ulucaköy, MD. Dr. Abdurrahman Yurtaslan Ankara Onkoloji Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, 06430 Yenimahalle, Ankara, Türkiye.

E-mail: coskunulucakoy@gmail.com

Citation: Çeltik M, Orhan Ö, Öztürk Emiral G, Yücel K, Türkoğlu HH, Ulucaköy C, et al. Health-related quality of life in patients undergoing surgery for upper extremity bone tumors: A cross-sectional study. Jt Dis Relat Surg 2026;37(2):501-509. doi: 10.52312/jdrs.2026.2663.

© 2026 Joint Diseases and Related Surgery. This is an open access article published under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0), which permits non-commercial use, distribution, reproduction, and adaptation in any medium, provided the original work is properly cited. http://creativecommons.org/licenses/by-nc/4.0/

ABSTRACT

Objectives: This study aims to evaluate health-related quality of life (HRQoL) in patients who underwent surgical treatment for upper extremity bone tumors, using validated patient-reported outcome measures, and to explore clinical factors associated with better or worse outcomes.

Patients and methods: Between January 2015 and January 2024, a total of 55 patients (26 males, 29 females; mean age: 42.4 ± 19.0 years; range, 16 to 81 years) who were treated surgically for upper extremity bone tumors and evaluated at least six months postoperatively were included. The patients completed the EuroQol EQ-5D-5L and the Short Form-12 (SF-12) questionnaires. Clinical variables included age, sex, tumor site, pathology, treatment modality, and adjuvant or neoadjuvant therapies.

Results: The humerus was the most frequent tumor site (60%), and joint involvement was present in 80% of cases. Benign tumors accounted for two-thirds of patients, while malignant tumors represented one-third. Curettage-based procedures predominated, and only two patients required amputation. Postoperative complications and recurrences were both observed in 7.3% of patients. On the EQ-5D-5L, 65.5% of patients reported no difficulty with mobility or self-care, but half experienced limitations in usual activities. Pain and discomfort were reported by 74.5%, and anxiety or depression by 67.3%. The mean EQ-5D-5L index was 0.55 ± 0.49 and the mean EQ-VAS was 70.9 ± 20.1. The mean SF-12 physical component score (PCS) and mental component score (MCS) were 42.6 ± 11.3 and 47.0 ± 11.2, respectively, indicating that physical functioning was more impaired than mental well-being. Correlation analyses demonstrated strong associations between EQ-5D-5L, EQ-VAS, and SF-12 scores, supporting convergent validity. Subgroup analyses revealed that younger patients (< 50 years), those with benign pathology, and individuals without adjuvant or neoadjuvant therapies reported significantly higher HRQoL scores.

Conclusion: Patients undergoing surgery for upper extremity bone tumors frequently experience pain and psychological distress despite preserved independence in mobility and self-care. Age, pathology, treatment intensity and tumor location were associated with HRQoL. These findings highlight the importance of rehabilitation and psychosocial support in postoperative care, alongside oncological and surgical management.

Keywords: Bone tumors, EQ-5D-5L, health-related quality of life, patient-reported outcome measures, SF-12, upper extremity.

of evaluating the effectiveness of modern healthcare.[7-10] In the field of orthopedic oncology, the goals of surgical treatment extend beyond local tumor control and limb preservation; equally important is the restoration of function and the improvement of patient-reported quality of life.[11] Given the anatomical and functional complexity of the upper extremity, surgical interventions, whether for malignant or benign tumors, can significantly impact patients' ability to perform daily tasks. Moreover, HRQoL data are increasingly incorporated into health-economic analyses, serving as a key parameter for determining the cost-effectiveness of orthopedic oncologic interventions.

The EuroQol-5 Dimension (EQ-5D) instrument is widely used in orthopedic practice, particularly in evaluating outcomes after hip and knee arthroplasty and in patients with low back pain.[8,9] These studies have demonstrated that the EQ-5D is a practical and reliable tool for monitoring changes in overall health status and quality of life. Despite this, little is known about its validity in patients with upper extremity bone tumors. Similarly, the Short Form-12 (SF-12) survey has been frequently used to assess HRQoL in orthopedic trauma populations, and its psychometric properties have been found adequate in diverse musculoskeletal conditions.[10] However, evidence regarding its application in upper extremity tumors remains scarce. Tumor location, joint involvement, and the use of adjuvant therapies are considered to play an important role in long-term function and quality of life. Yet, these associations have not been systematically examined in patients with upper extremity bone tumors.

In the literature, there is no study jointly examining the comparative utility of EQ-5D-5L and SF-12 for postoperative outcomes in patients with upper-extremity bone tumors. Taken together, there is a clear knowledge gap regarding patient-reported outcome measures (PROMs) in upper-extremity bone tumors, and the performance of EQ-5D-5L and SF-12 across key clinical strata (site, joint involvement, pathology, and (neo)adjuvant therapy) remains insufficiently defined. In the present study, we hypothesized that malignant pathology, humeral/joint involvement, and systemic therapies would be associated with lower HRQoL. We, therefore, aimed to quantify HRQoL using EQ-5D-5L and SF-12 in patients surgically treated for upper-extremity bone tumors and examined associations with tumor site, joint involvement, pathology, and (neo)adjuvant therapy.

PATIENTS AND METHODS

This single-center, descriptive, cross-sectional study was conducted at Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital, Department of Orthopedics and Traumatology between January 2015 and January 2024. During the study, a total of 67 patients underwent surgery for upper-extremity bone tumors. Only those aged ≥ 16 years were included, as the EQ-5D-5L and SF-12 are adult self-report HRQoL tools; younger patients typically require age-specific instruments and consent/assent procedures.[12,13] Accordingly, 11 patients were excluded due to the age criteria, and one patient died before follow-up. Additional exclusion criteria were the inability to complete the questionnaires and refusal to participate. Finally, a total of 55 patients (26 males, 29 females; mean age: 42.4 ± 19.0 years; range, 16 to 81 years) were included in the final analysis. A written informed consent was obtained from each patient. The study protocol was approved by the Dr. Abdurrahman Yurtaslan Ankara Oncology SUAM Non-Interventional Clinical Research Ethics Committee (Date: 19.09.2024, No: 2024-09/117). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data were collected using a structured questionnaire designed by the investigators. It consisted of three sections: sociodemographic information, clinical characteristics, and PROMs. The latter included the Short Form-12 (SF-12) Health Survey and the EuroQol EQ-5D-5L. All questionnaires were administered at or beyond six months after surgery (≥ 180 days postoperatively). When the routine six-month follow-up visit was not available, the first available visit after six months was used. Questionnaires were administered during the outpatient visit in a quiet room under researcher supervision.

The SF-12, developed by Ware et al.[12] as a shortened version of the SF-36, provides two component scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). Higher scores indicate better health status in the respective domains. The Turkish version of the SF-12, validated by Soylu and Kütük,[14] was used in this study.

The EQ-5D-5L, developed by the EuroQol Group, is a generic instrument measuring HRQoL across five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression.[15-17] Each item is rated on a five-level scale ranging from "no

problems" to "extreme problems." Additionally, the Visual Analog Scale (EQ-VAS) enables patients to rate their current health on a scale of 0 (worst imaginable) to 100 (best imaginable). The validated Turkish translation of the EQ-5D-5L was employed.[18] Since an official EQ-5D-5L value set for Türkiye has not yet been published, we employed an interim, approximate approach to calculate utility indices.[19] Specifically, we applied the coefficients from the Turkish EQ-5D-3L value set[20] and converted 5L responses to 3L levels using the crosswalk method described by van Hout et al.[21] in 2012, thereby deriving approximate index values. In this approach, VAS-based valuations from Turkish respondents were calibrated to the United Kingdom TTO-based value set via a linear 'exchange-rate' transformation; thus, while the coefficients reflect Turkish preferences, they do not constitute an independent TTO-based Turkish set.[22] We acknowledge this as a methodological limitation and report the resulting indices as approximate estimates. When a Turkish EQ-5D-5L value set becomes available, we plan to reanalyze the results accordingly.

TABLE I
Patient demographics, tumor/treatment characteristics-values

Variables	n	%
Sex		
Female	29	52.7
Male	26	47.3
Age group (year)		
< 50	32	58.2
≥ 50	23	41.8
Tumor site		
Humerus	33	60.0
Phalanx	10	18.2
Metacarpal	5	9.1
Radius	3	5.5
Clavicle	2	3.6
Ulna	1	1.8
Scapula	1	1.8
Laterality		
Right	26	47.3
Left	29	52.7
Joint involvement		
Absent	11	20.0
Present	44	80.0
Pathology		
Benign	37	67.3
Malignant	18	32.7
Treatment		
Curettage + graft	24	43.6
Curettage + fixation	20	36.4
Arthroplasty	9	16.4
Amputation	2	3.6
Neoadjuvant therapy		
None	46	83.6
CT	6	10.9
RT	3	5.5
Adjuvant therapy		
None	48	87.3
CT	2	3.6
RT	2	3.6
CT + RT	3	5.5
Complications		
None	51	92.7
Present	4	7.3
Recurrence		
None	51	92.7
Present	4	7.3

CT, chemotherapy, RT, radiotherapy.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 20.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were presented in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. Normality was tested using the Shapiro-Wilk test. Two-group comparisons were performed using the Mann-Whitney U test (two-tailed). Correlations were assessed using the Spearman rank. A p value of < 0.05 was considered statistically significant.

RESULTS

The humerus was the most frequent tumor site (60%), followed by the phalanx (18.2%) and metacarpals (9.1%). Joint involvement was present in 80% of cases. Benign tumors accounted for two-thirds of the cohort, while malignant tumors represented 32.7%. Curettage with or without fixation was the most common surgical

TABLE II
EQ-5D-5L domain summary (No *vs.* Any problem)-percentages per domain

	No problem		Problem present	
Domain	n	%	n	%
Mobility	36	65.5	19	34.5
Self-care	36	65.5	19	34.5
Usual activities	27	49.1	28	50.9
Pain/discomfort	14	25.5	41	74.5
Anxiety/depression	18	32.7	37	67.3

EQ-5D-5L, EuroQol EQ-5D-5L.

procedure, whereas only two (3.6%) patients underwent amputation. Most patients did not receive neoadjuvant or adjuvant therapy. The rates of postoperative complications (7.3%) and local recurrence (7.3%) were low (Table I).

Evaluation of the EQ-5D-5L domains showed that 65.5% of patients reported no difficulty in mobility or self-care. By contrast, limitations in usual activities were observed in 50.9% of the cohort. Pain and discomfort were the most frequent problems, reported by 74.5% of patients, followed by anxiety/depression in 67.3% (Table II).

A more detailed distribution of responses across each EQ-5D-5L domain is presented in Table III, which illustrates that while most patients maintained independence in mobility and self-care, pain and emotional distress were prevalent.

The mean EQ-5D-5L index score was 0.55 ± 0.49, while the mean EQ-VAS score was 70.9 ± 20.1. The SF-12 PCS and MCS were 42.6 ± 11.3 and 47.0 ± 11.2, respectively (Table IV). Both SF-12 summary scores were below the population mean of 50, indicating marked impairment in health status.[23] The decrement was larger for physical health (PCS 42.6) than for mental health (MCS 47.0); however, high rates of EQ-5D pain/discomfort (74.5%) and anxiety/depression (67.3%) confirm that both domains were substantially affected.

TABLE III
Five-level EQ-5D-5L distribution (no/slight/moderate/severe/extreme-unable) for each domain

Domain	Response categories	n	%
Mobility	Unable to walk	1	1.8
	Severe problems walking	3	5.5
	Moderate problems walking	7	12.7
	Slight problems walking	8	14.5
	No problems walking	36	65.5
Self-care	Unable to wash/dress	3	5.5
	Severe problems	4	7.3
	Moderate problems	7	12.7
	Slight problems	5	9.1
	No problems	36	65.5
Usual activities	Unable to perform	3	5.5
	Severe problems	9	16.4
	Moderate problems	7	12.7
	Slight problems	9	16.4
	No problems	27	49.1
Pain/discomfort	Extreme pain	5	9.1
	Severe pain	3	5.5
	Moderate pain	8	14.5
	Slight pain	25	45.5
	No pain	14	25.5
Anxiety/depression	Extreme	5	9.1
	Severe	4	7.3
	Moderate	15	27.3
	Slight	13	23.6
	None	18	32.7

TABLE IV
HRQoL summary scores-EQ-5D-5L index, EQ-VAS, SF-12 PCS/MCS

Measure	Mean ± SD	Median	IQR
EQ-5D-5L index	0.55 ± 0.49	0.74	0.27-0.90
EQ-VAS	70.98 ± 20.13	76.0	64.0-86.0
SF-12 PCS	42.62 ± 11.31	43.67	33.9-51.3
SF-12 MCS	47.05 ± 11.21	48.32	38.1-55.9

HRQoL, health-related quality of life; EQ-5D-5L, EuroQol EQ-5D-5L; VAS: Visual Analog Scale; SF-12, Short Form-12; PCS, physical component score; MCS, mental component score; IQR, interquartile range.

TABLE V
Correlations among instruments-Spearman's ρ and *p*-values (two-tailed)

	EQ-5D-5L index	EQ-VAS	SF-12 PCS	SF-12 MCS
	p	*p*	*p*	*p*
EQ-5D-5L index	-	0.859; < 0.001	0.787; < 0.001	0.644; < 0.001
EQ-VAS	0.859; < 0.001	-	0.699; < 0.001	0.521; < 0.001
SF-12 PCS	0.787; < 0.001	0.699; < 0.001	-	0.611; < 0.001
SF-12 MCS	0.644; < 0.001	0.521; < 0.001	0.611; < 0.001	-

EQ-5D-5L, EuroQol EQ-5D-5L; VAS: Visual Analog Scale; SF-12, Short Form-12; PCS, physical component score; MCS, mental component score.

TABLE VI
EQ-5D-5L index by clinical subgroups

			EQ-5D-5L Index scores		Statistical analysis U,(Z)
Variables	n	%	Median	IQR	*p*
Sex					
Female	29	52.7	0.82	0.47-0.90	0.852; 0.394
Male	26	47.3	0.70	0.18-0.88	
Age group (year)					
< 50	32	58.2	**0.87**	**0.73-0.95**	**4.039; < 0.001**
≥ 50	23	41.8	0.38	**–0.18-0.70**	
Tumor site					
Humerus	33	60.0	0.52	0.06-0.90	**2.141; 0.032**
Other sites	22	40.0	**0.87**	0.72-0.94	
Pathology					
Benign	37	67.3	**0.87**	**0.69-0.94**	**3.339; < 0.001**
Malignant	18	32.7	0.26	–0.31-0.74	
Neoadjuvant therapy					
Absent	46	83.6	0.82	0.47-0.94	**3.427; < 0.001**
Present	9	16.4	–0.18	–0.37-0.49	
Adjuvant therapy					
Absent	**48**	**87.3**	**0.80**	**0.48-0.94**	**2.970; 0.002**
Present	7	12.7	–0.06	–0.31-0.18	
Complications					
Absent	51	92.7	0.74	0.27-0.94	0.568; 0.584
Present	4	7.3	0.62	0.03-0.87	
Recurrence					
Absent	51	92.7	0.74	0.35-0.94	1.168; 0.261
Present	4	7.3	0.31	–0.68-0.83	

EQ-5D-5L, EuroQol EQ-5D-5L; IQR, interquartile range. Mann-Whitney U test (two-tailed); exact *p* reported where applicable.

All PROMs were positively correlated (Table V). The EQ-5D-5L index demonstrated a strong correlation with EQ-VAS (r = 0.859, $p < 0.001$), as well as with the SF-12 PCS (r = 0.787, $p < 0.001$) and MCS (r = 0.644, $p < 0.001$). These associations indicate consistency and convergent validity between the instruments used.

Subgroup comparisons revealed that patients younger than 50 years had significantly higher EQ-5D-5L index scores than older patients ($p < 0.001$). Those with benign pathology reported better outcomes than patients with malignant tumors ($p < 0.001$). Patients who did not receive neoadjuvant therapy ($p < 0.001$) or adjuvant therapy ($p = 0.002$) also showed higher scores. Tumors located outside the humerus were associated with better HRQoL compared to humeral tumors ($p = 0.032$) (Table VI). Variables identified as associated with the EQ-5D-5L index score in univariate analyses were entered into a multivariate linear regression; in this model, older age and receipt of neoadjuvant therapy were independently associated with lower EQ-5D-5L index scores (Figure 1).

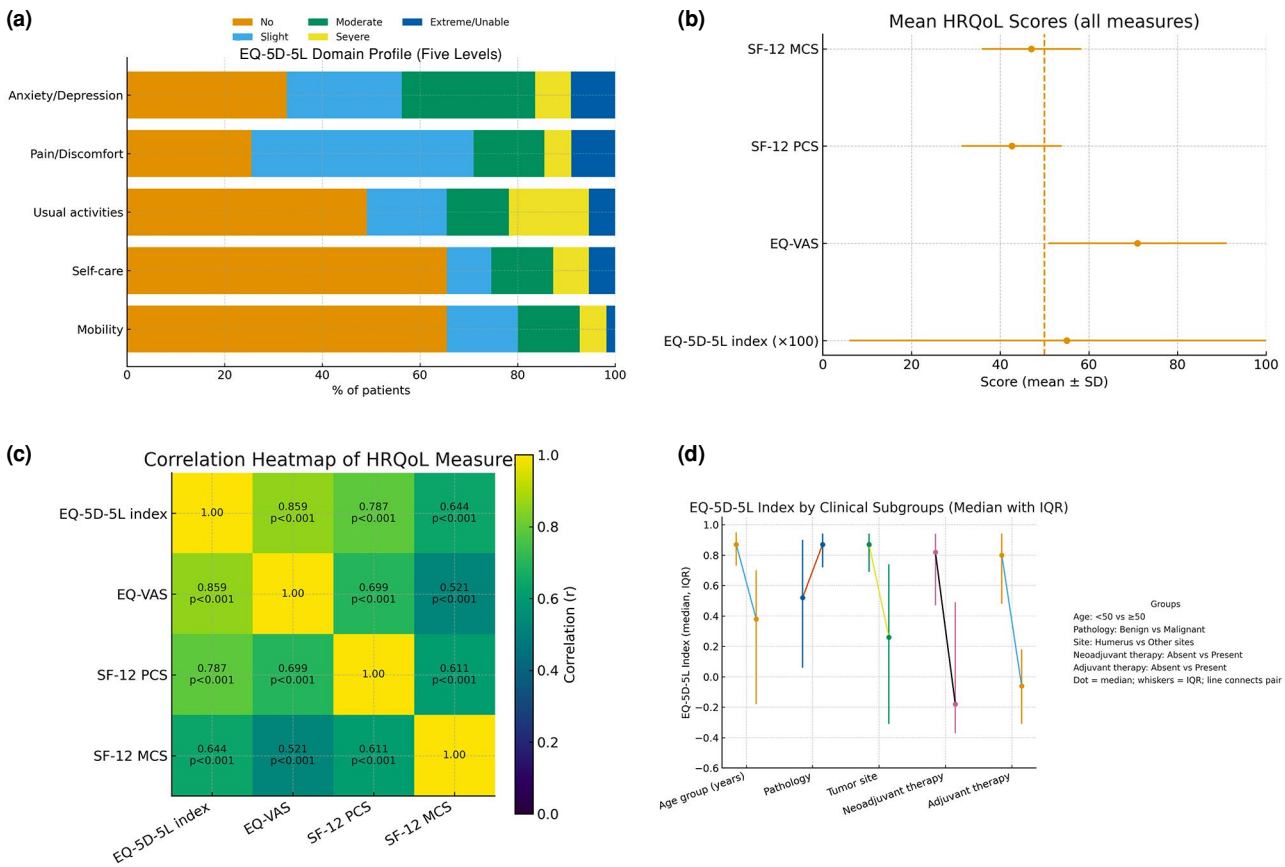


FIGURE 1. Health-related quality of life after surgery for upper-extremity bone tumors. **(a)** EQ-5D-5L domain profile (five levels). Pain/discomfort (74.5%) and anxiety/depression (67.3%) were the most affected domains; mobility and self-care problems were less frequent. Bars show the percentage of patients reporting 'No', 'Slight', 'Moderate', 'Severe', or 'Extreme/Unable' problems. **(b)** Mean scores across instruments. EQ-5D-5L index 0.55 (shown as ~55 on a 0-100 scale), EQ-VAS 70.9 ± 20.1, SF-12 PCS 42.6 ± 11.3, SF-12 MCS 47.0 ± 11.2. Both SF-12 summaries are below the population norm of 50, with a larger deficit in PCS. **(c)** Correlation heatmap. Measures were strongly correlated: EQ-5D-5L index with EQ-VAS r = 0.859, with SF-12 PCS r = 0.787, and with SF-12 MCS r = 0.644 (all $p < 0.001$). **(d)** Clinical subgroups (median, IQR). Higher EQ-5D-5L index scores were seen in patients <50 years ($p < 0.001$), with benign pathology ($p < 0.001$), without neoadjuvant ($p < 0.001$) or adjuvant therapy ($p = 0.002$), and with non-humeral tumors ($p = 0.032$). In multivariate analysis, older age and neoadjuvant therapy were independently associated with lower EQ-5D-5L index.

EQ-5D-5L, EuroQol EQ-5D-5L; PCS, physical component score; MCS, mental component score, SF-12, Short Form-12, VAS: Visual Analog Scale; IQR, interquartile range.

DISCUSSION

In the present study, we evaluated HRQoL using EQ-5D-5L and SF-12 in patients surgically treated for upper-extremity bone tumors and examined associations with tumor site, joint involvement, pathology, and (neo)adjuvant therapy. Our study results showed substantially impaired HRQoL compared to population norms, with pain and psychological distress being highly prevalent. Our findings confirm the convergent validity of EQ-5D-5L and SF-12 in this population and identify key clinical factors associated with poorer outcomes. In addition, the quality of life related to health was noticeably reduced: the average EQ-5D-5L index was 0.55, and both SF-12 summary scores fell below the general population norms (PCS 42.6, MCS 47.0). Pain/discomfort (74.5%) and anxiety/depression (67.3%) were common. The measures agreed well (EQ-5D-5L index with EQ-VAS r = 0.859, with PCS r = 0.787, with MCS r = 0.644; all $p < 0.001$). Higher scores were observed in patients younger than 50 years, with benign pathology, without neo/adjuvant therapy, and with non-humeral tumors. In the multivariate analysis, older age and neoadjuvant therapy were independently associated with lower EQ-5D-5L index scores. These findings suggest that postoperative HRQoL may be more adversely affected in older patients and in those receiving neoadjuvant therapy.

In the current study, the mean EQ-5D-5L index value of 0.55 observed in our cohort indicates a substantial level of health impairment. For comparison, similar EQ-5D index scores have been reported in patients with advanced hip or knee osteoarthritis awaiting joint replacement and in individuals recovering from major musculoskeletal trauma.[24-27] Therefore, the degree of impairment observed in patients treated for upper extremity bone tumors appears comparable to that seen in other severe orthopedic conditions known to markedly restrict daily function and overall well-being.

Pain and anxiety/depression were the most frequently reported problems in our study. This pattern is not surprising, as pain is often the dominant symptom both before and after tumor surgery, and psychological distress may persist despite good oncological outcomes. The high rates of pain/discomfort (74.5%) and anxiety/depression (67.3%) underline the importance of structured rehabilitation programs, including both physical therapy and psychological support, rather than focusing solely on surgical success. Similar observations have been reported in previous studies on survivors of extremity sarcomas, where residual symptoms often persist despite favorable oncological outcomes.[28] Previous research has explored patient-reported functional outcomes or provided overall assessments of perceived health.[29] However, patient-reported functional and quality of life outcomes subsequent to surgical intervention for benign bone tumors in the upper extremity have not been previously studied. Our results support these reports and point out the importance of rehabilitation programs that incorporate psychological support and effective pain management.

The strong correlations between EQ-5D-5L, EQ-VAS, and SF-12 scores confirm that these instruments are reliable for assessing quality of life in this patient group. This strengthens their validity for use in musculoskeletal oncology. In daily practice, either questionnaire may be sufficient, but the combined use of EQ-5D-5L and SF-12 can provide a broader view, particularly when designing follow-up or rehabilitation strategies.

Furthermore, subgroup analyses revealed that younger patients, those with benign tumors, and patients who did not require adjuvant or neoadjuvant therapy reported better quality of life scores. These findings are in line with expectations, since malignant tumors and systemic treatments are usually associated with greater physical burden and side effects.[30,31] Moreover, patients with tumors located outside the humerus demonstrated higher scores. Given the humerus' crucial role in shoulder and elbow mobility, surgical procedures in this region are more likely to compromise functional independence compared to interventions in the hand or forearm. Our findings are also consistent with literature showing that tumor site and surgical technique significantly influence postoperative function in the upper limb.[32,33] These results point out the importance of surgical planning that prioritizes joint preservation and early rehabilitation when feasible.

In our cohort, lower HRQoL was associated with older age, malignant pathology, humeral involvement, and receipt of neoadjuvant therapy. These markers can be used to risk-stratify patients preoperatively and tailor care pathways. Taken together, these results suggest that age, tumor type, treatment intensity, and anatomical location are associated with postoperative well-being. The practical implication is that surgical planning in the proximal humerus should prioritize joint-preserving

approaches whenever possible. Patients expected to receive systemic therapy may benefit from closer rehabilitation and psychosocial support.

Nonetheless, this study has certain limitations. First, the cohort was modest (n = 55) and several subgroups were small (e.g., adjuvant therapy n = 7); therefore, subgroup analyses are exploratory/hypothesis-generating and require confirmation in larger prospective cohorts. Second, multiple subgroup comparisons were performed; to avoid further loss of power we did not apply multiplicity corrections; therefore, all *p* values are two-tailed and unadjusted and should be interpreted with caution. Third, HRQoL was assessed at or beyond six months postoperatively, providing a single time point rather than longitudinal change. Preoperative HRQoL was unavailable; thus, within-patient change cannot be quantified and the relative contributions of disease, surgery, and adjuvant therapy to postoperative scores cannot be disentangled; values below population norms indicate impairment, not a measured decline. The causes of pain and anxiety were not clearly identified; we lacked detailed measures of nerve involvement and did not administer standardized psychological instruments, limiting interpretation of these domains. Additionally, residual confounding is possible (e.g., socioeconomic status, comorbidities, baseline function), and self-reported measures may introduce reporting bias. Finally, as this study is cross-sectional, it cannot establish causality. The links we observed (i.e., lower HRQoL in patients receiving neoadjuvant therapy) may reflect underlying differences such as tumor aggressiveness or patient frailty rather than a direct treatment effect. Further multi-center, large-scale, prospective studies with baseline and repeated assessments are needed to validate these observations and define longer-term outcomes.

In conclusion, patients undergoing upper extremity bone tumor surgery, particularly older individuals, those with malignant pathology or humeral involvement, and recipients of neoadjuvant therapy, represent a high-risk group for impaired HRQoL. A holistic postoperative management strategy incorporating structured, shoulder-focused rehabilitation, proactive psychosocial support, and PROM-guided follow-up is essential to optimize functional and quality of life outcomes alongside oncological control.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: M.C., O.O., G.O.E.: Idea/concept, literature review, analysis and/or interpretation; M.C., O.O., G.O.E., K.Y.: Design: M.C., G.O.E.: Control/supervision; O.O., K.Y., H.H.T., C.U., I.B.A.: Data collection and/or processing; M.C., O.O.: Writing the article, references and fundings; G.O.E., K.Y., H.H.T., C.U., I.B.A.: Critical review; K.Y., H.H.T., C.U., I.B.A.: Materials.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

AI Disclosure: The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

REFERENCES

1. Kumar N, Gupta B. Global incidence of primary malignant bone tumors. Curr Orthop Pract 2016;27:530-4.
2. Franchi A. Epidemiology and classification of bone tumors. Clin Cases Miner Bone Metab 2012;9:92-5.
3. MacKay BJ, McCormack RA, Blank AT, Bettiol P, Cox C, Brindley G, et al. Diagnosis and management of primary malignant tumors in the upper extremity. Orthop Rev (Pavia) 2021;12:8345. doi: 10.4081/or.2020.8345.
4. Kuo PY, Yen JT, Parker GM, Chapman S, Kandikattu S, Sohanpal I, et al. The prevalence of pain in patients attending sarcoma outpatient clinics. Sarcoma 2011;2011:813483. doi: 10.1155/2011/813483.
5. Westhovens R, Dequeker J. Musculoskeletal manifestations of benign and malignant tumors of bone. Curr Opin Rheumatol 2003;15:70-5. doi: 10.1097/00002281-200301000-00012.
6. Aksnes LH, Hall KS, Jebsen N, Fosså SD, Dahl AA. Young survivors of malignant bone tumours in the extremities: A comparative study of quality of life, fatigue and mental distress. Support Care Cancer 2007;15:1087-96. doi: 10.1007/s00520-007-0227-x.
7. Zampelis V, Ornstein E, Franzén H, Atroshi I. A simple visual analog scale for pain is as responsive as the WOMAC, the SF-36, and the EQ-5D in measuring outcomes of revision hip arthroplasty. Acta Orthop 2014;85:128-32. doi: 10.3109/17453674.2014.887951.
8. Soer R, Reneman MF, Speijer BL, Coppes MH, Vroomen PC. Clinimetric properties of the EuroQol-5D in patients with chronic low back pain. Spine J 2012;12:1035-9. doi: 10.1016/j.spinee.2012.10.030.
9. Giesinger K, Hamilton DF, Jost B, Holzner B, Giesinger JM. Comparative responsiveness of outcome measures for total knee arthroplasty. Osteoarthritis Cartilage 2014;22:184-9. doi: 10.1016/j.joca.2013.11.001.
10. Gosling CM, Gabbe BJ, Williamson OD, Sutherland AM, Cameron PA. Validity of outcome measures used to assess one and six month outcomes in orthopaedic trauma patients. Injury 2011;42:1443-8. doi: 10.1016/j.injury.2011.05.022.

11. Panagopoulos GN, Mavrogenis AF, Mauffrey C, Lesenský J, Angelini A, Megaloikonomos PD, et al. Intercalary reconstructions after bone tumor resections: A review of treatments. Eur J Orthop Surg Traumatol 2017;27:737-46. doi: 10.1007/s00590-017-1985-x.
12. Ware J Jr, Kosinski M, Keller SD. A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. Med Care 199634:220-33. doi: 10.1097/00005650-199603000-00003.
13. EUROQOL. User guides. EuroQol. Available from: [cited 05.09.2025] https://euroqol.org/information-and-support/documentation/user-guides/.
14. Soylu C, Kütük B. Reliability and validity of the Turkish Version of SF-12 Health Survey. Turk Psikiyatri Derg 2022;33:108-17. doi: 10.5080/u25700.
15. Coons SJ, Rao S, Keininger DL, Hays RD. A comparative review of generic quality-of-life instruments. Pharmacoeconomics 2000;17:13-35. doi: 10.2165/00019053-200017010-00002.
16. Buchholz I, Janssen MF, Kohlmann T, Feng YS. A systematic review of studies comparing the measurement properties of the three-level and five-level versions of the EQ-5D. Pharmacoeconomics 2018;36:645-61. doi: 10.1007/s40273-018-0642-5.
17. Hung MC, Lu WS, Chen SS, Hou WH, Hsieh CL, Wang JD. Validation of the EQ-5D in patients with traumatic limb injury. J Occup Rehabil 2015;25:387-93. doi: 10.1007/s10926-014-9547-0.
18. Dinç Horasan G, Tarı Selçuk K, Sakarya S, Sözmen K, Ergör G, Yardım N, et al. Health-related quality of life and perceived health status of Turkish population. Qual Life Res 2019;28:2099-109. doi: 10.1007/s11136-019-02167-z.
19. Funded projects-Table for Download-EuroQol. [cited 05.09.2025] Available from: https://euroqol.org/research-at-euroqol/our-research-portfolio/funded-projects-download/.
20. Chuang LH, Malhan S, Oksuz E, Kind P. PMC54 estimating social preferences for EQ-5D in Turkey : A novel method based on a valuation exchange-rate mechanism. Value Heal 2009;12:A397. doi: 10.1016/S1098-3015(10)74956-1
21. van Hout B, Janssen MF, Feng YS, Kohlmann T, Busschbach J, Golicki D, et al. Interim scoring for the EQ-5D-5L: Mapping the EQ-5D-5L to EQ-5D-3L value sets. Value Health 2012;15:708-15. doi: 10.1016/j.jval.2012.02.008.
22. Ramos-Goñi JM, Pinto-Prades JL, Oppe M, Cabasés JM, Serrano-Aguilar P, Rivero-Arias O. Valuation and modeling of EQ-5D-5L health states using a hybrid approach. Med Care 2017;55:e51-8. doi: 10.1097/MLR.0000000000000283.
23. Demiral Y, Ergor G, Unal B, Semin S, Akvardar Y, Kivircik B, et al. Normative data and discriminative properties of Short Form 36 (SF-36) in Turkish urban population. BMC Public Health 2006;6:247. doi: 10.1186/1471-2458-6-247.
24. Jansson KÅ, Granath F. Health-related quality of life (EQ-5D) before and after orthopedic surgery. Acta Orthop 2011;82:82-9. doi: 10.3109/17453674.2010.548026.
25. de Munter L, Polinder S, Havermans RJM, Steyerberg EW, de Jongh MAC. Prognostic factors for recovery of health status after injury: A prospective multicentre cohort study. BMJ Open 2021;11:e038707. doi: 10.1136/bmjopen-2020-038707.
26. Polinder S, Haagsma JA, van Klaveren D, Steyerberg EW, van Beeck EF. Health-related quality of life after TBI: A systematic review of study design, instruments, measurement properties, and outcome. Popul Health Metr 2015;13:4. doi: 10.1186/s12963-015-0037-1.
27. Salaffi F, Carotti M, Grassi W. Health-related quality of life in patients with hip or knee osteoarthritis: Comparison of generic and disease-specific instruments. Clin Rheumatol 2005;24:29-37. doi: 10.1007/s10067-004-0965-9.
28. Sebio A, Berger C, Tabone M-D, et al. Quality of life and patient-reported outcomes in patients with osteosarcoma: A systematic review. Eur J Cancer Care (Engl) 2025;2025:5802523. doi: 10.1155/ecc/5802523.
29. Davidge KM, Wunder J, Tomlinson G, Wong R, Lipa J, Davis AM. Function and health status outcomes following soft tissue reconstruction for limb preservation in extremity soft tissue sarcoma. Ann Surg Oncol 2010;17:1052-62. doi: 10.1245/s10434-010-0915-5.
30. Kinoshita H, Kinoshita S, Hagiwara Y, Kamoda H, Ohtori S, Yonemoto T. Postoperative limb function and QOL in elderly patients with malignant bone tumor/soft tissue sarcoma. Anticancer Res 2023;43:3273-9. doi: 10.21873/anticanres.16502.
31. Paredes T, Pereira M, Moreira H, Simões MR, Canavarro MC. Quality of life of sarcoma patients from diagnosis to treatments: Predictors and longitudinal trajectories. Eur J Oncol Nurs 2011;15:492-9. doi: 10.1016/j.ejon.2011.01.001.
32. Lee TS, Kilbreath SL, Refshauge KM, Herbert RD, Beith JM. Prognosis of the upper limb following surgery and radiation for breast cancer. Breast Cancer Res Treat 2008;110:19-37. doi: 10.1007/s10549-007-9710-9.
33. Otero JE, Graves CM, TeKippe A, Buckwalter JA, Miller BJ. Factors affecting outcomes in patients treated surgically for upper extremity tumors and tumor-like lesions. Iowa Orthop J 2013;33:119-29.