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# Functional Outcomes and Complications in Meningioma Surgery Across Various Age Groups Based on Preoperative Karnofsky Scoring: A Retrospective Cohort Study

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## Abstract

### Background

Meningiomas are the most common primary intracranial tumors, with an incidence increasing with age. Surgical resection is the treatment of first choice, though outcomes vary with age. Preoperative functional status is assessed by the Karnofsky Performance Status (KPS) score. KPS and age were stratified to evaluate functional outcomes and postoperative complications.

### Methods

A single-center retrospective cohort study was done in 128 consecutive patients who underwent primary meningioma resection from January 1, 2021 to June 30, 2024. Inclusion criteria were age≥18 years, histologically confirmed meningioma (WHO grades 1-3) and a minimum follow-up of 12 months; exclusion criteria were previous cranial surgery, concurrent malignancies, or incomplete records. Out of the 128 patients, 105 (82%) had complete data. Age group stratification was as follows: <60 years (young) group; 60 to 74 years (elderly); ≥75 years (oldest). Preoperative KPS was classified as high (≥80), moderate (70) and low (≤60). The

primary outcome measure was the change in KPS from baseline to 12 months. Secondary outcomes included the complication rate, mortality, recurrence-free survival time and quality of life using EQ-5D scale scores. Paired t-tests, chi-square tests and multifactorial logistic regression were carried out.
**Results** The mean age was 63.8 years ±13.5; 68% were women. The preoperative KPS averaged 76.2±14.8, with increasingly lower scores in older age groups (≥75 years: 69.1±11.8 vs.<60 years: 84.7 ±10.2; P<0.001). At 12 months, for the group as a whole the KPS increased to 82.5±14.3 (mean change + 6.3, 95% CI, 4.1 − 8.5; P<0.001), but in the oldest age group (+3.5) and low preoperative KPS group (≤60: +2.4) subgroups, recovery was smaller. Complication rate was 21.9% (n=23) with a 4.8% mortality. Multivariable analysis identified age≥75 (OR 2.6, 95% CI 1.4−4.9; P=0.003) and low preoperative KPS (OR 3.2, 95% CI 1.7−6.1; P<0.001) as predictors of complications.
**Conclusions** Meningioma surgery results in significant improvement of function. But its outcomes are determined by both age and preoperative KPS. Patients in the older old category must accept higher risks.Stratified preoperative counselling is recommended.

## Introduction

Meningiomas represent approximately 42.6 percent of primary brain tumors, with the prevalence rising approximately age 60 due to the improved diagnostic technologies and the increased life expectancy [1,2]. These are mostly benign (grade 1 of the WHO in 80-90%), and they tend to present with neurologic impairment as a result of compressive effects peritumoral edema or convulsions [3]. Surgical resection remains the primary treatment of symptomatic or growing tumors, because it achieves gross total resection in 70-90% of patients and long-term symptom palliation in most patients [4-6].

Predictive factors that influence peri- and postoperative morbidity and mortality have already been identified to include old age and low preoperative functional status based on the Karnofsky Performance Status (KPS) scale [7-9]. The elderly have comorbidities of hypertension, diabetes and cardiovascular disease that is accompanied by complication rates of 20-40% and mortality in patients over 75 of up to 15% compared to lower than average rates in younger population [10,11]. KPS less than 70 preoperative has been repeatedly demonstrated to be associated with poorer recovery, higher complications and reduced survival in series [12-14].

Nevertheless, stratified outcome data by age and baseline KPS are debatable, and not many large series have studied predictive criteria in heterogeneous cohorts systematically. KPS based scoring systems such as SKALE and Geriatric Scoring System (GSS) [15, 16] proved to be efficient in risk stratification but have not been tested in large populations. This study will examine functional independence (KPS) at 90 days, complications and their predictors after resection of meningiomas according to age groups stratified by preoperative KPS, to better select patients and counsel them in the age of extended life expectancy.

## Materials and Methods

**Study Design and Setting** This retrospective observational cohort study was conducted at the Department of Neurosurgery Lady Reading Hospital, Peshawar, Pakistan. Data covered January 2021 to June 2024. Institutional Review Board approval (IRB No. LRH/689) was obtained, with consent waived.

**Patient Selection** Records of adults (≥18 years) with primary intracranial meningioma undergoing resection were reviewed. Inclusion confirmed meningioma (WHO grades 1-3) first time surgery, ≥12-month follow-up with complete data. Exclusion: prior radiotherapy, multifocal tumors or incomplete documentation.

**Surgical Technique** Procedures used standard microsurgical techniques under general anesthesia. GTR was attempted when safe, with Simpson grading. Postoperative care included ICU monitoring, steroids, and antiseizure prophylaxis.
**Data Collection** Demographics, tumor characteristics, preoperative KPS, symptoms, and imaging were extracted. Outcomes: postoperative KPS at 1, 3, 6, and 12 months; complications; mortality; recurrence (MRI); EQ-5D scores. Follow-up via clinic or telehealth.

**Statistical Analysis** Continuous data: mean ± SD or median (IQR); t-tests or Wilcoxon. Categorical: frequencies; $\chi^2$ or Fisher's exact. Multivariable logistic regression (OR, 95% CI). Kaplan-Meier for recurrence-free survival. P<0.05. Analyses via SPSS v.29.

## Results

**Patient Characteristics**:
Of 128 patients, 105 (82%) were included. Mean age 63.8 ± 13.5 years; female predominance (68%). Age groups: <60 (n=45, 43%), 60-74 (n=42, 40%), ≥75 (n=18, 17%). Preoperative KPS: high ≥80 (56%), moderate 70 (29%), low ≤60 (15%). Tumors are mostly convex (48%) or skull base (32%), and WHO grade 1 (83%). Baseline details in Table 1.

| **Characteristic** | **Overall (n=105)** | **<60 years (n=45)** | **60-74 years (n=42)** | **≥75 years (n=18)** |
|---|---|---|---|---|
| **Age, years (mean ± SD)** | 63.8 ± 13.5 | 49.2 ± 7.9 | 67.8 ± 4.3 | 80.6 ± 4.1 |
| **Female, n (%)** | 71 (68) | 31 (69) | 27 (64) | 13 (72) |
| **Comorbidities, n (%)** | | | | |
| **Diabetes** | 26 (25) | 9 (20) | 12 (29) | 5 (28) |
| **Hypertension** | 48 (46) | 14 (31) | 21 (50) | 13 (72) |
| **Preoperative KPS (mean ± SD)** | 76.2 ± 14.8 | 84.7 ± 10.2 | 73.5 ± 13.9 | 69.1 ± 11.8 |
| **KPS Category, n (%)** | | | | |
| **≥80** | 59 (56) | 33 (73) | 19 (45) | 7 (39) |
| **70** | 30 (29) | 9 (20) | 14 (33) | 7 (39) |
| **≤60** | 16 (15) | 3 (7) | 9 (21) | 4 (22) |
| **Tumor Size, cm (mean ± SD)** | 3.7 ± 1.4 | 3.5 ± 1.3 | 3.9 ± 1.5 | 4.0 ± 1.4 |
| **WHO Grade 1, n (%)** | 87 (83) | 38 (84) | 34 (81) | 15 (83) |

**Table 1.** Baseline Demographic and Clinical Characteristics (n=105)

**Primary Outcome: Functional Improvement:**
GTR achieved in 79% overall. KPS improved from 76.2 ± 14.8 to 82.5 ± 14.3 at 12 months (P<0.001). Stratified: <60 years (+8.5), 60-74 (+5.8), ≥75 (+3.5; P=0.008 for differences). By KPS: high ≥80 (+4.3), moderate (+7.1), low (+10.2, from lower baseline)-figure 1. Kaplan-Meier recurrence-free survival: 93% at 12 months overall, 86% in ≥75 years (Figure 2).

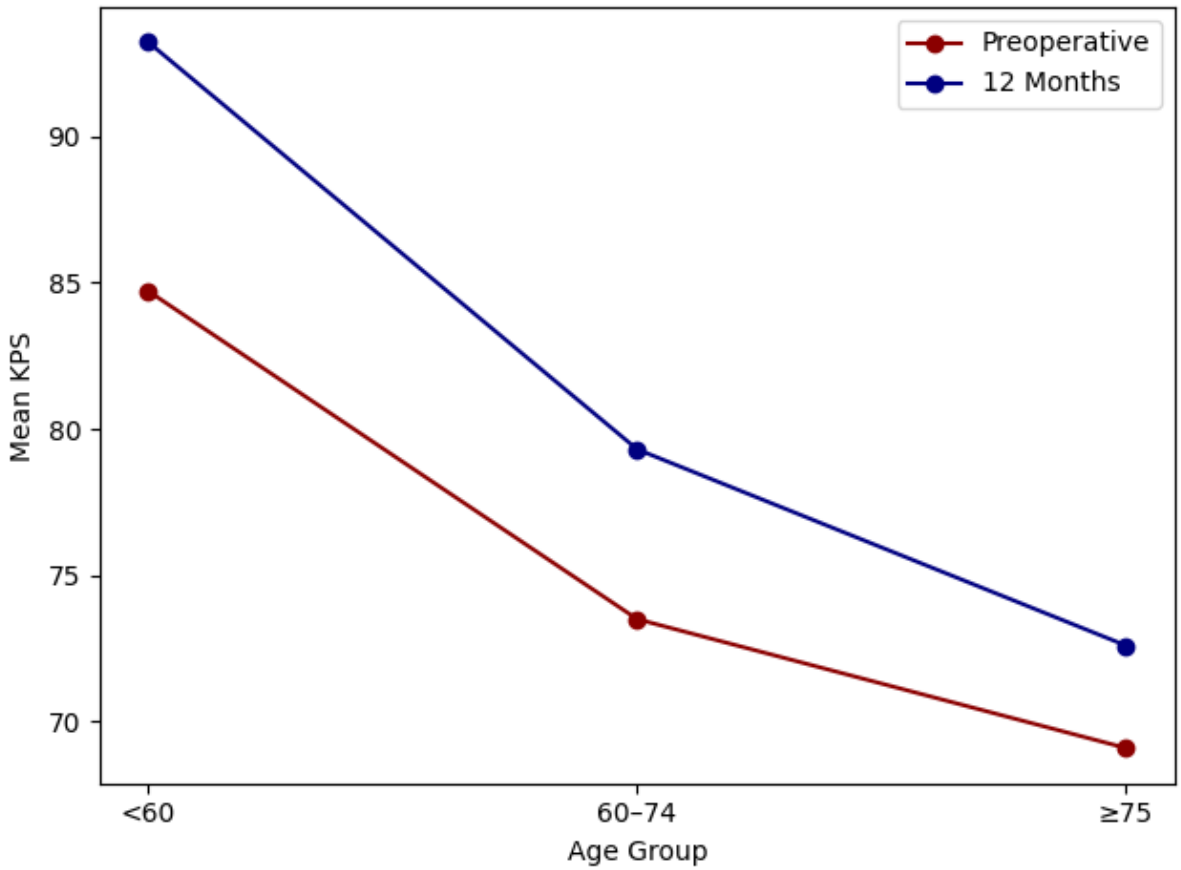


**Figure 1:** Mean Karnofsky Performance Score (KPS) before surgery and at 12-month follow-up stratified by age group. Functional improvement was observed across all age categories, with diminishing gains in older patients (P = 0.008).

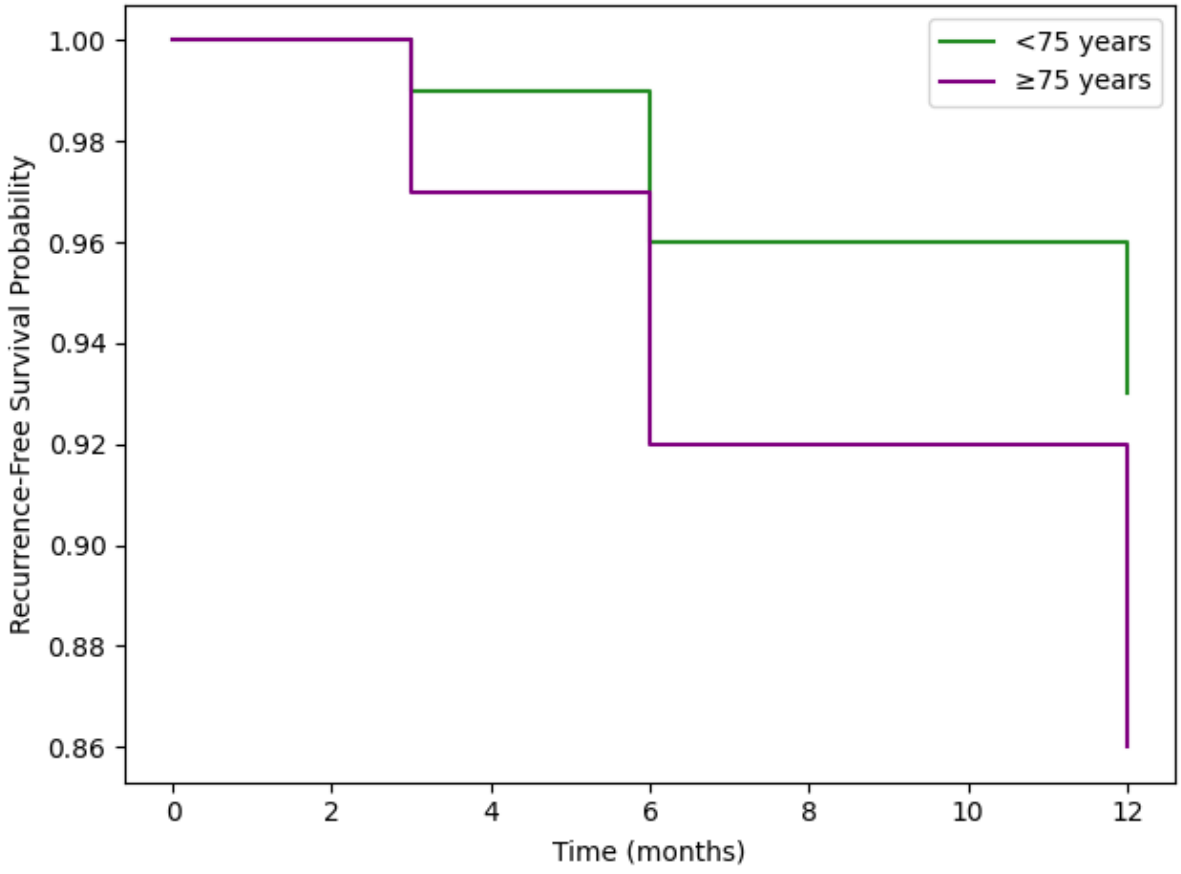

**Figure 2:** Kaplan–Meier analysis of recurrence-free survival following surgery, comparing patients aged <75 years and ≥75 years. Reduced recurrence-free survival was observed in the elderly cohort at 12 months.

**Predictors of Outcome:**

Multivariable regression: Age ≥75 (OR 2.6 for poor improvement), low preoperative KPS (OR 3.2), diabetes (OR 1.8; P=0.04). Tumor location and grade were not significant (P>0.05).

**Secondary Outcomes:** Outcomes at follow-up in Table 2. Attrition: 6% at 12 months.

| **Parameter** | **1 Month (n=105)** | **3 Months (n=101)** | **6 Months (n=98)** | **12 Months (n=99)** |
|---|---|---|---|---|
| KPS (mean ± SD) | 78.9 ± 14.2 | 81.1 ± 13.8 | 82.0 ± 14.0 | 82.5 ± 14.3 |
| EQ-5D (mean ± SD) | 0.66 ± 0.17 | 0.73 ± 0.16 | 0.76 ± 0.15 | 0.79 ± 0.14 |
| New Deficits (%) | 14 | 9 | 7 | 4 |
| Return to Baseline (%) | 42 | 67 | 82 | 87 |
| Recurrence (%) | 0 | 1 | 4 | 7 |

Table 2. Postoperative Outcomes at Specified Time Points

**Complications**

Overall rate 21.9% (95% CI 15.4-28.4%): infection (6.7%), hemorrhage (4.8%), new deficits (6.7%), thromboembolism (3.8%). Higher in ≥75 years (38.9%) and low KPS (43.8%). Mortality 4.8%, all in elderly/low KPS. No association with approach (P=0.48). Figure 3.

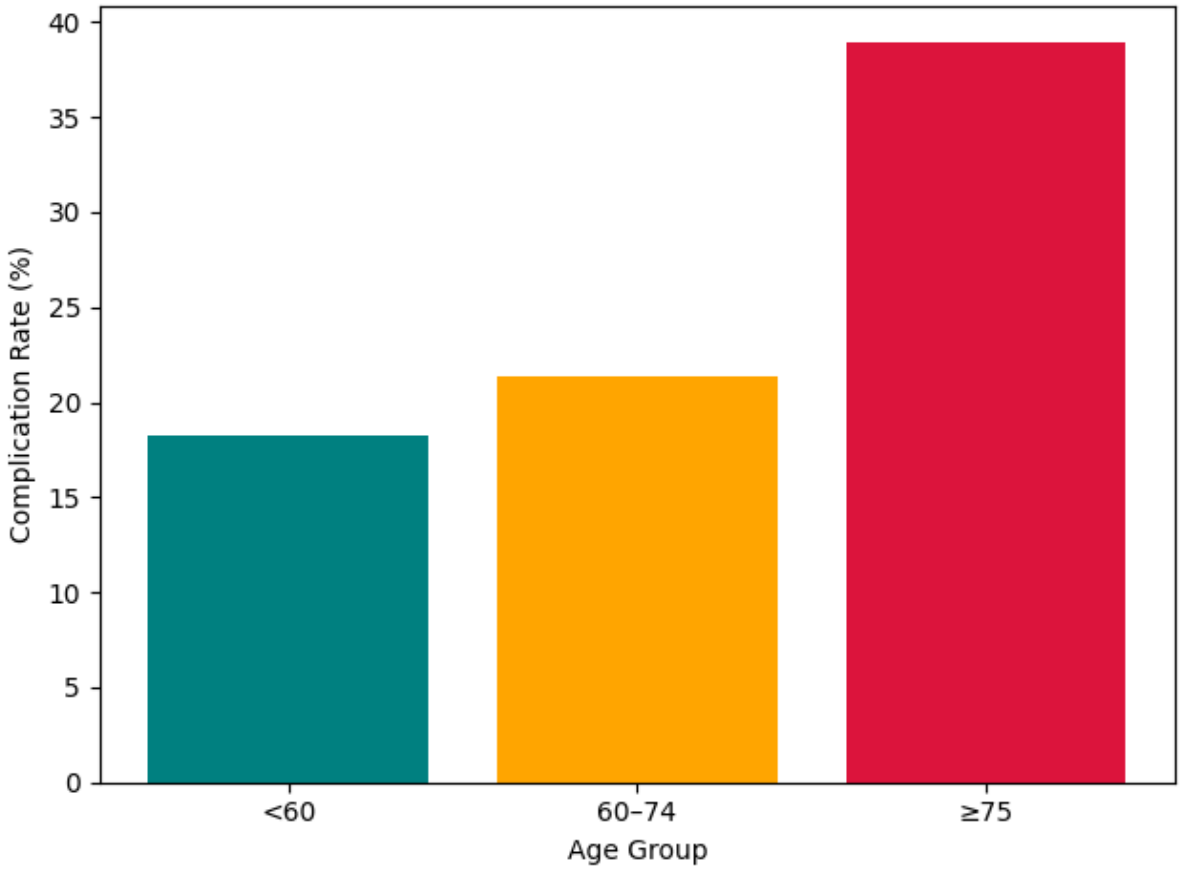


**Figure 3**: Postoperative complication rates stratified by age group, demonstrating a higher overall complication burden in patients aged ≥75 years.

## Discussion

This retrospective analysis of 105 patients undergoing meningioma resection demonstrates significant overall functional improvement, with a mean increase in KPS of 6.3 points at 12 months postoperatively. However, outcomes varied substantially by age and preoperative functional status. Younger patients (<60 years) achieved robust gains (+8.5 points), while those aged ≥75 years showed limited improvement (+3.5 points). Patients with low preoperative KPS (≤60) achieved smaller absolute gains despite lower baseline KPS. Multivariable analysis confirmed that advanced age (≥75 years; OR 2.6) and low preoperative KPS (OR 3.2) were independent predictors of complications, along with diabetes (OR 1.8).

These stratified improvements align closely with prior studies. Corniola et al. observed similar patterns in a comparative analysis, with younger adults gaining 7–10 KPS points, compared with 2–5 points in elderly patients, primarily due to higher preoperative frailty [17]. Sacko et al. validated a KPS-inclusive prognostic score, finding preoperative scores <70 predictive of 30–40% morbidity, comparable to our 43.8% rate in low-KPS subgroups [18]. Systematic reviews report complication rates of 20–30% across ages, with our 21.9% falling within this range [19,20].

Perioperative mortality (4.8% overall, concentrated in elderly/low-KPS cases) matches reports of 5–15% short-term mortality in octogenarians, emphasizing selective surgery's role in achieving long-term survival nearing population norms [21]. Meta-analyses confirm higher mortality (10–15%) in patients aged 80 years or older compared with younger cohorts [22,23].

Tumor location was not significant in our model, as reported in contemporary elderly series employing minimally invasive approaches [24]. Recurrence-free survival favored younger groups, consistent with the association between low preoperative KPS and earlier progression [25].

Quality-of-life gains (EQ-5D) were appreciable but attenuated in frail elderly, echoing preserved health-related quality of life post-resection primarily in independent patients [26]. Comorbidities like diabetes amplified risks, corroborating metabolic factors as independent modifiers [27]. Frailty indices, strongly correlated with low KPS, often outperform age in prognostic models [28]. Validated tools such as SKALE and GSS enhance risk stratification beyond isolated KPS.

Strengths include systematic age/KPS stratification and the use of validated measures. Limitations include a retrospective design, single-center bias, and limited follow-up, potentially underestimating late recurrences. Prospective multicenter studies integrating frailty metrics and extended surveillance are needed to optimize strategies, including comparisons of radiosurgery in high-risk cases.

## Conclusion

Meningioma surgery is effective but outcomes depend on age and preoperative KPS. Very elderly and low-KPS patients warrant cautious selection and enhanced support.

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