



Socioeconomic burden and quality of life in meningioma patients

Wirsching, Hans-Georg ; Morel, Corinne ; Roth, Patrick ; Weller, Michael

Abstract: **PURPOSE:** Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients, even after curative surgical resection. We sought to explore socioeconomic burden of meningioma surgery and associations with post-operative QoL to identify patients at risk for inferior outcome. **METHODS:** All patients with histological diagnosis of an intracranial meningioma treated at a single institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys comprised tools to assess socioeconomic status including social deprivation, QoL and symptom burden. Multivariate binary regression models controlling for established prognostic factors were applied to explore associations of socioeconomics with QoL 1 year after surgery. **RESULTS:** Completed surveys were returned by 249 patients. The median age at diagnosis was 56 years (SD \pm 12), 185 patients (74%) were female and 219 (88%) had World Health Organization grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients working ($p < 0.001$), 22% of full-time working patients transitioned to part-time work ($p < 0.001$) and more patients depended on professional care (14% versus 4%, $p < 0.001$). Patients reported improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable analyses, QoL after meningioma surgery was associated with preoperative employment status (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92). **CONCLUSION:** In a subset of meningioma patients, there is marked socioeconomic burden, which may be associated with inferior patient-reported outcome.

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Socioeconomic burden and quality of life in meningioma patients

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1 Abstract

- 2 Purpose:** Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients,
- 3** even after curative surgical resection. We sought to explore socioeconomic burden of meningioma

4 surgery and associations with post-operative QoL, seeking to identify patients at risk for inferior
5 outcome.

6 **Methods:** All patients with histological diagnosis of an intracranial meningioma treated at a single
7 institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys
8 comprised tools to assess socioeconomic status including social deprivation, QoL and symptom
9 burden. Multivariate binary regression models controlling for established prognostic factors were
10 applied to explore associations of socioeconomics with QoL one year after surgery.

11 **Results:** Completed surveys were returned by 249 patients. The median age at diagnosis was 56
12 years (SD +/-12), 185 patients (74%) were female and 219 (88%) had World Health Organization
13 grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients
14 working ($p<0.001$), 22% of full-time working patients transitioned to part-time work ($p<0.001$)
15 and more patients depended on professional care (14% versus 4%, $p<0.001$). Patients reported
16 improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-
17 26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable
18 analyses, QoL after meningioma surgery was associated with preoperative employment status
19 (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92).

20 **Conclusions:** In a subset of meningioma patients, there is marked socioeconomic burden, which
21 may be associated with inferior patient-reported outcome.

22

23 **Introduction**

24 The clinical course of meningioma patients is often benign and treatment intensity moderate,
25 comprising neurosurgery alone in most cases [1, 2]. Quality of life and symptom burden improve
26 after meningioma resection in the majority of patients, including a reduction in pain and discomfort
27 or anxiety [3-5], but a subset of meningioma patients experience a long-term decrease in quality of
28 life [3, 6, 7], particularly in the social and emotional functioning domains [7, 8]. Factors associated
29 with post-operative quality of life include age, symptom burden, histological tumor grade, tumor
30 size and extent of resection [4, 7].

31 Associations of lower socioeconomic status with unfavorable outcome has been reported from
32 pediatric and unselected brain tumor patients [9, 10], but in meningioma patients, putative
33 interactions of socioeconomics with quality of life have not been studied in detail.

34 To explore this possibility, we conducted a cross-sectional survey study in a clinically well-
35 characterized cohort of meningioma patients. The primary objective of our study was to address
36 the question whether or not socioeconomics should be assessed along with quality of life in
37 prospective studies of meningioma and potentially other brain tumor patients. A more thorough
38 understanding of the factors that determine quality of life will eventually improve the identification
39 and supportive care of patients at risk for deterioration of quality of life.

40 **Patients and methods**

41 Subject selection and study design

42 This cross-sectional survey study was approved by the local ethics committee and was performed
43 in accordance with the Declaration of Helsinki (IRB No. 2015-00130). Figure 1 details the primary
44 analysis population. All patients with histologically confirmed intracranial meningioma treated at
45 the University Hospital Zurich between 2000-2013 and with a follow-up of at least 1 year were
46 screened for inclusion. The analysis period was determined by the introduction of an electronic
47 chart system at this institution in the year 2000. Among 729 patients matching these criteria, 320
48 patients were not included in the study because at the time-point of survey distribution they were

49 either lost to follow-up (N=196) or had died (N=124). Surveys were sent to all 409 eligible patients
50 in August 2016 to retrospectively explore their quality of life and socioeconomic status.

51 Subject information and consent

52 Patients who were still alive were informed that his/her medical records may be examined by
53 authorized individuals other than their treating physician. Along with questionnaires on quality of
54 life and socioeconomic parameters, patients and their general practitioners received a subject
55 information sheet which explained the nature of the study and its purpose. Each subject was
56 informed that the participation in the study is voluntary and that he/she may withdraw from the
57 study at any time and that withdrawal of consent will not affect his/her subsequent medical
58 treatment.

59 Return of questionnaires by patients was considered consent with the further use of the data
60 provided by the patient. Concerning the further use of already available clinical data that were
61 obtained from the patients' general practitioners, the lack of refusal of further use of their clinical
62 data by the patient was considered consent. In the case of patients who have died or who were
63 unable to respond or who were lost to follow-up, no consent was sought in accordance with local
64 legislation for the following reasons: (1) In a majority of patients the tumor resection dated back
65 several years, thus making it impossible or disproportionately difficult to obtain consent or to
66 provide information on the right to dissent. (2) The interests of research outweigh the interests of
67 the person concerned in deciding on the further use of his or her data, because results from the
68 planned analyses were likely to have immediate implications for future patients.

69 Variables

70 Demographics and clinical data have been annotated and defined previously [11, 12]. Surveys were
71 sent to eligible patients in April 2016 and comprised level of education, profession, employment
72 status, subjective work ability, monthly income, an eleven-item socioeconomic assessment tool to
73 quantify material and social deprivation (EPICES, Evaluation of deprivation and health inequalities
74 in healthcare clinics) [13], quality of life utilizing the European Organization for Research and
75 Treatment of Cancer (EORTC) quality of life questionnaire C30 (QLQ-C30) and brain tumor
76 module BN20 [14], and symptom burden utilizing the MD Anderson Symptom Inventory Brain
77 Tumor (MDASI-BT) [15]. The EPICES questionnaire uses eleven weighted questions to evaluate

78 material and social deprivation. A score of 30 or higher corresponds to relevant deprivation [16].
79 The EORTC QLQ-C30 assesses health-related quality of life including global health status, five
80 functional scales and a number of scales and items assessing additional symptoms commonly
81 reported by cancer patients [14]. It is supplemented by the EORTC QLQ-BN20 that includes four
82 functional scales and seven symptom items to additionally assess quality of life parameters of
83 importance to patients with brain cancer [14]. The MDASI-BT measures the patient reported
84 symptom burden and interference with daily life by assessing the severity of 13 symptoms and by
85 adding six questions of interference with different aspects of patients' life. Symptom items were
86 grouped into previously defined subcategories, including general/disease-related such as fatigue,
87 pain, disturbed sleep or change in appearance, as well as affective, cognitive, neurological and
88 gastrointestinal.

89 All questionnaires were formally adapted for retrospective interrogation on the time points at
90 surgery and 1 year after surgery. All scales and items in the EORTC QLQ-C30/BN20 and MDASI-
91 BT were fitted to quasi-continuous scales ranging from 0-100, with higher scores representing
92 better quality of life and lower symptom burden. The categorical variables "Any clinically
93 meaningful deterioration in Quality of life" and "Any clinically meaningful increase in symptom
94 burden" were computed in addition by applying a 10% cut-off to all EORTC QLQ-C30/BN20 or
95 MDASI-BT scales [14].

96 The Charlson comorbidity index (CCI) [17] was applied to quantify comorbid disease burden for
97 the timepoint of surgery. In order to minimize missing data, items of the CCI retrieved from
98 patients' electronic charts were complemented through information obtained from the patients'
99 general practitioners. Comorbidities documented neither in the hospital's electronic chart system
100 nor reported by patients' general practitioners were assumed not to be present. The level of
101 professional care was determined through the patients' general practitioners.

102 Statistical methods

103 SPSS V23.0 (IBM) was utilized for all statistical analyses. The chi-square test was performed for
104 analysis of nominal variables. The Mann-Whitney U test was performed for ordinal variables and
105 for interval-scaled variables that were not normally distributed. Non-normality of continuously
106 scaled variables including quality of life was determined utilizing the Kolmogorov-Smirnov test.
107 Binary logistic regression was performed for multivariable testing of factors associated with

108 inferior quality of life. Variance inflation factors (VIF) of the regression model were determined
109 by linear regression to test for multicollinearity, and VIF <5 were defined as no multicollinearity
110 [18]. Linearity of independent variables was determined by Pearson's correlation and Nagelkerke's
111 R² test was done to estimate the model fit. No imputation of missing data was done. No sample
112 size estimation was done. A p-value <0.05 was considered statistically significant for any analyses.
113 Cronbach's α -test was applied as a measure of reliability of the applied scores.

114 **Results**

115 Patient characteristics

116 Completed surveys were obtained from 249 of 409 eligible patients (61%). There were 88 patients
117 (21%) who did not consent, 48 patients (12%) did not return the survey due to a foreign mother
118 tongue and 24 patients (6%) due to cognitive impairment. Characteristics of the primary analysis
119 population are summarized in Table 1. The median age at surgery was 56 years (standard deviation
120 +/- 12 years) and 185 patients (74%) were female. The high rate of female patients with
121 meningioma reflects the population-based gender distribution of meningioma [1]. The level of
122 education was an apprenticeship or higher in 214 patients (86%). The most common professional
123 background in 100 patients (40%) was employee, followed by leadership or academia in 49 patients
124 (20%) and 40 patients (16%) were industrial or agricultural workers. Relevant comorbidities
125 indicated by a CCI larger than 2 were present in 57 patients (23%). The vast majority of 219 patients
126 (88%) suffered from WHO grade I meningiomas. The most common tumor location was the skull
127 base in 89 patients (36%), followed by convexity meningiomas in 54 (22%). A radiographic gross
128 total resection was achieved in 189 patients (76%). Ninety-nine patients (40%) suffered from any
129 neurological deficit one year after surgery, and 31 (12%) experienced a recurrence of their
130 meningioma during this time. Patients who did not return surveys (N=160) compared to the primary
131 analysis population had a higher frequency of tumor recurrences one year after surgery (22%,
132 p=0.009). There was also a trend towards higher age at surgery (p=0.059), higher WHO grade
133 (p=0.085) and a lower rate of radiographic gross total resections (p=0.065), whereas no difference
134 was detected with respect to gender distribution (p=0.24), tumor location (p=0.19) or presence of
135 neurological deficits at 1 year after surgery (p=0.39, Table S1).

136 Socioeconomics before versus 1 year after surgery

137 Socioeconomic parameters before and 1 year after meningioma surgery are summarized in Table
138 2. There were 47 fewer patients (20%) working, including 13 patients (5%) who were unemployed,
139 11 patients (5%) who were disabled, and 23 patients (10%) who had retired due to age ($p<0.001$).
140 Of 101 patients working fulltime before surgery, 21 patients (21%) had transitioned to part-time
141 work and 24 patients (24%) had stopped working. Among 88 patients working part-time before
142 surgery, 23 patients (26%) had stopped working. This led to an overall decrease in the patients
143 working full time while the absolute number of patients working part time remained stable. The
144 monthly income was unaffected in the higher income segments over 8.000 CHF per month, but 11
145 patients (7%) had shifted into the lowest income segment below 4.000 CHF per month ($p=0.008$),
146 which is in the range of the guaranteed basic social security. There were 21 more patients (10%)
147 who required professional care ($p<0.001$), which was administered as home nursing in all but 2
148 patients (1%).

149 Quality of life 1 year after surgery versus before surgery

150 Figure 2A summarizes changes in quality of life before versus one year after surgery of an
151 intracranial meningioma. A clinically meaningful improvement one year after surgery was
152 observed in individual scales of the EORTC-QLQ-C30/BN20 (defined as a $\geq 10\%$ shift, see
153 methods) for global health (20.7%, 95% confidence interval [1] 15.2-26.2%), headaches (18.6%,
154 95% CI 13.6-23.6%) and seizures (12.1%, 95% CI 7.7-16.5%). There was also a $<10\%$
155 improvement of emotional and social functioning, future uncertainty and of several symptom items,
156 including nausea and vomiting, pain, appetite loss, visual disorder and motor dysfunction, whereas
157 no worsening of any scale was observed on the population level. The MDASI-BT did not determine
158 $>10\%$ changes in symptom burden or interference, albeit lower level improvement was noted for
159 all scales but cognitive functioning (Figure 2B). On the patient level worsening in one or more
160 scales of the EORTC-QLQ-C30/BN20 or the MDASI-BT one year after surgery has been reported
161 by 178 patients (71.5%). The score reliability was confirmed for both, the EORTC-QLQ-
162 C30/BN20 ($\alpha = 0.92$) and the MDASI-BT ($\alpha = 0.93$).

163 Multivariable analyses

164 We employed a binary regression model to explore predictors of a clinically meaningful decline in
165 quality of life on the patient level, i.e. of any scale of the EORTC-QLQ-C30/BN20 or the MDASI-

166 BT one year after surgery (Table 3). The model comprised the variables age (<55 versus \geq 55 years),
167 gender (female versus male), WHO grade (I versus II/III), tumor location (other versus skull base),
168 tumor diameter (<40 versus \geq 40 mm) and presence versus absence of any neurological deficits one
169 year after surgery. There was no multicollinearity (any VIF <5) and no linearity of independent
170 variables except for a mild association of WHO grade and gender (R=0.15, p=0.018). Univariate
171 analyses are summarized in Table S2. In the multivariable model, only younger age was associated
172 with a decline in quality of life (odds ratio [OR] 2.38, 95% confidence interval [CI] 1.20-4.76,
173 p=0.012).

174 We then utilized this model to explore associations of socioeconomic parameters at the timepoint
175 of surgery with inferior outcome of quality of life. There was an association with occupational
176 status (working versus unemployment or retirement, OR 0.41, 95% CI 0.17-0.98, p=0.049) and
177 along the same lines a subjective work ability of at least 70% was associated with better outcome
178 (OR 0.37, 95% CI 0.15-0.92, p=0.033). No associations were identified for level of education
179 (p=0.95), low income (p=0.30), workload (p=0.77), or social deprivation (p=0.54).

180 **Discussion**

181 This cross-sectional survey study was designed to explore socioeconomic burden and associations
182 with quality of life in meningioma patients. Our study confirms previous reports on improved
183 quality of life after meningioma resection in the majority of patients [3, 4, 19-21]. However,
184 associations of the diagnosis and surgery of an intracranial meningioma with socioeconomic status
185 changes has not been studied in detail. It was striking that the surgery of meningiomas, i.e.
186 relatively benign intracranial tumors, was followed by pronounced socioeconomic status changes
187 in a substantial fraction of patients, including unemployment or increased dependency on care.
188 Consistent with prior reports, e.g. on patients with multiple sclerosis [22] or a population-based
189 analysis [23], we have also identified an association of unemployment with inferior quality of life.
190 Our finding of an association of higher subjective work ability with better quality of life
191 underscores the relevance of self-efficacy as a source of resilience, especially in younger neuro-
192 oncology patients who appear to be less confident about their cognitive performance after surgery
193 [19, 24]. Likewise, the often more aggressive disease course of meningiomas in younger patients

194 may have contributed to an overall more pronounced volatility of quality of life among younger
195 patients in our cohort.

196 We hypothesize that even more prominent associations of socioeconomics with quality of life may
197 be present in societies that are lacking a socialized health care system and high social security
198 standards. Moreover, the question arises whether patients suffering from brain tumors with less
199 favorable prognosis are likewise affected by the socioeconomic impact of their diagnosis. In fact,
200 the quality of life of entire families is likely to be affected by the socioeconomic demands of care,
201 treatment and rehabilitation [15]. Other factors that will probably determine quality of life include
202 cognitive functioning and the presence of anxiety or depression [5, 7, 20, 25]. Notably, these
203 psychiatric symptoms are not reflected by the CCI. A trend towards reduced future uncertainty and
204 better emotional social functioning one year after surgery suggests that surgery may improve these
205 potential confounders of quality of life, but future prospective studies should be designed to clarify
206 putative interactions of these factors with socioeconomic burden.

207 An inherent limitation of the design of our study is random data loss due to unreturned surveys or
208 return of incomplete surveys, albeit the survey return rate in our study was high, at least in part due
209 to follow-up phone calls that were performed in patients who did not respond. We did not correct
210 statistically for multiple testing, as recommended by Bender and Lange (2001) for exploratory
211 studies in order to avoid false negative results [26]. We also report selection bias of our study
212 toward patients with a more favorable disease course, including less frequent tumor recurrence,
213 lower WHO grade and a higher rate of gross total resections. This selection might have led to an
214 overestimation of improvement of quality of life after surgery, but also implies that socioeconomic
215 burden may have been underestimated. The retrospective design of our study implies that
216 patients' quality of life at the time-point when the surveys were received has likely corroborated
217 the results. The key valuation of our study is however unaffected by these limitations, i.e. that
218 relevant socioeconomic burden is associated with meningioma surgery and that socioeconomics
219 may confound outcome measures.

220 **Conclusion**

221 Patients with meningioma experience socioeconomic burden, which is associated with inferior
222 quality of life. Prospective studies assessing associations of socioeconomics and quality of life are

223 warranted to define and meet public health challenges in meningioma patients more precisely,
224 including a more effective assignment of psychosocial support.

225

226 **References**

227

228

229 1. Ostrom, Q.T., et al., *CBTRUS Statistical Report: Primary Brain and Other Central*
230 *Nervous System Tumors Diagnosed in the United States in 2011-2015*. Neuro Oncol, 2018.

231 **20**(suppl_4): p. iv1-iv86.

232 2. Goldbrunner, R., et al., *EANO guidelines for the diagnosis and treatment of meningiomas*.
233 *Lancet Oncol*, 2016. **17**(9): p. e383-91.

234 3. Jakola, A.S., et al., *The influence of surgery on quality of life in patients with intracranial*
235 *meningiomas: a prospective study*. *J Neurooncol*, 2012. **110**(1): p. 137-44.

236 4. Miao, Y., et al., *A multivariate analysis of prognostic factors for health-related quality of*
237 *life in patients with surgically managed meningioma*. *J Clin Neurosci*, 2010. **17**(4): p. 446-9.

238 5. Waagemans, M.L., et al., *Long-term impact of cognitive deficits and epilepsy on quality of*
239 *life in patients with low-grade meningiomas*. *Neurosurgery*, 2011. **69**(1): p. 72-8; discussion 78-9.

240 6. Mohsenipour, I., et al., *Quality of life in patients after meningioma resection*. *Acta*
241 *Neurochir (Wien)*, 2001. **143**(6): p. 547-53.

242 7. Zamanipour, N.A., et al., *OS4.2 The long-term disease burden of meningioma patients:*
243 *results on health-related quality of life, cognitive function, anxiety and depression*. *Neuro Oncol*,
244 2018. **20**(suppl_3): p. iii222–iii223.

245 8. Benz, L.S., et al., *Quality of life after surgery for intracranial meningioma*. *Cancer*, 2018.
246 **124**(1): p. 161-166.

247 9. Curry, W.T., Jr., B.S. Carter, and F.G. Barker, 2nd, *Racial, ethnic, and socioeconomic*
248 *disparities in patient outcomes after craniotomy for tumor in adult patients in the United States,*
249 *1988-2004*. *Neurosurgery*, 2010. **66**(3): p. 427-37; discussion 437-8.

- 250 10. Scholtes, C., et al., *Health status, Health-Related Quality of Life and Socio-economic*
251 *Outcome in Childhood Brain Tumor Survivors: a German Cohort Study*. Neuro Oncol, 2019.
- 252 11. Wirsching, H.G., et al., *Predicting outcome of epilepsy after meningioma resection*. Neuro
253 Oncol, 2016. **18**(7): p. 1002-10.
- 254 12. Wirsching, H.G., et al., *Post-operative cardiovascular complications and time to*
255 *recurrence in meningioma patients treated with versus without pre-operative embolization: a*
256 *retrospective cohort study of 741 patients*. J Neurooncol, 2018. **140**(3): p. 659-667.
- 257 13. Sass, C., et al., [*Comparison of the individual deprivation index of the French Health*
258 *Examination Centres and the administrative definition of deprivation*]. Sante Publique, 2006.
259 **18**(4): p. 513-22.
- 260 14. Maringwa, J., et al., *Minimal clinically meaningful differences for the EORTC QLQ-C30*
261 *and EORTC QLQ-BN20 scales in brain cancer patients*. Ann Oncol, 2011. **22**(9): p. 2107-12.
- 262 15. Armstrong, T.S., et al., *The symptom burden of primary brain tumors: evidence for a core*
263 *set of tumor- and treatment-related symptoms*. Neuro Oncol, 2016. **18**(2): p. 252-60.
- 264 16. Morère, J.F., et al., *Lung cancer risks, beliefs and healthcare access among the*
265 *underprivileged*. Eur J Cancer Prev, 2015. **24** **Suppl**: p. S82-6.
- 266 17. Charlson, M.E., et al., *A new method of classifying prognostic comorbidity in longitudinal*
267 *studies: development and validation*. J Chronic Dis, 1987. **40**(5): p. 373-83.
- 268 18. McFatter, R.M., *The Use of Structural Equation Models in Interpreting Regression*
269 *Equations Including Suppressor and Enhancer Variables*. Applied Psychological Measurement,
270 1979. **3**(1): p. 123-35.
- 271 19. Kalkanis, S.N., et al., *Quality of life following surgery for intracranial meningiomas at*
272 *Brigham and Women's Hospital: a study of 164 patients using a modification of the functional*
273 *assessment of cancer therapy-brain questionnaire*. J Neurooncol, 2000. **48**(3): p. 233-41.

- 274 20. Krupp, W., et al., *Assessment of neuropsychological parameters and quality of life to*
275 *evaluate outcome in patients with surgically treated supratentorial meningiomas.* Neurosurgery,
276 2009. **64**(1): p. 40-7; discussion 47.
- 277 21. Chen, C.M., et al., *Contemporary surgical outcome for skull base meningiomas.*
278 Neurosurg Rev, 2011. **34**(3): p. 281-96; discussion 296.
- 279 22. Pack, T.G., et al., *Quality of life and employment in persons with multiple sclerosis.*
280 Work, 2014. **49**(2): p. 281-7.
- 281 23. Yang, X., et al., *Quality of Life and Its Related Factors in Chinese Unemployed People: A*
282 *Population-Based Cross-Sectional Study.* Int J Environ Res Public Health, 2016. **13**(8).
- 283 24. Veilleux, N., et al., *Quality of life in neurooncology--age matters.* J Neurosurg, 2010.
284 **113**(2): p. 325-32.
- 285 25. van Nieuwenhuizen, D., et al., *Differential effect of surgery and radiotherapy on*
286 *neurocognitive functioning and health-related quality of life in WHO grade I meningioma*
287 *patients.* J Neurooncol, 2007. **84**(3): p. 271-8.
- 288 26. Bender, R. and S. Lange, *Adjusting for multiple testing--when and how?* J Clin Epidemiol,
289 2001. **54**(4): p. 343-9.

290 **Figure legends**

291 Figure 1. Study population.

292 Figure 2. Quality of life (A) and symptom burden (B) one year after versus before meningioma
293 surgery. Forest plots depict effect sizes, defined as differences in mean values on quasi-continuous
294 scales ranging from 0-100.

295 **Supplemental Digital Content**

296 Supplemental Digital Content 1. Table. Characteristics of patients who returned the surveys versus
297 patients who did not return the surveys.

298 Supplemental Digital Content 2. Table. Univariate analyses of inferior quality of life one year after
299 surgery.

Purpose: Long-term impairment of quality of life (QoL) occurs in a subset of meningioma patients, even after curative surgical resection. We sought to explore socioeconomic burden of meningioma surgery and associations with post-operative QoL, seeking to identify patients at risk for inferior outcome.

Methods: All patients with histological diagnosis of an intracranial meningioma treated at a single institution 2000-2013 were screened for inclusion in this cross-sectional survey study. Surveys comprised tools to assess socioeconomic status including social deprivation, QoL and symptom burden. Multivariate binary regression models controlling for established prognostic factors were applied to explore associations of socioeconomics with QoL one year after surgery.

Results: Completed surveys were returned by 249 patients. The median age at diagnosis was 56 years (SD +/-12), 185 patients (74%) were female and 219 (88%) had World Health Organization grade I meningiomas. One year after surgery, there was a 20% decrease in the number of patients working ($p<0.001$), 22% of full-time working patients transitioned to part-time work ($p<0.001$) and more patients depended on professional care (14% versus 4%, $p<0.001$). Patients reported improved QoL, including improved global health (effect: 21%, 95% confidence interval [1] 15-26%), headaches (effect: 19%, CI 13-24%) and seizures (effect: 12%, CI 8-17%). On multivariable analyses, QoL after meningioma surgery was associated with preoperative employment status (odds ratio [OR] 0.41, 95% CI 0.17-0.98) and subjective work ability (OR 0.37, 95% CI 0.15-0.92).

Conclusions: In a subset of meningioma patients, there is marked socioeconomic burden, which may be associated with inferior patient-reported outcome.

Table 1. Patient characteristics.

Age at diagnosis: years	
Median	56
Range	18-79
Standard deviation	12
Gender: N (%)	
Female	185 (74)
Male	64 (26)
Highest level of education: N (%)	
No school education	2 (1)
School education	27 (11)
Apprenticeship	138 (55)
Higher education	76 (31)
Unknown	6 (2)
Profession: N (%)	
Leadership or academic	49 (20)
Employee	100 (40)
Industry worker or agriculture	40 (16)
Other	60 (24)
Charlson Comorbidity Index (CCI): N (%)	
CCI \leq 2	192 (77)
CCI 3-4	50 (20)
CCI \geq 5	7 (3)
WHO grade: N (%)	
I	219 (88)
II / III	30 (12)
Location: N (%)	
Multiple meningiomas	31 (12)
Convexity	54 (22)
Parasagittal / falx	35 (14)
Skull base	89 (36)
Posterior fossa	33 (13)

Other	7 (3)
Extent of resection: N (%)	
Gross total	189 (76)
Incomplete	49 (20)
No data	11 (4)
Neurological deficits 1 year after surgery: N (%)	
Yes	99 (40)
No	150 (60)
Tumor recurrence within 1 year after surgery: N (%)	
Yes	31 (12)
No	218 (88)

Table 2. Socioeconomics before versus one year after surgery.

	At surgery	One year after surgery	
Occupation: N (%)^a			p
Working	189 (78)	142 (58)	<0.001
Unemployed	7 (3)	20 (8)	
Retired	39 (16)	62 (26)	
Disabled	8 (3)	19 (8)	
<i>related to diagnosis</i>			
Yes	3 (1)	14 (6)	
No	5 (2)	5 (2)	
Workload: N (%)^a			
full time	101 (42)	56 (23)	<0.001
part time	88 (36)	86 (35)	
not working	54 (22)	101 (42)	
Monthly income: Swiss Francs^b			
< 4000	54 (32)	65 (39)	0.008
4000-8000	83 (50)	73 (44)	
8000-12'000	21 (13)	21 (13)	
>12'000	8 (5)	7 (4)	
Subjective work ability: %^c			
Mean	73	72	0.55
95% CI	69-77	67-76	
Standard deviation	2.6	2.8	
Care dependency: N (%)^d			
No professional care	214 (96)	193 (86)	<0.001
Care at home	9 (4)	28 (13)	
Nursing home	0 (0)	2 (1)	
Social deprivation (EPICES score \geq 30)^{e, f}			
No	123 (70)	124 (71)	1.000
Yes	53 (30)	52 (30)	

^a data available for 243 patients ^b data available for 166 patients ^c data available for 146 patients

^d data available for 223 patients ^e data available for 176 patients

^f Cronbach's alpha = 0.96

Table 3. Multivariable model of inferior quality of life one year after surgery.[#]

	Odds ratio and 95% CI	p
Age: <55y versus ≥55y	2.38 (1.20;4.76)	0.012*
Gender: female versus male	1.56 (0.77;3.13)	0.22
WHO grade: I versus II/III	1.16 (0.33;2.50)	0.84
Location: other versus skullbase	0.67 (0.34;1.33)	0.26
Diameter: <40mm versus ≥40mm	0.57 (0.29;1.12)	0.11
Postoperative neurological deficit: no versus yes	0.75 (0.38;1.47)	0.40
<i>Socioeconomic parameters at diagnosis⁺</i>		
Highest level of education: Apprenticeship or higher versus school or lower	1.02 (0.50;2.10)	0.95
Occupation: working versus unemployed or retired	0.41 (0.17;0.98)	0.049*
Monthly income: >4000 versus ≤4000 CHF	0.63 (0.26;1.52)	0.30
Workload: part-time versus full-time	0.88 (0.38;2.03)	0.77
Subjective work ability: ≥70 versus <70 %	0.37 (0.15;0.92)	0.033*
Social deprivation: EPICES <30 versus ≥30	2.79 (0.98;7.91)	0.54

[#] complete datasets were available from 192 patients; ⁺ tested as additional single variables; * p<0.05

Table S2. Univariate analyses of inferior quality of life one year after surgery.

	Odds ratio and 95% CI	p
Age: <55y versus \geq 55y	1.56 (0.89;2.75)	0.12
Gender: female versus male	1.60 (0.86;2.96)	0.14
WHO grade: I versus II/III	0.95 (0.40;2.24)	0.90
Location: other versus skullbase	0.70 (0.38;1.30)	0.26
Diameter: <40mm versus \geq 40mm	0.74 (0.41;1.34)	0.32
Postoperative neurological deficit: no versus yes	0.64 (0.36;1.16)	0.14
<i>Socioeconomic parameters at diagnosis</i>		
Highest level of education: Apprenticeship or higher versus school or lower	0.90 (0.49;1.65)	0.74
Occupation: working versus unemployed or retired	0.64 (0.31;1.33)	0.23
Monthly income: >4000 versus <4000 CHF	1.10 (0.55;2.22)	0.78
Workload: part-time versus full-time	1.05 (0.56;1.99)	0.88
Subjective work ability: >70 versus <70 %	0.56 (0.27;1.19)	0.13
Social deprivation: EPICES <30 versus >30	0.63 (0.30;1.37)	0.24

Table S1. Characteristics of patients who returned the surveys versus patients who did not return the surveys.

	Surveys returned	Surveys not returned	p
Age at diagnosis (years)			
Mean	56	59	0.016
Range	18-79	18-88	
Gender: N (%)			
Female	185 (74)	316 (66)	0.012
Male	64 (26)	164 (34)	
WHO grade: N (%)			
I	219 (88)	376 (78)	0.001
II / III	30 (12)	104 (22)	
Tumor location: N (%)			
Multiple meningiomas	31 (12)	27 (17)	0.19
Convexity	54 (22)	35 (22)	
Parasagittal / falx	35 (14)	30 (19)	
Skull base	89 (36)	54 (33)	
Posterior fossa	33 (13)	13 (8)	
Other	7 (3)	1 (1)	
Extent of resection: N (%)			
Gross total	189 (76)	332 (69)	0.079
Incomplete	49 (20)	115 (24)	
No data	11 (4)	33 (7)	
Neurological deficits 1 year after surgery: N (%)			
Yes	78 (31)	53 (33)	0.39
No	171 (69)	107 (67)	
Tumor recurrence within 1 year after surgery: N (%)			
Yes	31 (12)	125 (26)	<0.001
No	218 (88)	355 (74)	



