Long-term health-related quality of life in meningioma survivors: a mixed-methods systematic review

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Abstract

Background: Meningiomas account for ~25% of all primary brain tumours. These tumours have a relatively favourable prognosis with ~92% of meningioma patients surviving > 5 years after diagnosis. Yet, patients can report high disease burden and survivorship issues even years after treatment, affecting health-related quality of life (HRQOL). We aimed to systematically review the literature and synthesise evidence on HRQOL in meningioma patients across long-term survival, defined as $\geq$ 2 years post diagnosis.

Methods: Systematic literature searches were carried out using Medline, EMBASE, CINAHL, PsycINFO, and Web of Science Core Collection. Any published, peer reviewed article with primary quantitative, qualitative, or mixed methods data covering the physical, mental, and/or social aspects of HRQOL of meningioma survivors were included. Narrative synthesis method was used to interpret findings.

Results: Searches returned 2253 unique publications, of which 21 were included. Of these, *N*=15 involved quantitative methodology, *N*=4 mixed methods and *N*=2 were qualitative reports. Patient sample survival ranged from 2.75–13 years. HRQOL impairment was seen across all domains. *Physical* issues included persevering symptoms (e.g. headaches, fatigue, vision problems); *mental* issues comprised emotional burden (e.g., high prevalence of depressive symptoms and anxiety) and cognitive complaints; *social* issues included role limitations, social isolation, and affected work productivity. Due to study heterogeneity, the impact of treatment on long-term HRQOL remains unclear.

Conclusions: Findings from this review highlight the areas of HRQOL that can be impacted in long-term survivorship for patients with meningioma. These findings could help raise awareness among clinicians and patients, facilitating support provision.

Keywords: meningioma; health-related quality of life; disease burden; survivorship; mixed-methods

Importance of the study

Patients diagnosed with meningioma can experience high disease burden, yet little is known about long-term health-related quality of life (HRQOL) outcomes. This systematic review of 21 publications on HRQOL of long-term survivors of meningioma ($\geq$ 2 years post diagnosis) highlights impairment across physical, mental, and social functioning. Study heterogeneity precluded conclusions on impact of treatment, which requires further investigation. Findings suggest that despite the generally favourable prognosis, meningioma patients could benefit from supportive care into longer term survivorship to limit the impact of diagnosis/treatment on everyday life.

Introduction

Meningiomas make up approximately 25% of all primary brain tumours diagnosed in the United Kingdom.[1] Symptoms can vary depending on size, location and grade, and may include motor or sensory deficits, seizures and/or other functional impairments.[2, 3] Meningiomas are often benign and removable through surgery, [4] with some patients managed through 'watch-and-wait' strategy until intervention may become necessary. However despite high survival rates, patients may experience long-term impaired daily functioning such as problems with memory, executive function or language processing[5] which can negatively influence their health-related quality of life (HRQOL).[3]

HRQOL is a multidimensional concept that covers the physical, mental and social aspects of a patient's life.[6] Diagnosis and treatment can have significant implications on different domains of HRQOL. One systematic review has found when compared with glioma populations, meningioma patients have fewer cognitive and emotional complaints.[2] Yet other studies have found that patients diagnosed with meningioma have more greatly impaired HRQOL than the general population.[3] In the longer term, one study on neurocognitive functioning and HRQOL in patients with skull base meningioma ($\geq$5 years since diagnosis) found that patients reported a clinically relevant impairment of emotional and physical role functioning compared to informal caregivers as controls.[7] However, findings may not be generalisable to other meningioma subgroups. In general, the long-term impact of a meningioma diagnosis on HRQOL is not well represented in the literature. Obtaining a clearer picture of HRQOL in meningioma survivors will help inform both patients and clinicians of any long-term consequences of treatment, and could identify areas of unmet support needs. Therefore, the aim of this systematic review is to provide an overview of the literature depicting the HRQOL of meningioma patients across long-term survival, which we defined as $\geq$ 2 years since diagnosis.

Methods

Search Methods

This review was reported in line with PRISMA guidelines, where applicable.[8] The following databases were searched: PubMed/Medline, Embase, PsycInfo, Web of Science. These searches were completed on 17th November 2022. The search terms and strategies were created with advice from an information specialist (JW, see Acknowledgments), specifically for the following concepts: meningioma, adult, health-related quality of life and long-term survivorship. Search strategies were developed using a combination of free text terms and subject headings. No limit was placed on time since publication. See supplementary material 1 for the complete search strategy. The protocol for this review was registered on PROSPERO (CRD42020207211). Literature titles found were exported to EndNote X9 software where the duplicate removal function was used followed by title/abstract screening.

Selection Criteria

Literature was included according to the following criteria:

1. Human, adult participants (≥18 years old); if samples included mixed age groups then the proportion of adults (≥18 years old) must be over 50%;
2. Patients with WHO grade I and II meningiomas (or imaging suggestive of this where a tissue diagnosis was not feasible, e.g. small tumours undergoing a ‘wait and see’ approach or optic nerve meningioma). Grade III meningiomas were excluded due to their more aggressive nature and, as such, relatively different disease trajectory;
3. Mean/median time since diagnosis (TSD) had to be ≥ 2 years. This cut-off allowed us to assess HRQOL after diagnosis, while providing the earliest indication of ‘long-term’ survival;
4. Published in English language;

5. Studies must have included either quantitative or qualitative, self-reported measures of HRQOL (e.g. questionnaires, interviews etc.)

Exclusion criteria were as follows:

1. Reviews, case studies and case reports;
2. Reporting on other primary or secondary brain tumours only;
3. Studies using non-self-reported measures of HRQOL e.g., clinician- or proxy-reported outcomes.

Articles were assessed for eligibility in two stages (title/abstract then full text), by the lead investigator (SF). Conference abstracts could be included if these contained sufficient detail. As pre-specified in the protocol (PROSPERO CRD42020207211), a second reviewer (FB) independently screened a random sample (20%) at each stage. Of these original libraries, we found a discrepancy of 11% at title screening. The lead reviewer (SF) revisited the inclusion and exclusion criteria related to discrepancies to ensure consistency of study selection.

Data Extraction and Quality Assessment

Data extraction was carried out using a standardised template. Data extracted included study design, study outcomes, sample size and participant selection criteria, as well as the selected method used to report on HRQOL. Outcome data was extracted in line with the themes derived from Hays & Reeve's definition of HRQOL - "*how well a person functions in their life and his or her perceived wellbeing in physical, mental & social domains of health*".[6] We used the Mixed Methods Appraisal Tool (MMAT)[9] for quality assessment of included studies. Following quality assessment, no studies were removed; however, studies of lower quality should be interpreted with caution and in consideration of their limitations. See supplementary material 2 for MMAT scores.

Narrative Synthesis

Narrative synthesis methods were used to interpret findings[10] due to the variety of HRQOL outcomes. Evidence was categorised based on the themes of our chosen definition of HRQOL.[6] This included physical, mental, and social aspects affected by diagnosis or treatment, with added domains where appropriate based on themes emerging from included papers e.g. fatigue, coping, positive changes. Associations between sociodemographic and/or clinical characteristics in relation to HRQOL impairment were also considered, where possible.

Results

Search Results

2657 hits were returned from initial searches with a further 406 added through an updated search. Removing duplicates using EndNote software left 2253 titles for screening. Following title/abstract screening, 295 publications remained for full text screening. In total, 21 publications were included for data extraction and narrative synthesis. See Figure 1 for screening results and reasons for exclusion.

Study characteristics

This review included 71% (*N*=15) quantitative methodology articles, 19% (*N*=4) mixed methods and 10% (*N*=2) qualitative articles, from 16 unique studies. 71% of publications (*N*=15) originated from Europe. Sample sizes within publications ranged from *N*=16[11] to *N*=1852[12], and mean/median time since diagnosis ranged from 2.75[13, 14]– 13[15] years. In total, 3864 unique study participants were represented (age range: 16-92), of whom 2709 (70%) were female. Seizure prevalence (reported in 6 publications[12-14,17,20,24]) ranged between 3.4[20]-24.4%[24]. There were various outcome measures for HRQOL used across these studies, with the Short Form-36 (38%; *N*=8) and the Hospital Anxiety and Depression Scale (24%; *N*= 5) most commonly reported. Study characteristics can be found in Table 1.

Health-related Quality of Life

Figure 2 shows key findings related to the physical, emotional, and social domains of HRQOL, with results covered in more detail below.

Physical Functioning

Meningioma patients reported negative impacts to their physical capability and increased symptom burden.[7, 11, 16-23] A variety of symptoms were reported,[7, 11, 18, 20] e.g., headaches,[19] fatigue,[12, 18, 20, 24] increased levels of pain,[22] epilepsy[7,12-14,17,20,24] and alopecia.[17, 20] Grade I meningioma patients with epilepsy (*N*=56) had worse HRQOL as measured with the Functional Assessment of Cancer Therapy-Brain (FACT-BR) summary score compared to meningioma patients without seizures (*N*=109).[24] A cross-sectional observational study found that patients with grade I meningioma (*N*=181) scored worse than general population controls on overall measures of physical functioning, yet 86% of patients did return to pre-surgery levels of physical functioning, independence, and ability to drive.[18] Reduced physical functioning appeared associated to radiotherapy treatment in one study comparing 18 patients who were irradiated to 18 patients who were not.[16] Yet, in a study of 507 skull base meningioma patients treated with high precision photon radiotherapy, 56% had validly completed patient-reported outcomes data which showed no major detriment of radiotherapy treatment, with only 4.2% rating their HRQOL as worse following radiotherapy.[17] Furthermore, 47.7% of patients in this study reported stable HRQOL after radiotherapy, and 37.5% reporting improvement during follow-up.[17] Other determinants for worse physical functioning outcomes found in a large meningioma patient cohort (*N*=190) were female sex, comorbidities, larger tumour size, lower level of education, and lower Karnofsky Performance Score at the time of study .[21] In a secondary analysis which compared subgroups of 89 skull base meningioma patients to 84 convexity meningioma patients and 65 caregiver controls, no statistically significant differences in physical functioning were found between groups.[20]

Mental Functioning

Psychological/Emotional Functioning

Psychological and emotional experiences of meningioma patients were reported in many studies, using a variety of outcome measures (see Table 1).[7, 13, 18, 24-26] Elevated psychological distress,[7, 13, 15, 23] anxiety and depression[7, 13, 15, 23, 26, 27] as well as a number of general 'emotional problems' including low scores on emotional (role) functioning scales of HRQOL outcomes were reported.[13, 14, 18, 22, 23, 27] Estimates of the prevalence of anxiety varied between 14-50%, and between 7-87% for depression, depending on timing of assessment and outcome measure used.[7, 13, 15, 23, 26, 27] There were also reports of more specific psychological difficulties, with a cross-sectional observational study showing 11 out of 70 participants (16%) experienced elevated meningioma-related post-traumatic distress. In this small sample, higher post-traumatic stress symptoms were related to mood disturbances and higher support needs, as well as reduced scores on physical, emotional, and functional wellbeing aspects of HRQOL (as measured with the FACT) compared to patients with low post-traumatic stress symptoms.[19] Cognitive complaints and epilepsy have also been linked to worse emotional wellbeing.[13] Benefit finding, a psychological change that can arise in response to a traumatic event, was found to be associated to higher levels of depressive symptoms in meningioma patients <2 years after diagnosis (*N*=27), whereas higher benefit finding was associated with intrusions and avoidance symptoms in longer term survivors (*N*=43).[25] The study authors explain this as an evolving strategy meningioma patients may use to cope with the future uncertainty of tumour recurrence as time goes on.[25]

Treatment strategies might contribute to mental difficulties. In a study of 62 meningioma patients, those who were followed with a wait-and-watch strategy (*N*=31) had a 4.26-fold higher risk of depression than those who received surgical resection (*N*=31); yet a worse score on the observer-completed Neurologic

Assessment in Neuro-Oncology (NANO) scale was associated with a lower risk of depressive symptoms, underscoring the importance of patient self-report.[26] Yet, in an investigation comparing 18 surgery-only patients at 3 years post-treatment to 18 patients treated with surgery and radiotherapy at 7.6 years post-treatment, no differences in emotional functioning between treatment groups were found.[16]

Self-reported Cognitive Functioning

Several studies made mention of subjective cognitive complaints.[7, 11-13, 24, 26] In a study of 136 meningioma patients on average 32 months after surgery, 23% reported subjective cognitive complaints using the cognitive failures questionnaire (CFQ) – however, patients scored better than would be expected of the general population.[13] Higher degrees of cognitive complaints have also been reported - in another investigation of 1542 meningioma patients of whom 58.8% were long-term survivors (>3 years post-diagnosis), 42.3% of patients reported cognitive issues. Cognitive complaints covered in included studies were vision and communication impairments[7, 20] concentration issues,[19, 26]changes in personality,[19]difficulties with language expression,[13]and confusion.[24] Cognitive issues such as impaired concentration, being slower, and difficulty making decisions have been linked to patients' difficulties in everyday life including work.[7, 13]

Social Functioning

Patients can face disruptions to their social functioning,[7, 11, 12, 18] impacting on their overall HRQOL.[18] Social functioning may be linked to cognitive complaints such as communication difficulties,[7, 20] impacting the relationship with peers and loved ones. In conjunction with concentration issues and personality changes, meningioma patients with higher post-traumatic stress symptoms (*N*=11) were more bothered by a decline in what they could contribute to family, compared to meningioma patients who had lower post-traumatic stress symptoms (*N*=59).[19] In a small cross-sectional study, while social functioning scores did not differ between groups, those meningioma patients who received radiotherapy (*N*=18) had worse role limitations due to physical problems than those who did not receive radiotherapy (*N*=18), although differences did not hold after correction for duration of disease.[16] In a qualitative investigation of 30 patients, seizure-related driving restrictions were found to impact on psychological as well as social wellbeing, with the ability to drive strongly linked to a sense of independence and freedom.[36]

Patients described receiving support from family, partner/caregivers and friends as well as through the internet or message boards designed for brain tumour patients.[12, 19] However, a lack of support is also described, with a mixed methods cross-sectional study reporting that meningioma patients and their family caregivers have missed support with reintegration into society, psychosocial aftercare, and care for partners.[11] In 11 meningioma patients with elevated post-traumatic stress symptoms, many reported unmet support needs related to distress (82%) and fear of tumour recurrence (91%).[19] Feelings of isolation, occurring in 22% of a large sample of long-term meningioma survivors (*N*=190, ≥5 years after intervention), were identified as impacting on work productivity.[7] Meningioma patients of working age were less likely to have a paid job (48%) compared to the general population (72%).[7]

Treatment Impact on HRQOL

Studies included patients who had undergone active treatment for meningioma, as well as those who remained under surveillance post diagnosis. Surgical complications, radiotherapy and re-operation notably contributed to long-term disease burden,[7] although not consistently.[20] Long-term HRQOL outcomes did not seem related to multiple surgical treatments or presence/absence of postoperative complications in a sample of *N*=89 patients with skull base meningioma.[20]

There are indications that those receiving multimodal treatment (surgery and radiotherapy) suffer worse HRQOL outcomes than those who only receive surgery.[16] However, this difference may be explained by other sociodemographic and clinical factors: one study found negative HRQOL scores to be associated with younger age at surgery;[14] another found worse effects of meningioma patients who received radiotherapy (*N*=18) compared to those who did not receive radiotherapy (*N*=18), which disappeared after correction for time since diagnosis.[16] A median of 9 years after treatment, HRQOL scores (pain, vitality) were lower in skull-base meningioma patients who received radiotherapy as the primary treatment (*N*=6), compared to those whose primary treatment was surgery (*N*=63).[20] The impact of radiotherapy on

HRQOL is also unclear in a study of 340 meningioma patients who completed a study-specific HRQOL measure (67% of total sample), with 47% reporting stable HRQOL and 37% reporting improvement in HRQOL following radiotherapy.[17]

Discussion

In this systematic review of 21 publications from 16 studies, we organised issues faced by long-term survivors of meningioma in line with the physical, mental, and social domains of HRQOL.[6] We found that impaired physical functioning was commonly reported, with symptom burden impacting on functioning into long-term survival. This is in line with a previous systematic review, which did not specifically focus on long-term survivorship, found that meningioma patients reported worse physical functioning compared to healthy controls, but better compared to glioma populations.[2] Yet, in our previous systematic review of long-term HRQOL outcomes in patients with WHO grade II or III glioma, we found similar symptom complaints and physical impairments.[28]

Our review highlights the numerous reports of mental impairments of HRQOL. Despite good prognosis, the emotional burden placed on patients at diagnosis is life changing and persists across long-term survival. Prevalence of anxiety and depressive symptoms ranged between 14-50% and 7-87%, respectively[7, 13, 15, 23, 26, 27] – depending on timing of assessment, outcome measure used, and cut-off employed. Previous studies highlight that prior to formal diagnosis of meningioma, mental health seems to be affected – and may in fact be a presenting neurologic sign.[29, 30] Prescription of antiepileptic drugs, antidepressants, and sedatives was comparable to controls two years before surgery for meningioma (*N*=2070), yet is higher in meningioma patients from the point of diagnosis up to two years post-surgery.[31] Our review highlights that mental health issues do not seem to resolve over time, with emotional wellbeing impacted even years after diagnosis.

As this review focused on patient self-report measures, we reported on subjective cognitive complaints rather than results from objective cognitive assessment – which is known to be impaired with approximately 80% of studies finding evidence of cognitive impairment in meningioma patients up to a year after treatment.[32] Cognitive complaints as reported by patients may reflect better the impact of cognitive impairment on everyday life in longer term survivorship, as experienced by patients, as over time patients may adopt compensatory strategies and/or undergo neurorehabilitation. Importantly, in this review we did not focus on family caregiver reports, which can substantially differ from patient self-reports, especially when cognitive impairment results in reduced self-awareness of functioning.[33] Still, patients self-reported that changes in personality/behaviour, difficulties with communication, concentration, processing speed, and decision-making abilities impact on their everyday life. This appeared linked to social functioning, including feelings of isolation, and employment issues. This is in keeping with the results of our review in long-term survivors of WHO grade II/III glioma patients,[28] suggesting that despite the relatively favourable prognosis, meningioma patients still feel substantial disease burden affecting their ability to function in social settings.

The extent to which treatment contributes to HRQOL outcomes in meningioma patients in the long-term, remains uncertain. While a more aggressive treatment strategy, including the use of multimodal treatment, seems linked to worse HRQOL outcomes, it is important to consider that treatment strategies align with expected tumour behaviour and feasibility of anti-tumour treatment depending on e.g., tumour location. In the interpretation of long-term survivorship studies, it is crucial to take into account that treatments do evolve over time, with potentially, fewer or less severe late effects associated with newer treatment regimens. Regardless of treatment, it is reasonable to expect that more aggressive meningiomas and/or those associated with genetic syndromes might lead to higher symptom burden and worse HRQOL. Of note, studies included in this review did not consistently report on seizures or use of anti-epileptic drugs, which tends to be associated with HRQOL.[2] The relationship between treatment and HRQOL remains complex and requires further investigation – ideally from prospective, longitudinal studies, such as the ROAM trial (Radiation versus Observation following surgical resection of Atypical Meningioma; EORTC1308-ROG-BTG).[38]

This systematic review holds strengths in its focus on long-term survival and HRQOL outcomes as assessed through patient self-report – ensuring findings reflect direct perspectives of meningioma patients. Including mixed methodology studies allowed us to identify themes across the quantitative and qualitative findings. Limitations include that evidence to date largely stems from cross-sectional studies; large differences in sample sizes within studies; overrepresentation of some unique study participants due to multiple reports from 16 unique studies; the difficulty in linking clinical/treatment factors to HRQOL aspects; and limited opportunities for cross-study comparisons due to the variety of outcome measures and cut-off scores reported on. Furthermore, patients may have experienced other substantial life stressors contributing to HRQOL impairment throughout the extended period of survivorship, outside of tumour and treatment related factors. Finally, meningioma is not always accompanied by major symptom burden and can go undetected until cerebral imaging is performed for other reasons; hence, patients who take part in research studies may not be representative of the population of patients with meningioma per se. To some extent, these limitations impact on drawing clinically relevant conclusions. Yet, this investigation clearly highlights that even years after diagnosis and treatment, meningioma patients can experience substantial physical, mental, and social HRQOL impact. Greater recognition of long-term HRQOL and disease burden associated with meningioma could aid access to, or development of, support services.

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Figures and Tables

Figure 1: Flow chart of screening process.

Footnote: Abbreviations: TSD: time since diagnosis; HRQOL: health-related quality of life

Figure 2: Narrative synthesis, domains, and key findings

Table 1: Study characteristics

Table 1

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Kangas, Williams and Smee	2011	Benefit finding in adults treated for benign meningioma brain tumour patients: relations with psychosocial wellbeing	4.4 years	Quantitative	Australia	Benign meningioma patient sample (n = 70)	Cross sectional observational	N/A	Investigate the association between BF and demographic and psychosocial variables	- Profile of Mood States Subscales: - - Impact of Event Scale	- -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment

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	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Van der vossen, schepers, van der sprenkel, visser	2014	Cognitive and emotional problems in patients after cerebral meningioma surgery	32.6 months (post-operative)	Quantitative	Netherlands	Patients operated on for a cerebral meningioma (n = 194)	Cross sectional observational	N/A	Determine long-term cognitive complaints an symptoms of depression or anxiety in patients following surgery and related factors	- Cognitive Failures Questionnaire - HADS	- -	-

	Author	**Year**	**Title**	**TSD (years)**	**Methodology**	**Location**	**Sample style (n =)**	**Study Design**	**Controls/Co**	**Study Aims**	**Instrument**	**Clinical**	**Treatment**
	meily, post												
	Najafabadi; van der Meer, Boele, Taphoorn, Klein, Peerdman, van Furth, Dirven	2020	Determinants and predictors for the long-term disease burden of intracranial meningioma patients	10 years since diagnosis	Quantitative	Netherlands	WHO Grade I/II meningioma (n = 190)	Cross sectional observational	N/A	Assess the determinants for long-term disease burden, defined as impaired HRQOL and neurocognitive functioning	- surveys-36	-	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Niewenhu	2007	Differential effect of surgery and radiotherapy on neurocognitive functioning and health-related quality of life in WHO grade I meningioma	Surgery only group: 3 years	Quantita	Netherland	WHO Grade I meningioma (n = 18)	Cross sectional	RT grou	Quantify the effects of conventional RT vs RT+ surgery	- SF-36 - EORTC BN20	-	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	izen, Klein, Stalpers, Leenstra, Heimans, Reijneveld			Surgery + RT: 7.6 years	tive	s		observational	p vs RT + surgery			-	-
	Combs, Adeberg, Dittmar, Welzel, Rieken, Habermehl, Hu	2013	Skull based meningiomas: long-term results and patient self-reported out come in 507 patients treated with fractioned stereotactic radiotherapy	107 months	Quantitative	Germany	Skull base meningioma patients (n = 340)	Cross-sectional observational	N/A	Evaluate long-term toxicity and QOL as a result of fractionated stereotactic radiotherapy or intensity modulated radiotherapy	- Un-validated questionnaire	-	- -

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	ber, Debus												
	Timmer, Seibi-Leven, Wittenstein, Grau, Stravrinou, Rohn, Krishek, Cold	2019	Long-term outcomes and HRQOL of elderly patients after meningioma surgery	3.8 years	Mixed methods	Germany	Meningioma patients who had undergone surgical resection (n = 133)	Cross-sectional observational	N/A	Assess long-term impairments of HRQOL after meningioma resection in different ages	- SF 36	-	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	brunner												
	Zamanipoor, Najafabadi et al	2021	Long-term disease burden survivorship issues after surgery and RT of intracranial meningioma patients	(median 9 years)	Quantitative	Netherlands	Intracranial meningioma patients (n = 190)	Cross-sectional observational	N/A	Assess long-term disease burden in meningioma patients	- SF36 - HADS - EORTC BN20 - SF-HLQ	- - - -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
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	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Nassiri, price, shehab, Au, Cusimano, Jenkinson, Jungk, Mansouri,	2019	Life after surgical resection of a meningioma: a prospective, cross-sectional study evaluating health-related quality of life	37 months (first assessment); 47.5 months (all assessments)	Quantitative	Australia	Grade I intracranial meningioma (n = 181)	Longitudinal observational	Normative population	Evaluate possible determinant of changes in global HRQOL	- EORTC QLQ C30	- -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Santarius, Suppiah, Teng, Toor, Zadeh, Walbert, Drummond, Internatgional consortium and meningioma												

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	s												
	Nassiri, Suppiah, Wang, Badhivala, Juraschua, Meng, Nejad, Au, Willmarth, Cusimana & Zadeh	2020	How to live with a meningioma: experiences, symptoms and challenges reported by patients	3 years (19.4%) 5 years (39.4%)	Quantitative	Canada	Meningioma patients (83%) (n = 1852)	Cross-sectional observational	N/A	Explore the gaps in care of meningioma patients that would improve quality of care by better understanding	- 19 item self-report questionnaire from American Brain Tumour Association	-	- - -

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Najafabadi et al.,	2019	Unmet needs and recommendations to improve meningioma care through patient, partner and health care provider input: a mixed method study	(median) 66 months	Mixed methods	Netherlands	Suspected or confirmed Grade I or II meningioma patients (n = 16)	Cross-sectional observational	N/A	Evaluate the current structure and issues faced by meningioma patients	- Semi structured interviews	-	- -

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Zamanipoor Najafabadi et al.,	2018	The disease burden of meningioma patients: long-term results on work productivity and healthcare consumption	(median) 10 years	Quantitative	Netherlands	Meningioma patients (n = 106)	Cross-sectional observational	N/A	Impact of short and long-term neurological sequalae and HRQOL impairments on work productivity	- SF-HLQ	-	-
	Kangas, Williams, Snee	2012	The association between posttraumatic tress and health related quality of life in adults treated for benign meningioma	4.4 years	Mixed methods	Australian	Meningioma patients previously treated with radiotherapy (n = 70)	Cross sectional observational	N/A	Objective investigate the incidence of MGM-related PTSS in patients who had been diagnosed and treated for primary benign MGM	- Impact of Event Scale Revised - FACT - Profile of Mood States - Semi-structured interviews	- - - -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
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	Baba, McCradden, Rabski,	2019	Determining the unmet needs of patients with intracranial meningioma – a qualitative assessment	10 years	Qualitative	Canada	Patients with intracranial meningioma (n = 50)	Cross sectional observational	N/A	Determine the unmet needs of patient with intracranial meningioma	- Semi-structured interviews	-	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Cusimano												-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Pintea, Kandenwein, Lorenzen, Bostrom, Daker, Ve	2018	Factors of influence upon the SF-36 based HRQOL of patients following surgery for petroclival and lateral posterior surface of pyramid meningiomas	59 months (post-operative)	Quantitative	Germany	Patients operated on for petroclival meningioma or lateral posterior surface of pyramid meningiomas (n = 78)	Cross sectional observational	'Normal' population means	To describe the patient's self-assessed health related quality of life	- SF-36	-	- -

	Author	**Year**	**Title**	**TSD (years)**	**Methodology**	**Location**	**Sample style (n =)**	**Study Design**	**Controls/Co**	**Study Aims**	**Instrument**	**Clinical**	**Treatment**
	lazquez, Kristof												
	Kalascuskas, Kerc, Ajaj van Cube, Ringel, Renovanz	2020	Psychological burden in meningioma patients under a wait-and-watch strategy and after complete resection is high results of a prospective single centre study	39 months	Quantitative	Germany	Meningioma patients under a wait and watch strategy or no neurologic deficits after complete resection (n = 62)	Cross-sectional experimental	N/A	Compare the psychosocial situation of meningioma under a wait and watch strategy to those who had undergone complete resections	- Distress Thermometer - HADS - BFI - SF - 36	- - -	- -

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
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	Tanti, Marsch, Jenkinson	2017	Epilepsy and adverse quality of life in surgically resected meningioma	3.9 years (median, time since surgery)	Quantitative	United Kingdom	Patients who had undergone surgical resection for supratentorial WHO grade I meningioma (n = 229)	Cross-sectional observational	N/A	Comparing HRQOL between MGM patients with and without epilepsy and between epilepsy patients with/without	- FACT-BR - LAEP	- -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	Kalkanis, Quinones-Hinojosa, Buzney, Ribaudo, Blac	2000	Quality of life following surgery for intracranial meningiomas at Brigham and Women's Hospital: a study of 164 patients using a modification of the functional assessment of cancer therapy-brain questionnaire	33 months (mean), 28 months (median)	Qualitative	USA	Patients who had undergone craniotomy for resection of an intracranial meningioma (n = 155)	Cross-sectional observational	N/A	Determine the reported QOL of patient with meningioma that had been surgically treated	Standardised QOL questions modified from the FACT-BR	-	-
	Zamanipoor Najafabadi, van der Meer, Boele, Re	2018	The long-term disease burden of meningioma patients: results on health-related quality of life, cognitive function, anxiety and depression	9.9 years (median)	Quantitative	Netherlands	Intracranial meningioma patients after antitumor therapy (n = 164)	Multi-centre cross-sectional observational	Newly diagnosed glioblastoma patients	Assess the long-term disease burden of meningioma patients	- SF-36 - EORTC QLQ BN20 - HADS	- - -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	ijneveld, Taphoorn, Klein, van Furth, Dirven, Peerdema												
	Pettersson-Segerlind, Fletcher-Sandersjoo, von	2022	Long-Term Follow-Up, Treatment Strategies, Functional Outcome, and Health-Related Quality of Life after Surgery for WHO Grade 2 and 3 Intracranial Meningiomas	13 years (grade II) 1.4 years (grade III)	Mixed methods	Sweden	WHO grade 2 and 3 meningioma patients surgically treated (n = 51 [12-13 patients for the HRQOL measures]; 43 grade 2, 8 grade 3)	Population based, observational, cross sectional cohort study	N/A	Determine the HRQOL of long-term progression free survival and overall survival for WHO grade 2 and 3 intracranial meningiomas	- EQ-5D-3L - FACT-BR - HADS, structured interviews	• •	-

	Author	**Year**	**Title**	**TSD (years)**	**Methodology**	**Location**	**Sample style (n =)**	**Study Design**	**Controls/Co**	**Study Aims**	**Instrument**	**Clinical**	**Treatment**
	Vogelsang, Peresson, Kihlstrom, Linder, Forander, Mathiesen, Edstrom, Elmi-Terander											- -	

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
27	Pettersson-Segerlind, von Vogelsang, Fletcher Sandersjoo, Tatter, Mathiesen, Edstrom, Elmi Tera	2021	Health-Related Quality of Life and Return to Work after Surgery for Spinal Meningioma: A Population-Based Cohort Study	8.7 years (mean)	Quantitative	Sweden	Spinal meningioma surgically treated (n=84)	Population based observational cohort study	General population	Assess the HRQOL and the frequency of return to work in patients surgically treated for spinal meningiomas compared to the general population	- EQ-5D-3DL	- -	-

	Author	Year	Title	TSD (years)	Methodology	Location	Sample style (n =)	Study Design	Controls/Co	Study Aims	Instrument	Clinical	Treatment
	nder												
	Fisher, Najafabadi, van der Meer, Boele, Peerdeman, Peul, Taphoorn, Di	2022	Long-term health related quality of life and neurocognitive functioning after treatment in skull base meningioma patients	9 years (median)	Quantitative	Netherlands	Skull base meningioma (n=89)	Cross-sectional	Convexity meningioma patients and informal caregivers of skull base meningioma patients	Assess the long-term HRQOL and neurocognitive functioning after treatment in the long-term	- SF-36, - EORTC QLQ-BN20	- -	-

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	rven, van Furth												

Abbreviations: BFI: Brief Fatigue Inventory; EORTC QLQ-C30: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire Core 30; EORTC BN20: European Organisation for Research and Treatment of Cancer BN20 Brain Tumour module.; EQ-5D-3L: 3 level version of EQ-5D; FACT: Functional Assessment of Cancer Therapy; FACT-BR: Functional Assessment of Cancer Therapy-Brain; GAD-2: Generalised Anxiety Disorder-2; HADS: Hospital Anxiety and Depression scale; HRQOL: health-related quality of life;

LAEP: Liverpool Adverse Events Profile; N/A: not applicable; PHQ: Patient Health Questionnaire; SF-36: Short Form 36; SF-HLQ: Short form – health and labour questionnaire

WHO: World Health Organisation.

Figure 1

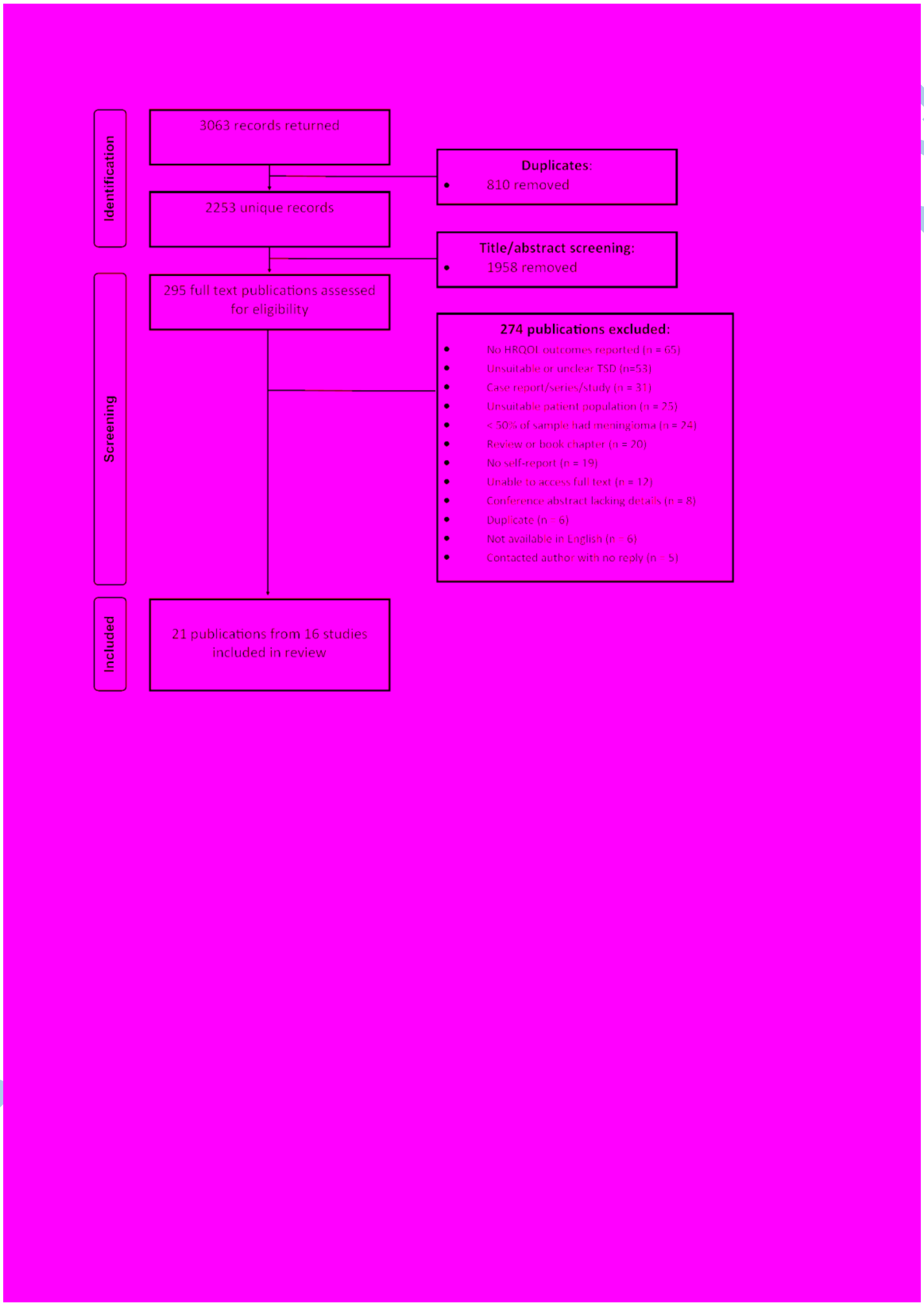
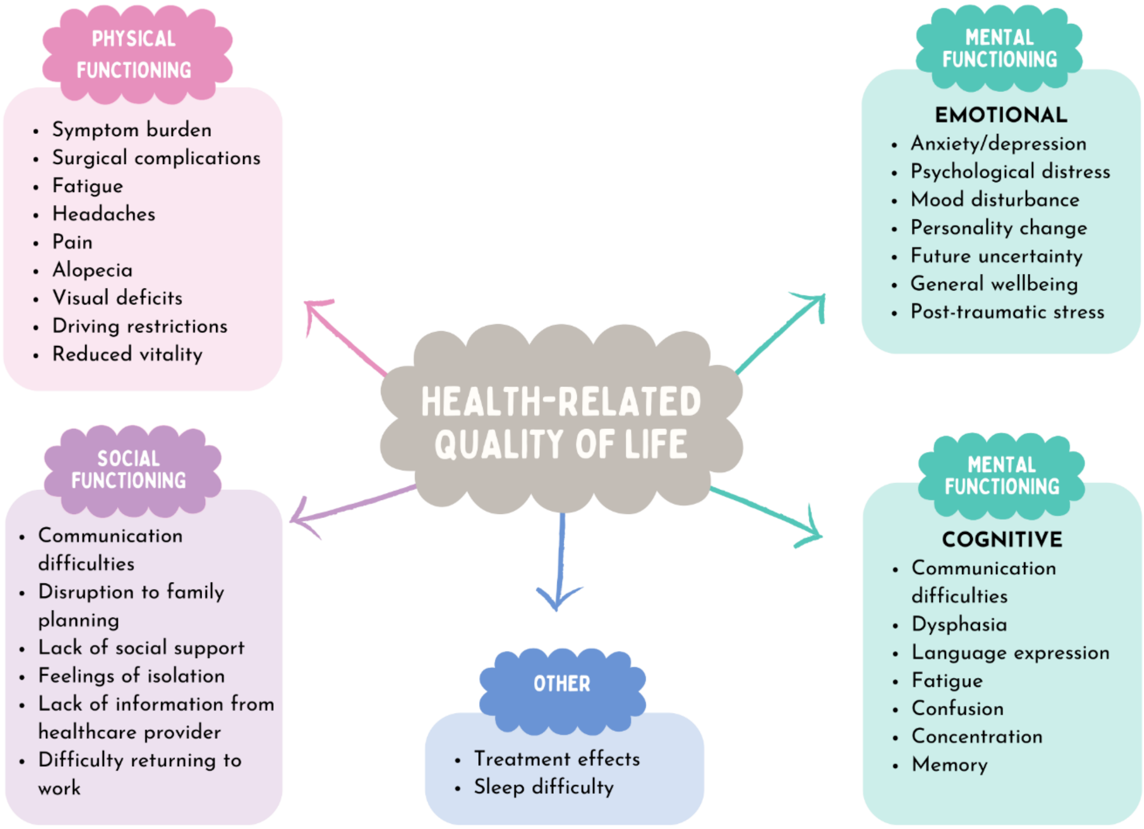

Identification
Screening
Included
3063 records returned
Duplicates:
810 removed
2253 unique records
Title/abstract screening:
1958 removed
295 full text publications assessed for eligibility
274 publications excluded:
No HRQOL outcomes reported (n = 65)
Unsuitable or unclear TSD (n=53)
Case report/series/study (n = 31)
Unsuitable patient population (n = 25)
< 50% of sample had meningioma (n = 24)
Review or book chapter (n = 20)
No self-report (n = 19)
Unable to access full text (n = 12)
Conference abstract lacking details (n = 8)
Duplicate (n = 6)
Not available in English (n = 6)
Contacted author with no reply (n = 5)
21 publications from 16 studies included in review

Figure 2


HEALTH-RELATED QUALITY OF LIFE
PHYSICAL FUNCTIONING
Symptom burden
Surgical complications
Fatigue
Headaches
Pain
Alopecia
Visual deficits
Driving restrictions
Reduced vitality
SOCIAL FUNCTIONING
Communication difficulties
Disruption to family planning
Lack of social support
Feelings of isolation
Lack of information from healthcare provider
Difficulty returning to work
OTHER
Treatment effects
Sleep difficulty
MENTAL FUNCTIONING
EMOTIONAL
Anxiety/depression
Psychological distress
Mood disturbance
Personality change
Future uncertainty
General wellbeing
Post-traumatic stress
MENTAL FUNCTIONING
COGNITIVE
Communication difficulties
Dysphasia
Language expression
Fatigue
Confusion
Concentration
Memory