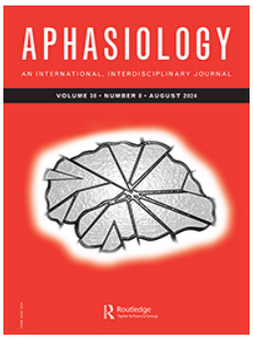

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Impact of subjective and objective language function and psychological distress on quality of life in glioma patients awaiting surgery

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ABSTRACT

Background: Maintaining quality of life (QoL) and identifying contributing factors is an important aspect of treatment for glioma patients. Little is known about to what extent language function and psychological distress impact QoL before surgery.

Aims: The aim of the present study was to investigate the impact of subjective and objective language function, as well as psychological distress on domains of QoL before surgery.

Methods and procedures: Twenty-seven patients (52% female) with a suspected glioma, grade 1–3 based on symptoms and MRI imaging diagnostics were assessed pre-surgery. Subjective language concerns, psychological distress and QoL were investigated with self-reported questionnaires. A Subjective language index was calculated, based on items addressing word-finding, expression of thoughts, reading and writing. Objective language function was assessed with tasks of naming (The Boston Naming Test), verbal comprehension (Vocabulary and Similarities), verbal fluency (Semantic and Phonemic fluency) and verbal short-term and working memory (Digit span forward and backward). The strength of associations was determined using Spearman's rho correlations. Linear regression analyses were used to examine predictors for QoL.

Outcomes and Results: Clinically significant reductions in QoL were found in 48% of the sample. Subjective language concerns were highly common, with 85% reporting some degree of difficulty. Group means on objective language tests were within normative range on the included measures. The Subjective language index correlated significantly with several QoL domains, whereas

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objective performance mainly correlated with functional well-being. Psychological distress was a strong predictor for QoL.
Conclusions: The findings demonstrate that reductions in QoL may occur during the diagnostic phase, even before glioma treatment starts. Subjective language concerns and psychological distress contributed to all aspects of QoL and highlight the importance of acknowledging patient-reported information. The results suggest a comprehensive multi-modal assessment of glioma patients pre-surgery, to establish a base-line and facilitate patient-centered treatment planning.

Introduction

Gliomas are the most frequent type of primary brain tumors, often located in eloquent areas of the brain (Duffau, 2005). These tumors are not curative, but advances in surgical and adjuvant treatment have improved life expectancy substantially (Allemani et al., 2018). Patients are nevertheless at risk of neurological and neurocognitive impairments due to infiltrative tumor growth and the side-effects of treatment (Ownsworth et al., 2009; Taphoorn et al., 2010).

Already during the diagnostic process, patients are confronted with uncertainty about disease progression and ability to maintain responsibilities such as family roles, social and occupational activities. This contributes to elevated levels of psychological distress and reduced quality of life (QoL; Noll et al., 2017). QoL metrics are commonly based on the domains of physical, social, emotional, and functional well-being (Gabel et al., 2019). A recent study showed that 80% of glioma patients value maintaining QoL over survival when decisions about treatment are made at the time of diagnosis (Gabel et al., 2019). A patient-centered approach to treatment planning should therefore aim to find the optimal onco-functional balance, i.e., to preserve QoL whilst maximizing the extent of tumor resection (Duffau & Mandonnet, 2013).

Language impairment has been reported in approximately 10–35% of glioma patients before surgery (Antonsson et al., 2018; Bello et al., 2007; Duffau et al., 2008; Sanai et al., 2008). The variation in numbers may be due to differences in patient selection and assessment methods. Glioma patients are a heterogeneous group with a complex symptom burden and many factors (e.g., tumor grade, location and recurrence) can impact language function (Röttgering et al., 2023). Some authors have suggested that the occurrence of language disturbance is higher when subtle difficulties are accounted for. Subtle difficulties are possibly not detected on standardized language batteries, as they were developed to classify patients within traditional frameworks of aphasia (Brownsett et al., 2019; Papagno et al., 2012). To assess subtle difficulties wide-range and sensitive language tasks have been recommended (Papagno et al., 2012). Yet, there is still no consensus on which tasks should be used pre-surgery or what aspects of language should be addressed (O'Neill et al., 2020; De Witte & Marien, 2013). It is well documented that aphasia is associated with reduced QoL (Santini et al., 2012; Veretennikoff et al., 2017), but less is known about the impact of subtle language problems. Further, patients with

communication difficulties are often excluded from QoL research, which limits understanding of how language function relates to QoL in glioma patients (Rimmer et al., 2023).

Worsening of language and communication abilities is one of the most prominent concerns in glioma patients during the diagnostic process (Gabel et al., 2019; Pranckeviciene et al., 2017; Racine et al., 2015). Before treatment, up to 60% of patients report word-finding difficulties (Moojiman et al., 2021; Pranckeviciene et al., 2017; Racine et al., 2015). Other subjective language concerns may exist but have hardly been addressed so far. Pranckeviciene et al. (2017) reported subjective problems with writing (31%), expression of thoughts (29%) and reading (21%) in their sample. Their study did not investigate relationships with QoL. Umezaki et al. (2020) found that subjective communication difficulties were related to reduced general and social well-being in over 50% of their sample. Studies on other patient populations demonstrate that even mild language concerns can affect social relationships and return to work (Cavanaugh & Haley, 2020; Fama et al., 2022).

Occurrence of subjective concerns does not always correspond with results from objective assessment (Gehring et al., 2015; Moojiman et al., 2021; Påhlson et al., 2003). Therefore, language assessment should not only include objective tests but also subjective measures as they can indicate functionally disruptive changes and may independently relate to reductions in QoL (Lycke et al., 2019; Nicol et al., 2019).

Psychological distress is highly common in glioma patients, even before treatment onset (Pranckeviciene et al., 2017; Noll et al., 2017). The diagnosis of a life-threatening disease and the upcoming surgery can have considerable impact on mental well-being and ability to cope (Moreale et al., 2017; Singer et al., 2009). Screening for psychological distress may identify patients that are in need of support and further treatment, resulting in better overall QoL (Lycke et al., 2019).

In this study, we aim to investigate how QoL is associated with subjective language concerns, objective language function and psychological distress in glioma patients, as few empirical studies have examined these relationships before treatment onset. Even though language and communication are involved in almost every aspect of daily life, language is commonly only addressed briefly as part of a wider neurocognitive assessment. We wish to investigate subjective and objective language functioning explicitly to find a better understanding of how these variables impact the domains of physical, social, emotional, and functional well-being. The results may help clinicians identify support care needs and aid treatment planning.

Methods

Study design

The current study is a small-scale cross-sectional study, embedded in a prospective longitudinal study on glioma patients.

Recruitment procedure and inclusion criteria

In a period of 34 months, all consecutive patients with a suspected glioma grade 1–3, based on symptoms and MRI imaging diagnostics, referred to the Department of

Table 1. Demographic and clinical characteristics of the sample.

	n= 27
Sex, female	14 (52%)
Age, years^	42.9 (14.4)
Education, years^	14.8 (2.9)
Seizures˘	16 (59%)
Handedness, right	24 (89%)
Localization	
Left hemisphere	20 (74%)
Language eloquent area*	9 (45%)
Language non-eloquent area	11 (55%)
Right hemisphere	6 (22%)
Bilateral	1 (4%)
Frontal*	11(40%)
Temporal	6 (22%)
Parietal*	1 (4%)
Limbic cortex	4 (15%)
Parietooccipital	1 (4%)
Temporoparietal	2 (7%)
Frontoparietal	1 (4%)
Frontotemporal	1 (4%)
Histopathology	
LGG	15 (56%)
Grade 1	
Ganglioglioma	1
Not definable	1
Grade 2	
Astrocytoma	5
Oligodendroglioma	4
Not definable	4
HGG	12 (44%)
Grade 3	
Anaplastic astrocytoma	3
Anaplastic oligodendroglioma	9

^Mean (*SD*), ˘All patients with seizures had started taking anti-epileptic medication at the time of assessment *One patient with bilateral tumors. Seizure history, histological diagnosis and tumor characteristics were registered from medical journals

Neurology or the Department of Neurosurgery, Haukeland University Hospital, Norway, were considered for participation. Patients were included regardless of hemispheric tumor localization, as studies show that language difficulties may be detected in glioma patients with tumors outside language eloquent areas of the left hemisphere (Satoer et al., 2014; Yordanova et al., 2011) and by patients with tumors in the right hemisphere (Thomson et al., 1998; Vilasboas et al., 2017; De Witte et al., 2015). Non-native speakers of Norwegian were carefully considered for participation and included if they spoke the language fluently and Norwegian was their first language in everyday life. Exclusion criteria were severe psychiatric disorders, alcohol or substance abuse, a histologically confirmed glioblastoma, prior record of neurological disease and non-fluent Norwegian language. Demographic characteristics, seizure history, histological diagnosis and tumor characteristics were registered from medical journals (Table 1).

Participants

The sample consisted of 41 patients. Fourteen patients were excluded from the study group. This was due to a histologically confirmed non-neoplastic lesion (N = 2) or glioblastoma (N = 5), poor Norwegian language skills (N = 2) and missing data on questionnaires (N = 5). This left 27 patients in the sample of the current study. Fourteen patients (52%) were women, the mean age (years) was 42.9 (*SD* 14.4) and the mean length of education (years) was 14.8 (*SD* 2.9). Histological diagnosis after surgery revealed low-grade glioma (LGG) in 15 patients (grade 1, n = 2, grade 2, n = 13) and high-grade glioma (HGG) in 12 patients (grade 3, n = 12). Tumor location was determined by a neuroradiologist using FLAIR images. T1-weighted and T2-weighted images were read when FLAIR images were unequivocal. A gyrus was regarded affected if any part (either in the cortical gray matter or in the juxta- or subcortical white matter) showed increased signal intensity on FLAIR images compared to the normal appearing brain. Tumors in the left hemisphere were categorized as follows: (a) language eloquent areas (inferior frontal gyrus, subcentral gyrus, supramarginal gyrus, angular gyrus, inferior, middle and superior temporal gyrus), (b) non-language eloquent areas (precentral, middle and superior frontal gyrus, with no involvement of the inferior frontal gyrus; Naidich et al., 2001). Twenty patients had a tumor in the left hemisphere, 9 of these had a lesion within language-eloquent areas and 11 had a lesion outside language-eloquent areas. Six patients had tumors in the right hemisphere, with an equal number of three with tumors within and outside homologue language-eloquent areas in the right hemisphere. One patient had bilateral tumors (involving language eloquent areas). Left-hemispheric language lateralization was determined with fMRI assessment in 23 patients. The remaining four patients were right-handed, three had tumors outside language eloquent areas of the left hemisphere and one had a tumor in the right hemisphere. In these cases, the clinical judgment of the operating surgeon suggested left hemispheric dominance. Two included patients were non-native speakers of Norwegian. Their language abilities were regarded sufficient according to the inclusion criteria.

The study was approved by the Regional Committee for Medical Research Ethics (REK West, #2018/345) and conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013). All patients provided written informed consent to participate.

Materials

All patients were tested by the first author (EO) a speech language pathologist or the last author (EW) a neuropsychologist. The median interval between assessment and surgery was eight days (*range* 1–43 days).

Assessment of QoL

QoL was assessed with the Functional Assessment of Cancer Therapy – General (FACT-G) version 4 (Cella et al., 1993). The questionnaire includes the following subscales: physical well-being (7 items, maximum score 28), social well-being (7 items, maximum score 28), emotional well-being (6 items, maximum score 24) and functional well-being (7 items, maximum score 28). A total score is also calculated measuring general well-being

(maximum score 108). The patients were asked to rate their current state over the past seven days. Each item was rated using a five-point Likert scale ranging from 0 (not at all) to 4 (very much). Higher scores indicate better QoL on all scales. A clinically significant reduction in QoL was calculated based on recommendation that differences are to be regarded as clinically important when they fall at least 0.5 standard deviations (*SD*) below group means of a reference group (Revicki et al., 2008). In the current study normative values of Brucker et al. (2005) were used.

Assessment of subjective language concerns

Four items addressing language function from the Brain cancer subscale of The Functional Assessment of Cancer Therapy – Brain (FACT-Br; Weitzner et al., 1995) were chosen for the current study. These items were: "*I am able to find the right word(s) to say what I mean*", "*I have difficulty expressing my thoughts*", "*I am able to read like I used to*", and "*I am able to write like I used to*". Rating scales were the same as described above for the FACT-G. For the current analysis a score of 0–1 was regarded as serious concerns, 2 as moderate concerns, 3 as mild concerns and 4 as no concerns. Item scores were reversed where indicated, and scores of the four items were summed up in line with previous work of Zarrella et al. (2021) forming the Subjective language index (maximum score 16). Cronbach's alpha for the four items included in the Subjective language index was 0.7. Higher scores indicate less concerns on individual items as well as on the Subjective language index.

Assessment of objective language function

Neuropsychological tests were used to measure various aspects of verbal function and language skills, including measures of naming and word retrieval, ability to produce fluent speech and integrity of the language system (Lezak et al., 2012). Performance scores on a confrontation naming test (Boston Naming Test, BNT; Kaplan et al., 1983), a test of lexical knowledge (Vocabulary; Wechsler, 2008), a verbal concept formation test (Similarities; Wechsler, 2008), phonemic and semantic fluency (Verbal Fluency; Delis et al., 2001), and verbal short-term and working memory (Digit Span forward and backward, Digit Span Test; Wechsler, 2008) were included.

Assessment of psychological distress

Self-reported symptoms of anxiety and depression were assessed by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). The HADS is a screening instrument consisting of one subscale for anxiety (HADS-A) and one for depression (HADS-D). Each subscale contains seven items, summing up to scores between 0–21 for each scale, with higher scores indicating more self-reported symptoms of anxiety or depression.

Statistical analysis

Descriptive statistics were applied to characterize the sample. The data was visually explored and analysed with the Shapiro-Wilk test of normality. To analyze performance on language tests, raw scores were transformed into T-scores with a mean of 50 and a *SD*

of 10 according to normative data from the respective test manuals. For the BNT, the normative scores of Tallberg (2005) were applied. Deviant performance was defined as a score below 2.0 *SD* on at least one test or a score below 1.5 *SD* on at least two tests, to avoid a deviation by chance (Lezak et al., 2012). Since each language test provides individual scores, it was necessary to combine groups of related scores into composite measures. T-scores belonging to the same domain were averaged. In doing so, we relied on the domain-pertinence of each variable as established by the original test construction and validation. This approach was likely to be more adequate than using other combinations of scores that depended on empirical correlation structure of scores in our specific sample. In the present study, we chose generic terms to label the merged scores which may deviate from other studies. For *verbal comprehension*, T-scores from the Vocabulary test and Similarities were combined. For *verbal fluency*, T-scores of the subtests of Phonemic and Semantic fluency tests were combined. To yield a composite measure for *verbal working memory*, the T-scores of Digit span forward and Digit span backward were combined. The BNT score was the only measure of *naming*. Spearman's rho correlations were run to investigate associations between FACT-G subscales and the Subjective language index, composite scores of objective language function, and HADS scores. Finally, separate multiple linear regressions were performed to identify variables predicting scores for each FACT-G subscale. Due to the small sample size, a maximum of three variables were included as predictors of each FACT-G scale. Variables that showed significant correlations with the FACT-G scales were considered as predictors. Since the general well-being and functional well-being scales correlated significantly with several of the objective language variables and multicollinearity testing indicated high collinearity between the objective language variables, only the variable with the strongest correlation with the respective FACT-G scale was chosen for the final model. Predictor variables were entered simultaneously in the final regression models. An alpha-level was set at $p < .05$. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY; IBM Corp was used for all analyses.

Results

Quality of life

Scores on the FACT-G and subscales are displayed in Table 2. Clinically significant reductions were seen in general (36%), physical (44%), social (7%) emotional (48%) and functional well-being (24%).

Subjective language concerns

Eighty-five percent of the patients reported one or more language concerns. Word-finding difficulties were most frequently reported (74%), followed by concerns about reading (67%), expression of thoughts (63%) and writing (58%). Out of the individual response categories *no concerns* and *mild concerns* were most frequently reported. Only few patients reported *serious concerns* (Figure 1). Mean scores for individual subjective language items and the Subjective language index are presented in Table 2.

Table 2. Ratings on subjective measures of QoL, language concerns and psychological distress and performance scores on objective language tests.

Test/measure	*n*	*M* (*SD*)	Max.	
QoL				Normative scores*
General well-being	25	81.1 (12.5)	108	80.1 (18.1)
Physical well-being	27	22.0 (5.1)	28	22.7 (5.4)
Social well-being	27	22.6 (4.0)	28	19.1 (6.8)
Emotional well-being	25	16.8 (4.3)	26	19.9 (4.8)
Functional well-being	25	19.3 (5.1)	28	18.5 (6.8)
Subjective concerns				
I can find the right word(s) to say what I mean	27	2.7 (1.0)	4	
I am able to express my thoughts	27	3.0 (1.0)	4	
I can read as before	27	2.7 (1.1)	4	
I can write as before	27	3.3 (0.7)	4	
Subjective language index	27	11.7 (2.9)	16	
Objective tests		Raw scores		T scores
Naming				
Boston Naming Test	26	50.4 (6.3)	60	43.7 (15.1)
Verbal comprehension	27			50.0 (8.5)
Vocabulary	27	56.2 (8.3)	80	48.8 (8.6)
Similarities	27	22 (4.7)	36	51.2 (10.0)
Verbal fluency	27			53.6 (10.4)
Phonemic fluency	27	37.9 (11.9)	^	50.2 (11.8)
Semantic fluency	27	43.6 (9.5)	^	56.9 (12.9)
Verbal working memory	27			47.5 (7.7)
Digit Span forward	27	8.7 (2)	16	48.0 (10.0)
Digit Span backwards	27	7.6 (1.9)	16	47.0 (8.7)
Psychological distress				
HADS-A	26	6 (3.3)	21	
HADS-D	26	3.1 (2.5)	21	
HADS total	26	9.2 (5.2)	42	

QoL: quality of life, *M*: mean, *SD*: standard deviation, BNT: Boston Naming Test, HADS-A: Hospital Anxiety and Depression Scale – Anxiety, HADS-D: Hospital Anxiety and Depression Scale –Depression, ^Produced words per minute, *Normative values according to Brucker et al. (2005).

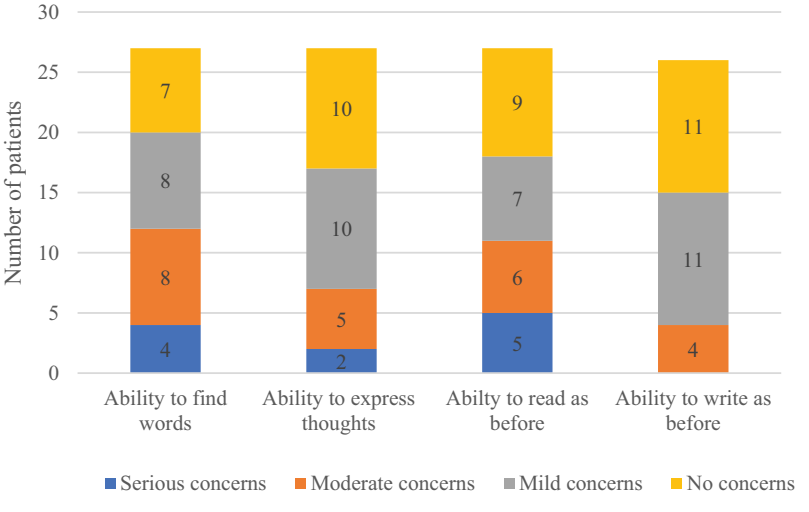

Figure 1. Number of patients expressing language concerns on individual items comprised in the Subjective language index.

Table 3. Individual patient scores on objective tests and number of subjective language concerns.

	Sex/Age/ Edu	Hand	Tumor grade	BNT	Voc	Sim	SF	PF	Dig-fw	Dig-bw	Number of concerns
LH: Language eloquent areas	M/21/12	R	1	**16**	**33**	43	50	**30**	37	40	4
	M/29/12	R	2	–	**25**	**33**	47	43	40	57	4
	F/47/14	R	3	38	39	50	43	43	40	47	4
	F/49/16	R	3	**33**	46	57	50	50	53	57	2
	F/27/18	R	2	55	47	50	67	77	37	50	3
	F/64/17	R	2	45	60	70	77	63	57	53	1
	F/41/16	R	3	52	50	**33**	63	40	37	43	3
	M/33/16	R	2	**7**	48	53	**33**	40	40	**33**	2
	F/29/19*	R	2	45	54	60	70	47	47	53	4
	M/63/9	R	2	48	45	53	53	**27**	**30**	**33**	4
LH: Language non-eloquent areas	F/24/16	L	3	**33**	48	53	57	47	43	**30**	4
	M/48/13	R	2	55	56	47	43	40	57	63	0
	F/53/13	R	3	52	49	57	47	50	57	47	4
	M/42/18	R	2	64	54	50	43	57	47	50	3
	M/57/12	L	1	**16**	41	**33**	70	57	43	50	1
	M/49/12	R	3	43	42	43	50	53	60	50	4
	F/66/12	R	2	36	49	47	63	57	43	43	2
	F/21/15	R	3	**21**	44	53	53	40	37	43	4
	F/47/18	R	3	48	57	60	30	63	57	57	0
	M/46/16	L	2	48	46	43	60	50	47	**33**	2
	F/55/14	R	3	52	54	43	70	50	47	47	4
Right hemisphere	M/48/10	R	2	40	45	47	67	43	53	53	4
	M/35/12	R	3	62	59	67	77	73	73	53	0
	F/36/16^	R	3	57	46	57	80	67	60	43	0
	M/70/19^	R	2	60	59	47	57	47	53	50	2
	F/33/19^	R	3	60	57	67	57	47	60	**33**	1
	M/24/14	R	3	52	64	67	60	57	43	57	4

LH: left hemisphere, M: male, F: female, R: right, L: left, Edu: education, Hand: handedness, BNT: Boston Naming Test, Voc: Vocabulary, Sim: Similarities, SF: Semantic fluency, PF: Phonemic fluency, Dig-fw: Digit span forward, Dig-bw: Digit span backward, M: male, F: female, R: right, L: left, *bilateral tumors, ^ tumor involved homologue language-eloquent areas in the right hemisphere, –: missing data, All scores are T-scores ($M = 50$, $SD = 10$), Performance below 1.5 *SD* is marked in bold. Deviant performance is defined as a score < 30 (- 2.0 *SD*) on at least one test, or a score < 35 (- 1.5 *SD*) on at least two tests.

Objective language function

Performance on objective language tests revealed group means slightly below or above average based on peer-normative data (Table 2). A total of 7 out of the 27 patients (26%) included in the sample demonstrated deviant performance on objective tests. Patients who performed below cut-off were found in both groups of patients with left-hemisphere tumors. When the tumor was found within language eloquent areas 40% (4/10) showed deviant performance. When the tumor was outside language eloquent areas 27% (3/11) showed deviant performance. All patients with tumors in the right hemisphere performed above cut-off (Table 3).

Psychological distress

Mean scores for the HADS total were 9.2 (*SD* 5.2). For HADS-A the mean scores were 6 (*SD* 3.3) and for HADS-D the mean scores were 3.1 (*SD* 2.5).

Table 4. Spearman`s rho correlation coefficients demonstrating associations between subscales of QoL and subjective language concerns, objective tests and psychological distress.

Measure	General well-being	Physical well-being	Social well-being	Emotional well-being	Functional well-being
Subjective concerns					
Subjective language index	**.63****	**.44***	.36	.33	**.77****
Objective tests					
Naming	**.47***	.21	.33	.18	**.59****
Verbal comprehension	**.45***	**.47***	.13	.22	**.60****
Verbal fluency	.30	.23	.17	.10	.23
Verbal working memory	.18	.10	.17	.10	**.47***
Psychological distress					
HADS-A	**−.60****	−.31	−.35	**−.58****	−.36
HADS-D	**−.84****	**−.75****	**−.42***	**−.44***	**−.74****
HADS total	**−.79***	**−.59****	**−.40***	**−.58****	**−.58****

*$p < 0.05$; **$p < 0.01$; HADS-A: Hospital Anxiety and Depression Scale – Anxiety; HADS-D: Hospital Anxiety and Depression Scale – Depression

Associations between the Subjective language index and QoL

Results of Spearman's rho correlation analyses are displayed in Table 4. Significant positive correlations were found between the Subjective language index and general well-being (r(22) = .63, p = .001), physical well-being (r(24) = .44, p = .024) and functional well-being (r(22) = .77, p = .001). The results indicate that higher scores on the Subjective language index (less concerns) correlated with higher QoL.

Associations between objective language function and QoL

Significant positive correlations were found between *naming* and general (r(22) = .47, p = .019) and functional well-being (r(22) = .59, p = .002). Performance scores on verbal comprehension correlated positively with general, physical and functional well-being (r (25) = 45, p = .023; r(25) = .47, p = .015; r(25) = .60, p = .002, respectively). Verbal fluency did not correlate significantly with any of the QoL scales. Verbal working memory correlated with functional well-being (r(23) = .47, p = .018). The results indicate that higher scores (better performance) on objective tests correlated with higher QoL (Table 4).

Associations between psychological distress and QoL

The HADS-A showed significant negative correlations with general well-being (r(22) = .60, p = .002) and emotional well-being (r(22) = .58, p = .003). The HADS-D and the HADS total showed significant negative correlations with all subscales of the FACT-G (all r(22) > .42, all p < .033; all r(22) > .40, all p < .041, respectively). The results indicate that lower rating on the HADS (less symptoms of psychological distress) correlated with higher QoL (Table 4).

Predictors of QOL

Results of regression analyses are summarized in Table 5. The regression model for general well-being was statistically significant (R^2 = 0.60, F(3, 18), p < .001) with the

Table 5. Linear regression analyses reporting predictors of subscales of QoL.

	R^2	B	SE_B	ß	t
General well-being					
Constant	0.60	78.24	11.19		7
Subjective language index		1.13	0.74	0.26	1.53
Naming		0.05	0.13	0.67	0.44
HADS total		−1.41	0.39	−0.61	**−3.71****
Physical well-being					
Constant	0.32	16	6.52		2.5
Subjective language index		0.78	0.37	0.45	0.21
Verbal comprehension		0.18	0.10	0.33	1.77
HADS total		−0.40	0.19	−0.44	**−2.17***
Social well-being		no significant predictors			
Emotional well-being					
Constant	0.27	20.73	1.52		13.69
HADS total		−0.45	0.15	−0.55	**−3.08****
Functional well-being					
Constant	0.59	4.53	5.52		0.82
Subjective language index		0.99	0.31	0.56	**3.25****
Verbal comprehension		0.11	0.09	0.18	1.19
HADS total		−0.23	0.16	−0.24	−1.46

*$p < 0.05$; **$p < 0.01$; HADS: Hospital Anxiety and Depression Scale, *SE_B*: Standard Error of beta (*B*)

HADS total as a significant predictor (ß = −0.61, p = .002). Regression models for the individual subscales became significant for physical well-being (R^2 = 0.32, F(3, 21), p < .011) with the HADS total as a significant predictor (ß = −0.44, p = .041) and emotional well-being (R^2 = 0.27, F(1, 22), p < .005) with the HADS total as a significant predictor (ß = −0.55, p = .005). For functional well-being the regression was significant (R^2 = 0.59, F (3, 19), p < .001) with the Subjective language index (ß = 0.56, p = .004) as the only significant predictor.

Discussion

The current study aimed to investige to what extent QoL in glioma patients is associated with subjective language concerns, objective language function and psychological distress before surgery. QoL was significantly reduced in a considerable proportion of patients. Subjective language concerns were highly common and showed significant associations with several domains of QoL, whereas objective language performance mainly correlated with functional well-being. Psychological distress was a strong predictor of QoL.

Our results indicate that reductions in QoL occur pre-surgery, in particular in the domains of emotional (e.g., sadness, coping, fear of progression in the disease), physical (e.g., pain, nausea, lack of enery), and functional (e.g., occupation and satisfaction in daily living) well-being. Reductions in emotional well-being were the highest, in line with earlier findings (Noll et al., 2017). This was expected as thoughts of the upcoming surgery might have induced unsettling feelings and future uncertainty. Results on the HADS confirmed higher symptoms of anxiety than depression, a pattern often found in glioma patients at the time of diagnosis (Pranckeviciene et al., 2017; Noll et al., 2017). Previous studies have documented that one third of all cancer patients experience elevated symptoms of psychological distress associated with diagnosis (Carlson et al., 2004).

Psychosocial treatments have shown to decrease symptoms of psychological distress and improve QoL (Carlson & Bultz, 2003; Cunningham, 2000). Furthermore, it has been suggested that psychoeducation may be an effective method during the diagnostic process, when the need for information is high (Carlson et al., 2004). Our results support a patient-centered approach, that recognizes symptoms of psychological distress, as these seem to persist if not treated (D'Angelo et al., 2008) and are independently related to reduced survival time (Mainio et al., 2006; Noll et al., 2014).

Our study showed that a large proportion of patients expressed concerns about various language functions. Word-finding difficulties were the most common concern in the sample, with 75% of the patients reporting some degree of difficulty. Earlier studies have described subjective word-finding difficulties in 57–63% of patients before surgery (Moojiman et al., 2021; Pranckeviciene et al., 2017; Racine et al., 2015; Satoer et al., 2012). Additionally, we found that more than half of the patients reported concerns about expression of thoughts, reading and writing abilities. Pranckeviciene et al. (2017) investigated similar items and found considerably lower occurance of difficulties. An explanation for this difference may be that answers in our study were based on a 5-point Likert-type scale while Prankevicience et al. used a dichotomized answer format. Ordinal scales may be better fitted to capture the magnitude of concerns. This is supported by the observation that for all items, answers were distributed between response categories. Yet, we acknowledge that patients often avoid extreme response categories, potentially causing central tendency bias, a known weakness of Likert-type scales (Taherdoost, 2019). Despite differences in answer formats, the findings recommed that to meet patients' concerns, clinicians should not solely address word-finding difficulties. Other aspects of language may be of importance. For example, reading and writing are essential for communication and social engagement through smartphones and the internet.

We found subjective language concerns associated with several domains of QoL. Positive correlations were found between the Subjective language index and general, physical, and functional well-being. The results implicate that less concerns about language abilities were related to higher QoL. The Subjective language index was the only significant predictor for functional well-being. Questions on this subscale address aspects of independence and occupational abilities. It has previously been reported that approximately 60% of glioma patients cannot perform work-related activities after treatment due to various cognitive concerns (Gosselt et al., 2021). Furthermore, brain tumor patients have the lowest return to work rate after treatment among cancer patients (Liaset & Kvam, 2018). Our results underline the importance of both subjective and objective language for functional well-being, and support the findings of Ammanuel et al. (2021) who demonstrated a relation between natural language (e.g., lower speech rate) in glioma patients and functional domains of QoL.

The objective language assessment demonstrated group averages within normative range on all tests. Overall, objective language difficulties were mild with only a limited number of patients preforming below cut-off level on at least one test. The patients with tumors within language eloquent areas in the left hemisphere seemed to have the lowest scores on the language measures compared to patients with tumors outside language eloquent areas in the left hemisphere and patients with right-sided tumors. However, our small sample size did not allow for statistical group comparisons.

We observed that patients from all groups reported subjective language concerns. A common finding in earlier studies is that patients report worse language function than test results indicate (Moojiman et al., 2021; Racine et al., 2015; Satoer et al., 2012). On the one hand, this could suggest that objective tests have insuffisient sensitivity to detect subtle language difficulties. On the other hand, patients may be in need of reassurance, as studies have shown that subjective concerns are often induced by psychological distress (Gehring et al., 2015; Nicol et al., 2019). Clinicians should provide careful feed-back and explanations about objective findings, as that can lessen distress and help the patients to understand themselves. Unfortunately, the patients' need for information and reassurance is often overlooked (Lezak et al., 2012). In a recent survey administered in the United Kingdom amongst speech-language pathologists working in neurosurgical departments, only 30% believed that the concerns of each patient were identified and addressed in the pre-surgery stage (O'Neill et al., 2020).

To secure suitable assessment and subsequent follow-up of language difficulties in glioma patients there seems a need for greater involvement of speech-language pathologists in multidisciplinary teams from the start of treatment (Manso-Ortega et al., 2022). Our results support that both subjective and objective assessment should be part of the evaluation of language function (Påhlson et al., 2003; Papagno et al., 2012). Yet, we highlight that glioma patients often undergo extensive testing. Minimizing the response burden should therefore be given careful thought. Addressing subjective language concerns, either with a questionnaire or semi-structured interviews can provide indications about aspects of language function that are important to the patient in everyday life and need further inquiry. Considering the heterogeneity in clinical and personal characteristics of the patient group, it seems unfeasible to develop universal assessment and treatment procedures (Manso-Ortega et al., 2022). Approaches should rather be individualized and targeted to improve personal well-being.

We acknowledge the limitations of our study. First, the small sample size limited our possibilities to generalize the findings, and to include further predictors in the analyses. We argue that there is still value in our data, as studies on QoL before surgery are scarce and associations between QoL and language function have rarely been the focus of prior studies. Secondly, we addressed subjective language concerns beyond word-finding difficulties, but the number of items was limited. We acknowledge that communicative QoL was not assessed with specifically designed questionnaires. The use of multi-item scales could address concerns in more detail. Yet, we argue that our study demonstrates that using items from a QoL scale can provide valuable indications about subjective language functioning. Thirdly, clinically meaningful reductions in QoL were defined as scores that fell at least 0.5 *SD* below group means of a reference sample. We recognize that setting the cut-off so close to the mean may present a risk of over-interpretation of slightly reduced scores which could also occur in the normal population. We highlight that the patients in our sample were mostly young with no prior neurological disease and that even minimal reductions in QoL may indicate a change that should be addressed to ensure patient-centered care. At last, glioma patients often suffer from multiple symptoms simultaneously, including fatigue, cognitive impairment, pain and seizures (Röttgering et al., 2023). These symptoms may have been interrelated with the variables investigated in our study. It was not within the scope of this study to address other

contributing factors, yet we acknowledge that they may have had an impact on our results.

Unanswered questions and future research

Subjective and objective language skills, psychological distress and QoL in glioma patients at a single point in time before surgical resection were addressed in this study. The relationships between these variables will most likely change dynamically as the patients move further in the course of disease (Sagberg et al., 2016). Longitudinal studies are needed to examine the effect of surgery and adjuvant therapy on subjective and objective language functions and psychological distress and how possible changes in functioning contribute to QoL.

Conclusion

This study demonstrated that pre-surgery objective language performance was within normal range in most patients but subjective concerns about language were frequent in the sample. Further, the study indicates that QoL, especially emotional, physical, and functional well-being, may be reduced in glioma patients even before surgery. Subjective concerns about language function showed stronger associations than objective language performance with domains of QoL. That underlines the importance of accounting for the patient's perspective in clinical procedures. This was further strengthened in findings showing that self-reported symptoms of psychological distress had an impact on all aspects of QoL. Our results support that subjective and objective language function, in addition to psychological distress should be addressed during the diagnostic process. In that way, treatment goals can be facilitated and followed with the aim of improving patient well-being.

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