

# Impairments in Quality of Life and Cognitive Functions in Long-term Survivors of Glioblastoma

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ABSTRACT

**Background:** The incidence of long-term survival in glioblastoma (GBM), i.e., >3 years, ranges from 3% to 5%. Although extensive research is performed in novel therapies for prolonging survival, there is a scarcity of research focusing on the impact of tumor and treatment on cognitive, psychological, and social status of survivors. This study is an attempt to look into this poorly addressed important issue. **Materials and Methods:** Nine patients (six adults and three children) with GBM who had survived >3 years were included in the study. The quality of life (QOL) functions were assessed with the World Health Organization QOL Questionnaire BREF questionnaire. The neuropsychological assessment was done using the National Institute of Mental Health and Neurosciences neuropsychology battery for adults and children. The scores were compared with normative data. **Results:** The physical and psychological health-related QOL of long-term GBM survivors were affected considerably due to fatigue, poor quality of sleep, inability to concentrate, presence of depression, financial burden with impaired personal and social relationships ( $P < 0.05$ ). Different domains of cognitions such as motor speed ( $P = 0.0173$ ), mental speed ( $P = 0.0022$ ), sustained attention ( $P = 0.0001$ ), long-term memory ( $P = 0.0431$ ), mental flexibility ( $P < 0.05$ ), and planning and executive functions ( $P < 0.05$ ) were significantly impaired affecting personal, social, and professional lives. **Conclusion:** The health-related QOL and cognition are significantly impaired in GBM long-term survivors. As the incidence of long-term survival is very less, there is a need for larger multicenter studies to come up with definitive results, which in turn can help in formatting the rehabilitative and support programs for these patients.

**KEYWORDS:** Cognitive functions, glioblastoma, long-term survival, quality of life

## INTRODUCTION

Despite multimodal aggressive treatment of glioblastoma (GBM), comprising surgical resection, local radiotherapy (RT), and systemic chemotherapy, the median overall survival time after diagnosis remains still in the range of 12–15 months only. Modest 2%–4% increases in incidence have been shown in the last 10–20 years, with minimal improvements in 2-year GBM survival from 3% to 6%.<sup>[1]</sup> A small fraction of GBM patients survive for >36 months, which constitutes 2%–5% of all GBM patients.<sup>[2]</sup> These patients are referred to as long-term survivors. Some of the studies have earlier considered >18 months of survival as long-term survival.<sup>[3]</sup> The long-term survival of >3 years in a study by Scott *et al.* was only 1.8%.<sup>[4]</sup> Recent studies have demonstrated that survival in GBM has significantly improved with overall survival reaching 27.2% at 2 years, 16.0% at 3 years with RT, and temozolomide (TMZ) chemotherapy.<sup>[5]</sup>

The adjuvant RT and chemotherapy can also have significant effects on the quality of life (QOL). Further, the involvement of brain by the disease and surgery can also result in varied

neurological deficits in either motor or cognitive domain. The QOL and cognitive deficits, especially in long-term survivors are important aspects which have not been studied extensively till date. Although the neurological outcome may be good at discharge following surgery, neuropsychological tests may reveal an array of cognitive defects disabling patients in their daily routine life. The QOL is a complex entity that originates from the interaction between a person's values and expectations and his/her actual experience.<sup>[6]</sup> QOL is defined as a multidimensional concept consisting of at least social, psychological, and physical phenomena.<sup>[7]</sup> Cognitive impairment is an outstanding sign of patients with brain tumors and constitutes the main domain of their QOL.<sup>[8–11]</sup> QOL is affected by a number of social, emotional, financial, physical, and neurological factors. Modification of these factors may improve QOL.

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As the median survival of GBM is expected to get better with more aggressive novel therapies in the future, the cohort of patients surviving beyond 3 years is expected to increase. The real issue is the notable scarcity of research on the QOL and cognitive outcomes in patients with GBM. An awareness and evaluation of these issues are essential to provide a wholesome care for these patients, in addition to medical therapy. The objective of the present study is to evaluate the impact on QoL and cognitive functions in the long-term survivors of GBM.

## MATERIALS AND METHODS

The clinical data of patients of GBM who underwent surgical management at our institute from January 2006 to September 2011 were reviewed. The patients who have survived for >3 years from the time of diagnosis (long-term survivors) were included for the study. Patients with preexisting psychiatric disorders or other preexisting cognitive or behavioral disorders were excluded from the study. The histopathological review of slides was done for confirmation of diagnosis. The QOL of the patients were evaluated in detail using the World Health Organization QOL Questionnaire BREF version (WHOQOL-BREF). The cognitive functions of the patients were evaluated using the National Institute of Mental Health and Neurosciences (NIMHANS) neuropsychological battery for adults and children, as appropriate and Vineland Social Maturity Scoring Scale in patients who were not in the physical or mental state to undergo detailed psychological examination. All patients gave consent for participating in the study. This study was approved by NIMHANS Ethics Committee. The assessments of all the patients were done in the hospital setting.

### Quality of life assessment

The QoL of long-term survivors of GBM patients was assessed by the WHOQOL-BREF questionnaire, which consists of 30 questions which finally determine the QOL in four domains, namely, physical health, psychological health, social relationship, and environmental health. The transformed scores of each domain were compared with the normative data from the WHO international field trial report.<sup>[12]</sup> From the international field trial report, the normative data of field trial conducted in Chennai (Madras), India, in 420 normal healthy individuals was selected as reference control values. The means of transformed scores of both case and control groups were compared by *t*-test. The  $P < 0.05$  was considered as statistically significant.

### Description of National Institute of Mental Health and Neurosciences neuropsychological battery tools

For neuropsychological evaluation of patients, the selected tools from NIMHANS neuropsychological battery were used.<sup>[13]</sup>

The motor speed was tested with the finger tapping. Mental speed was tested by the Digit Symbol Substitution test, which is a test for visuomotor coordination, motor persistence, sustained attention, and response speed. The color trail test was used for focused attention. Category fluency was tested using the animal naming test (ANT). The verbal working

memory was tested using the N back tests. The visual working memory was tested by Spatial Span test forward and backward versions. The Tower of London (TOL) Test was used to test planning. Rey's test was used for auditory verbal learning and memory test (AVLT) and complex figure test for visual learning and memory. The method of testing in each test and the neuropsychological testing scores which were compared with the normative data have been published in NIMHANS neuropsychological battery manual.<sup>[13]</sup> The Student's *t*-test was used to calculate the significance.

## RESULTS

Out of 717 patients with GBM, 254 were not contactable. Out of 463 patients who were contactable, 452 patients had expired due to the disease. We had a total of 11 patients who were surviving for >3 years. During the follow-up, one patient died before evaluation and one patient failed to respond to further communication. Therefore, nine patients were evaluated for QOL and cognitive status.

### Clinical details of patients

Out of total nine long-term survivors of GBM, six patients were adults and three were children. Four were females and five were males. The age ranged from 11 to 60 years, with mean adult age was 41.34 years and mean age of children was 13 years. The clinical details of all the patients are as shown in Table 1. All the patients underwent surgical resection of tumor followed by adjuvant chemotherapy and radiation therapy. All the adult patients had received adjuvant RT and chemotherapy. Patients usually had received 54 Gy in fractions and 5–6 cycles of TMZ chemotherapy. One patient had received only two cycles of chemotherapy. All the children had received only RT. The treatment details are provided in Table 1. The patients clinical condition, pre- and post-operative Karnofsky performance scores have been provided in Table 1.

Eight out of nine patients did not have recurrence during the follow-up period. One patient, a 40-year-old female (patient number 1) had recurrence of the left frontal GBM after 7 years of diagnosis and treatment. She had undergone resection of the recurrence followed by adjuvant chemo-RT. The duration of survival ranged from 3 to 8 years. The mean overall survival of all patients was 62 months.

### Quality of life of long-term glioblastoma survivors

The physical and psychological health were significantly impaired in patients with GBM. In addition, social life was affected in these patients. The physical health domain of QOL showed that patients had a significant amount of fatigue and impaired quality of sleep. Six patients (66.67%) had significant lack of energy during daily routine activities, and 4 (44.44%) patients had significant restricted mobility with one patient being wheelchair bound. In psychological health assessment, out of nine patients, eight patients were not able to enjoy life the way they wanted to. Seven (77.778%) patients had their QOL affected significantly so that they were able to enjoy life only to moderate amount or a little and they did not find their life meaningful to a significant extent. Eight (88.88%) patients reported that they were not able to concentrate in their work to significant extent. Five patients (55.56%) expressed mild

Table 1: Clinical details of long-term glioblastoma survivors

Age	Sex	Location	Signs and Symptoms at presentation	KPS at presentation	Condition at discharge	KPS at discharge	KPS after RT/chemotherapy	Adjuvant therapy	Follow-up duration	Present clinical status	Radiological status
40	Female	Left frontal lobe	Headache for 1 month, right hemiparesis 2-3/5, right UMN facial paresis	60	Right paucity improved and patient improved in sensorium	70	70	Taken RT and TMZ chemotherapy 6 cycles; redo surgery for recurrence followed by RT	7 years 9 months	No deficits	Recurrence after 7 years and 5 months
27	Male	Right temporal lobe	Headache, seizures for 6 months. B/L VI nerve paresis, fundus B/L papilledema	80	Conscious, Obeying, moving all four limbs	100	100	Taken RT and TMZ chemotherapy 6 cycles	4 years 2 months	No deficits	No recurrence
32	Female	Right frontal lobe	Headache, vomiting, diminution of vision right eye for 1 month. Fundus B/L papilledema, No sensorimotor deficit	80	Conscious, obeying, moving all four limbs	100	100	Completed RT, 2 cycles of temozolomide	8 years	No deficits	No recurrence
58	Female	Left frontoparietal lobe	Headache, vomiting, fundus B/L papilledema	80	Conscious, obeying, moving all four limbs	90	80	RT 59 Gy in 33 fractions, over 6½ weeks, temozolomide for 5 cycles	6 years 5 months	Right hemiparesis with aphasia	Extensive post-RT changes <sup>†</sup>
60	Male	left frontal lobe	Headache for 4 months, vomiting for 15 days, 2 episodes of GTCS, altered behavior, and involuntary movements for the last 1 week	80	Disoriented, incontinent, walking with stick support, moving all four limbs, dependent for all activities	60	80	Completed RT and CT TMZ 5 cycles	3 years 2 months	No deficits	No recurrence
31	Male	Left temporal lobe	Headache 3 months, multiple episodes of vomiting and abnormal behavior for 5 days, B/L VI nerve paresis, fundus shows papilledema	70	Conscious, obeying, oriented, moving all four limbs	100	100	Completed RT and CT TMZ 5 cycles	7 years	No deficits	No recurrence
11	Male	Left temporal lobe	Headache, vomiting, and blurring of vision since 1 month fundus Grade II papilledema	80	Conscious, obeying, moving all four limbs vitals stable	100	100	Completed RT 54 Gy 30 Fr	3 years 1 month	No deficits	No recurrence

Contd...

Table 1: Contd...

Age	Sex	Location	Signs and Symptoms at presentation	KPS at presentation	Condition at discharge	KPS at discharge	KPS after RT/ chemotherapy	Adjuvant therapy	Follow-up duration	Present clinical status	Radiological status
14	Male	Brain stem (exophytic lesion)	Headache for 3 days and multiple episodes of vomiting. B/L nystagmus with fast component to the left, right Grade II LMN facial, right reduced fifth nerve sensation	80	Conscious, obeying, moving all four limbs, right 5, 6, 7, nerve palsies with right cerebellar signs	100	80	Taken RT	3 years 1 month	No deficits	Brain stem signal changes*
14	Female	Right temporal lobe	Reduced ability to see for 20 days, headache for 4 months, vomiting for 1 week. Fundus shows B/L secondary optic atrophy	80	Conscious, obeying, moving all four limbs	100	100	Taken RT 54 Gy 30 Fr	4 years	Right eye PL negative (due to secondary optic atrophy)	No recurrence

RT: Radiotherapy, UMN: Upper motor neuron, LMN: Lower motor neuron, B/L: Bilateral, CT: Computed tomography, TMZ: Temozolomide, KPS: Karnofsky performance scores, PL: Perception of light

to moderate degree of negative feelings such as depression, anxiety, despair, or blue mood. In the assessment of social relationships, 7 (77.78%) patients were not satisfied with their personal relationships. Most of the adults were also not satisfied with their sexual life. They were also dissatisfied to some extent with the social support from their friends and family. In environmental health assessment, 8 (88.89%) patients expressed a feeling of uncertainty and loss of safety in their life to moderate amount as well as not feeling the environment healthy. Most of the patients thought they did not have enough money according to their needs. The mean of transformed scores of all the domains as compared to normals are significantly different in all domains [Table 2].

### Cognitive outcome in adult long-term glioblastoma survivors

Out of six adults, one patient (patient number 4) was significantly disabled both physically as well as psychologically with gross cognitive decline and she was not in a clinical condition to undergo detailed assessment.

Finger tapping in the right hand was significantly impaired on analysis. All patients being right handed, the impaired motor speed on the right side irrespective of location of lesion suggests generalized impaired motor function in these patients. The visuomotor coordination, motor persistence, sustained attention, and response speed were significantly impaired in these patients. On Color Trail Test, two patients took significantly more time than controls ( $P = 0.0001$ ). This result suggests impairment of mental flexibility in addition to sustained attention, perceptual thinking, and simple sequencing. On ANT, the patients were able to tell an average of 13 names in a minute which was quite similar to controls without any significant difference, indicating that the category fluency was not impaired. Both verbal and visual working memories were not impaired. On "TOL" test, the impairment in ability of planning was significant. In the AVLT, long-term memory was significantly affected in GBM survivors. Visual learning and visual working and recent memories were not affected in the GBM survivors [Table 3].

Hence, we noted that adult long-term survivors of GBM had impaired motor speed on dominant side, impairment in mental speed, focused attention, planning ability, and long-term memory as compared to normal healthy individuals.

### Cognitive outcome in pediatric long-term glioblastoma survivors

As the normative cognitive data were separate for pediatric population, the children with GBM, who are surviving beyond 3 years after diagnosis could not be included in the analysis along with the adult patients. Since there were only three patients in test group, it was plausible only to compare the test value with the normative cutoff scores for the particular age. Hence, detailed statistical analysis was not possible in pediatric age group.

There was no impairment in motor function on either side with normal preserved attention span in these patients. The lower 2 back score in these patients was suggestive of impairment of verbal working memory [Table 4]. The AVLT was used to assess the verbal learning and memory. For all the three

**Table 2: Mean scores of different domains of quality of life**

Mean transformed score (out of 20)	Mean±SD		P
	Study group (n=9)	Control group (n=420)	
Physical health	11.78±3.45	14.08±2.30	0.0001
Psychological health	12.89±2.98	15.4±2.20	0.0008
Social relationship	11.11±2.26	14.80±2.90	0.0002
Environmental health	14.44±2.35	14.80±2.50	0.6689

SD: Standard deviation

children, the scores were above the cutoff values suggesting no deterioration in verbal learning capacity and verbal memory [Table 5]. In addition, the intelligence quotient (IQ) was calculated for these children. The IQ of three patients ranged from 107 to 127, demonstrating that the overall cognitive functioning in children was not affected.

## DISCUSSION

The development of brain tumor itself can result in significant physical disabilities, predominantly associated with the specific tumor locations in eloquent areas, impairment of cognitive skills and memory. The effects of surgical resection of the tumor, RT, and chemotherapy can compound the effects on QOL and cognitive abilities of these patients, although increasing the period of survival after cancer diagnosis.

In the present study, all patients, except one, had independence in activities of their daily living despite the impairments caused by tumor and its treatment. The physical health domain of QOL showed that the patients had a significant amount of fatigue and impaired quality of sleep. Six patients (66.67%) had a significant lack of energy during daily routine activities, and 4 (44.44%) patients had significant restricted mobility with one patient being wheelchair bound. This study noted that patients had significant impairment of physical QOL. Similarly, fatigue is reported to be the most common symptom in patients with brain tumors in general.<sup>[14]</sup> Steinbach *et al.* showed in long-term survivors of GBM that these patients were unable to work and participate in everyday and social activities due to fatigue.<sup>[15]</sup>

Loss of self-esteem and depression are important psychological morbidities prevailing in patients with cancer. The fear of uncertainty and prolonged treatment and follow-up required in the disease management affect the general mood of the patients. Overall, patients had significant impairment of psychological aspect of QOL in this study. Similar studies have reported significant amount of depression in high-grade glioma patients and also in long-term survivors of GBM.<sup>[3,14-17]</sup>

The present study revealed that patients had significantly impaired personal and social relationships. They were also dissatisfied by the support they get from their family members and friends. The high-grade gliomas not only affect the QOL of the patient but also that of the family members and caretakers, thus acting as a double-edged sword. In a study by Janda *et al.*, it was found that even the QOL of the caregivers of brain tumor patients was also affected significantly.<sup>[18]</sup> That

adds to the impairment of quality of social life of patients. Taphoorn *et al.* found similar results related to impairments in QOL in patients diagnosed to have GBM.<sup>[19]</sup>

Compared to the Western countries, the social fabric and culture in India assure a good amount of social support to the patients with medical illness. The prevalence of joint family system and predominantly patriarchal type of family setup ensures the availability and willingness of the caregivers to take care of the patients. Despite that, we noticed that patients with GBM have a significant extent of impairment in social relationships.

The feeling of future uncertainty and lack of safety were also the factors affecting the quality of living environment, also the financial burden adding to the misery. Hahn *et al.* also reported that patients with primary malignant brain tumors found their lives hopeless with significant amount of depression and confusion.<sup>[17]</sup> In a study conducted in Austria by Flechl *et al.*,<sup>[20]</sup> they found future uncertainty and financial problems significantly affecting the QOL in long-term GBM survivors. In Austria, despite having one of the best healthcare and social security systems in the world, their long-term GBM survivors are suffering from significant financial burden. In a developing country like India where most of the people meet the medical expenses through personal savings, the need for a prolonged and costly treatment can become a significant financial burden on the patient and family. The effects of RT can be progressive and may appear many months to years after the treatment.<sup>[21]</sup>

The present study documented impairment of specific cognitive functions in these long-term survivors of GBM. The effects on cognitive functions are probably multifactorial, namely, the tumor itself, surgery, RT, and chemotherapy effects. We found that the motor speed on the right side, which was the dominant side for all patients, was significantly affected as compared to healthy controls on test of finger tapping. There was no significant association between location of tumor and motor speed.

The subjects in our study had impaired visuomotor coordination, motor persistence, and sustained attention. The response speed was also affected. These patients also had impaired mental flexibility and long-term memory. Steinbach *et al.* also found that attention was significantly affected in patients with GBM who had survived for >5 years.<sup>[15]</sup> We also found impairments in ability to plan and remember information for a longer period, thereby affecting independence in day-to-day functioning. Similar results were reported in another study on recurrent glioma patients.<sup>[22]</sup> Hottinger *et al.* noted that the long-term GBM survivors had significant impairment of cognitive functions with affected attention and memory.<sup>[23]</sup>

We did not find association of cognitive deficits and location of tumor, though the sample is very small to make any definite inferences. Flechl *et al.* also did not find such association in long-term GBM survivors.<sup>[20]</sup> Some studies performed in patients with low-grade glioma found that cognitive deficits are common when the tumor is located in the left frontal lobe.<sup>[24,25]</sup> However, no studies have found similar association

**Table 3: Results of tests for cognition in adults**

	GBM cases		Control		P
	n	Mean±SD	n	Mean±SD	
Finger-tapping test-average number of taps					
Right hand	5	33.60±1.69	596	42.19±8.03	0.0173
Left hand	5	33.64±2.73	596	39.26±6.91	0.0699
Digit symbol substitution test - total time					
Total time	5	437.80±122.19	415	259.82±128.78	0.0022
Color trails test-total time					
Color trails 1 total time	5	99.6±23.77	436	114.18±53.34	0.5422
Color trails 2 total time	5	246.6±115.38	400	113.19±69.60	0.0001
Animal names test-total new words					
Total new words	5	13±1	684	11.69±4.25	0.4986
Verbal N-back test-hits and errors					
1 back hits	5	7.8±1.3	627	7.60±1.61	0.8661
1 back errors	5	1.4±1.52	627	2.19±2.43	0.7635
2 back hits	5	6.8±0.84	627	6.17±1.82	0.6743
2 back errors	5	2.6±1.52	627	4.50±2.76	0.5794
Spatial span test					
Total score	5	12±0	240	14.24±2.93	0.0893
Tower of London test					
II moves					
MT	5	6.9±3.13	563	8.85±8.78	0.6201
MM	5	2.2±0.45	563	1.98±1.60	0.7595
NPS	5	2±0	563	1.13±0.56	0.0006
III moves					
MT	5	11.4±6.26	487	13.45±13.17	0.7279
MM	5	3.35±0.38	487	2.92±1.75	0.5795
NPS	5	2.8±0.45	487	1.86±1.07	0.0511
IV moves					
MT	5	17.2±6.50	563	20.33±15.89	0.6613
MM	5	6.05±1.94	563	4.71±2.53	0.2376
NPS	5	2.8±0.84	563	1.63±1.07	0.0143
V moves					
MT	5	25.1±14.06	563	22.20±15.16	0.6705
MM	5	7.4±1.57	563	5.37±2.32	0.0514
NPS	5	1.2±0.84	562	1.28±1.04	0.8712
TNPSMM	5	8.8±1.3	566	7.66±2.64	0.3373
		<b>Males</b>		<b>Females</b>	<b>P</b>
		<b>n</b>		<b>Mean±SD</b>	
AVLT-scores					
Trial 1	5	7.2±2.17	350	6.37±2.39	0.4392
Trial 2	5	9.2±2.39	350	8.99±2.84	0.8674
Trial 3	5	11.2±2.68	350	10.37±2.90	0.5227
Trial 4	5	12.2±2.49	350	11.25±2.80	0.4509
Trial 5	5	13.4±2.07	350	11.90±2.60	0.1990
Total	5	53.2±11.19	350	49.33±12.45	0.4881
List B	5	5.4±2.07	350	5.18±2.37	0.8365
IR	5	11.4±2.97	350	10.88±2.99	0.6976
DR	5	10.6±4.56	350	10.83±3.08	0.8678
LTPR	5	73.98±40.79	350	90.87±18.34	0.0431
Hits	5	14.2±0.45	350	14.13±1.42	0.9163
Misses	5	1.2±0.45	350	0.86±1.39	0.5858
FA	5	2.2±1.1	350	0.99±1.48	0.0685
Complex figure test - number correct					
Copy NC	5	32.8±3.11	408	33.59±3.91	0.6522

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**Table 3: Contd...**

	Males		Females		P
	n	Mean±SD	n	Mean±SD	
Immediate recall NC	5	19±8.43	408	22.31±7.16	0.3057
DR NC	5	17.2±9.04	408	21.74±7.24	0.1656

IR: Immediate recall, DR: Delayed recall, FA: False alarm, LTPR: Long-term percent retention, MT: Meantime, MM: Mean moves, NPS: Number of problems solved with minimum moves, TNPSMM: Total number of problems solved with minimum moves, NC: Number correct, AVLT: Auditory verbal learning and memory test, SD: Standard deviation, GBM: Glioblastoma

**Table 4: Motor function and working memory in children with glioblastoma**

	Patient 7 11 years/male	Patient 8 14 years/male	Patient 9 14 years/female
Finger-tapping test			
Right hand	41	35	35
Left hand	31.8	32	30
Cutoff values			
Right hand	32	35	35
Left hand	28	31	31
Color trail test			
Trail A	73	82	100
Trail B	143	166	168
Cutoff values			
Trail A	142	104	104
Trail B	254	174	174
Verbal N-back test			
1 back hit	8	9	9
2 back hit	8	6	6
Cutoff values			
1 back hit	8	8	8
2 back hit	11	13	13

**Table 5: Auditory verbal learning test in children**

	AVLT-scores				
	Patient 7 11 years/ males	Cutoff values	Patient 8 14 years/ male	Patient 9 14 years/ female	Cutoff values
Trial 1	5	3	6	6	3
Trial 2	8	6	10	11	6
Trial 3	9	7	12	14	8
Trial 4	11	8	12	13	10
Trial 5	10	10	13	15	11
Total	43	38	53	59	42
DR	9	8	13	15	9
Retention	9	7	10	11	9

DR: Delayed recall, AVLT: Auditory verbal learning and memory test

for high-grade gliomas. It can be considered that high-grade primary brain tumors may have changes in higher mental functions irrespective of their location in either eloquent or noneloquent areas of brain, which can possibly be due to the systemic chemotherapy and RT, resulting in global cognitive dysfunction, irrespective of the location.

In children, the long-term survivors of GBM did not have a significant effect on cognitive functions. However, these results should be interpreted with caution due to very small sample size. Another concern in pediatric age group is that the GBM in children is a different entity with relatively better prognosis as compared to adults. The median overall survival is reported as 43 months with the median progression-free survival of 12 months. The overall survival rate was 67% at 1 year, 52% at 2 years, and 40% at 5 years.<sup>[26]</sup> There is a potential to study these children separately for the impairment in QOL and cognitive functions in a multicenter study to obtain sufficient number of long-term survivors and to derive strong conclusions.

To summarize, the patients with GBM, despite having improved survival, are left with significantly impaired overall health-related QOL as well as impairments in various domains of cognition affecting functional status. Consequentially, there is an explicit necessity to address these issues of QOL and cognitive status in addition to improving the treatment strategies for prolonging survival. There should be a lot of emphasis and need for integrated rehabilitative and support programs as well as financial safeguard and social integration of these patients and caregivers to improve the QOL of these patients. A more inclusive multidisciplinary approach with stress on post-treatment care, psychological support, awareness of the disease, improvement in social support, disease-specific patient group interactions with active inputs from medical personnel can enhance the QOL of these patients in the long term.

## CONCLUSION

The QOL of long-term GBM survivors is affected considerably due to fatigue, poor quality of sleep, inability to concentrate, presence of depression, financial burden, and impaired personal and social relationships. Different domains of cognition like motor speed, sustained attention, long-term memory, mental flexibility and executive functions are significantly impaired affecting personal, social, and professional lives. The limitation of this study is that the sample size is small. Notwithstanding the limitations, the present study clearly portrays the significant impairment of QOL in long-term survivors of GBM and identifies need to simultaneously address these issues in management of these patients and to ensure a wholesome approach in the management of GBM.

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## Conflicts of interest

There are no conflicts of interest.

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