Journal of Psychosomatic Research 76 (2014) 257–260

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

Short communication

The moderating effect of estimated pre-morbid IQ on the relationship between neuropsychological status and subjective well-being after brain tumour

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ARTICLE INFO

Article history:
Received 16 October 2013
Received in revised form 19 December 2013
Accepted 21 December 2013

Keywords:
Brain tumour
Neuropsychological impairment
Emotional well-being
Quality of life and cognitive reserve

ABSTRACT

Objective: People with brain tumour experience complex and distressing symptoms. Neuropsychological impairment is proposed to have a negative impact on subjective well-being; however, research is yet to examine the influence of estimated premorbid IQ on this relationship. This preliminary study investigated the moderating effect of estimated premorbid IQ on the relationship between global neuropsychological status (GNF) and depression and quality of life.
Methods: 73 adults (51% male) aged 21–65 years with primary brain tumour (52% benign) were administered a test battery assessing estimated premorbid IQ, GNF, depression (Depression Anxiety Stress Scales) and quality of life (Functional Assessment of Cancer Therapy, FACT).
Results: A series of two-way analysis of covariance (ANCOVA) controlling for education found a significant interaction between estimated premorbid IQ (low average to average vs high average) and GNF (low vs high) on levels of depression ($p < .05$) and FACT emotional well-being ($p < .05$). For these outcomes, individuals with high average estimated premorbid IQ and low GNF reported better well-being than those with low-average to average estimated premorbid IQ and low GNF. Higher GNF was related to greater functional well-being ($p < .01$) irrespective of estimated premorbid IQ.
Conclusion: The finding that higher premorbid cognitive ability buffers the effect of neuropsychological impairment on emotional well-being after brain tumour advances understanding of the role of cognitive reserve in adjustment to neurological disorders.

Introduction

Brain tumours are rare, but serious and chronic and they have the combined effects of brain injury and cancer. The worldwide incidence of malignant and benign tumours is 6.4/100,000 and 2.9/100,000 respectively [1]. Although brain tumours vary in their neuropathology and treatment, all forms pose a significant threat to people's functional status and subjective well-being [2,3]. People typically experience alarming symptoms (e.g., seizures, sensory loss) prior to diagnosis with uncertainty about their future outcome. Anxiety and depression has been reported in 30–50% of patients [3].

While neurological characteristics (e.g., tumour type, grade and treatment) are generally reliable predictors of survival and functional status [4–6] they are poor predictors of subjective well-being indicators, such as depression and quality of life [3,7]. Adjustment to brain tumour is influenced by an interplay of premorbid characteristics, neurological status and personal and social resources [3]. Theories of stress and coping have been applied to understand how people make sense of and cope with their illness [8,9]. However, cognitive impairments arising from brain tumour can compromise the adjustment process.

Neuropsychological testing is a common method to determine the impact of brain injury on everyday functioning [10]. Indeed, such results can be more sensitive to early tumour recurrence than imaging techniques [11]. Numerous studies have documented the effects of brain tumour on global cognitive functioning, processing speed, attention, memory, visuo-spatial skills, language and executive functioning [5,6,12]. However, research investigating the relationship between neuropsychological impairment and quality of life (QoL) has yielded mixed findings [3]. A possible explanation for these inconsistent results relates to the influence of premorbid cognitive ability or IQ [13]. Specifically, people with higher

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0022-3999/$ – see front matter.
http://dx.doi.org/10.1016/j.jpsychores.2013.12.008

premorbid IQ may have greater capacity to cope with neuropsychological decline than those with low premorbid IQ.

The concept of cognitive reserve has been proposed to account for differences in functional outcomes of individuals with similar brain pathology in the context of head injury, stroke and dementia [13]. Cognitive reserve refers to the process of optimising performance by drawing upon one's neural networks to cope with increased task demands or to compensate for brain damage [13]. According to Jones et al. [14], cognitive reserve is "a feature of brain structure and/or function that modifies the relationship between injury or pathology and performance on neuropsychological tasks or clinical outcomes." (p. 593)

Cognitive reserve develops throughout life and is strongly influenced by environmental stimulation, including educational and occupational opportunities. Greater cognitive reserve (i.e., higher education, occupational status or premorbid IQ) is found to be a protective factor and enhance well-being in the context of dementia [15], head injury [16], psychopathology [17] and chemotherapy treatment for cancer [18]. However, the role of cognitive reserve in adjustment to brain tumour has yet to be investigated.

This preliminary study investigated the moderating effect of estimated premorbid IQ on the relationship between neuropsychological functioning and depression and QoL after brain tumour. It was hypothesised that high average estimated premorbid IQ would buffer the effects of low global neuropsychological status on emotional status and QoL.

Methods

Participants

Seventy-three adults with brain tumour were recruited from metropolitan-based neurosurgery clinics and brain injury and cancer support services from 2008 to 2012. The sample included a subset of participants ($n = 28$) from a previous study [19]. Study inclusion criteria included: diagnosis of a primary brain tumour; aged 18–65 years; no pre-existing psychiatric, neurological or literacy disorder; adequate receptive and expressive English language skills. An informal screen for aphasia during the pre-assessment interview identified two participants with expressive language difficulties who were excluded from the study. Participants were aged 21–65 years ($M = 47.61$, $SD = 12.1$) and on average were diagnosed 2.94 years ($SD = 3.6$) ago. Education ranged from 8 to 19 years ($M = 12.9$, $SD = 2.7$). Approximately half of the sample (52%) had been diagnosed with benign or low grade tumour (pituitary = 10, meningioma = 8, astrocytoma = 6, oligodendroglioma = 4, craniopharyngioma = 3, colloid cyst = 3, oligoastrocytoma = 2 and unspecified low grade glioma = 6). Malignant or high grade tumours (48%) included glioblastoma multiforme ($n = 17$), oligodendroglioma ($n = 8$), anaplastic astrocytoma ($n = 4$) and unspecified high grade glioma ($n = 2$). Most participants had received surgery as the primary treatment (79.5%) in isolation or combined with chemotherapy and/or radiation.

Measures and procedure

Following ethical clearance and informed consent procedures participants completed an assessment battery lasting 1–1.5 h. Participants were initially administered the Wechsler Test of Adult Reading [20], a word pronunciation test that provides a reliable estimate of premorbid IQ in the context of neurological disorder. Participants also completed standardised tests of attention, memory, visuospatial skills, language and executive function (Digit Span, Hopkins Verbal Learning Test [total recall and delayed recall], Rey Complex Figure [copy and 30-minute recall], Trail Making Test [part A and B], and Verbal Fluency [total words]). Standardised scores (z-scores) were calculated using age-based norms (i.e., Digit Span and Rey Complex Figure) or age and education-based norms where available (i.e., Trail Making Test, Verbal Fluency, Hopkins Verbal Learning Test) [10,21]. Based on the approach of Armstrong et al. [12] a composite score was calculated by summing and averaging the z-scores on each test. A principal components analysis found that test scores loaded onto one factor ($\lambda = 3.10$, commonalities = .38–.75), labelled global neuropsychological function (GNF).

The Functional Assessment of Cancer Therapy (FACT) [22] includes physical, social, emotional, and functional well-being subscales that combine to form a general index (FACT-G). Higher scores reflect better QoL and scores ≥0.5 SD below the norms ($M = 80.1$, $SD = 18.1$) signify poor QoL [23].

The Depression Anxiety and Stress Scales (DASS) [24] depression scale assesses low mood over the past week. Scores >9 are considered clinically meaningful. The scale has good reliability and validity for the brain tumour population [25].

Results

The data were screened for missing values and checked for relevant assumptions. Participants' mean depression score was in the mild clinical range ($M = 11.34$, $SD = 9.9$) and the mean FACT-G score ($M = 71.87$, $SD = 18.3$) was approximately 0.5 SD lower than population norms [23]. The mean estimated premorbid IQ for the sample was 103.72 ($SD = 8.3$; range = 78–119). According to standard clinical categories, 12.3% were in the "low average" range (IQ = 80–89), 54.8% were in the "average" range (IQ = 90–109) and 32.9% were in the "high average" range (IQ = 110–119). Participants with malignant tumour demonstrated slightly poorer GNF than participants with benign tumour ($M = -0.91$, $SD = 0.94$ vs. $M = -0.61$, $SD = 0.90$), which was not significant ($t = -1.38$, $p = .17$). There were no significant differences in estimated premorbid IQ, depression and QoL according to tumour type ($p > .3$). Of the other potential covariates (i.e., age, gender, education, and chronicity), only education was significantly related to

Table 1
Results of ANCOVA investigating the interactive effects of estimated premorbid IQ (EPIQ) and global neuropsychological function (GNF) on emotional well-being and quality of life ($n = 73$)

Independent variables (IVs)		Depression M (SD)	FACT-General M (SD)	FACT-Emotional Well-Being M (SD)	FACT-Functional Well-being M (SD)
Low average–average EPIQ	Low GNF[a] ($n = 28$)	17.00 (11.5)	64.77 (21.8)	14.56 (6.3)	14.00 (5.0)
	High GNF ($n = 21$)	6.00 (6.7)	80.08 (13.6)	18.93 (4.2)	19.55 (5.0)
High average EPIQ	Low GNF ($n = 9$)	9.78 (10.1)	74.48 (16.1)	19.39 (6.3)	14.11 (5.8)
	High GNF ($n = 15$)	8.92 (6.2)	73.67 (15.6)	17.55 (5.0)	17.78 (4.9)

		F	$\eta\rho^2$	F	$\eta\rho^2$	F	$\eta\rho^2$	F	$\eta\rho^2$
Covariate	Education	1.82	.03	3.46	.05	–	–	3.62	.05
IV (low average to average/high average)	EPIQ	0.43	.00	0.28	.00	1.51	.02	2.12	.03
IV (low/high)	GNF	4.99*	.07	1.44	.02	0.82	.01	9.91**	.13
Interaction	EPIQ × GNF	5.03*	.07	3.47	.05	4.92*	.07	0.63	.01

[a] Low GNF ≤ −.68 (z-score); High GNF > −.68 (z-score).
* $p < .05$.
** $p < .01$.