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ORIGINAL REPORT

ASSOCIATION OF AGE WITH LONG-TERM PSYCHOSOCIAL OUTCOME FOLLOWING TRAUMATIC BRAIN INJURY

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Objective: **To examine the association of age with long-term psychosocial outcome following traumatic brain injury.**
Participants: **One hundred and twelve participants with mild to very severe traumatic brain injury, aged 26–89 years at 5–22 years post-injury, 112 significant others and 112 healthy controls matched for current age, gender, education and estimated IQ.**
Methods: **Changes in occupational activity, interpersonal relationships and independent living skills were assessed in participants with traumatic brain injury using the Sydney Psychosocial Reintegration Scale (SPRS). Employment status of participants with traumatic brain injury and control participants was compared at the time of assessment.**
Results: **No age effects were demonstrated on the 3 SPRS domains. However, compared with healthy individuals, older participants with traumatic brain injury showed greater likelihood of unemployment relative to younger participants with traumatic brain injury.**
Conclusion: **By using matched controls this study has demonstrated that older individuals with traumatic brain injury are less likely to return to the workforce than younger individuals with traumatic brain injury. Other aspects of psychosocial outcome appeared to be less affected by age, although specific domains require closer examination in relation to healthy age-matched controls.**

Key words: brain injuries, traumatic, psychosocial aspects, ageing, employment status, independent living, family relationships, interpersonal relations, leisure activities.

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INTRODUCTION

Age is a strong demographic predictor of labour force participation, involvement in leisure activities, the nature of interpersonal relationships and independence in living skills. In the general population, workforce participation tends to decline beyond the age of 50 years (1) and participation in leisure activities increases from the mid-40s (2). Research indicates that young adults rely more upon relationships with friends, while older individuals tend to draw on support from spouses and family members (3). The perceived quality of relationship interactions is thought to improve with advancing age (4). Levels of functional independence are observed to decline beyond the age of 60 years, with a growing need for daily assistance in elderly individuals aged over 85 years (5).

Traumatic brain injury (TBI) also affects the ability to cope with various aspects of everyday life. Psychosocial outcome, or the extent of participation in the context of everyday life, is a multidimensional construct that is determined by a complex interplay of injury factors, including cognitive and emotional functioning, pre-morbid characteristics, demographic variables and family/community supports (6). Studies involving individuals with TBI followed up 1–5 years post-injury have identified older age as a factor that negatively influences employment outcome (7–9) and living skills (10), particularly after the age of 50 years (11). Younger age has been suggested to impact negatively on interpersonal relationships over the short term (12, 13). Of the studies that have included long-term survivors, there is evidence to suggest that increasing age is associated with poorer employment outcomes (14, 15), although findings across studies are by no means consistent (16, 17). Previous studies have not supported the notion that age affects independence in activities of daily living over the long term (6, 16, 18, 19). Consensus has not yet been reached regarding the effect of increasing age on participation in leisure activities and relationships over the long term (16, 18). There is, however, a suggested link between older age and poorer leisure outcome (18).

The use of different measures of psychosocial outcome may, to some extent, explain these variable findings. Some measures have been inappropriate for assessment of psychosocial outcome many years post-injury. Previous studies have also tended to use global outcome measures, which provide limited information about specific psychosocial domains. The size and composition of TBI samples has also varied between studies. Some studies have examined the effect of age over a narrow age range and several studies have inappropriately included patients in the early stages of recovery, potentially confounding long-term psychosocial reintegration with early adjustment issues.

The aims of the present study were to examine, in individuals with TBI sustained at least 5 years earlier, the association of current age with psychosocial outcome, as reported by patients and significant others, after controlling for injury-related variables, pre-morbid demographic variables and current function-

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ing variables (as measured by neuropsychological tests and an emotional distress inventory), and relative to pre-injury functioning, in the domains of:

- Living skills. It was expected that older individuals would show a lower level of independent living skills.
- Interpersonal relationships. Older age was predicted to be associated with better perceived relationship outcome relative to younger participants.
- Occupational activity. It was hypothesized that older participants with TBI would show poorer work and leisure outcome and that old age would make a unique negative contribution in the prediction of employment status, relative to controls matched for age, gender, education and IQ.

METHODS

Participants

All 224 participants were concurrently enrolled in a long-term cognitive outcome study following TBI (20). Participants with TBI were recruited from the database of patients with TBI receiving rehabilitation between 1984 and 2002 at Epworth Hospital, Melbourne, Australia. In order to examine the influences of age an attempt was made to recruit equal numbers of participants across age-groups and including a broad representation of time post-injury, from 5 to 22 years post-injury. After dividing the database into 3 age-groups according to age at injury (16–34, 35–54 and 55 years or older), participants were randomly selected in the following way: individual Statistical Package for the Social Sciences (SPSS) identity codes were entered into a random number generator program from the website www.random.org. Participants were contacted until there were approximately equal groups of consenting and eligible participants across age-groups. Based on tests of analysis of variance (ANOVA) and Pearson's χ^2 analysis, there was no significant difference in time post-injury ($F(2, 109)=2.22, p=0.11$), gender (χ^2 (2, $n=112$)$=1.02$, $p=0.60$), duration of post-traumatic amnesia (PTA) ($F(2, 109)=0.14, p=0.87$), and estimated pre-morbid intelligence ($F(2, 109)=0.84, p=0.44$) across the 3 sub-groups. Patients were excluded from the study if there was evidence of subsequent head injury ($n=1$), history of other neurological disease ($n=1$) or degenerative dementia ($n=6$), significant psychiatric illness ($n=2$) and drug or alcohol dependency ($n=1$). Twenty-three patients were excluded as they were inappropriate for neuropsychological assessment due to poor vision, hearing, physical function, or general health. These included 4 patients residing in nursing homes. An additional 27 patients were deceased, 52 were living interstate or overseas, and 62 declined to participate.

A pool of 112 healthy controls was recruited from the general community in order to assess whether the employment rates of patients at different ages were related to their brain injury. Controls were individually matched with participants with TBI in terms of age, gender, education and estimated IQ. Exclusionary criteria for controls included history of TBI, neurological disease, psychiatric illness, drug or alcohol dependency or general medical condition.

A total of 112 participants with TBI were recruited. They had a mean age at assessment of 54.9 years (standard deviation (SD) 17.5, range 26–89), mean education of 11.5 years (SD 2.7, range 6–19 years) and estimated full scale IQ of 101.7 (SD 9.7, range 84–124). Controls had a mean age at assessment of 55.1 years (SD 17.3 range 28–89), mean education of 11.5 years (SD 2.5, range 8–21) and estimated full scale IQ of 102.4 (SD 8.7, range 85–125).

All participants with TBI had received rehabilitative therapy at Epworth Rehabilitation Centre aimed at return to independent living, study, work, recreational and social activities and relationships. Each participant's programme varied according to individual needs. The mean combined duration of inpatient and outpatient rehabilitation was 705.1 days (SD 400.5, range 24–1229).

The TBI cohort was divided into the following 5 approximately equal groups spanning 12-year age intervals based on current age at time of assessment: 26–37 years (mean 31.7, SD 3.2), 38–49 years (mean 43.1, SD 3.5), 50–61 years (mean 55.8, SD 3.1), 62–73 years (mean 67.9, SD 3.4) and 74 years or older (mean 78.3, SD 4.5), with the oldest participant being 89 years. The 5 subgroups formed the basis of statistical analyses when age was used as a categorical variable. ANOVA and Pearson's χ^2 analyses revealed no significant differences between the 5 subgroups in terms of time post-injury ($F(4, 107)=0.88, p=0.48$), gender (χ^2 (4, $n=112$)$=2.67$, $p=0.62$), PTA ($F(4, 107)=0.37, p=0.83$) and estimated pre-morbid intelligence ($F(4, 107)=0.83, p=0.51$). The descriptive data for the 5 subgroups are presented in Table I.

Pearson's χ^2 analyses revealed that the gender ratios in each age bracket were commensurate with that of the population with TBI in Australia, χ^2 (4, $n=112$)$=3.07$, $p=0.08$ (21). Pearson's χ^2 analyses and *t*-tests revealed no significant differences between the original database and the selected study group in terms of age ($t(535)=3.09$, $p=0.76$), gender (χ^2 (1, $n=535$)$=5.08$, $p=0.48$, PTA ($t(535)=-0.90$, $p=0.37$) and years of education ($t(535)=10.55$, $p=0.21$). Pearson's χ^2 analysis revealed that the deceased group and the group of TBI individuals who refused to participate included a significantly higher proportion of older (>55 years) individuals (χ^2 (4, $n=535$)$=30.05$, $p<0.001$).

The pre-morbid and current relationship status, living arrangements and employment status of the TBI group are presented in Table II. In terms of current employment status of the control group, 64% of individuals were employed and 36% unemployed.

Measures

The SPRS (form A; 22) was used to assess changes in psychosocial functioning from pre-injury levels. The SPRS is a self-report questionnaire, completed by patients and their significant others (SOs), which covers 3 domains: occupational activity, interpersonal relationships, and living skills. Each domain comprises 4 questions, rated on a 7-point scale, with higher ratings reflecting better outcome. Scores can be calculated for each domain (ranging from 0 to 24). The SPRS has been shown to have adequate psychometric properties (22, 23).

Employment status of TBI and control participants was determined at the time of assessment. Individuals were classified as employed if they were currently working on a full-time (31.2%), part-time (7.1%) or casual basis (2.7%), irrespective of the number of hours worked. Individuals engaging in volunteer work were not considered "employed".

Table I. *Descriptive data for 5 age groups of participants with traumatic brain injury*

	Age at assessment, years				
	26–37 ($n=27$)	38–49 ($n=19$)	50–61 ($n=18$)	62–73 ($n=28$)	74–89 ($n=20$)
Time post-injury					
Mean	10.56	11.32	10.72	12.25	11.05
SD	1.22	3.53	3.58	4.43	4.72
Range	9–14	8–22	7–20	6–20	5–20
Gender					
Male:female ratio (%)	63:37	63:37	72:28	50:50	55:45
PTA					
Mean	28.15	22.47	30.67	22.68	27.10
SD	26.04	27.84	27.34	29.25	24.28
Range	0–90	1–92	1–99	0–120	1–90
Estimated pre-morbid intelligence					
Mean	102.81	104.53	99.72	101.04	100.25
SD	10.46	9.71	9.23	8.49	10.50
Range	85–124	85–122	85–117	85–118	84–115

PTA: duration of post-traumatic amnesia; SD: standard deviation.

Table II. *Relationship status, employment status and living arrangements of traumatic brain injury group*

	Participants with TBI	
	Pre-injury, *n*	At the time of assessment, *n*
Married/de facto	54	68
Never married	38	17
Separated/divorced	15	17
Widowed	5	10
Of those not married/de facto: living alone or with flatmates	31	29
Of those not married/de-facto: living with parents	27	4
Of those not married/de facto: living with children	0	10
Employed	76	46
Unemployed	36	66

PTA: duration of post-traumatic amnesia; SD: standard deviation; TBI: traumatic brain injury.

The Hospital Anxiety and Depression Scale (HADS) was used to measure emotional distress. The HADS is a brief, 14-item self-assessment scale consisting of 2 subscales measuring anxiety and depression. Total scores for each subscale range from 0 to 21. High internal consistency has been reported for the anxiety and depression subscales (24). The HADS has been frequently used to document emotional consequences of TBI (25–28). Anxiety and depression subscales were examined both separately and as a combined total.

Estimates of pre-morbid intelligence were obtained using the Wechsler Test of Adult Reading (29). Neuropsychological tests of attention and information processing speed were used to assess current cognitive functioning, as this domain was found to be most frequently impaired 5–22 years following TBI (20). Tasks included the Symbol Digit Modalities Test (SDMT; 30) and Trail Making Test, Part A (TMT-A; 31).

Procedures

The study protocol was approved by the ethics committees of Monash University and Epworth Hospital. After obtaining written consent from each individual selected from the hospital database, an interview and assessment was arranged at the hospital or the participant's home. Following interview to determine current and pre-injury demographic and medical information, including medications used, the SPRS (patient version) and HADS were completed by participants. TBI participants identified a healthy individual to serve as their matched control and a relative, spouse or close friend to complete the SPRS SO form. Further medical and treatment details including medical history, date of injury, cause of injury, duration of rehabilitation, Glasgow Coma Scale (GCS) scores and estimated PTA duration were obtained from medical records. Selected healthy controls were interviewed over the telephone for employment data as part of their participation in a concurrent study (20).

Data analysis

The relationships between current age and time post-injury, PTA, HADS depression and anxiety scores and SPRS scores were examined using scatterplots and bivariate curve estimations under SPSS version 15. Due to non-linear associations between age and HADS depression and anxiety, SPRS subscales and employment, the 5 age subgroups formed the basis of further statistical analyses when age was used as a categorical variable. ANOVA and Pearson's χ^2 analysis were conducted to determine age differences for SPRS scores and employment/unemployment rates, respectively.

Pearson product-moment correlation coefficients, Spearman's rank order correlation, and *t*-tests were conducted to examine the relationships between SPRS patient and SPRS SO ratings and to undertake bivariate analyses of the relationship between SPRS ratings with demographic, injury-related and current functioning variables. These variables included age, gender, pre-morbid estimated IQ, current and pre-injury employment status (employed vs unemployed), current and pre-injury relationship status (single vs married/*de facto*), PTA duration, time post-injury, cognitive ability and HADS anxiety and depression scores. The significance level was set to 0.05 (2-tailed) for all analyses.

In order to compare the relative contributions of the predictors identified in the bivariate analyses, analyses of covariance (ANCOVA) were performed. Patients' and SOs' scores on the 3 domains of the SPRS (occupational activity, interpersonal relationships and living skills) were entered as the dependent variables in each ANCOVA. Those demographic, injury-related and current functioning variables that were significantly associated with SPRS ratings in the bivariate analyses were entered as between-subjects factors or covariates in the ANCOVAs. Current employment and relationship status were not entered in the ANCOVAs, as this information was partly contained within the scale items. Preliminary checks were conducted to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariates.

To further investigate the findings of the SPRS occupational activity domain, Pearson's χ^2 analysis and *t*-tests were conducted to compare those who were currently employed vs unemployed according to current age, gender, pre-morbid estimated IQ, pre-injury employment status, current and pre-injury relationship status, PTA duration, time post-injury, cognitive ability and HADS anxiety and depression scores. A blockwise binary logistic regression was then conducted, with current employment entered as the dependent variable and the significant predictors identified from the bivariate analyses entered as independent variables in blocks. In order to consider the relative contribution of each block to the prediction of employment status the blocks entered were: (*i*) pre-injury and injury-related variables; (*ii*) controls' employment; (*iii*) current functioning scores; and (*iv*) current age of TBI participants. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. No outliers were identified, as defined by Cook's distance > 1. Nagelkerke R^2 was used as a measure of the proportion of variance accounted for in the dependent variable.

RESULTS

Participants

TBI participants were seen at an average of 11.2 years post-injury (SD 3.65; range 5–22 years). The mean age of participants at the time of injury was 43.6 years (SD 17.6; range 16–81). Sixty percent of the sample were male ($n = 67$). Cause of injury for 88.7% was motor vehicle accident. Injury severity ranged from mild to severe as measured by GCS and PTA. Of the 83 participants (74.1%) for whom GCS scores were available, the mean GCS was 8.1 (SD 4.5; range 3–15). Prospectively determined PTA duration (32) was available for all participants; the mean PTA duration was 26.0 days (SD 26.8; range 0.1–120). Bivariate analyses revealed no significant correlations between age at injury and PTA or between age at injury and time since injury. A Kruskal-Wallis test showed no significant difference in age across the various accident causes.

SPRS results

As shown in Table III, there was wide variability in outcomes across the SPRS domains, with ratings made by participants with TBI and their SOs ranging from 0 (extreme change) to 24 (no

Table III. *Sydney Psychosocial Reintegration Scale (SPRS) means and standard deviations (SD) for participants with traumatic brain injury (TBI) and their significant others (SO)*

	Participants with TBI		SO	
SPRS domain	Mean (SD)	Range	Mean (SD)	Range
Occupational activity	14.65 (5.92)	2–24	14.05 (6.72)	0–24
Interpersonal relationships	17.35 (5.56)	1–24	17.09 (5.54)	4–24
Living skills	20.00 (4.25)	6–24	19.28 (4.93)	3–24

change). The most marked changes were reported in occupational activity, followed by interpersonal relationships and living skills. Paired sample *t*-tests revealed no significant differences between reports of participants with TBI and their SOs on any SPRS domains or total scores. High correlations were found between participants with TBI reports and SO reports on individual SPRS domains (occupational activity, $r=0.71$; interpersonal relationships, $r=0.55$; living skills, $r=0.58$). For ease of presentation, subsequent results will be presented for SOs only.

Hypothesis 1: relationship between SPRS living skills and age

From the bivariate statistics (Table IV), there were significant relationships between the Living Skills scale and longer PTA, worse performance on attention and speed of information processing tasks, and higher levels of depression and anxiety. Age was not significantly associated with the living skills domain. After controlling for variables that were significantly related to SPRS living skills in the bivariate analyses, ANCOVA revealed no significant differences between the age groups, $F(1,102)=0.30$, $p=0.88$.

Hypothesis 2: relationship between SPRS interpersonal relationships and age

From the bivariate analyses (Table IV), ratings showed that lower pre-morbid IQ, longer PTA, poorer performance on attention and information processing speed tasks, higher levels of anxiety and depression, and pre-morbid marital status were associated with poorer interpersonal relationships outcome compared with pre-injury functioning. After controlling for variables that were significantly related to SPRS interpersonal relationships in the bivariate analyses, ANCOVA revealed no significant differences between the age groups, $F(1,100)=0.21$, $p=0.93$.

Hypothesis 3a: relationship between SPRS occupational activity and age

As detailed in Table IV, bivariate analyses revealed that lower scores on the SPRS occupational activity were significantly associated with older age, lower pre-morbid IQ, longer PTA, greater cognitive impairment on attention and speed of information processing tasks, higher levels of depression and anxiety and premorbid marital status. After controlling for variables

Table IV. *Bivariate comparisons*[1] *of Sydney Psychosocial Reintegration Scale (SPRS) scores with demographic, pre-injury, injury-related and current functioning variables*

	SPRS Occupational activity		SPRS Interpersonal relationships		SPRS Living skills	
Variables	Pearson's *r*	*p**	Pearson's *r*	*p**	Pearson's *r*	*p**
Pre-morbid estimated IQ	0.27	0.01	0.33	0.00	0.18	0.08
PTA duration	–0.29	0.00	–0.25	0.00	–0.23	0.00
Time post-injury	0.05	0.62	0.08	0.44	0.15	0.13
SDMT	0.41	0.00	0.38	0.00	0.37	0.00
TMT-A	–0.41	0.00	–0.33	0.00	–0.44	0.00
HADS depression	–0.33	0.00	–0.37	0.00	–0.31	0.00
HADS anxiety	–0.32	0.00	–0.37	0.00	–0.33	0.00
Age (years)	Mean (SD)	*p*‡	Mean (SD)	*p*‡	Mean (SD)	*p*‡
26–37	17.20 (6.83)	0.00	18.80 (5.72)	0.14	20.56 (4.93)	0.22
38–49	16.44 (5.44)		18.44 (5.68)		20.56 (4.78)	
50–61	10.53 (7.53)		14.80 (6.16)		17.40 (5.58)	
62–73	12.04 (5.83)		16.62 (4.81)		18.50 (4.58)	
74–89	13.16 (6.14)		16.00 (5.14)		18.95 (4.77)	
Gender						
Male	14.63 (6.38)	0.30	17.70 (5.32)	0.19	19.57 (5.21)	0.19
Female	13.23 (7.16)		16.23 (5.80)		18.88 (4.54)	
Pre-morbid employment						
Employed	13.86 (6.70)	0.68	17.09 (5.66)	0.10	19.06 (5.12)	0.52
Unemployed	14.44 (6.20)		17.09 (5.37)		19.74 (4.58)	
Pre-morbid marital status						
Single	15.57 (6.49)	0.02	18.24 (5.21)	0.04	19.88 (4.65)	0.22
Married/de facto	12.56 (6.66)		15.96 (5.67)		18.96 (5.17)	

*$p<0.05$ (two-tailed); ‡*p*-value for ANOVA.

[1]Bivariate statistical tests: Pearson's correlations, Spearman's rank order correlations, Student's *t*-tests and ANOVA.

HADS: Hospital Anxiety and Depression Scale; PTA: duration of post-traumatic amnesia; SD: standard deviation; SDMT: Symbol Digit Modalities Test; TMT-A: Trail Making Test, Part A.

that were significantly related to SPRS occupational activity in the bivariate analyses, ANCOVA revealed no significant differences between the age groups, $F(1,100)=1.83$, $p=0.13$.

Hypothesis 3b: relationship between TBI employment rates and age relative to controls

Bivariate analyses indicated significant relationships between TBI participants' employment status and controls' employment status, pre-morbid employment status, pre-morbid marital status, pre-morbid IQ, PTA duration and TBI participants' age and performance on tests of attention and speed of information processing, as shown in Table V. Pearson χ^2 analysis revealed a significant relationship between current employment status of TBI participants and current employment status of controls according to age (Table VI), whereby the proportion of employed TBI participants reduced with age, relative to employed controls matched for gender, age, estimated IQ and level of education, χ^2 (4, $n=112$) $=26.16$, $p<0.001$

Table V. *Predictors* of participants with traumatic brain injury (TBI) employment rates from bivariate comparisons†*

	Current employment status of participants with TBI		
Variables	Employed *n* (%)	Unemployed *n* (%)	*p*‡
Controls' employment			
Employed	41 (89.1)	31 (47.0)	0.00
Unemployed	5 (10.9)	35 (53.0)	
Gender			
Male	31 (67.4)	36 (54.5)	0.17
Female	15 (32.6)	60 (45.5)	
Pre-morbid employment			
Employed	37 (80.4)	39 (59.1)	0.02
Unemployed	9 (19.6)	27 (40.9)	
Current marital status			
Single	18 (39.1)	26 (39.4)	0.98
Married/de facto	28 (60.9)	40 (60.6)	
Pre-morbid marital status			
Single	33 (71.7)	25 (37.9)	0.00
Married/de facto	13 (28.3)	41 (62.1)	
Age, years			0.00
26–37	20 (43.5)	7 (10.6)	
38–49	15 (32.6)	4 (6.1)	
50–61	7 (15.2)	11 (16.7)	
62–73	3 (6.5)	25 (37.9)	
74–89	1 (2.2)	19 (28.8)	
	Mean (SD)	Mean (SD)	*p*§
Pre-morbid estimated IQ	104.48 (10.13)	99.77 (8.88)	0.01
PTA duration	18.63 (22.01)	31.20 (28.72)	0.01
Time post-injury	11.00 (2.74)	11.38 (4.18)	0.56
SDMT	51.89 (13.26)	37.11 (12.47)	0.00
TMT-A	29.85 (12.22)	57.59 (40.38)	0.00
HADS depression	5.27 (3.94)	6.42 (4.08)	0.61
HADS anxiety	6.34 (4.67)	6.80 (4.11)	0.15

*Significant predictors from the bivariate analyses were entered as independent variables in the binary logistic regression analysis
†Bivariate statistical tests: Pearson's χ^2 and Student's *t*-tests.
‡*p*-value for Pearson's χ^2.
§*p*-value for Student's *t*-tests.
HADS: Hospital Anxiety and Depression Scale; PTA: duration of post-traumatic amnesia; SD: standard deviation; SDMT: Symbol Digit Modalities Test; TMT-A: Trail Making Test, Part A.

Table VI. *Relationship between employment status and age for participants with traumatic brain injury (TBI), whose matched controls are employed and unemployed*

Controls' employment status	Current age (years)	Participants with TBI employment rate *n* (%)
Employed	26–37	19 (82.6)
	38–49	14 (82.4)
	50–61	6 (37.5)
	62–73	2 (14.3)
	74–89	0 (0.0)
Unemployed	26–37	1 (25.0)
	38–49	1 (50.0)
	50–61	1 (50.0)
	62–73	1 (7.1)
	74–89	1 (5.6)

Blockwise logistic regression analysis predicting TBI employment status revealed a significant model. Pre-injury and injury-related variables (block 1) accounted for 28.3% of the variance in the dependent variable ($p<0.001$, 80.3% correct classification of employment, 54.3% correct classification of unemployment, 69.6% overall correct classification), while controls' employment status (block 2) added another 9.7% in explained variance ($p<0.01$, 71.2% correct classification of employment, 71.4% correct classification of unemployment, 71.4% overall correct classification). With the inclusion of current cognitive scores (block 3), an additional increase in explained variance of 16.5% ($p<0.001$, 83.3% correct classification of employment, 80.4% correct classification of unemployment, 82.1% overall correct classification) was observed and the addition of age (block 4) brought a further increase in variance of 9.3% ($p<0.01$, 89.4% correct classification of employment, 78.3% correct classification of unemployment, 84.8% overall correct classification). The overall model explained 63.8% of variance ($p<0.001$; all Cook's distances <0.3). In the full model (Table V), TBI participants' employment was predicted by shorter PTA and younger age.

DISCUSSION

The first aim of this study was to determine the impact of increasing age on the SPRS living skills domain. Despite the expectation that the trend seen in short-term studies (i.e. poorer functional outcome with older age) would continue with increasing time post-injury, our results did not support the prediction that older age would be associated with a lower level of adaptive living skills, relative to pre-injury functioning. Previous studies conducted at 5 years or more post-injury have also reported no age effects on ADL independence (6, 16, 18, 19). It would appear that age-related effects on living skills may diminish over time post-injury, perhaps over-ridden by other factors that influence outcome more strongly, as demonstrated by previous studies that have highlighted the strong role played by injury severity, cognitive function and levels of emotional distress in influencing long-term functional outcome

(6, 16, 19). However, the relatively low Cronbach's alpha of 0.77 reported for the SPRS living skills domain, together with the presence of inter-correlations between the 3 domains (22), raises the possibility that it may be tapping into other aspects of psychosocial functioning, thereby potentially preventing the emergence of age effects on independent living skills. For example, social skills may be better grouped with the interpersonal relationships domain or may constitute another domain altogether.

The second aim of this study was to examine whether age has an effect on the SPRS interpersonal relationships domain. The hypothesis that older TBI participants would show better perceived relationship outcome relative to pre-injury functioning than younger TBI participants was not supported, as there were no differences in relationship outcome across age-groups. The impact of age on relationship outcome is arguably more complex following TBI than in the general population, given the dynamic interplay between pre-injury relational ability, severity of injury and post-injury support level. Literature on uninjured individuals suggests that older adults derive most social support from spouses and family, while younger adults are mostly supported through friendships (3). This finding prompts the question as to whether all relationships should be examined within a single homogenous domain when studying age-related effects. Younger individuals with TBI, for whom consolidation of existing friendships is the primary developmental task, may be more affected by their reduced ability to develop intimate friendships (12). Conversely, the emphasis on spousal/parent-child relationships from middle age onwards may result in a greater impact of TBI on the quality of marital and family relationships. As the SPRS integrates all relationships into the interpersonal relationships domain, it is not possible to discern any differential impact of age on various types of relationships. Indeed, the authors of the SPRS concede that the Cronbach's alpha coefficient of 0.69 for the interpersonal relationships domain is somewhat lower than ideal (22), raising the question as to whether the interpersonal relationships domain items may be measuring a somewhat heterogeneous construct.

The final aim of this study was to examine the association between age and occupational activity. Contrary to the hypothesis that older participants with TBI would obtain poorer SPRS occupational activity ratings, no age effects were demonstrated. This contrasts with previous long-term studies that have alluded to the positive effect of younger age on employment outcome (14, 15) and the association between increasing age and poorer leisure participation, albeit across a restricted age range (18). The only other long-term study investigating SPRS occupational activity outcome in younger and older participants also failed to find age differences (16). As suggested by the literature on healthy ageing, it is arguable that retirement may cause individuals to seek out leisure activities as a means of occupying their non-productive time (2). Previous studies have not used measures that take into consideration the individual's pre-injury interests (18); however, if patterns of post-TBI leisure participation were to mirror those of the general population, some potential age effects on leisure may not emerge on the occupational activity scale, as it combines the constructs of employment and leisure into a single domain. Without a control group to partial out normal age-effects, one can only speculate about the basis of the current occupational activity findings.

In order to examine further the premise of age-related changes in employment outcome, we investigated the employment status of TBI participants, relative to that of healthy controls. To our knowledge this is the first investigation of long-term employment outcome that has differentiated the effects of TBI from demographic ageing. In keeping with expectations, compared with healthy individuals of the same age, gender and estimated IQ, older TBI participants were less likely to be employed than younger TBI participants, after controlling for injury severity, pre-morbid IQ and employment, and current cognitive ability. Nightingale et al. (17) asserted that age is not a strong predictor of employment outcome, claiming that there are no differences in the propensity to work in people of typical employment age. However, the current study's findings suggest that, after considering the population trends of declining employment with advancing age, the likelihood of employment in working aged TBI participants does reduce with increasing age. By extending our investigations to those individuals aged above the typical working age, we were also able to show that retirement may not have been inevitable for these older injured individuals, had they not experienced a TBI.

Several limitations need to be considered when interpreting the findings of this study, most notably its cross-sectional design. Comparisons on the SPRS between TBI participants of different ages may have been influenced by other factors that were not controlled for, including the degree of family involvement, pre- and post-injury social support networks and financial resources. The findings regarding employment status were, however, based on stringent individual matching of healthy individuals and participants with TBI in order to minimize cohort differences.

On the basis of a previous study suggesting that Form A of the SPRS is a valid measure of long-term outcome (16), this version was used in the present study rather than Form B, which examines current status of functioning. While Form B may be appropriate in some circumstances where pre-morbid functioning is irrelevant, it was considered unsuitable for the present study as we deemed it important to evaluate changes in pre- to post-injury psychosocial functioning. However, it is arguable that age-related changes at such long periods post-injury may have been masked by using Form A due to the difficulty raters may have experienced in attributing change to injury vs normal age-related transitions that are likely to have occurred since injury. To overcome this issue, future research could compare Form B ratings for long-time TBI survivors with those of healthy controls, closely matched on a broader range of demographic variables, including leisure pursuits, friendships, relationship status and living situation in order to account for pre-injury lifestyle and interests. This would present a significant challenge.

The presence of sample bias is possible in this study, given that all TBI participants (up to the age of 89 years) were community-dwelling residents. Four potential participants residing in nursing homes had to be excluded on the basis of cognitive or physical inability to complete the assessments due to other medical conditions and dementia. The necessary exclusion of individuals too disabled to complete the assessment procedures may have contributed to the non-significant findings regarding age effects on living skills. Another potential source of sample bias in this study was the higher rate of attrition and participation refusal in older compared with younger non-participants, which is expected in any study that has a lengthy follow-up period and includes older individuals (33). All TBI participants in this study received inpatient rehabilitation and, while treatment was provided irrespective of injury severity or socioeconomic status, our sample may not be comparable with patients receiving different levels of rehabilitation or none at all.

This study was, however, the first to specifically examine the effect of age on long-term psychosocial outcome following TBI with an adequate sample size in the older age-groups and using an outcome measure that assesses changes in specific domains of psychosocial functioning due to TBI. In addition, this was the first attempt to investigate whether increasing age affects long-term employment outcome, after taking into account the declining rates of workforce participation in the general population beyond the age of 60 years.

The findings of the current study show an absence of age effects on each of the domains of the SPRS. It would appear that factors such as injury severity, cognitive impairment and time post-trauma may override specific age-related effects on long-term functioning after TBI. However, given that psychosocial adjustment is a complex construct that is mediated by a number of variables, it may be useful to examine some of its domains separately in relation to healthy age-matched controls, rather than as they are combined on the current SPRS scales. As acknowledged by the developers of the SPRS, the way in which the 3 domains have been conceptualized "may not be the best division" (p. 554; 22). Drawing on psychosocial trends in the general population across the lifespan, it may be possible to more precisely capture age-related patterns following TBI by evaluating the domains of employment, leisure, family/spousal relationships, friendships, social skills and activities of daily living separately, relative to age-matched healthy controls. Alternatively, the domains of participation defined by the WHO International Classification of Functioning, Disability and Health (ICF), including Personal maintenance, Mobility, Exchange of information, Social relationships, Occupation, Economic life and Civic and community Life might serve as an appropriate focus of comparisons across age-groups.

According to the ICF the environment, or more specifically a country's social service and welfare system, has a part to play in an individual's wellbeing and level of functioning. Australia's service response to disability is such that individuals are relatively well supported following TBI. To this end, it is arguable that long-term psychosocial outcomes in Australia may not be comparable to those of other nations. Indeed, the lack of age effects in the current study may be explained to some extent by the social system supports of which the participants of this study were recipients.

The finding of age-related differences in employment status many years or decades following TBI is useful in delineating the focus of rehabilitation planning and vocational support services. The knowledge that older age is associated with a lower likelihood of returning to employment compared with the healthy population of same age, education, gender and IQ, is likely to be useful to health professionals in making prognoses, to TBI individuals in planning for the future, and particularly to vocational rehabilitation professionals in tailoring their programmes. It is arguable that older individuals may require greater attention and rehabilitation resources should they desire to return to work.

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