A population survey found an association between self-reports of traumatic brain injury and increased psychiatric symptoms

Kaarin J. Anstey*, Peter Butterworth, Anthony F. Jorm, Helen Christensen, Bryan Rodgers, Timothy D. Windsor

Centre for Mental Health Research, Australian National University, Canberra, ACT 0200, Australia
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Abstract

Objective: This study determined whether self-reported Traumatic Brain Injury (TBI), identified in a community sample and occurring up to 60 years previously, is associated with current psychiatric symptoms, suicidality, and psychologic well-being.

Study Design and Setting: Three age cohorts (20–24, 40–44, 60–64) were randomly sampled from the cities of Canberra and Queanbeyan, Australia, yielding a total of 7,485 participants. The samples were administered scales measuring anxiety, depression, suicidality, positive and negative affect, personality traits, and physical health status.

Results: Of the total sample, 5.7% reported history of TBI involving loss of consciousness for at least 15 min, occurring an average of 22 years previously. History of TBI was associated with increased symptoms of depression, anxiety, negative affect, and suicidal ideation.

Conclusion: History of TBI is a risk factor for psychiatric morbidity. The effect is greatest in young adults, and occurs up to several decades subsequent to the occurrence of TBI. © 2004 Elsevier Inc. All rights reserved.

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1. Introduction

Traumatic Brain Injury (TBI) is the most common cause of hospitalization in young people, and is a major cause of severe disability, with a greater prevalence in men [1]. Prevalence rates based on hospital discharge data from the United States during 1985 were 120 per 100,000. This is similar to an Australian estimate based on hospital data of 100 per 100,000 [2]. For TBI involving disability, the Canadian Household Survey reported a prevalence of only 97 per 100,000 for males and 53 per 100,000 for females [2]. An Australian estimate of incidence of TBI based on hospital data is 100 per 100,000 [3], whereas rates of 200 to 430 per 100,000 population per year have also been reported [4]. About 70% of TBIs are mild [5].

Emotional disturbances after TBI are some of the most disruptive consequences socially and occupationally [6]. These may include personality change, post-traumatic stress disorder, anxiety, mania, aggression, impulsivity, psychosis, and depression [4]. Clinical studies have shown that mood disturbances are among the most common emotional problems in patients with TBI, with depressive disorders reported to occur in 20–50% of cases [7]. An increased risk for depression persists many decades following TBI [8,9]. Follow-up studies of patients hospitalized after TBI have found that psychiatric conditions are associated with poorer outcomes, even in patients with mild head injuries [10]. Premorbid psychiatric conditions have been identified as increasing the risk of TBI in hospital-based samples and case–control studies [8,9]. Hospital-based studies have shown increased suicide rates following TBI that have been attributed to psychosocial disadvantage and psychiatric disorders resulting from TBI [11,12].

The rates of psychiatric morbidity following TBI or self-reported head injury vary greatly between studies. These differences reflect not only the sample characteristics, but also varying measures of psychiatric morbidity; varying time intervals between TBI and assessment of psychiatric symptoms; differences in the scales used to measure psychiatric symptoms and disorders, and differences in the statistical control for explanatory or confounding variables. For example, Kreutzer et al. [13] reported that 42% of outpatients with brain injury met DSM-IV criteria for major depressive disorder 2.5 years after being assessed at a trauma center. However, the only epidemiologic study involving interviews of a community sample reporting data on TBI and psychiatric disorders, Silver et al. [14] document a 11.1% lifetime prevalence of major depression in adults reporting a history of

* Corresponding author. Tel.: +61 2 61258410; fax: +61 2 61250733. E-mail address: kaarin.anstey@anu.edu.au (K.J. Anstey).

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TBI. This was 2.4 times that of individuals not reporting a history of TBI. In addition, this study reports lifetime prevalences of 3.2% for panic disorder, 4.7% for obsessive compulsive disorder, and 24.5% for alcohol abuse or dependence among individuals reporting history of “severe” TBI. These authors also found that individuals reporting a history of head injury report 5.7 times the rate of suicide attempt than those not reporting a history of TBI. In an epidemiologic study based on review of hospital inpatient records, TBI during childhood or adolescence was found to increase the risk of subsequent mental disorder twofold [15].

Most research on psychiatric disorders in TBI has been conducted on patients hospitalized subsequent to TBI or receiving ongoing rehabilitation through specialized clinics. Inferences about the population prevalence of affective symptoms and psychiatric disorders based on such studies are not possible due to biases associated with selection effects [16]. That is, patients who are admitted to hospital or receive treatment at an outpatient clinic may be characterized by factors including distance to hospital, cost, severity of TBI, social support, and availability of specialized medical services [14]. Therefore, the true estimate of psychiatric morbidity in TBI needs to be established in a population-based sample. It is especially important to establish the psychiatric sequelae of TBI in young adults, for whom incidence is highest and potential cost in terms of quality of life and psychosocial function is greatest.

Surveys of population-based and convenience samples using self-report measures of history of TBI have used various definitions. Two studies of college students have used questions such as “Have you ever had a head injury in which you lost consciousness?” [17], and “have you ever had a medically diagnosed head injury/illness or a period of unconsciousness of 20 or more minutes?” [18]. The New Haven National Institute of Mental Health (NIMH) Epidemiologic Catchment Area Study identified individuals with TBI as those responding “yes” to the question “Have you ever had a severe head injury that was associated with loss of consciousness or confusion?” [14]. The Canadian Household and Institutional Health and Activity Limitation Surveys identified national prevalence rates of TBI using the following questions (answers in parentheses are required to each question to identify head injury): 1. “From time to time, everyone has trouble remembering the name of a familiar person, or learning something new, or they experience moments of confusion. However, do you have ongoing problems with your ability to remember or learn?” (Yes). 2. “Are these problems caused by a condition that you had when you were born?” (No). 3. “What condition caused you these problems?” (Head injury) [3]. Clearly, the self-report measures adopt a variety of approaches to operationalising TBI, and mostly do not indicate severity of head injury.

Another important issue in studying psychiatric symptoms and conditions in TBI is that they overlap with the symptoms of postconcussion syndrome [19]. DSM-IV research criteria for postconcussion disorder include becoming fatigued easily, disordered sleep, headache, vertigo or dizziness, unprovoked irritability or aggression, anxiety, depressive affective lability, personality change, and apathy or lack of spontaneity. Clinically, this overlap in definitions is problematic because psychiatric symptoms and disorders may be confused with postconcussion disorder, so patients may not receive adequate psychiatric treatment [4]. From a research perspective, it is important to consider that postconcussion symptoms may be included as items in measures of depression and anxiety, leading to bias in prevalence estimates of depression and anxiety disorders and symptoms.

Factors that both predispose individuals to TBI, or that may result from TBI, potentially explain or confound the association between history of TBI and psychiatric symptoms. These include physical illness, personality, and demographic variables such as age, gender, and financial hardship. For example, where psychiatric symptom scales include somatic symptoms, high scores may simply reflect poorer general health of individuals with a history of TBI that is a direct result of the TBI. Prospective studies have shown financial and physical problems occur post-TBI in association with psychiatric disorder [20]. Interactions between psychiatric symptoms and age, gender, or socioeconomic status may also influence the observed association between head injury and psychiatric symptoms. It is possible that certain antisocial personality characteristics including impulsivity and risk-taking may predispose individuals to both head injury and psychiatric symptoms or disorders [21]. The age of the sample surveyed may also affect prevalence rates. Older adults may not recall head injuries earlier in life; motor vehicle accidents have declined over the past 20 years, and there have been improvements in occupational health and safety practices and rehabilitation. These factors mean that different age cohorts may demonstrate different prevalence rates of head injury and associated psychiatric morbidity [22].

The present study investigates psychiatric symptoms, suicidality, and psychologic well-being in individuals reporting history of TBI in a community survey of adults aged 20–24, 40–44, and 60–64. Among the three age groups combined, the average number of years since TBI was 22, and even in the youngest age group, the average number of years since TBI was 7. This is the first epidemiologic study to determine whether current psychiatric symptoms and psychologic well-being are significantly associated with TBI occurring many years previously. The robustness of the findings is evaluated by considering potentially confounding or explanatory variables in multivariate analyses.

2. Methods

2.1. Participants

The sample came from the PATH Through Life Project, a large community survey concerned with the health and
well-being of people aged 20–24, 40–44, and 60–64 years who live in the Canberra or the neighboring town of Queanbeyan. Each cohort is to be followed up every 4 years, over a total period of 20 years. Results presented here concern the first-wave interviews with 20–24 year olds, which were conducted in 1999 and early 2000, with 40–44 year olds, which were conducted in 2000 or early 2001, and with 60–64 year olds, conducted in 2001 and early 2002. Participants had to be in their respective age group on 1 January of either 1999 (for 20–24 year olds), 2000 (for 40–44 year olds), or 2001 (for 60–64 year olds). The sampling frames were the Electoral Rolls for Canberra and Queanbeyan, Australia. Registration on the Electoral Roll is compulsory for Australian citizens. Because the Australian Electoral Commission would only release decade age ranges for research purposes, we wrote to 12,414 persons recorded as aged 20–29 years on the Electoral Roll and asked for participation of those aged 20–24 years. Out of these, 5,058 were found to be out of the required age range, 1,061 were known to have moved out of the area, 2,190 could not be found, 1,701 refused or had poor English language skills, and 2,404 were interviewed. The participation rate of those who were found and who were in the required age range was 58.6%. Similarly, for the 40–44 year olds, 9,033 persons were sent letters, 4,222 were out of the required age range, 280 had moved, 612 could not be found, 1,389 refused or had poor English, and 2,530 were interviewed (64.6% of those found and in age range). For the 60–64 year olds, there was a change to the law allowing the Australian Electoral Commission to release more specific age group information. Letters were sent to 4,831 persons, 34 were out of the required age range, 182 had moved, 28 were dead, 209 could not be found, 1,827 refused or their English was too poor to allow an interview, and 2,551 were interviewed (58.3% of those found and in age range). The gender breakdown of the sample was 1,163 males and 1,241 females at age 20–24, 1,193 males and 1,337 females at age 40–44, and 1,319 males and 1,232 females at age 60–64.

2.2. Survey procedure

Persons selected at random from the Electoral Roll were sent a letter informing them about the survey and noting that an interviewer would contact them to see if they wanted to participate. If a person agreed to participate, the interviewer arranged to meet them at some convenient location, usually the participant’s home or the Centre for Mental Health Research. Participants completed the survey and answered demographic questions on a Hewlett-Packard 620LX palm-top personal computer using the Surveycraft software for computer-assisted personal interviewing. The study was approved by the Australian National University Research Ethics Committee.

2.3. Measures

Anxiety and depression symptoms in the past month were assessed by the Goldberg anxiety and depression scales, which give scores of 0 to 9 for a number of symptoms of anxiety and of depression [23]. Lifetime history of depression was assessed by the single question “Have you ever in your life been markedly depressed; that is, for several weeks or more, you felt sad, lost interest in things, and felt lacking in energy?” (Yes/No). Physical and Mental Health were measured by the Physical and Mental Component Summary of the SF-12, each with a mean of 50 and standard deviation of 10 in the U.S. general population, with higher scores reflecting better health [24]. Suicidality was assessed with questions taken from the Psychiatric Symptom Frequency Scale [25]. The questions were: “In the last year have you ever: (a) felt that life is hardly worth living? (b) thought that you really would be better off dead? (c) thought about taking your own life? (d) made plans to take your own life?, and, (e) attempted to take your own life?” These required Yes (0) or No (1) responses, and were summed to form a “Suicidality” measure. Scores on the Suicidality measure ranged from 0 to 5. Emotional well-being was measured using the Positive and Negative Affect Scales (PANAS), which give scores ranging from 10 to 50. Higher scores indicate greater affect, either positive or negative [26].

Personality was assessed with the Eysenck Personality Questionnaire–Revised (EPQ-R) [27], which yields a score for Neuroticism (EPQ-N), Extraversion (EPQ-E), and Psychoticism (EPQ-P). Education was completed full time years of education. People with financial problems replied “Sometimes” or “Often” to the question “Have you or your family had to go without things you really needed in the last year because you were short of money?”

Alcohol consumption was measured using the World Health Organization (WHO) Alcohol Use Disorders Identification Test [28]. Weekly consumption of standard drinks was estimated from items measuring reported frequency of alcohol intake, and the number of standard drinks consumed on typical drinking days, following quantity-frequency assessment procedures [29,30]. An adjustment was made to this algorithm based on the frequency participants reported consuming six or more standard drinks (binge drinking).

History of TBI was assessed by asking “Have you ever had a serious head injury where you became unconscious for more than 15 minutes?” Possible answers included Yes, No, and Uncertain. Individuals who answered “Uncertain” (n = 295) were excluded from the present study. In addition, for those who reported history of TBI, data was collected on the number of TBIs (coded 0, 1, >1), and age at first and most recent TBI.

2.4. Statistical analysis

Frequency data was analyzed using chi-square, and associations among continuous and ordinal variables were analyzed using Pearson correlations. T-tests were used to compare TBI and No-TBI groups in unadjusted analyses. General Linear Models were used to investigate the association of TBI with psychiatric morbidity adjusting for demographic, health, and personality factors. Means (described
as marginal means) for the key dependent variables were estimated after adjusting for demographic, physical health, and personality variables.

3. Results

3.1. Prevalence of self-reported head injury and demographic characteristics

Overall prevalence of self-reported TBI was 5.7%. This did not vary between age groups with the prevalence rates by age group being 6.0, 5.6, and 5.6% for 20–24-, 40–44-, and 60–64-year-olds, respectively. A larger proportion of the TBI group (49.9%) reported having ever been depressed compared with the No-TBI group (42.6%) ($\chi^2[1] = 8.60$, $P < .01$).

Demographic characteristics of the TBI and No-TBI groups are shown in Table 1. TBI was more prevalent among males (8.8%) than females (3.3%) ($\chi^2[1] = 93.05$, $P < .01$) with 72.2% of the 20–24-year-old TBI group being male, 67.61% of the 40–44-year-old TBI group being male, and 73.9 of the 60–64-year-old TBI group being male. The TBI group did not differ from the No-TBI group on any other demographic characteristics. There was a main effect of age group on education such that the 60–64-year-old age group reported less education than the younger age groups. Participants in the 20–24-year-old group were more likely to report financial problems and less likely to be married.

3.2. Personality and physical health

There were no differences between TBI and No-TBI groups in levels of EPQ neuroticism or EPQ extroversion. Scores on the EPQ psychoticism scale were higher in the 60–64-year-old males reporting history of TBI than the 60–64-year-old males not reporting TBI ($F[1, 1253] = 9.30$, $P < .01$), but there were no other differences in Psychoticism between groups. Self-reported physical health (SF12-Physical Health) was worse in the TBI group regardless of gender ($F[1, 7140] = 26.20$, $P < .01$) and an interaction between the TBI group and age group ($F[2, 7140] = 6.04$, $P < .01$) revealed that this difference was greater in the 60–64 year olds.

3.3. Unadjusted mean differences in symptom scales, alcohol consumption, and suicidality by age group and TBI group

The means and standard deviations for anxiety, depression, affect, and suicidality according to TBI group, age group, and gender are shown in Table 2. In 20–24-year-old males TBI was associated with higher levels of anxiety, mental health symptoms on the SF-12, and suicidality. In 20–24-year-old females, TBI was associated with poorer scores on the SF-12 mental health scale, higher levels of suicidality, higher positive and negative affect, and greater alcohol consumption. In 40–44-year-old females, TBI was associated with higher levels of anxiety and suicidality. In 60–64-year-old males, TBI was associated with higher levels of anxiety and depression, poorer mental health on the SF-12, and reduced positive affect. In 40–44-year-old males and 60–64-year-old females TBI was not associated with higher scores on any of the scales.

3.4. Effect of TBI on symptom scales and suicidality adjusting for demographic, personality, and health variables

Table 3 shows the marginal means and standard errors for TBI and No-TBI groups adjusting for demographic (age group, gender), physical health, and EPQ-Psychoticism. Overall, TBI was associated with higher levels of anxiety,
poorer mental health, higher levels of negative affect, and higher levels of suicidality.

### 3.5. Symptom patterns among TBI and No-TBI groups on Goldberg scales and suicidality

Fig. 1 shows the difference between TBI and No-TBI groups in the prevalence of symptoms of depression and anxiety measured by the Goldberg scales. Analysis of individual symptoms showed that the TBI group were more likely to report poor sleep ($\chi^2[1] = 6.35, P < .01$); dizziness ($\chi^2[1] = 18.00, P < .01$); worry about health ($\chi^2[1] = 7.82, P < .01$); difficulty concentrating ($\chi^2[1] = 93.05, P < .01$); and weight loss ($\chi^2[1] = 4.04, P < .01$). The TBI group was more likely to report that life is hardly worth living ($\chi^2[1] = 7.98, P < .01$); thinking that that would really be better off dead ($\chi^2[1] = 14.67, P < .01$); that they had thought about taking their own life ($\chi^2[1] = 11.28, P < .01$) but were not more likely to report having made plans to take their own life or having attempted to take their own life.

### 3.6. Number of TBI and time since TBI

Of the 428 participants reporting TBI, 91 reported more than one TBI. There was a significant association between number of TBI (0, 1, >1) and anxiety ($F[2, 7432] = 9.82, P < .01$) and poorer mental health as measured by the SF-12 Mental Health scale ($F[2, 7446] = 8.65, P < .01$).

Within age-group correlations of years since last TBI and Goldberg Anxiety Scale, PANAS Negative Affect Scale, SF-12 Mental Health, and EPQ-Psychoticism.
SF12 Mental Health scale, and Suicidality are shown in Table 4. Recency of TBI was not associated with Anxiety, Negative Affect, or the SF-12 Mental Health scale in the 20–24-year-old age groups. However, there was a pattern of higher symptom scores occurring in participants with more recent TBIs in the two older age groups. There was no association between suicidality and recency of TBI. The most recent TBI for the youngest cohort was only 7 years previous compared with 22 years previous and 37 years previous in the two older age cohorts.

4. Discussion

We report rare, population-based data on psychologic well-being, anxiety, depression, and suicidality in three cohorts of community dwelling adults with self-reported history of TBI. Although there have been clinical studies on the long-term psychiatric consequences of TBI [4,7,31], we have been able to identify only two other epidemiologic study of psychiatric morbidity following TBI [14,15], neither of which report information on symptom levels. Importantly, our results confirm the general finding from clinical studies, and epidemiologic studies based on hospital admission [15] and clinical diagnoses [14]. These findings are that individuals with a history of TBI report more symptoms of anxiety and negative affect and higher levels of suicidality, and that these effects persist for up to decades. Our results suggest that in the middle and older age cohorts, symptoms of depression, anxiety, and negative affect diminish over time and that a history of multiple TBI is associated with higher levels of affective symptoms. Reported TBI was not related to alcohol consumption after adjusting for relevant demographic, personality, and health variables.
Although the measure of TBI used in the present study was more stringent than in some studies requiring any period of unconsciousness to make a diagnosis, our measure did not discriminate between mild and severe TBI, and was based on self-report rather than clinical assessment. This has both advantages and disadvantages. On the one hand, clinical studies overlook individuals who have TBI but do not engage with health services, and so do not give a true estimate of the prevalence and possible impact of TBI at a population level. On the other hand, individuals with no adverse effects from a TBI would be included in our category of history of TBI. That is, individuals who have been unconscious for 15 min or more as a result of a TBI, but who have had no long-term adverse consequences were included. This would dilute an effect of TBI on psychiatric morbidity, although some studies have reported similar psychosocial outcomes for both mild and severe TBI [20].

The results of our study are likely to underestimate the association between TBI and suicidality because individuals who have actually committed suicide would not be included in the study. This may in part explain why we found history of TBI associated with more suicidal symptoms but not with higher rates of suicide attempts. Although this was a population survey, our participation rate of 68% may not have included individuals with significant impairment from TBI, and hence, we have most likely underestimated the psychiatric symptoms of the entire population of individuals with a history of TBI.

Another issue raised by the present study is the problem of differentiating postconcussion syndrome from depression and anxiety after a TBI. The symptoms on the Goldberg depression and anxiety scales, which were endorsed more frequently by the TBI group, were all symptoms of postconcussion syndrome listed by either by DSM-IV or referred to in clinical studies as being part of postconcussion syndrome [4]. It is therefore possible that the psychiatric morbidity associated with TBI is, in fact, simply postconcussion syndrome, or that postconcussion syndrome is better defined in terms of existing psychiatric diagnoses. The TBI group did not report more worry or feelings of hopelessness than the No-TBI group, and yet these are key symptoms of anxiety and depression. However, the overall patterns of responses on the Goldberg scales were similar for both the TBI and the No-TBI groups. Our study did not measure post-traumatic stress disorder (PTSD), which is strongly associated with TBI [32], and it is possible that some of the symptoms of depression and anxiety identified were attributable PTSD.

Another important finding from the present study was the differential effects observed within different age cohorts. TBI was associated with greater psychiatric morbidity in the 20–24-year-old age group, but this group had overall higher symptom scores and reported higher levels of suicidality than the older age groups. These results suggest that it is important to statistically control for age in samples with wide age ranges when studying morbidity associated with TBI. It is likely that age differences are, in part, caused by the recency of TBI in the younger compared with the older age cohorts. However, even though age effects were present, the most significant finding of the study was the presence of psychiatric symptoms decades after TBI. It is possible that this observation is, in part, explained by the propensity of individuals with psychiatric disorders to be at greater risk of TBI [10]. Nevertheless, the results of this study suggest that the association between history of TBI and psychiatric morbidity persists over the lifespan. This study also confirms previous research showing that individuals with a history of multiple TBI report higher levels of symptoms on affect scales, and higher levels of suicidality.

It is not possible to draw causal inferences from the data reported here because they are cross-sectional, and do not relate time of TBI to onset of psychiatric symptoms. Evidence that premorbid psychiatric conditions are a risk factor for TBI should be considered when interpreting the results, especially for multiple TBI. The present study is also limited by the lack of clinical assessment and lack of severity rating for head injury. Nevertheless, the finding of increased psychiatric morbidity among individuals reporting TBI was consistent across various measures, reduced with time and increased with multiple head injury. The fact that on average most recent TBI for in the 60–64-year-old age group occurred at age 25, and yet males reporting TBI in this group still experienced poorer mental health than their peers, suggests that TBI may represent a lifetime risk factor for psychiatric symptoms. We conclude, therefore, that self-report of TBI is associated with increased psychiatric symptoms and increased suicidality, and that this association is greatest for young adults.

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