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Psychological Outcomes following Moderate-to-Severe Acquired Brain Injury: A Longitudinal Study

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Abstract

Emotional distress is highly prevalent in the years following an Acquired Brain Injury (ABI). Yet, there is a lack of research examining the long-term psychological outcomes, and potential influencing factors, among individuals with ABIs. In this study we trace longitudinal changes in neuropsychological outcomes in 32 individuals with moderate-to-severe ABI who engaged in neurorehabilitation in a post-acute hospital. Outcomes assessed at one- and eight-years post-ABI include emotional distress, coping, subjective experience of injury-related difficulties and quality of life. Almost half of all participants reported clinically elevated symptoms of anxiety and depression at eight-years post-ABI (t2). There was minimal variation in neuropsychological outcomes between one- and eight-years post-ABI. Greater use of maladaptive coping responses was associated with greater symptoms of anxiety and depression at t1. As the subjective experiences of injury-related difficulties increased, so too did the symptoms of anxiety and depression at both timepoints. Higher levels of depression were associated with lower psychological and social quality of life at t1 and lower levels of psychological, physical, social and environmental quality of life at t2. **This** study offers a unique insight into the intricate links that exist longitudinally between coping responses, subjective experiences of injury-related difficulties, quality of life and emotional distress following an ABI. It also highlights the need to conceptualise ABI as a chronic health condition that requires long term psychological support.

Keywords: Longitudinal outcomes, Acquired Brain Injury, Anxiety, Depression, Quality of Life, Coping

Introduction

Acquired brain injury (ABI) **is a leading cause of death and disability globally**, often result**ing** in chronic neurological, physical, cognitive, emotional, behavioral, and interpersonal challenges (Alway et al., 2016; Draper et al., 2007; **Gregório et al., 2014;** Jacobsson et al., 2010).

Psychologically, individuals with ABI frequently face identity issues (Dwyer et al., 2017; O'Keeffe et al., 2020), adjustment difficulties (Mitchell et al., 2017), and elevated rates of mental health disorders (e.g., anxiety, depression; Bryant et al., 2010; Diaz et al., 2012; Mitchell et al., 2017). Reported rates of psychological distress vary widely from 22% to 75% in the initial years post-injury (Bombardier et al., 2010; Alway et al., 2016; Jørgensen et al., 2016; Litofsky & Resnick, 2009; Liu et al., 2024; Bryant et al., 2010; Bergersen et al., 2013).

Research on the long-term psychological outcomes of ABI is limited, with few studies examining these outcomes beyond five years post-injury, and even fewer taking a longitudinal approach (Alway et al., 2016; de Bekker et al., 2022; Neumann et al., 2022).The existing research on neuropsychiatric difficulties following ABI suggest that symptoms can persist beyond the first decade post-injury (Alway et al., 2016; Dikmen et al., 2004; Blum et al., 2020; Kvam et al., 2024; Tang et al., 2012).

Psychological distress following ABI is likely to be influenced by both direct and indirect consequences of the injury. Direct effects may include damage to neural regions such as the frontal, temporal, or limbic areas, which are associated with psychiatric conditions like anxiety and depression (Beitchman al, 2020; Bryant et al., 2010; Guo et al., 2021). Indirect factors, such as difficulties adjusting to life post-injury, may also

contribute to the psychological distress experienced following ABI (Brands et al., 2012; Cardile et al., 2024; Vaghela et al., 2023). Additionally, pre-existing psychological vulnerabilities can further exacerbate distress following ABI (Alway et al., 2016; Goldman et al., 2022).

Mood difficulties, particularly when undetected and untreated, are associated with poorer post-injury functional and psychological outcomes, diminished quality of life (QOL), and increased suicidality (Bombardier et al., 2010; Osborn et al., 2016; Scheenen et al., 2017). **Psychological distress following ABI also significantly contributes to the overall disability burden post-injury (Alway et al., 2016; Bryant et al., 2010).**

Coping styles may be an important mediating factor in psychological distress and general wellbeing following ABI (Gregorio et al., 2014; Scheenen et al., 2017; Wolters et al., 2010). It is generally accepted that adaptive coping strategies, for example active and problem-focused coping, lend to more favorable outcomes than maladaptive coping strategies following ABI (Tomberg et al., 2007; Wolters et al., 2015; Gregorio et al., 2014). People with ABI are more likely to use maladaptive coping strategies, such as avoidance, than the general population (Wolters et al., 2015; Wolters et al., 2011), the use of which has been linked to maladjustment, emotional distress and psychosocial and executive dysfunction and emotional distress (Anson & Ponsford, 2006; Tomberg et al., 2007; Kegel et al., 2014). Although few studies have examined long-term coping after ABI, some indicate an increase in maladaptive coping strategies over time (Tomberg et al., 2010; Miller & Mittenberg, 1998). Still, the coping trajectory, and its relationship to psychological distress following ABI, remains unclear, particularly in the long term.

QOL is considered to be reflective of general wellbeing, and is an important indicator of successful ABI rehabilitation (Jacobsson et al., 2010; Verdugo et al., 2019). Most studies on QOL after ABI focus on the initial years post injury, indicating a decline in QOL during this period (Jacobsson et al., 2010; Teasdale & Engberg, 2005). As a core component of QOL, psychological functioning- and in turn, psychological distress- are key determinants of reported QOL (Group, 1997). Studies consistently demonstrate that psychological distress is related to lower QOL in the first years following ABI (Bryant et al., 2010; Hume et al., 2023; Diaz et al., 2012), though the relationship between these factors in long term ABI rehabilitation remains poorly understood (Teasdale & Engberg, 2006; Verdugo et al., 2021).

Psychological distress experienced post-ABI may be influenced by the subjective experience of injury related difficulties (Bergersen et al., 2013; Teasedale & Engberg 2005; Schonberger et al., 2014). The few existing studies examining this relationship focus on the early rehabilitation period, demonstrating that individuals reporting more ABI-related symptoms have higher levels of emotional distress (Schonberger et al., 2014; Whelan-Goodinson et al., 2010; de Koning et al., 2016). Current evidence suggests that this relationship persists some 3-4 years into neurorehabilitation (Bergensen et al., 2013; Haacke et al., 2006), though few studies have examined this relationship several years post-injury.

In summary, there is much uncertainty about the role of emotional distress, and related psychological factors in the post acute stage of ABI rehabilitation. The extent to which psychological distress secondary to ABI persists in the long-term is an important question that merits further attention. Additionally, **further** consideration should be given to the degree to which factors **associated with psychological distress post-ABI,** such as coping, QOL and **the** subjective experience of injury, influence emotional **outcomes**.

This study aims to trace longitudinal changes in mood, coping, injury-related difficulties, and quality of life experienced between one-and eight-years post-ABI. It seeks to assess the prevalence of emotional distress at one and eight-years post-ABI, and to determine whether coping, quality of life and injury-related difficulties are associated with emotional distress at each timepoint. Based on the existing literature, it was hypothesised that emotional distress would be prevalent at both one-and eight-years post-ABI, and linked with greater use of maladaptive coping responses, lower QOL and greater injury related difficulties resulting from brain injury at both timepoints.

Materials and Methods

Design

The study was longitudinal in design. Individuals with moderate-to-severe ABI completed outcome assessments at one- and eight-years post-injury.

Procedure

At t1, (one-year post-ABI), information about the study was posted to all eligible participants. A member of the research team contacted participants by telephone to discuss the study in more detail. Where participants agreed to participate, they were asked to give verbal consent over the telephone and a consent form, and the outcome measures were posted to them. Telephone support was offered in completing the questionnaires where participants were experiencing cognitive, motor, language or visual difficulties. Seven years later (eight-years post-ABI; t2), those who participated at t1 and had consented to be contacted about follow-up studies, were contacted by letter to inform them that a second phase of the study would be taking place and that they would be contacted by telephone to discuss it further.

Exclusion Criteria

Participants were excluded from the study if they were under 18 years of age, if it was less than one year since the onset of their ABI at t1, if their level of disability or level of fluency in English meant that they were unable to complete the measures, even with telephone support from the research team, or if they were unable to give informed consent.

Participants

Participants comprised of 45 adults with ABI who attended an inpatient post-acute neurorehabilitation programme following a brain injury between 2010 and 2012. Between timepoints, 13 participants were lost to follow-up. Of these 13 participants, five (38.46%) had died from causes unknown to the research team, five (38.46%) did not consent to participate at t2 and a further three (23.07%) were not contactable at t2. Thus, the final sample for the longitudinal analyses comprised 32 adults who experienced a moderate-to-severe ABI (20 male).

On average, participants were 52.7 years, ranging from 27 to 76 years (see Table 1 for demographic information). Two (6.25%) participants reported having a Psychiatric history prior to injury. There were no significant differences in the demographic and injury characteristics of those who completed t2 participation and those who were lost to follow-up between timepoints (see Table 1)

All participants were classified as having a moderate to severe ABI based on neurological and/or neurosurgical indicators (e.g., Glasgow Coma Scale). The neurorehabilitation programme consisted of input from physiotherapy, speech and language therapy, occupational therapy, medical, social work and psychology. Upon completion of the programme some participants had access to outpatient and community rehabilitation services. At t1, twelve participants (37.5%) reported having received psychological support in the community, which increased to fourteen participants (43.8%) by t2.

Outcome Measures

Participants were asked to complete the following outcome measures one- (t1) and eight-years (t2) after completing the post-acute neurorehabilitation programme.

Hospital Anxiety and Depression Scale (HADS)

The Hospital Anxiety and Depression Scale (HADS) is a 14 item self-report measure which is designed to assess the symptoms of anxiety and depression in medical patient samples including ABI populations (Whelan-Goodinson et al., 2009; Zigmond & Snaith, 1983). Each item is rated on a four-point scale, ranging from 0 to 3, with 3 indicative of greater symptom frequency. The HADS yields a separate subscale score for anxiety (HADS-A) and depression (HADS-D; total score possible range of 0 to 21). **The** recommended cut-off score of ≥ 8 **was used in this study to** establish the presence of depression and anxiety (Krpan et al., 2011). Scores above the clinical cut-off were categorised into mild (8-10), moderate (11-14) and severe (15-21) groupings (Whelan-Goodinson et al., 2009).

The Brief-COPE

The Brief-COPE is a 28-item self-report measure which is designed to assess a broad range of coping responses (Carver et al., 1997). The Brief-COPE has been shown to be a reliable and valid measure of coping strategies in ABI research (Rogan et al., 2013; Snell et al., 2011). The measure comprises 14 theoretically derived subscales: Active Coping, Planning, Positive Reframing, Acceptance, Humour, Religion, Using Emotional Support, Using Instrumental Support, Self- Distraction, Denial, Venting, Substance Use, Behavioural Disengagement, and Self-Blame (Carver et al., 1997). Each item is rated on a four-point scale, ranging from 1 to 4. Due to the limited number of participants in the current study, the

two-factor maladaptive-adaptive divide, which has been used in prior ABI and health-related research (Rogan et al., 2013; Meyer, 2001) was used for analyses.

European Brain Injury Questionnaire (EBIQ)

The EBIQ is a 63-item self-report measure that assesses a person's subjective experience of cognitive, social and emotional difficulties after brain injury (Teasdale et al., 1997). Each item is rated on a three-point scale, ranging from 1 to 3. The EBIQ yields a scale score for eight specific areas of functioning: Somatic, Cognitive, Motivation, Impulsivity, Depression, Isolation, Physical, Communication, in addition to a global scale score ("Core Symptoms"). The mean of the participants' scores on the core symptoms subscale was used for analyses in the present study.

World Health Organization Quality of Life Scale Abbreviated (WHOQOL-BREF)

The WHOQOL-BREF (Group, 1997) is an abbreviated 26-item version of the WHOQOL-100 quality of life assessment (Group, 1998). It measures an individual's perceptions of QOL across four domains of functioning: physical, psychological, social, and environmental). The WHOQOL-BREF has been shown to be a reliable and valid tool for assessing QOL in persons who have experienced brain injury (Group, 1997).

Statistical analyses

Section 1 uses Chi square and McNemar's tests to describe longitudinal changes in the proportion of participants presenting with emotional distress as indexed by clinically elevated levels of anxiety and depression at t1 and t2. A series of paired sample t-tests were used to examine the stability of the longitudinal profiles of coping responses, subjective experiences of cognitive, social and emotional difficulties after brain injury and QOL across the follow-up t2 period.

Section 2 examines the relationship between emotional distress and all other clinical outcome measures at t1 and t2 using correlational analysis and multiple linear regression. Tables 4-6 report the measure of association (zero-order correlation- Pearson's correlation coefficient) between each variable and emotional distress (HADS-A & HADS-D scores) at both timepoints. One-way ANOVAs were used to obtain the unique variance contributed toward emotional distress scores by each variable. Finally, the total variance explained in emotional distress scores at both timepoints by each complete variable is also reported (e.g., QOL includes all WHOQOL subscales - physical, psychological, social, environmental).

The data **of the present study** met the statistical assumptions underpinning the use of parametric tests. An a priori power analysis indicated that a sample size of 34 participants would be sufficient to provide 80% power to detect a moderate effect size. Considering the anticipated number of statistical analyses, a more conservative alpha threshold of $p < 0.01$ was applied to reduce the probability of type 1 error. Statistical analyses were conducted using R studio (version 4.31) and 'SPSS' (version 28) programmes.

Results

Section 1: Longitudinal Trajectory of Emotional Distress, Coping Reponses, Perceived QOL and Subjective Experiences of Injury-Related Difficulties

One quarter of participants (25%) reported emotional distress one-year post-ABI (t1), as indexed by clinically elevated symptoms of anxiety or depression. Almost 10% of participants reported clinically elevated symptoms of both anxiety and depression one-year post-ABI (t1). **The proportion of participants reporting clinically elevated symptoms of anxiety *or* depression increased from 34.4% to 43.8% by eight-years post-ABI (t2), while the number of participants that reported experiencing clinical levels of both anxiety *and* depression decreased from 9.4% to 3.1% by t2 (See Table 2).**

A similar proportion of participants reported clinically elevated symptoms of anxiety and depression at each timepoint (see Table 2). At both timepoints, the majority of individuals with HADS scores above the clinical cut-off were in the 'mild' range of emotional distress (see Table 2). There were no significant changes in mean scores of anxiety or depression between timepoints (see Table 3).

There were no significant changes in the use of adaptive or maladaptive coping mechanisms between t1 and t2 (see Table 3). There were also no significant differences in physical, psychological, social and environmental QOL, or in subjective experiences of difficulties after brain injury between timepoints (see Table 3).

Section 2: Relationship Between Emotional Distress, Coping Responses, QOL and Subjective Experiences of Injury-Related Difficulties, Over Time

Relationship between Emotional Distress and Coping Responses

At t1 symptoms of anxiety were moderately positively correlated with maladaptive coping, such that greater use of maladaptive coping responses was associated with more symptoms of anxiety (see Table 4). At t2 there were no significant associations between coping responses and anxiety (see Table 4). There were no significant associations between coping responses and depression at either timepoint (see Table 4). At t1 maladaptive coping explained a significant amount of variance in symptoms of anxiety (21.63%), $F(1,30)= 10.29$, $p = .003$. Maladaptive coping also explained a substantial amount of variance in scores relating to symptoms of depression at t1 (14.52%), $F(1,30)= 4.94$, $p = .034$. There were no significant associations between adaptive coping and symptoms of depression, or symptoms of anxiety at either timepoint. Together, coping responses explained 39% of the variance in anxiety at t1, and 12.06% at t2. At t1 coping responses explained 14.67% variance in depression at t1 and 6.80% at t2.

Relationship between Emotional Distress and Subjective Experiences of Injury-Related Difficulties

There was a strong positive correlation between self-reported difficulties in the context of the brain injury, and anxiety at the two timepoints such that greater subjective difficulties were associated with greater symptoms of anxiety at t1 and t2 (see Table 5). Accordingly, subjective difficulties of brain injury explained a significant amount of variance in symptoms of anxiety at both timepoints, t1: 53.30%, $F(1,30)= 34.24$, $p= .001$; t2: 28.06%,

F(1,30)= 11.70, *p*= .01. Additionally, there was a strong positive correlation between self-reported difficulties in the context of the brain injury, and depression at the two timepoints such that greater subjective difficulties were associated with greater symptoms of depression at t1 and t2. Subjective difficulties of brain injury explained a significant proportion of variance in symptoms of depression at both timepoints, t1: 36.80%, F(1,30)= 17.48, p= .001; t2: 25%, F(1,30)= 10.01, *p*= .01.

Relationship between Emotional Distress and Quality of Life

At t1 there were moderate negative correlations between psychological and social QOL and depression such that lower QOL in these two domains was associated with greater depressive symptoms (see Table 6). Similarly, at t2 there were moderate-large negative correlations between QOL across all four domains and symptoms of depression (see Table 6*).* There were no significant associations between symptoms of anxiety and QOL at t1 or t2. None of the QOL subscales independently explained a significant amount of unique variance in symptoms of anxiety, or symptoms of depression, at either timepoint. Combined, WHOQOL subscales accounted for 19.70% of the variance explained in anxiety scores at t1, and 11.70% at t2. WHOQOL variables contributed 33.90% of variance explained in depression scores at t1, and 54.07 % at t2.

Discussion

We show that in **the** sample **of the present study** there was minimal variation in psychological outcomes among individuals with moderate-to-severe ABIs between one and eight-years post-injury. We highlight the high level of emotional distress experienced following ABI, with almost half of all participants continuing to report clinically elevated symptoms of anxiety and depression at eight-years post-injury. These rates align with previous research showing persistent emotional distress after ABI (Alway et al., 2016; Ayerbe et al., 2013; Bergersen et al., 2013; Bombardier et al., 2010; Bryant et al., 2010; Jørgensen et al., 2016; Liu et al., 2024).

Given that only two individuals reported a mental health history prior to the injury, the emotional distress observed is likely secondary to the ABI. These findings may reflect the chronic nature of ABI and the enduring challenges associated with its long-term effects, which often include emotional, behavioral, physical, cognitive, social, and adaptive difficulties (Cardile et al., 2024; Kinsella et al., 2020; Vaghela et al., 2023). Thus, for a subset of individuals, ABI may lead to a life-long vulnerability to mood difficulties that do not always resolve with time, particularly without intervention. Despite enduring and significant levels of emotional distress, fewer than half of all participants had accessed psychology services by eight-years post injury. Most sought help within the first-year post-injury, suggesting barriers to accessing services beyond the initial post-acute period (e.g., service availability, awareness, ease of access; Twomey et al., 2021).

Previous studies assessing longitudinal patterns of coping post-ABI report that most individuals demonstrate an increase in the use of maladaptive coping responses over time (Kendall et al., 2001; Tomberg et al., 2007). The same pattern was not observed in the data

from the present study; we demonstrate minimal changes in the use of coping responses **between one and eight-years post-ABI**. Subjective difficulties experienced after brain injury and physical, psychological, social and environmental QOL did not change significantly between one-and eight-years post-ABI. The lack of improvement in the perceived sequelae of the brain injury over time is consistent with a robust evidence base which suggests that ABI can lead to long-term difficulties (Alway et al., 2016; Ponsford et al., 2014; Teasdale & Enberg, 2005). **These findings** are also consistent with the existing longitudinal studies which suggest QOL does not fluctuate in the later years following injury (Burleigh et al., 1998; Hume et al., 2023; Jacobsson et al., 2010; Tomberg et al., 2007).

While the factors of coping, subjective difficulties post-injury and QOL are considered pertinent in the development of emotional distress following ABI, these factors are typically analysed for their individual contributions, using cross sectional, or shorter longitudinal designs (Bombardier et al., 2010; Gregorio et al., 2014; Hume et al., 2023; Osborn et al., 2016; Mitchell et al., 2017; Scheenen et al., 2017; Schönberger et al., 2014). **This** longitudinal study uniquely explores the concurrent impact of these factors on emotional distress in individuals with ABI across a timespan of several years, providing intricate insights into the psychological sequelae of ABI.

Emotional distress was associated with use of maladaptive coping strategies at t1, findings which are congruent with the existing literature (Anson & Ponsford et al., 2006; Wolters et al., 2015). Emotional distress experienced in the initial post injury period may prompt the use of maladaptive coping strategies, which may in turn increase emotional distress experienced (Cardile et al., 2024). Notably, in the present study the level of emotional distress experienced at t2 was not significantly associated with coping responses.

The lack of relationship between coping responses and emotional distress at t2 may suggest a more pervasive and persistent emotional distress experienced.

Greater subjective difficulties related to brain injury were associated with higher anxiety and depression levels at both time points. Much existing research reports that more subjective brain injury symptoms worsen mood outcomes (Andruszkow et al., 2013; Stocchetti & Zanier, 2016; Verdugo et al., 2019; Whelan-Goodinson et al., 2010). The relationship between mood disorders and ABI difficulties is complex due to similar assessment tools and overlapping symptoms, and it may be that mood difficulties negatively distort perceptions of ABI symptoms (de Koning et al., 2016). If a person with an ABI continues to report ongoing symptoms many years post-injury, healthcare practitioners should consider exploring the relationship between psychological distress and perceived sequelae of ABI.

Higher levels of depression were associated with lower QOL at both time points, findings that are parsimonious with a robust evidence base which suggests that depression is associated with a lower QOL several years post ABI (Bombardier et al., 2010; Kreuter et al., 1998; Sharma et al., 2015). It may be that poorer QOL leads to a person experiencing more emotional distress (Bombardier et al., 2010), or that emotional distress leads to negatively skewed perceptions of QOL domains (Sharma et al., 2015). While acknowledging the myriad of possibilities regarding causation, it remains that results from this study support the conclusion that greater use of maladaptive coping strategies, greater subjective symptoms of brain injury, and lower QOL, may be significant risk factors for mood difficulties following ABI.

Limitations of Study

There were several limitations in the present study which should be acknowledged. Participants consisted of individuals with moderate-to-severe ABIs who attended an inpatient neurorehabilitation program in a post-acute hospital, meaning these results do not apply to individuals with mild or very severe ABI or those without access to specialist neurorehabilitation. Furthermore, **the** exclusion criteria prevented us from capturing outcomes for other subsets of individuals with ABIs, such as those unable to complete the questionnaire due to severe disability, or those in inappropriate placements like nursing homes. Insight difficulties are common among individuals with ABIs, and since **the** outcome measures **used in the present study** relied on self-report, some participants may have over- or under-reported their experiences due to a lack of insight into their challenges (Sansonetti et al., 2024). Although we report the number of participants who self-reported having accessed psychology services in their community post-discharge at each timepoint, details about the type or duration of any psychological interventions attended were not available.

Due to unavoidable attrition between timepoints, 13 participants were lost to follow-up, leaving data from 32 individuals for the final analyses. The existing literature extensively documents significant levels of participant attrition in longitudinal ABI research, which may be due to factors including high mortality rates, relocation, or a loss of willingness to participate (de Graaf et al., 2020; Ponsford et al., 2014; Snell et al., 2013; Tomberg et al., 2007). Though **the** final sample size is in line with those reported in published longitudinal studies (see Tomberg et al., 2007; Hackett et al., 2009), it is nonetheless small which limits the generalisability of the results.

While **a** power analysis indicated that a sample size of 34 participants would be sufficient to detect a moderate effect size, the nature of **the** study design and analyses meant that probability of Type 1 error was increased. A more stringent alpha threshold ($p < 0.01$) was used to evaluate statistical significance to offset the risk of Type 1 error however, it continues to be a potential issue in **this** study.

The substantial rate of attrition, small sample size, and related statistical limitations are important caveats to acknowledge when interpreting **the** findings **from the present study** and those of other longitudinal studies using similar statistical approaches. **Despite its limitations, this study contributes valuable insights to the limited literature on psychological distress across the first decade following ABI, further highlighting the pervasiveness of long-term psychological challenges, and the factors associated with psychological distress, in post-injury recovery.**

Clinical Implications of Findings

While ABI services in Ireland and elsewhere offer intensive support during the first two years post-injury, fewer long-term outpatient or community-based services are available**. The findings from the present study add to the evidence base by demonstrating** that following ABI, most individuals face ongoing challenges for at least a decade post-injury that require long term monitoring and intervention at each stage along the continuum of care (Andelic et al., 2018; Tomberg et al., 2007; Osborn et al., 2016; Twomey et al., 2021; Kinsella et al., 2018; Burke et al., 2020).

As emotional distress often goes undetected or inadequately treated in the ABI population, specialised training in psychological distress and interventions among clinicians/services in general healthcare settings and within ABI care pathways could promote awareness and competencies surrounding the long-term psychological difficulties among individuals with ABIs.

The findings of the present study suggest that interventions that promote adaptive coping styles and address underlying cognitive distortions, for example, Cognitive Behavioural Therapy, could improve emotional health among individuals with different subtypes of ABIs (Anson & Ponsford, 2006; Fann et al., 2009; Soo & Tate, 2007). Acceptance and Commitment Therapy and Compassion Focused Therapy could be used to foster self-compassion and acceptance post-injury (Ashworth et al., 2014; Robinson et al., 2019). These interventions may also aim to promote the phenomenon of positive psychological growth (posttraumatic growth; PTG), which is more likely to be reported among individuals with fewer depressive symptoms, higher use of adaptive coping strategies and fewer injury related difficulties in the first decade post-injury (Igoe et al., 2023; Gangstad et al., 2009; Powell et al., 2012; Allen et al., 2021).

Future research utilising a longitudinal study design with several timepoints (e.g., at one, three, five, seven and ten-years post-injury), and research examining outcomes across longer periods of time (e.g., 10-to-20-to-30-years) would be beneficial in providing a more in depth understanding of the trajectory of psychological outcomes post-ABI. Multi-site research centres will be essential in future studies to address common challenges in ABI research such as participant attrition and limited sample sizes. Further, research demonstrating the long-term benefits of psychological interventions will be crucial for integrating psychological services into routine ABI care.

Conclusions

In conclusion, there was minimal variation in neuropsychological outcomes in the first decade post-ABI. At eight-years post-ABI, almost half of participants continued to report clinically elevated symptoms of anxiety **or** depression. The level of emotional distress experienced was most strongly associated with the coping responses used, the subjective experiences of injury-related difficulties and QOL. One-year post-injury a significant amount of variance in the level of emotional distress experienced was accounted for by maladaptive coping and subjective difficulties associated with brain injury. Almost a decade later, subjective difficulties associated with brain injury continued to explain a significant amount of variance explained in the level of emotional distress experienced. Psychological QOL also explained a significant amount of variance in emotional distress at eight-years post-ABI.

Although these findings are based on a sample of 32 participants—with 13 lost to follow-up from t1 and therefore should be interpreted with caution—participant attrition is a common occurrence in longitudinal studies involving ABI populations. Nevertheless, findings from this study highlight the need for greater awareness of the long-term psychological impacts of ABI in both general and specialized healthcare settings. Additionally, these results offer valuable insights into the longitudinal trajectory of psychological distress, and the factors that may contribute to its development, between one- and eight-years post-ABI.

Increasing awareness and training among healthcare practitioners and providing ongoing monitoring and intervention for the long-term mental health sequelae of ABI within

the community along the rehabilitation continuum will improve psychological adjustment and long-term emotional outcomes for individuals affected by ABI.

Acknowledgements

AH, SC and FOK contributed to the research design and protocol development at t1. MLFA, AH , FOK and AH[2] recruited the participants and performed the outcome assessments. AI, DMT, NB, FOK analysed the data. AI, DMT, NA, MLFA, AMH, AH, SC, RR, DH, JB, NB and FOK prepared, edited and contributed the manuscript preparation. This study was partially supported by a Health Research Board (HRB) Summer Scheme Scholarship to L.M.F.A. (SS/2012/155). We wish to thank the individuals with ABIs who generously contributed their time to this study.

Declaration of Interest

The authors report no conflict of interest.

Ethical Approval

This research was granted ethical approval by the University College Dublin, Trinity College Dublin and the National Rehabilitation University Hospital Ireland.

Data availability

The datasets analysed during the current study is not publicly available so that the anonymity of participants involved may be preserved. The dataset may be available from the corresponding author on reasonable request.

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Table 1. Summary of demographic and injury characteristics of adults with an ABI included in the longitudinal analyses and those who were lost to follow-up between t1 and t2 (not included in longitudinal analyses).

Demographic & Injury Characteristics	***Mean (SD)* or n *(%)***		
	t2 follow-up (*N* = 32)	**Lost to follow-up t2 (*N* = 13)**	***p-value***
Gender			
Male	20 (62.50)	8 (61.50)	
Female	12 (37.50)	5 (38.50)	0.605[1]
Years of Education (years; t2 only)	14 (12-18)	Not available	
Age (years)	52.70 (12.20)	54.90 (19.31)	0.709[1]
Type of Injury			
TBI	13 (40.6)	3 (23.0)	
Stroke	8 (25.0)	8 (61.5)	
Other ABI	11 (34.4)	2 (15.4)	0.066[2]
Length of Hospital Admission (weeks)	8.30 (3.58)	7.58 (4.0)	0.594[3]
Employment Status Before ABI			
Employed	25 (78.10)	9 (69.20)	
Unemployed	7 (21.90)	4 (30.80)	0.393[1]
Psychiatric History Prior to ABI (t2 only)			
Yes	2 (6.25)	Not available	
No	30 (93.75)	Not available	

Note: [1]Fishers Exact Test, [2]Chi-Square Test, [3] Independent Samples T-Test.

Table 2. Longitudinal trajectory of emotional distress across the seven-year interval.

HADS Scale				
	N (%) t1	**N (%) t2**	***Test Statistic***	***p-value***
Depression & Anxiety Non-clinical Range	21 (65.63)	17 (53.13)		
Depression or Anxiety Clinical Range	8 (25.00)	14 (43.75)		
Depression & Anxiety Clinical Range	3 (9.38)	1 (3.13)	- 0.43	0.670[1]
HADS-D				
Non-clinical Range	25 (78.13)	24 (75.00)		
Clinical Range [3]	7 (21.88)	8 (25.00)		1.00[2]
Mild	4 (57.14)	5 (62.50)		
Moderate	3 (42.86)	3 (37.50)		
Severe	-	-		
HADS-A				
Non-clinical Range	25 (78.13)	24 (75.00)		
Clinical Range [3]	7 (21.88)	8 (25.00)		1.00[2]
Mild	4 (57.15)	8 (100)		
Moderate	2 (28.57)	-		
Severe	1 (14.29)	-		

Note: [1] Chi Square Test, [2] McNemar's Test. HADS score ≥ 8 indicates clinically elevated symptoms of anxiety and/or depression. HADS score < 8 indicates non-clinically elevated symptoms of anxiety and/or depression [18]. [3] HADS clinical range classification: Mild (8-10), Moderate (11-14), Severe (15-21) [49].

Table 3. Longitudinal trajectory of emotional distress, coping responses, QOL and subjective experiences of injury-related difficulties.

Outcome Variable	M *(SD)* t1	M *(SD)* t2	Mean Diff [95% CI]	$t_{(31)}$	*p-value*	Effect Size
HADS						
Anxiety	4.91 (3.86)	5.13 (3.10)	- .22 [-1.66, 1.22]	- .31	.76	.06
Depression	5.00 (3.66)	5.09 (3.55)	- .09 [-1.64, 1.45]	- .12	.90	.02
Brief-COPE						
Adaptive	39.31 (8.43)	38.03 (10.62)	1.28 [-2.35, 4.19]	.72	.48	.13
Maladaptive	20.91 (4.97)	18.16 (4.68)	2.75 [.33, 5.18]	2.31	.03 ^	.57
WHOQOL-BREF						
Physical QOL	50.33 (11.91)	50.25 (10.86)	.08 [- 4.90, 5.07]	.04	.97	.01
Psychological QOL	52.47 (13.42)	57.59 (12.06)	-5.12 [-10.89, 0.65]	1.81	.08	.32
Social QOL	63.80 (21.23)	60.34 (20.70)	- 3.45 [-5.35, 12.26]	.80	.43	.14
Environmental QOL	67.00 (15.36)	70.59 (15.69)	-3.58 [-9.53, 2.36]	1.2	.23	.22
EBIQ						
Core Symptoms	1.6 (0.4)	1.66 (0.4)	-0.06 [-0.21, 0.08]	0.86	0.40	0.15

Note: Adaptive = Brief COPE adaptive subscale, Maladaptive= Brief COPE maladaptive subscale. Physical QOL= WHOQOL Brief version physical subscale, Psychological QOL= WHOQOL Brief version psychological subscale, Social QOL= WHOQOL Brief version social subscale, Environmental QOL= WHOQOL Brief version environmental subscale, Core symptoms= EBIQ Core symptoms subscale. t2 = measured at time 2.** $p < 0.001$, * $p < 0.01$, ^ $p < 0.05$. Effect Sizes reflect Cohen's *d*. 0.2 = small effect size, 0.5 = medium effect size and 0.8 = large effect size

Table 4: Relationship between scores of the HADS and Brief-COPE subscales

HADS	**Brief-COPE**	*r*	sr^2	*β*	*SE*	*t*	*p*
HADS-A	Adaptive t1	.42	.05	.11	.07	1.57	.13
	Maladaptive t1	.58 **	.22	.37	.12	3.21	.003 *
	Adaptive t2	.29	.03	.06	.06	1.01	.32
	Maladaptive t2	.31	.00	.15	.13	1.16	.26
HADS-D	Adaptive t1	- .04	.03	.30	3.46	0.53	.60
	Maladaptive t1	.34	.14	0.30	.14	2.22	.03 ^
	Adaptive t2	.01	.00	- .04	.07	- .57	.58
	Maladaptive t2	.24	.07	.22	.15	1.45	.16

Note: HADS-A= HADS Anxiety subscale, HADS-D = HADS depression subscale, Adaptive= Brief COPE adaptive subscale, Maladaptive= Brief COPE maladaptive subscale, t1= measured at time 1, t2= measured at time 2, ** $p < 0.001$, * $p < 0.01$, ^ $p < 0.05$

Table 5: Relationship between scores of the HADS and EBIQ subscales

HADS	**EBIQ**	*r*	sr^2	β	*SE*	*t*	*p*
HADS-A	EBIQ Core t1	.73**	NA	7.25	1.24	5.85	.001 **
	EBIQ Core t2	.53*	NA	4.53	1.32	3.42	.002 *
HADS-D	EBIQ Core t1	.61**	NA	5.72	1.37	4.18	.001 **
	EBIQ Core t2	.50*	NA	4.90	1.55	3.16	.004 *

Note: HADS-A= HADS Anxiety subscale, HADS-D = HADS Depression subscale, EBIQ Core= European Brain Injury Questionnaire core symptoms subscale, t1= measured at time 1, t2= measured at time 2, ** $p < 0.001$, * $p < 0.01$, ^ $p < 0.05$

Table 6: Relationship between scores of the HADS and WHOQOL subscales

HADS	**WHOQOL**	*r*	sr^2	*β*	*SE*	*t*	*p*
HADS-A	Physical t1	- .35 ^	.02	-. 05	.07	-.72	.48
	Psychological t1	- .36 ^	.04	- .07	.06	-1.21	.24
	Social t1	- .30	-.03	- .03	.04	- .92	.3
	Environment t1	- .25	.00	.01	.05	.09	.93
	Physical t2	.02	.03	.06	.06	1.01	.32
	Psychological t2	- .25	.02	- .05	.07	- .70	.49
	Social t2	- .26	.02	- .03	.04	- .82	.42
	Environment t2	- .22	.00	- .01	.05	- .28	.78
HADS-D	Physical t1	- .26	.01	.03	.06	.50	.63
	Psychological t1	- .43 *	.10	- .11	.05	-2.06	.05 ^
	Social t1	- .47 *	.13	- .08	.03	-2.33	.03^
	Environment t1	- .31	.00	.00	.47	.09	.93
	Physical t2	- .49 *	.03	- .06	.05	-1.24	.23
	Psychological t2	- .71 **	.14	- .16	.06.	-2.84	.01 *
	Social t2	- .53 *	.01	- .02	.03	- .76	.46
	Environment t2	- .45 *	.00	.00	.04	.07	.94

Note: HADS-A= HADS Anxiety subscale, HADS-D = HADS Depression subscale, Physical= WHOQOL Brief version physical subscale, Psychological= WHOQOL Brief version psychological subscale, Social= WHOQOL Brief version social subscale, Environmental= WHOQOL Brief version environmental subscale, t1= measured at time 1, t2= measured at time 2, ** $p < 0.001$, * $p < 0.01$, ^ $p < 0.05$