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REVIEW

Work-related difficulties in patients with traumatic brain injury: a systematic review on predictors and associated factors

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ABSTRACT

Purpose: To address the content of work-related difficulties and explore which variables are associated to or determinants of these difficulties in persons that suffered from Traumatic Brain Injury (TBI). **Method**: Papers published between 1993 and February 2015 were included. Quality was judged as poor, acceptable, good or excellent. Determinants were extracted from longitudinal data, associated variables from cross-sectional data; variables were grouped by similarity. Evidence was judged as strong if the same results were reported by two or more good studies; limited if reported by one good and some acceptable studies. **Results**: Forty-two papers were selected (25,756 patients). Work-related difficulties were referred as unemployment, job instability or job cessation. Strong evidence of impact was found for: low educational level, pre-injury unemployment, Glasgow Coma Scale score and TBI severity, length of stay in acute and rehabilitation settings, lower Functional Independence Measure scores and presence of cognitive disturbances. **Discussion**: Evidence on the effect of rehabilitation interventions on TBI patients' work-related difficulties exists, but is poorly measured. Future studies should address the sustainability of holistic and tailored interventions targeting employees, employers and workplaces and aimed to reduce the gap between work duties and worker's abilities, using appropriate assessment instruments measuring difficulties in work activities.

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➤ IMPLICATIONS FOR REHABILITATION

- Traumatic Brain Injury (TBI) primarily affects young persons of working age causing a broad range of motor, sensory and cognitive impairments. A combination of variables related both to pre-morbid and to injury-related factors predict and are associated to work-related difficulties.
- While demographic and injury characteristics cannot be modified, some TBI outcomes (e.g. cognitive impairments or functional status) may be addressed by specific rehabilitative interventions: the knowledge of the specific work-related difficulties of TBI patients is of importance to tailor rehabilitation programs that maximize vocational outcomes.
- Rehabilitation researchers should give attention to vocational issues and use assessment instruments addressing the difficulties in work-related activities, in order to demonstrate the benefits of rehabilitative interventions on TBI patients' ability to work.

Introduction

Traumatic Brain Injury (TBI) is a leading cause of death and disability worldwide [1] and it is 3 times more common in men than in women. It is defined as damage to brain tissue caused by an external mechanical force to the head, e.g. motor vehicle accidents, falls and violence,[2] leading to loss of consciousness, post-traumatic amnesia (PTA) or skull fracture.[3,4] This definition covers a wide and heterogeneous kind of traumas and outcomes,[5] usually classified as mild, moderate and severe TBI. In USA, incidence of TBI is 200 per 100,000/year, whereas in Europe incidence is 235 per 100,000/year and prevalence is 3565 per 100,000.[6]

Those who survive TBI often experience a broad range of motor, sensory and cognitive impairments, including problems with memory, concentration, slowed thinking, word-finding, planning and problem-solving, fatigue, irritability, temper control, self-centredness, headaches, dizziness, sleep disturbance, balance and co-ordination, anxiety and depression.[7] Although these symptoms can resolve within some months, the sequelae of TBI often lead to long-lasting impairments that affect the patient's life [8] and are often complicated by the presence of multi-trauma (e.g. spinal cord and orthopaedic injuries or chest trauma). TBI-related outcomes impact on a wide range of activities: among them, work difficulties are particularly pronounced and, as shown in a literature review, return to work (RTW) was achieved in ∼40% of patients at 1- or 2-year post-injury.[9]

Two recent reviews [10,11] were specifically aimed to identify which factors are predictive of RTW after TBI. Saltychev and colleagues did not identify strong evidence supporting effects of rehabilitation intervention on vocational outcomes among people with TBI, but pointed out some tendencies referred to age, education, pre-injury occupational status, TBI severity, levels of depression and anxiety, gender and race.[10] van Velzen and colleagues also failed in identifying strong evidence of factors positively

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Supplemental data for this article can be accessed here associated to RTW: they found weak evidence that residual physical deficits were negatively associated to RTW, and that having a family was positively associated to RTW; strong evidence was only found for a negative association between length of stay (LOS) and RTW, and for the absence of association between Glasgow Coma Scale (GCS), presence of Depression and Anxiety and RTW.[11] In both these reviews, reasons for failure were identified: Saltychev and colleagues focused on the low quality and on the heterogeneity of the studies, and addressed the need of randomized trials and of well-conducted follow-up studies; van Velzen and colleagues also addressed quality issues and added the need to focus on treatable variables, such as presence of residual deficits and the number of associated injuries. van Velzen also highlighted that in her review RTW was defined as either returned or not returned, while other variables, such as the number of working hours or any change of job place or job demands, were not take into account: addressing these issues would provide better evidence on the way people RTW, and this should be the focus of future research.[11]

By focusing only on the rates and on the prognostic factors for RTW, the kind and amount of problems patients have with working, i.e. the work-related difficulties, remained completely not addressed by the two recent reviews. Moreover, since these reviews failed in identifying strong evidence on predictive factors, not only the determinants of work-related difficulties, but also the associated factors should be taken into account. Therefore, we carried out a systematic literature review to explore the work-related difficulties in TBI survivors. Specifically, we aimed at the following: (a) exploring the content of specific work-related difficulties addressed in literature and (b) identifying determinants and associated factors of work-related difficulties.

Methods

Search strategy

We performed a search on PubMed database for peer-reviewed papers that reported information on work-related problems in patients with TBI and that had been published between January 1993 and February 2015. Search criteria in titles and/or abstracts were the following: Traumatic Brain Injury AND (work* OR employ* OR job* OR jobless* OR occupation* OR vocation* OR unemploy*).

Papers' inclusion and exclusion criteria

Papers had to be primary research articles, i.e. observational studies (cross-sectional or longitudinal) and clinical trials (only of phase III and IV), written in English and had to have an abstract. Studies reporting qualitative data, case reports, literature reviews, meta-analyses, editorials, letters to the editors and commentaries were excluded.

Papers were included if they contained clear information with regard to employment or difficulties in work-related activities specifically connected to TBI, or reported information on the impact of clinical or psychosocial variables on work participation or on work performance of TBI patients, and if participants of the studies were of working age (18–65 years).

Papers were excluded if they reported data on occupation without distinguishing between paid workers and students, and if they reported data collected >10 years after TBI. We chose this threshold for two reasons: first, studies with follow-up higher than 10 years are a minority (5% in the review of Saltychev,[10] 6% in that of van Velzen [9]) and excluding them would reduce the heterogeneity of results; second, a longer period might make it difficult to address the effects of TBI from those of retirement on core variables such as unemployment or job cessation, which might also be connected to "normal" retirement. Studies in which employment (e.g. occupational status) was used as a predictor of other variables (e.g. satisfaction with life, quality of life or incidence of TBI) were excluded too. Finally, papers in which TBI was not diagnosed by a clinician (i.e. self-reports) were also excluded.

Papers selection and data extraction

One researcher screened all abstracts, and 20% of them were double-checked by a second researcher, blinded to the decision of the first one; the same procedure was used for full-texts. If the agreement rates were <70%, each of the double checked abstract or manuscript was reviewed again by the two researches in order to reach a joint decision.

Extracted data included information on the following: (a) study design, classified as prospective, retrospective or cross-sectional; (b) general characteristics of the study population, i.e. sample size, percentage of females, age and education; (c) TBI characteristics, i.e. severity, GCS score and post-traumatic amnesia (PTA) when available, time from acute event, aetiology; (d) hospitalization and rehabilitation characteristics, i.e. length of acute and rehabilitation stay; (e) data on employment, i.e. employment and unemployed rates before and after TBI and (f) variables associated with or determinants of work-related problems (determinants were extracted exclusively from prospective and retrospective studies, while associated variables were collected from cross-sectional studies or from cross-sectional analyses in longitudinal studies). Quality of the selected studies was assessed using the guidelines of the National Institute for Health and Clinical Excellence (NICE),[12] according to which quality is judged as poor (1), acceptable (2), good (3) or excellent (4). Papers of poor quality were excluded.

According to Popay's guidelines on how to analyze narrative reviews,[13] associated variables and determinants were grouped into overarching categories by similarity of content. Following a methodology employed in some recent reviews on the difficulties experienced by patients with brain disorders,[14–18] level of evidence was defined as "strong" if there were two or more good or excellent papers with the same results; "limited", if there was only one good or excellent paper and some acceptable studies reporting similar results; "controversial", if studies reported contrasting results; and "inconsistent" if the result was reported in only one study, or if no good study reported the result. In the remainder of the article, only information on strong and limited evidence will be described. (Please refer to supplementary material for data extracted from single articles).

Results

A total of 916 records were retrieved from PubMed, of which 307 were retained for full-text analysis, and finally 42 were used for data extraction [19–60] (Figure 1). The level of agreement was 79% for abstract and 85% for full-texts.

Table 1 reports the main characteristics of the selected studies. Most studies were longitudinal (38 out of 42): 24 were prospective and 14 were retrospective. In total, these studies reported data on 25,756 TBI patients, of whom 28.9% were females, with an aggregate mean age of 34.9. Most patients sustained a severe TBI or were sedated (51.4%), 14.1% a moderate TBI and 33.5% a mild TBI. Data on the presence of multi-trauma was available in nine studies. The mean time from acute event was 14.6 months and the aggregate mean employment rate at this time was 42.5%. In 11 studies, only persons that were employed prior to TBI were enrolled. Most of the studies (39 out of 42) reported the difference

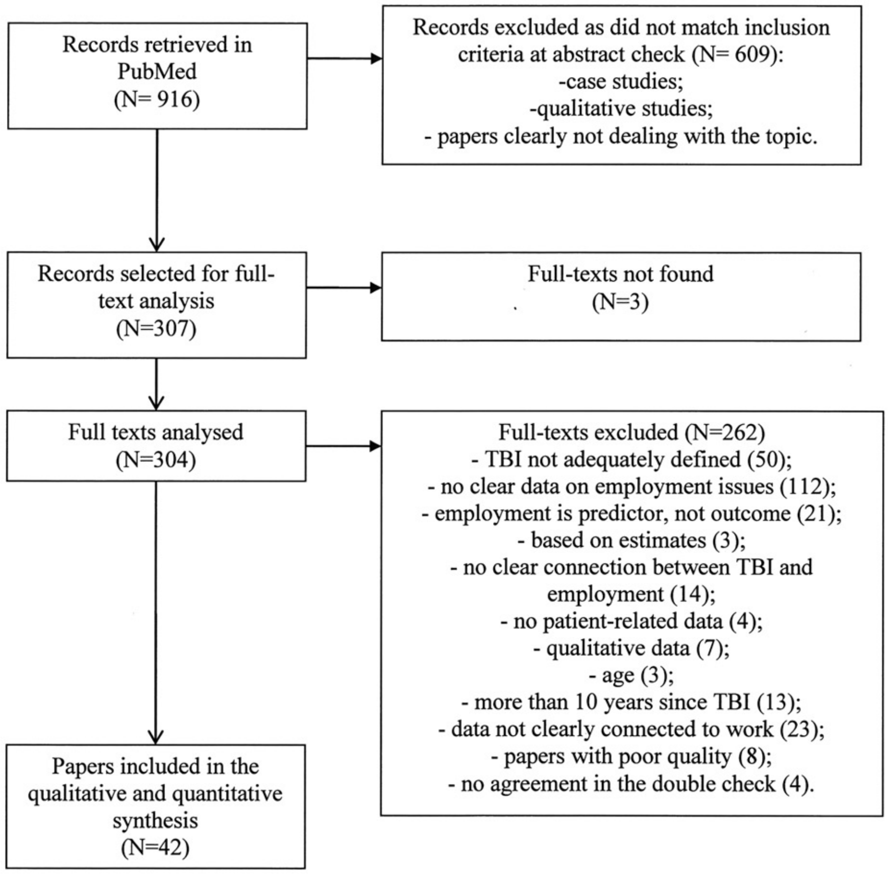

Figure 1. Flow chart of paper selection.

Table 1. Main features of selected studies.

	Prospective ($N = 24$)	Retrospective ($N = 14$)	Cross-sectional ($N = 4$)	Total ($N = 42$)
Sample size				
Total	14,231	11,167	358	25,756
Mean (Min–Max)	593 (16–3444)	797 (42–5831)	90 (33–154)	613 (16–5831)
% Females (Min–Max)	28.3% (16–44%)	29.8% (12–35%)	24.3% (20–33%)	28.9% (12–44%)
Aggregate mean age (Min–Max)	36.5 (28–51.4)	32.7 (25.7–35.9)	34.0 (32.9–34.6)	34.9 (25.7–51.4)
Aggregate mean years of education (Min–Max)	11.9 (8.5–12.8)	11.1 (9.9–12.6)	11.5 (11.4–12.1)	11.3 (8.5–12.8)
Severity of TBI (aggregate %; Min–Max)				
Mild	35.8% (5–100%)	23.8% (8.1–100%)	–	33.5% (5–100%)
Moderate	13.8% (7–67.4%)	15.2% (2.7–35.4%)	–	14.1% (2.7–35.4%)
Severe/sedated	49.4% (13–100%)	60.2% (34.2–89.2%)	–	51.4% (13–100%)
Initial GCS (aggregate mean; Min–Max)	8.7 (4.7–14.6)	8.0 (5.5–8.6)	8.1 (7.9–8.3)	7.8 (4.7–14.6)
PTA, days (aggregate mean; Min–Max)	26.3 (17.7–33.5)	35 (29.1–81.8)	29.7 (20.9–34.9)	32.4 (17.7–81.8)
Etiology (aggregate %; Min–Max)				
Traffic/accident	57.3% (42.6–100%)	64.2% (37.2–87.7%)	55.2% (36.4–59.8%)	57.6% (36.4–100%)
Fall	18.1% (9.0–38.9%)	16.5% (3.4–26.4%)	33.3%	18% (3.4–38.9%)
Violent/assault	13.3% (2.5–16.5%)	14.6% (1.2–23.8%)	21.2%	13.8% (1.2–23.8%)
Other	12.7% (2–41.9%)	8.3% (2.9–17.8%)	9.1%	11.9% (2–41.9%)
Distance from acute event, months (aggregate mean; Min–Max)	13.0 (3–72)	18.7 (6–90)	19.2 (12–26)	14.6 (3–90)
Length of hospital stay, days (aggregate mean; Min–Max)	18.1 (11.8–39.7)	29.9 (21.6–81.9)	26.6 (24–37.1)	21.3 (11.8–81.9)
Length of hospital rehabilitation, days (aggregate mean; Min–Max)	25 (21–55)	37.4 (26–94.8)	35.9 (31.7–37)	29.5 (21–94.8)
Aggregate % employed before TBI (Min–Max)	78.5% (29.7–100%)	75% (46.8–100%)	86.3% (66.4–100%)	77.7% (29.7–100%)
Aggregate % employed after TBI (Min–Max)	45.3% (7.7–72.1%)	35.2% (20.4–63%)	40.4% (37.1–60.6%)	42.5% (7.7–72.1%)
Average quality (Mean ± SD)	2.5 ± 0.7	3.1 ± 0.8	2.7 ± 0.5	2.7 ± 0.7

Aggregate percentages and means are calculated for valid categories. No Min–Max data are reported for fall, violent/assault and other etiology from cross-sectional studies as the information was reported in one article only.
TBI: Traumatic Brain Injury; GCS: Glasgow Coma Scale; PTA: Post-Traumatic Amnesia.

in employment rate before and after TBI, and work-related difficulties were mostly operationalized as unemployment or job cessation after injury, as well as "job stability", i.e. the fact that across different follow-up evaluation a patient was always employed. The main outcome measure reported in the studies was the RTW rate. Few studies reported data on change in the amount of worked hours or in the tasks performed, mean time needed for returning to work, or limited function at work. Finally, only two studies investigated the impact of different types of treatment on RTW.

A total of 40 variables were found to be determinants of work problems in TBI patients: these were reported on 101 occasions in

Table 2. Variables associated and determinants of work-related difficulties in TBI patients.

Overarching category	Variables	Determinants	Associated variables
Demographic issues	Old age	8*	–
	Low education	9*	2*
	Female gender	4*	–
	Unemployed at injury	6*	2*
	Unmarried	2*	2*
	Manual worker	2*	–
	Minority group	–	2*
TBI features	Initial GCS score	3*	4*
	Severity of TBI	3	4*
	PTA	6*	–
	Violent etiology	3*	–
	Multi-trauma	2*	–
Hospitalization and rehabilitation features	Length of acute stay	5*	3*
	Length of hospital rehabilitation	4*	2*
Functional status	FIM	7*	2*
	DRS score	4*	–
Psychological and Neuropsychological symptoms	Cognitive dysfunction	5*	2
	Behavioral/personality change	3*	–
	Psychiatric symptoms	2	–
	Attention/concentration	–	2

Items marked with * are indicative of strong evidence.
TBI: Traumatic Brain Injury; GCS: Glasgow Coma Scale; PTA: Post-Traumatic Amnesia; DRS: Disability Rating Scale; FIM: Functional Independence Measure.

22 papers. For 16 variables a strong level of evidence was found, for two, a limited level of evidence, and for the remaining 22 variables the evidence was inconsistent. A total of 46 variables were found to be associated to work-related difficulties in TBI patients: these were reported on 62 occasions in 18 papers. For nine of them, there was a strong evidence of impact, for two, a limited evidence, and for the majority of them (35 out of 46), the evidence was inconsistent. Information on determinants and associated variables are reported in Table 2. See supplementary material for full description of manuscripts' contents.

Demographic variables

There is strong evidence that older age at injury is a predictor of work-related problems defined as job instability over 5-year post-injury [19] and as unemployment,[20–26] with persons aged 35–54 years having a 13% reduction probability of being employed compared to those younger than 34 years.[25]

Strong evidence exists that, compared to males, females had lower workforce participation,[23] were more likely to reduce the amount of worked hours or stop working [27] and had 26% more the probability of being unemployed post-injury.[21] On the contrary, men were 1.2 times more likely to be employed than women after vocational rehabilitation intervention.[25]

Low educational level was found to predict work difficulties with strong level of evidence:[23–25,28,29] lower education levels pre-injury increased the odds of being unemployed post-injury.[21,28] Individuals who completed high school were 2.3 times more likely to RTW than those without a high school diploma [30] and persons with a college degree had a 3 times the odds of being employed at follow-up than those ungraduated.[28,31] With regards to the time needed to RTW, patients with high school degree or higher were 1–2 times more likely to RTW by 6 months after injury than patients with lower education levels.[32] Low educational level was also found, with strong level of evidence, to be associated to work-related difficulties after TBI in terms of reduced RTW rate [29] and work instability.[33]

Similarly, there was strong level of evidence that pre-injury unemployment predicted post-injury unemployment.[23,24] Compared to those who were employed at injury, those that were unemployed had between 2 and 4.7 the odds of not being competitively employed 1-year post-TBI.[21,26,28,31] The same direction was also found for the association between variables: employment status at injury was also associated to employment status after TBI [34] and those that were unemployed had 95% lower probability of being employed 1-year post-injury compared to those employed before TBI.[35]

Being unmarried at injury was found, with a strong level of evidence, to be both associated to [29,33] and determinant of [21,23] work difficulties: individuals who were not married were more likely to be unemployed at 1-year post-injury,[21] whereas those who were married were more likely to remain stably employed.[33]

Being a manual worker before TBI was found, with a strong level of evidence, to be a predictor of unemployment: 68% of manual workers were unemployed at 1-year post-TBI,[30] and being machinery operators or manual workers before injury were more likely to have unstable employment over 3-year post-TBI.[36]

Finally, a strong level of evidence exists that being part of a minority group was associated to work-related difficulties, such as difficulties in terms of RTW [29] or to remain stably employed after injury.[33]

TBI features

There was a strong evidence that severity of injury is associated with low rates of RTW,[31,37] with those more severely injured being more likely to be unemployed 1-year post-injury than those with mild–moderate injuries.[38] TBI severity was also found to be negatively correlated to the amount of time worked: higher TBI severity was associated to reduced worked hours.[39] Higher TBI severity was also found, with a limited level of evidence, to be a determinant of work-related problems, defined as unemployment [31,40] or lost work time: patients with mild TBI tended to resume to work earlier (in a period between 3- and 6-month post-injury) in comparison to those with more severe TBI [32] and the probability to resume working was 3–4 times higher in patients with mild TBI compared to those with moderate or severe TBI.

A strong level of evidence exists that low GCS score at admission is associated to unemployment 1 year after injury,[35,41,42] and to reduced working time.[39] Initial GCS score was also identified, with a strong level of evidence, as a determinant of work-related problems: employment status up to 2 years after TBI was predicted by GCS score at acute rehabilitation.[22,43] Higher GCS score was a significant predictor of job stability over 5 years after TBI.[19]

A strong level of evidence exists that the length of PTA is a determinant of unemployment:[24,43] the odds of being unemployed 1-year post-TBI were 4.9 times greater among those who were still in PTA at rehabilitation discharge compared to those with PTA <2 weeks,[28] and persons with shorter PTA duration had 1.6 the odds of being employed at follow-up.[31] Shorter PTA was a significant predictor of job stability over 3 [36] and over 5 years after TBI.[19]

Strong evidence was found that a violent aetiology of injury is a determinant of work-related difficulties:[21,23] the odds of being unemployed 1-year post-TBI were 4.0 times greater for those with TBI from violent aetiologies compared to those from road accidents.[28]

Finally, the presence of polytrauma was found, with strong evidence, as a determinant of work-related difficulties.[24] Those with spinal cord injury had 7.2 higher odds of being unemployed 1-year post-injury compared to those with TBI only.

Hospitalization and rehabilitation features

There is strong evidence that LOS in acute and in rehabilitation setting after TBI are determinants of and associated to higher unemployment rates. The odds of being unemployed post-injury were significantly higher for those with longer acute and rehabilitation LOS,[20,21,28,43] and those with longer acute stay had one-third the likelihood to RTW that those with shorter stay.[30] LOS in acute and rehabilitation settings have a direct association with unemployment rates or changes in employment rate after injury,[23,35,42] and longer LOS was a predictor of job instability over 5 years after TBI.[19]

Functional status

Functional status at discharge, measured by the Functional Independence Measure (FIM), was a determinant of work-related problems with a strong level of evidence.[20,21,30] Lower FIM scores, both in the motor and in the cognitive sub-scales, predicted the odds of being unemployed post-injury,[23,28,43] and also predicted failure in RTW.[29] FIM score at discharge was also found, with strong evidence, to be associated to decreased employment rate after injury.[35] Persons needing assistance or supervision in one or more activities, were more likely to fail to RTW by 1-year post-injury than those with higher FIM scores.[29] The probabilities of being employed 1-year post-injury were 82% lower for those with lower FIM Cognitive score.[35]

With regards to the degree of disability caused by injury, we found strong evidence that a higher Disability Rating Scale score, both at admission and at discharge, is a determinant of higher unemployment rates up to 2 years after TBI.[21–23,43]

Psychological and Neuropsychological symptoms

There is strong evidence that cognitive impairment, at different levels, is a determinant of work-related difficulties. Cognitive impairment post-TBI resulted in higher unemployment rate at 6- to 12-month follow-up [24,44] and higher job instability over 3 years after injury.[36] Unemployed persons at 1 year after TBI reported lower cognitive functioning,[43] while those who were less cognitively impaired had 60% probability more of being employed than those more impaired.[31] Cognitive impairment was also found, although with limited evidence, to be associated to unemployment and failure in RTW.[35,41]

Behavioural changes after injury (e.g. self-centredness, inappropriate social behaviour, impulsivity and irritability) were found, with strong evidence, as a determinant of unemployment 1 year after injury.[24] Patients showing confused, agitated or inappropriate behavioural functioning at admission and discharge were found to be less likely to RTW.[43] In a study, patients that showed a relevant personality change after TBI were >10 times more likely to not RTW 18-month post-TBI.[45]

Limited evidence was found on the ability of psychiatric symptoms to be predictive of employment difficulties: patients with psychiatric symptoms were less likely to be employed up to 3 years after TBI,[20] and >80% of those that were followed-up by a psychiatrist were able to resume working at the previous level after 12 months from TBI.[46]

Finally, limited evidence was found that attention and concentration difficulties are associated to lower RTW rates:[37] those who were employed at follow-up had better attention and concentration performance than those not employed.[41]

Discussion

With this review we aimed at exploring the content of specific work-related difficulties addressed in literature, and identifying the determinants and associated factors of work-related difficulties. Work-related difficulties were mostly operationalized as unemployment or job cessation after injury (depending on the cross-sectional or longitudinal study design), as well as "job stability", i.e. the fact that across different follow-up evaluations a patient was always employed, although in different companies or with different duties. These difficulties were predicted by or associate to a combination of variables related both to pre-morbid factors (e.g. demographic factors) and injury-related factors (e.g. TBI features, hospitalization and rehabilitation characteristics, functional status, psychological and neuropsychological symptoms). In particular, the variables that were most commonly reported were: low educational level and pre-injury unemployment as pre-morbid factors; GCS score and TBI severity, LOS in acute and rehabilitation settings, lower FIM scores and presence of cognitive disturbances as injury-related factors.

With regard to pre-morbid factors, lower educational level and pre-injury unemployment were found both as predictors of and associated to unemployment and reduced RTW rates, which is likely to be directly connected to the lower employability of these patients after brain injury. We think that it is not casual that two other variables that are commonly associated to lower education, namely older age and being a manual worker, were also found to be determinants of unemployment and reduced RTW rates. In our opinion, it is possible to suppose that these patients might decide, or might be advised, to move to early retirement or to disability pension.

Variables connected to the clinical profile of TBI patients were also found to be of relevance: these include TBI severity and GCS score, as well as other variables that – more or less directly – are used to define severity of brain trauma, i.e. duration of PTA, LOS in acute and rehabilitation settings. It has to be noted that these variables are closely interrelated: therefore, it is more than reasonable to presume that their effect is overlapping. The same is to be said for functional status indicators, i.e. measures of disability, independence, psychosocial adjustment or level of impairments such as the FIM or the DRS. These results are consistent with previous reviews on factors related to employment outcomes following TBI, which found that persons who were more independent and less impaired reported higher RTW rates.[1,61] Cognitive impairment was found as both a determinant of and associated to work difficulties after TBI, and behavioural change was a determinant of negative employment outcomes. However, it is important to note that many different neuropsychological assessments were used in relation to vocational outcomes and, as also noted in another review,[10] it is not possible to synthesize results per type of cognitive function under examination.

Taken as a whole, our findings are consistent with previous literature reviews: the factors most consistently associated with employment outcomes included pre-injury occupational status, functional status at discharge, and general cognitive functioning,[61] while the main predictors of RTW were age at injury, pre-injury occupational and educational characteristics, types and degrees of impairment resulting from injury and TBI severity as measured by length of PTA or by GCS.[62] Consistently with the conclusion of van Velzen, that addressed the need for future research to focus on treatable variables, such as presence of residual deficits and the number of associated injuries [11] we believe that research should give priority to issues that are susceptible to change. If some pre-morbid characteristics cannot in fact be changed (e.g. age and educational level), it is important that rehabilitation interventions address those injury-related factors (e.g. cognitive impairments or functional status) that are expected to positively impact also on vocational outcomes. By systematically addressing the outcome on work-related difficulties, it will be possible to promote rehabilitation praxis that are effective on a clinical side, and determine considerable economic advantages for societies.

With regard to the specific work-related difficulties herein identified, work problems were mostly conceptualized as job cessation, RTW and unemployment and the mean employment rate after injury was 42.5% (range 7.7–72.1%). This result is consistent with other reviews, indicating an average of 40.7% of persons who sustained TBI returned to work after 1 year,[9] with a range of 13–70%.[1] At least four reasons for this variability can be hypothesized. First, the definition of RTW was not consistent across studies, as it was conceptualized as change in the job tasks [37,44] or in the amount of time worked,[27,39] job stability after TBI [32,38] or return to the same or shift to a different work activity.[20,44,47,48] Second, follow-up duration was very different across studies: on average, it was 26.3 months (SD 22.3) and varied between 3 [49] and 90 months.[40] It has to be noted that in the studies with multiple follow-up evaluation, a tendency toward higher employment rates consistent with increased follow-up duration was generally observed:[19,21,23,26,33,36,49–51] this makes it difficult to define a time which RTW should be expectable. Third, the wide spectrum of TBI severity across studies also plays a role, as TBI severity (or duration of PTA) is strongly connected to RTW and employment rates. A recent review focused on mild TBI only to overcome this limitation,[63] but this makes it impossible to address TBI severity itself, which is a core variable. Fourth, the presence of employment support service and compensation systems may positively impact on the RTW rates.[1] Only two studies specifically investigated the effect of these services on employment rate after TBI:[24,52] no information was available in the other studies, so we do not know, and this is particularly relevant for large studies, how many subjects benefit from vocational services. Two reviews on a similar topic, suggested that the heterogeneity of studies in the area of vocational outcomes after TBI weakens the strength of the evidence that is still insufficient [10] and makes it impossible to exactly predict the likelihood to achieve RTW after TBI.[1] In addition to this, the heterogeneity of studies makes it critical to conduct a meta-analysis, as also observed by Saltychev and colleagues.[10]

Recent reviews showed that vocational rehabilitation had positive effects on RTW, however authors concluded that evidence was insufficient to draw conclusions about effectiveness and that controlled studies are needed:[64,65] as TBI primarily affects young individuals of working age, it is crucial that future research investigates the effectiveness of different vocational rehabilitation programs.

The lack of information on work-specific difficulties is a consequence of the fact that outcomes are mostly expressed in terms of unemployment or RTW rates, rather than in terms of "abilities to carry out work duties". This is both due to the easiness of use of these group-level variables, particularly in large studies, but also the non-use of specific measures of work-related difficulties. This makes our results of particular importance for future research: in our opinion, clinicians and researchers that are interested in the evaluation of TBI outcomes should give particular attention to the vocational issues, and try to address it using outcome measures that provide information that can be exploited to pursue the reintegration at work of persons after TBI: examples of this include the ICF Core Set for Vocational Rehabilitation [66] and the questionnaire that was derived from it, the Work Rehabilitation Questionnaire (WORQ).[67] Another issue to be considered is the suggestion, to the employers of people that suffered a TBI, to consider change in duties and, when possible, in the characteristics of the workplaces. A review from Kendall and colleagues, that analyzed data on 26 studies on RTW after TBI, showed that those receiving vocational interventions returned to competitive employment earlier:[68] however, competitive employment is often not a viable option after TBI. In another review [69] it has been made clear that program-based vocational interventions, i.e. those aimed to maximize vocational outcomes, are weak in terms of sustainability of employment with time. On the contrary, supported employment models, based on long-term support and job-skill reinforcement through on-the-job coaching, are deemed to overcome the limitations of program-based models. In this case, viable ways to get to the "employability outcome" might include a reduction of worked hours or a change or a simplification of work duties: our results provide input as they indicate which variables should be taken into account to foresee the opportunity for taking this action. Future studies have to take into account the sustainability of holistic and tailored vocational interventions aimed to reduce the gap between work duties and worker's abilities. Such "on the job" and personalized programs, targeting employees, employers and workplaces, require that assessment instruments measuring difficulties in work activities are used as outcome measures.

Some limitations should be mentioned. First, even though our search was extensive, we cannot be sure that all relevant articles were included and three papers could not be located. Second, our search was carried out on PubMed only: the decision to rely on a medical search engine derives from an attempt to include only papers in which TBI was diagnosed by a clinician. However, this might have influenced the results. Third, the wide heterogeneity of the studies in terms of sample size (16–5831), percentage of employed persons (7.7–72.1%), severity of TBI and distance from injury (3–90 months) represents a limitation to the generalization of the results.

Conclusions

Employment after TBI is a multidimensional phenomenon influenced by many factors. In particular, variables related to demographic and pre-morbid features (lower education, older age, being a manual worker or being unemployed) and to injury-related factors as TBI severity (GCS and PTA scores), LOS in acute and rehabilitation settings, post-discharge conditions (FIM and DRS scores), and finally cognitive and behavioural impairments are predictors of or associated to work difficulties.

Future research should consider work-related problems not only in terms of unemployment or job cessation that could be subject to other factors (not necessarily linked to TBI), but also in terms of specific impacts of TBI on work difficulties. For this purpose it is of primary relevance to use assessment instruments that specifically address the difficulties in carrying out work-related activities, and that should be used to directly monitor the effectiveness of vocational rehabilitation interventions, and interventions in the work settings.

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