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Workplace Factors Associated With Return to Work After Mild-to-Moderate Traumatic Brain Injury

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Objective: Sociodemographic and injury-related predictors for return to work (RTW) after mild-to-moderate traumatic brain injury (TBI) have been extensively explored. However, there is a knowledge gap regarding work-related predictors of RTW. The main aim of this study was to explore work-related predictors of work participation 6 and 12 months after mild-to-moderate TBI. **Setting:** Data were collected at baseline 8 to 12 weeks after injury, and 3, 6, and 12 months after baseline, at a specialized TBI rehabilitation outpatient clinic at Oslo University Hospital, Oslo, Norway. **Participants:** Eligible patients had suffered a mild-to-moderate TBI 8 to 12 weeks previously, were employed 50% or more at time of injury, were between 18 and 60 years of age, and sick listed 50% or more at time of inclusion due to symptoms of TBI (based on the Rivermead Post-Concussion Symptoms Questionnaire). In total, 116 patients were included in a randomized controlled trial, of whom 113 were included in the 1-year analysis. **Design:** Patients were originally included in a randomized controlled trial. There were no between-group differences in RTW after 1 year. Thus, the participants were evaluated as one cohort in this study. **Main Measures:** The primary outcome measure was work participation 1 year after study inclusion. Work-related predictors were chosen on the basis of previous research and expert opinion and entered into a multivariable linear regression model. The model controlled for sociodemographic and injury-related factors. **Results:** The best-fitting model explained 25% of variation in work participation at 1 year. Significant predictors were predictability, quantitative demands and rewards (recognition) at the workplace, private or public employment, symptom burden at baseline, and sex. **Conclusion:** In this study, several work-related predictors outperformed some of the established sociodemographic and injury-related predictors of RTW after TBI, thus stressing the need for further focus and research on amendable predictors of RTW after mild-to-moderate TBI. **Key words:** *concussion*, *mild-to-moderate TBI*, *postconcussion symptoms*, *prediction*, *return to work*, *traumatic brain injury*, *vocational rehabilitation*, *workplace*

APPROXIMATELY 69 million people suffer a traumatic brain injury (TBI) globally each year,[1] with approximately 92% classified as mild TBI (mTBI) or moderate TBI.[1,2] Most people recover quickly (days to weeks) after an mTBI, while some continue to experience somatic, cognitive, and emotional symptoms for a prolonged period.[3] Regardless of injury severity, the typical symptoms (eg, headache, fatigue, dizziness, difficulties with concentration and memory) often

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affect the person's day-to-day life and may hamper their ability to work.[4] Return to work (RTW) rates in patients with moderate and severe TBI vary between 35% and 50%[5] depending on study methodologies. For people with mTBI, the proportion of RTW is higher, with an RTW rate at 89% 12 months after injury.[6] However, in a cohort of participants with prolonged symptoms (resembling the current sample), the proportion that had returned to work after 1 year was 76%.[7]

It is crucial to understand which patients are at risk of a less favorable outcome, including reduced work participation to provide optimal treatment and reduce the societal cost of TBI. The literature on predictors of RTW after TBI has most commonly focused on examining patient and injury characteristics.[8,9] These aspects have been thoroughly studied as predictors of clinical improvement and RTW. Different studies have found diverging results for the same predictors,[10] but there is a relative consensus regarding the importance of factors such as age, injury severity, and premorbid psychiatric problems[9,11–16] as predictors of work-related outcomes.

Irrespective of medical diagnosis, returning to stable work participation is a complex process[17] that relies on more than sociodemographic and injury-related circumstances. Some studies have highlighted the importance of workplace psychosocial predictors such as greater independence and decision-making latitude,[18,19] reward and recognition,[20] work predictability,[21] quality of leadership, and quantitative demands.[19] However, the relative influence of these factors is still uncharted territory, especially in quantitative research regarding specific diagnoses. Although studies have established these psychosocial factors to be important in reducing sick leave, it is reasonable to think that some psychosocial factors might be important for RTW regardless of diagnosis, whereas other factors might vary in importance depending on the specific diagnosis (in this case, TBI) and symptoms.

In line with this, factors related to the workplace also affect the individual's likelihood of successful RTW after mild-to-moderate TBI,[9,22] although they have been much less studied.[23] In contrast to demographic and injury-related factors, work-related factors are more often modifiable and, consequently, a potential target for intervention to increase the likelihood of RTW after TBI. While some work-related factors, such as duration of employment and type and size of the enterprise, will be difficult to alter after a TBI, psychosocial workplace factors (eg, experienced workload, decision authority, and predictability of work schedule) may be more easily amended.

Concerning workplace factors, type of occupation and preinjury occupational status are 2 of the more examined work-related predictors,[9,15] most commonly comparing manual (blue-collar) with nonmanual (white-collar) occupations,[24] and being employed previous to injury versus not employed. A systematic review from 2020[23] examined work-related factors associated with RTW after acquired brain injury. The authors found moderate evidence that patients with a nonmanual occupation are more likely to RTW. They also found an increased likelihood of returning to work if the patient works in a large enterprise ($\geq$250 employees), but no relationship if the enterprise size exceeds 1000 employees.[23] However, the main conclusion of the systematic review was that there is a pronounced lack of studies focusing on the predictive value of workplace-related factors on RTW after acquired brain injuries.

The present study, therefore, aimed to evaluate work-related predictors of RTW for patients with mild-to-moderate TBI 6 and 12 months after inclusion in a randomized controlled trial (RCT) comparing treatment as usual with a combined cognitive and vocational intervention. On the basis of previous studies, we hypothesized that work participation at 6- and 12-month follow-up would be associated with factors related to the psychosocial work environment and workplace, age, sex, education, marital status, injury severity, presence of extracranial injury, and symptom burden.

METHOD

Study design

This study includes a sample from an RCT with 1-year follow-up. The protocol and results from the RCT have been published previously.[25–27] The 116 patients were randomized to either combined cognitive and vocational intervention ($n = 60$) or treatment as usual ($n = 56$). Treatment as usual was provided by a multidisciplinary team at a specialized TBI rehabilitation outpatient clinic and did not comprise specific vocational efforts. No differences were found regarding RTW when the groups were compared at 6 or 12 months, and the participants were evaluated as one cohort in this study. The trial was registered in ClinicalTrial.gov (NCT03092713),[25] approved by the Regional Committee for Medical and Health Ethics in southeast Norway (2016/2038), and adhered to the Declaration of Helsinki.

Setting

Eligible patients were identified at a specialized TBI rehabilitation outpatient clinic at Oslo University Hospital (Oslo, Norway) between July 2017 and April 2019. After providing informed written consent, the patients attended a baseline assessment, followed by randomized group allocation and treatment for 6 months. Follow-up assessments were conducted at the

outpatient clinic or by telephone 3, 6, and 12 months after inclusion.

Participants

Patients were eligible for inclusion[25] if they had suffered a mild or moderate TBI 8 to 12 weeks previously, were 18 to 60 years old, resided in Oslo or Akershus county, were employed 50% or more at time of injury (ie, working ≥18.75 hours per week), and sick listed 50% or more due to postconcussion symptoms as assessed by the Rivermead Post-Concussion Symptoms Questionnaire (RPQ)[28] at time of inclusion. Mild-to-moderate TBI was defined as a Glasgow Coma Scale (GCS)[29] score of 10 to 15, loss of consciousness of less than 24 hours, and posttraumatic amnesia of less than 7 days. The criteria of the American Congress of Rehabilitation Medicine (ACRM) were used to classify mTBI.[30] Exclusion criteria were inability to speak or read Norwegian, progressive neurological disease, or ongoing substance abuse.

Outcome and predictor variables

The main outcome variable representing work participation (work percentage at 12 months, 0%-100%) was collected by patients' self-report 12 months after study inclusion.

The predictor variables were chosen on the basis of previous research[9,11–16,18–21] and expert opinion. Predictor data were collected at baseline through medical records and interviews with the patients and classified as work-related, sociodemographic, injury-related, or representing symptom burden.

The work-related predictors were number of employees in the enterprise, duration of employment (months) at the enterprise at baseline, and whether the enterprise was in the public or private sector. Preinjury occupational status was not included as a predictor because the sample was selected on the basis of being employed at the time of injury. Furthermore, type of occupation was not entered into the model, as 89% of the sample had white-collar jobs.

A psychosocial risk assessment used selected items from the Copenhagen Psychosocial Questionnaire II-Short version (COPSOQ-II)[31] to represent aspects of the psychosocial workplace environment. This questionnaire was established on the basis of core dimensions of 7 major theories in occupational health psychology.[32] The COPSOQ-II is divided into 13 scales, each consisting of 1 or 2 items that are scored on a scale from 0 ("never" or "to a very small extent") to 4 ("always" or "to a very large extent"), giving a total scale score of 0 to 8. This study examined the scales termed Predictability, Quantitative Demands, Rewards (Recognition), and Influence at Work (Decision authority). See Appendix 1 (Supplemental Digital Content, available at: http://links.lww.com/JHTR/A529).

Sociodemographic variables included in the analyses were age (years), sex (male/female), marital status (cohabiting or single/living alone), and education (years).

Injury-related factors included TBI severity as assessed by ACRM criteria (mild/moderate TBI) and extracranial injury. Extracranial injuries were registered according to the affected body part and scored by severity using the Abbreviated Injury Scale[33] but were dichotomized to yes/no in these analyses. The total score on the RPQ was included to control for somatic, cognitive, and emotional symptom burden at baseline. The RPQ is a 16-item self-report measure of postconcussion symptoms scored on a 5-point Likert scale from 0 to 4, where 0 = "not experienced," 1 = "no longer a problem," 2 = "mild problem," 3 = "moderate problem," and 4 = "severe problem."[28]

Statistical analysis

All statistical analyses were performed using Stata version 16. Descriptive statistics were reported for baseline characteristics. In cases of missing work percentage data at 12-month follow-up, work percentage at 6 months was used (last value carried forward), if available. The predictor models were built using multivariable linear regression with a continuous endpoint (work percentage at 12 months). As per recommendation,[34] a global model was built on the basis of expert knowledge and previous research and then reduced using manual backward elimination until reaching the best-fitting model. However, at least one predictor per category (sociodemographic, injury-related, symptom burden, and work-related) was kept in the model. An evaluation of the Akaike information criterion was performed at each step. For comparison, the global model was also reduced to a best-fitting model for work percentage at 6 months, using the same method. The amount of variance in work percentage explained by the model is represented by R^2 and adjusted R^2. Multicollinearity was checked for using variable inflation factor and normality of the residuals controlled using a Q-Q plot. No relationship between the COPSOQ-II scales and total RPQ or GCS scores was found in correlation analyses. To check for internal validity, the models were run with 1000 bootstrap repetitions. Statistical significance was set to $P < .05$.

RESULTS

Of 116 participants randomized to the 2 intervention groups at baseline (see Figure 1), 113 were included in the prediction analysis for work participation at 1 year and 110 at 6 months. There were few missing items, with no variable missing more than 3%. The baseline

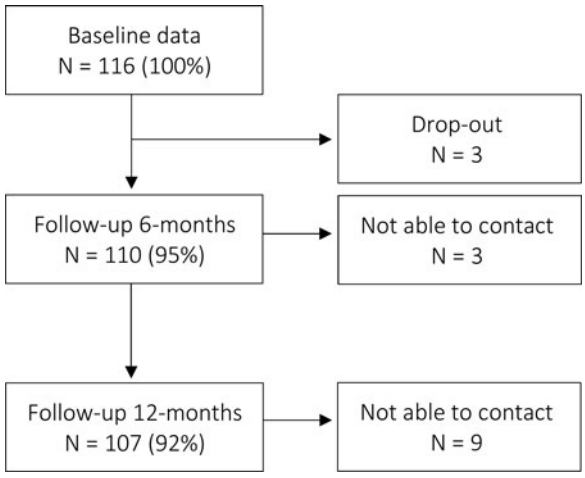

Figure 1. Flowchart.

characteristics of the sample are presented in Table 1 and thoroughly described elsewhere.[35] Of the 113 patients, 11 were still on 100% sick leave at 1 year. Additional work-related data on 95 patients at 1 year are provided in Appendix 2 (Supplemental Digital Content, available at: http://links.lww.com/JHTR/A530).

Global prediction model

The global model contains the predictors deemed important for RTW at 1 year (see Table 2). The predictor values are presented in Table 1. In the global model, sex, RPQ total score, employment in a private or public enterprise, and the workplace scales Predictability and Quantitative Demands from COPSOQ-II were significant predictors for work participation at 1 year. The model explained 26% of the variance in work participation at 1 year. Bootstrapping analysis supported all statistically significant predictors in this model with equal coefficients.

Best-fitting prediction model

In the best-fitting model, the same factors (ie, sex, RPQ total score, private/public enterprise, predictability, and quantitative demands) remained significant predictors for work participation at 1 year (see Table 3). Bootstrapping analysis confirmed all statistically significant predictors and coefficients of the best-fitting model. In addition, the scale Rewards (Recognition) had a P value of .05 in the best-fitting model and a regression coefficient of −4 (95% CI, −9 to −1), $P <$ .04, in the bootstrapping analysis. The best-fitting model explained 25% of the variance on work participation at 1 year. Marital status did not contribute significantly, but the quality of the model was degraded if it was excluded. Extracranial injury was the factor closest to being significant among the injury-related predictors and was therefore kept in the model to include at least one variable representing each group of predictors.

TABLE 1 *Baseline characteristics of individuals with mild-to-moderate traumatic brain injury at 8 to 12 weeks postinjury*[a]

	Total sample ($N = 113$)
Sociodemographic factors	
Age, median (range), y	42 (24-60)
Sex, female	66 (58)
Education, mean (SD), y	16 (3)
Married/cohabitating	74 (65)
Injury-related factors	
Cause of injury	
Falls	49 (43)
Traffic accidents	21 (19)
Sports	14 (12)
Violence	6 (5)
Exposure to inanimate objects	22 (20)
Unknown	1 (1)
CT/MRI findings, traumatic intracranial	27 (24)
Injury severity by ACRM criteria	
Mild	106 (94)
Moderate	7 (6)
LOC	
Yes	40 (36)
No LOC	58 (51)
Not registered	15 (13)
PTA	
Yes	52 (46)
No PTA	49 (43)
Not registered	12 (11)
Extracranial injury (yes)	51 (45)
Work-related factors	
Employed in private sector	63 (56)
Duration of employment, median (range), mo	54 (0-480)
Number of employees in enterprise, median (range)	70 (1-20 000)
Occupation, white-collar	100 (89)
Permanent position	102 (90)
Full-time position	100 (89)
Symptom burden	
Total score on RPQ at baseline, mean (SD)	28 (11)

Abbreviations: ACRM, American Congress of Rehabilitation Medicine; CT, computed tomography; LOC, loss of consciousness; MRI, magnetic resonance imaging; PTA, posttraumatic amnesia; RPQ, Rivermead Post-Concussion Symptoms Questionnaire.

[a]The values given are *n* (%) unless otherwise specified.

According to the estimates in the final prediction model (see Figure 2), women worked 16% less than men did at 1 year. Employees in the public sector worked 16% more than those who were privately employed. Furthermore, an employee worked 8% more for each

TABLE 2 *Global prediction model for work participation at 1 year*

Predictor	Coefficient (estimate)	95% CI	*P*[a]	*P*[a] (Bootstrapping)
Constant[b]	74.7	10.5 to 138.8	**.02**	**.03**
Age	0.3	−0.6 to 1.1	.55	.57
Sex[c]	−17.0	−32.3 to −1.6	**.03**	**.03**
Education	−1.1	−4.2 to 2.1	.50	.57
Marital status[d]	−12.1	−26.4 to 2.2	.10	.11
Injury severity[e]	−3.7	−34.4 to 27.0	.81	.83
Extracranial injury[f]	−5.3	−19.8 to 9.3	.47	.50
RPQ total score	−0.7	−1.4 to −0.1	**.04**	**.03**
No. of employees	−0.1	−0.1 to 0.1	.63	.58
No. of months employed	−0.1	−0.1 to 0.1	.42	.35
Private or public sector[g]	17.7	2.9 to 32.6	**.02**	**.01**
Predictability	7.6	2.4 to 12.8	**<.01**	**<.01**
Quantitative demands	4.9	0.4 to 9.5	**.03**	**.03**
Rewards (recognition)	−4.4	−9.1 to 0.2	.06	.05
Influence at work	0.5	−4.1 to 5.0	.84	.84

Abbreviation: RPQ, Rivermead Post-Concussion Symptoms Questionnaire.
[a]Bold values indicate statistically significant.
[b]Constant: *Y*-intercept of the model.
[c]Sex: Male (referent); female.
[d]Marital status: Married/cohabitating (referent); single/living alone.
[e]Injury severity: Mild (referent); moderate.
[f]Extracranial injury: No (referent); yes.
[g]Private or public sector: Private (referent); public.

increase in predictability score at the workplace, and for each increase of 1 in the quantitative demands score, they worked 5% more. In addition, the scale Rewards (Recognition) decreased the average work participation by 4% per increase of 1. Finally, for each increase of 1 in the total baseline RPQ score, they worked, on average, 1% less.

The best-fitting model for work participation at 6 months also contained total RPQ score ($P = .02$) and predictability ($P < .01$) at the workplace. Additional

TABLE 3 *Best-fitting prediction model of work participation at 1 year*

Predictor	Coefficient (estimate)	95% CI	*P*[a]	*P*[a] (Bootstrapping)	R^{2b}
Constant[c]	66.2	29.4 to 103.1	**<.01**	**<.01**	
Sex[d]	−16.0	−30.0 to −2.1	**.02**	**.02**	0.04
Marital status[e]	−12.5	−26.2 to 1.4	.07	.07	0.03
Extracranial injury[f]	−3.8	−17.0 to 9.4	.57	.60	<0.01
RPQ total score	−0.7	−1.3 to −0.1	**.04**	**.03**	0.05
Private or public sector[g]	15.8	2.3 to 29.3	**.02**	**.02**	0.03
Predictability	7.9	3.3 to 12.6	**<.01**	**<.01**	0.06
Quantitative demands	4.5	0.4 to 8.7	**.03**	**.03**	0.01
Rewards (recognition)	−4.5	−9.0 to 0.1	.05	**<.04**	<0.01
Total R^2					0.25
Adjusted R^2					0.20

Abbreviation: RPQ, Rivermead Post-Concussion Symptoms Questionnaire.
[a]Bold values indicate statistically significant.
[b]R^2 from univariate analyses.
[c]Constant: *Y*-intercept of the model.
[d]Sex: Male (referent); female.
[e]Marital status: Married/cohabitating (referent); single/living alone.
[f]Extracranial injury: No (referent); yes.
[g]Private or public sector: Private (referent); public.

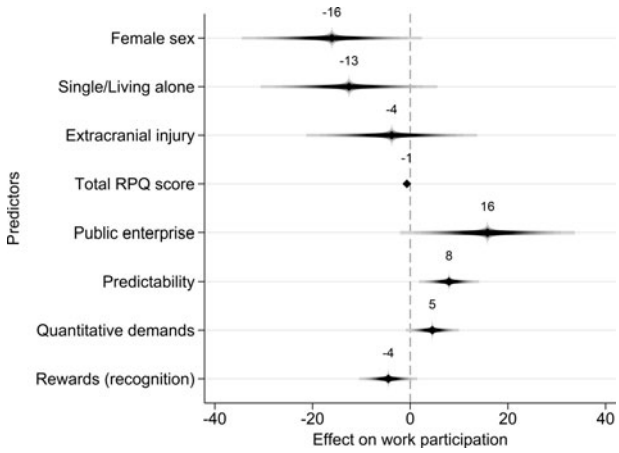

Figure 2. Linear regression estimates with 95% confidence intervals of the best fitting model to predict work participation at 1 year.

significant predictors were marital status ($P < .01$) and extracranial injury ($P = .04$). See Appendix 3 (Supplemental Digital Content, available at: http://links.lww.com/JHTR/A531).

DISCUSSION

This study found that certain work-related factors outperformed some of the established sociodemographic and injury-related predictors of RTW after TBI, as only sex and postconcussion symptom burden remained significant factors in the best-fitting model. Employment in the private or public sector, predictability, quantitative demands, and rewards (recognition) at the workplace all predicted work participation at 1 year, in line with our expectations.

Sex is a much-debated potential predictor for work participation after a TBI.[10] However, contrary to our findings, the consensus is that sex probably does not play an integral part in predicting RTW rates after TBI[9,36] but may contribute to predicting symptoms lasting more than 1 month.[10,37] The sample in this study was included specifically because they had symptoms lasting 8 weeks or more. That these patients were selected on the basis of prolonged symptoms may partially explain why women in this sample worked less than men.

As expected, we also found that a higher postconcussion symptom burden was negatively associated with work participation. Symptom burden has previously been documented as associated with RTW,[38] and our results align with previous research and suggest that etiology-specific factors play a role.

When examining the structural work-related predictors, employment in the public or private sector had the greatest impact. As previously mentioned, work-related factors have not been studied meticulously,[9,23] and the reason for the 16% increase of work participation in those publicly employed can only be hypothesized. A potential explanation might be the Norwegian working life model (IA Agreement),[39] in which most public enterprises in Norway take part. This agreement aims to "... improve the working environment, help bring employees back to work, prevent and reduce absence due to illness and prevent expulsion and withdrawal from working life"[39] and may make it easier for patients in the public sector to work with accommodations to their specific needs and to experience a greater sense of job security. The agreement may also have increased the probability of a worker to return to the same employer in a different role. However, an evaluation of an earlier version of the IA Agreement only found a small decrease in long-term sickness absence for women[40] whereas others only found a decrease among men working shifts.[41] Furthermore, we have no measure of the quality or amount of work performed and cannot conclude that employees in the public sector accomplish more work. Possibly, patients in the public sector are simply allowed more time to perform the same amount of work than in the private sector.

As expected, the amendable psychosocial workplace factors, predictability, quantitative demands, and rewards (recognition) predicted work participation at 1 year. This is particularly interesting as these factors may be intervened upon, even after the injury has occurred.

Previous findings suggest that predictability at the workplace decreases the number of absence days, regardless of diagnosis or profession.[42] This is in line with our results, in that higher predictability in work tasks facilitates higher work participation. This finding seems sensible for all employees, but perhaps particularly so for patients with TBI, due to typical symptoms as fatigue, headache triggered by screen time, and problems with concentration, memory, and planning, which might leave them reliant on a predictable workday and the possibility of scheduling their work. Moreover, clinical experience suggests that many people who have sustained a TBI report reduced stress tolerance and may especially benefit from routines and structure, avoiding unforeseen changes, and high work stability. In turn, this may provide an opportunity to complete work tasks in a satisfactory manner, leading to a sense of achievement.

Concerning quantitative demands, it may be intuitive to think that a patient with a great workload may be hesitant to RTW with the fear of being overwhelmed and experiencing increased symptoms. However, our results show that a higher workload leads to increased work participation. This is in line with some previous research on quantitative demands, showing that medium to high quantitative demands were associated with a reduced risk of long-term sickness absence in a sample of 39 000 Danish workers.[19] It has been suggested that this is due

to the increased workload serving as a challenge stressor that gives the employees more energy and contributes to increased motivation and work-related well-being,[19] thus increasing work participation. We cannot be completely certain concerning causality of the association in this study. However, the COPSOQ-II was completed at baseline and before most patients had RTW, thus suggesting that a higher preinjury workload predicted a higher work participation at 1 year, not vice versa.

The importance of the scale Rewards (Recognition) at the workplace is also highlighted in this study. The findings were surprising and in contrast to previous research,[20,43] in that high reward levels were associated with lower RTW. This finding may reflect that patients feel less pressure to RTW before they are ready if they believe the management understands their situation, appreciates their work, and treats them fairly at their workplace. This finding needs replication, and additional qualitative data from the RCT is under production.

Influence at work and decision-making latitude have previously been positively associated with a higher work participation and a lower risk of long-term sickness absence,[19,42] also when examining patients after mTBI.[18] For unknown reasons, this factor was not a predictor of RTW in this study. One could speculate this might be because this sample is highly educated, mostly employed in white-collar jobs, and thus has a high degree of decision authority at work. However, the average score of influence at work in this sample (4.3, SD = 1.7) is comparable with the norm score from a Danish population (4.1, SD = 1.8) and does not appear to be particularly high. The similar scores may be due to an overall well-regulated labor market and welfare system in the Scandinavian countries.

In opposition to our hypothesis, extracranial injuries did not predict work participation at 1 year. However, they predicted work participation at 6 months (see Appendix 3, Supplemental Digital Content, available at: http://links.lww.com/JHTR/A531), in line with previous research.[13] The impact of extracranial injuries at 6 months, and not at 12 months, likely reflects that the burden of these injuries is more pronounced earlier in the recovery process and then decreases with time since injury. However, others have found extracranial injuries to predict RTW at 1 year.[44] Thus, the results are divergent and underline the necessity for more research on the association between extracranial injuries and long-term work participation.

Limitations and strengths

While the best-fitting model explained 25% of the variance in work participation at 1 year, this still leaves 75% of the variance to be accounted for. Relevant factors that might account for some of the unexplained variance may include occupation type, premorbid psychiatric problems, substance abuse, length of stay in acute care, prior TBI, or other factors not yet explored. Sick leave in the year before injury and preinjury work participation had low correlation with work participation at 1 year in this sample. RTW after TBI is influenced by a multitude of factors and is difficult to predict at both the individual and group levels. The sample size in this study limited the number of predictors in the model. However, while previous studies have focused mainly on personal and injury-related factors, this study adds to the knowledge base identifying vocational predictors of work participation.

In addition, symptom severity reports and the main outcome are self-reported, which may introduce some bias, but it is reasonable to believe that patients after mild-to-moderate TBI can provide valid information concerning their current work and symptom status.[45]

The generalizability of this study may be limited for patients with severe TBI or with blue-collar jobs since this sample solely includes patients with mild-to-moderate TBI who are mainly in white-collar occupations.

To expand on the knowledge of the impact of work-related factors on RTW, future studies may investigate further whether there are changes in work tasks or positions, or changes in jobs after a TBI, and may evaluate this with regard to psychosocial and organizational factors at the workplace.

CONCLUSION

This study examined predictors of work participation at 1 year after mild-to-moderate TBI. Sex, symptom burden, working in a public enterprise, and predictability and workload, along with recognition from management, predicted work participation, although not necessarily in the expected direction. This illustrates that several work-related factors outperformed some of the established sociodemographic and injury-related predictors of RTW after TBI. The findings demonstrate a complex interplay between individual, injury-related, and workplace-related factors, stressing the complexity of the RTW process. There is a need for further research on this complexity and, in particular, amendable predictors of RTW after mild-to-moderate TBI. In this study, amendable factors in the RTW process and their influence on work participation have been identified, which reveal new targets for potential intervention and thus may improve the RTW rates and work participation in patients with mild-to-moderate TBI.

REFERENCES

1. Dewan MC, Rattani A, Gupta S, et al. Estimating the global incidence of traumatic brain injury. *J Neurosurg.* 2018:1–18. doi:10.3171/2017.10.JNS17352
2. Cassidy JD, Carroll LJ, Peloso PM, et al. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med.* 2004;(43)(suppl):28–60. doi:10.1080/16501960410023732
3. Carroll LJ, Cassidy JD, Peloso PM, et al. Prognosis for mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med.* 2004;(43)(suppl):84–105. doi:10.1080/16501960410023859
4. Kumar KS, Samuelkamaleshkumar S, Viswanathan A, Macaden AS. Cognitive rehabilitation for adults with traumatic brain injury to improve occupational outcomes. *Cochrane Database Syst Rev.* 2017;6(6):CD007935. doi:10.1002/14651858.CD007935.pub2
5. Gormley M, Devanaboyina M, Andelic N, Røe C, Seel RT, Lu J. Long-term employment outcomes following moderate to severe traumatic brain injury: a systematic review and meta-analysis. *Brain Inj.* 2019;33(13/14):1567–1580. doi:10.1080/02699052.2019.1658222
6. Bloom B, Thomas S, Ahrensberg JM, et al. A systematic review and meta-analysis of return to work after mild traumatic brain injury. *Brain Inj.* 2018;32(13/14):1623–1636. doi:10.1080/02699052.2018.1532111
7. Vikane E, Hellstrøm T, Røe C, Bautz-Holter E, Aßmus J, Skouen JS. Predictors for return to work in subjects with mild traumatic brain injury. *Behav Neurol.* 2016;2016:8026414. doi:10.1155/2016/8026414
8. Singh R, Choudhri K, Sinha S, Mason S, Lecky F, Dawson J. Global outcome after traumatic brain injury in a prospective cohort. *Clin Neurol Neurosurg.* 2019;186:105526. doi:10.1016/j.clineuro.2019.105526
9. Arango-Lasprilla JC, Zeldovich M, Olabarrieta-Landa L, et al. Early predictors of employment status one year postinjury in individuals with traumatic brain injury in Europe. *J Clin Med.* 2020;9(6):2007. doi:10.3390/jcm9062007
10. Iverson GL, Gardner AJ, Terry DP, et al. Predictors of clinical recovery from concussion: a systematic review. *Br J Sports Med.* 2017;51(12):941–948. doi:10.1136/bjsports-2017-097729
11. Saltychev M, Eskola M, Tenovuo O, Laimi K. Return to work after traumatic brain injury: systematic review. *Brain Inj.* 2013;27(13/14):1516–1527. doi:10.3109/02699052.2013.831131
12. Garrelfs SF, Donker-Cools BH, Wind H, Frings-Dresen MH. Return to work in patients with acquired brain injury and psychiatric disorders as a comorbidity: a systematic review. *Brain Inj.* 2015;29(5):550–557. doi:10.3109/02699052.2014.995227
13. Cancelliere C, Kristman VL, Cassidy JD, et al. Systematic review of return to work after mild traumatic brain injury: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Arch Phys Med Rehabil.* 2014;95(3)(suppl):S201–S209. doi:10.1016/j.apmr.2013.10.010
14. Zeldovich M, Wu YJ, Gorbunova A, et al. Influence of sociodemographic, premorbid, and injury-related factors on postconcussion symptoms after traumatic brain injury. *J Clin Med.* 2020;9(6):1931. doi:10.3390/jcm9061931
15. Howe EI, Andelic N, Perrin PB, et al. Employment probability trajectories up to 10 years after moderate-to-severe traumatic brain injury. *Front Neurol.* 2018;9:1051. doi:10.3389/fneur.2018.01051
16. Odgaard L, Pedersen AR, Poulsen I, Johnsen SP, Nielsen JF. Return to work predictors after traumatic brain injury in a welfare state. *Acta Neurol Scand.* 2018;137(1):44–50. doi:10.1111/ane.12806
17. Shames J, Treger I, Ring H, Giaquinto S. Return to work following traumatic brain injury: trends and challenges. *Disabil Rehabil.* 2007;29(17):1387–1395. doi:10.1080/09638280701315011
18. Friedland JF, Dawson DR. Function after motor vehicle accidents: a prospective study of mild head injury and posttraumatic stress. *J Nerv Ment Dis.* 2001;189(7):426–434. doi:10.1097/00005053-200107000-00003
19. Clausen T, Burr H, Borg V. Do psychosocial job demands and job resources predict long-term sickness absence? An analysis of register-based outcomes using pooled data on 39,408 individuals in four occupational groups. *Int Arch Occup Environ Health.* 2014;87(8):909–917. doi:10.1007/s00420-014-0936-7
20. Roelen C, Thorsen S, Heymans M, Twisk J, Bültmann U, Bjørner J. Development and validation of a prediction model for long-term sickness absence based on occupational health survey variables. *Disabil Rehabil.* 2018;40(2):168–175. doi:10.1080/09638288.2016.1247471
21. Christensen KB, Nielsen ML, Rugulies R, Smith-Hansen L, Kristensen TS. Workplace levels of psychosocial factors as prospective predictors of registered sickness absence. *J Occup Environ Med.* 2005;47(9):933–940. doi:10.1097/01.jom.0000172864.16001.85
22. Donker-Cools B, Schouten MJE, Wind H, Frings-Dresen MHW. Return to work following acquired brain injury: the views of patients and employers. *Disabil Rehabil.* 2018;40(2):185–191. doi:10.1080/09638288.2016.1250118
23. Alves DE, Nilsen W, Fure SCR, et al. What characterises work and workplaces that retain their employees following acquired brain injury? Systematic review. *Occup Environ Med.* 2020;77(2):122–130. doi:10.1136/oemed-2019-106102
24. Forslund MV, Arango-Lasprilla JC, Roe C, Perrin PB, Sigurdardottir S, Andelic N. Multi-level modelling of employment probability trajectories and employment stability at 1, 2 and 5 years after traumatic brain injury. *Brain Inj.* 2014;28(7):980–986. doi:10.3109/02699052.2014.888770
25. Howe EI, Langlo KS, Terjesen HCA, et al. Combined cognitive and vocational interventions after mild to moderate traumatic brain injury: study protocol for a randomized controlled trial. *Trials.* 2017;18(1):483. doi:10.1186/s13063-017-2218-7
26. Fure SC, Howe EI, Andelic N, et al. Cognitive and vocational rehabilitation after mild-to-moderate traumatic brain injury: a randomised controlled trial. *Ann Phys Rehabil Med.* 2021;64(5):101538. doi:10.1016/j.rehab.2021.101538
27. Howe EI, Fure SCR, Løvstad M, et al. Effectiveness of combining compensatory cognitive training and vocational intervention vs. treatment as usual on return to work following mild-to-moderate traumatic brain injury: interim analysis at 3 and 6 month follow-up. *Front Neurol.* 2020;11:561400. doi:10.3389/fneur.2020.561400
28. King NS, Crawford S, Wenden FJ, Moss NE, Wade DT. The Rivermead Post Concussion Symptoms Questionnaire: a measure of symptoms commonly experienced after head injury and its reliability. *J Neurol.* 1995;242(9):587–592. doi:10.1007/BF00868811
29. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet.* 1974;2(7872):81–84. doi:10.1016/s0140-6736(74)91639-0
30. ACRM Mild Traumatic Brain Injury Committee. Definition of mild traumatic brain injury. *J Head Trauma Rehabil.* 1993;8(3):86–87.
31. Pejtersen JH, Kristensen TS, Borg V, Bjorner JB. The second version of the Copenhagen Psychosocial Questionnaire. *Scand*

J Public Health. 2010;38(3)(suppl):8–24. doi:10.1177/1403494809349858

32. Kristensen TS, Hannerz H, Høgh A, Borg V. The Copenhagen Psychosocial Questionnaire–a tool for the assessment and improvement of the psychosocial work environment. *Scand J Work Environ Health.* 2005;31(6):438–449. doi:10.5271/sjweh.948
33. Greenspan L, McLellan BA, Greig H. Abbreviated Injury Scale and Injury Severity Score: a scoring chart. *J Trauma.* 1985;25(1):60–64. doi:10.1097/00005373-198501000-00010
34. Heinze G, Wallisch C, Dunkler D. Variable selection–a review and recommendations for the practicing statistician. *Biom J.* 2018;60(3):431–449. doi:10.1002/bimj.201700067
35. Fure SCR, Howe E, Spjelkavik Ø, et al. Postconcussion symptoms three months after mild-to-moderate TBI: characteristics of sick-listed patients referred for specialized treatment and consequences of intracranial injury. *Brain Inj.* 2021;35(9):1054–1064. doi:10.1080/02699052.2021.1953593
36. Cancelliere C, Donovan J, Cassidy JD. Is sex an indicator of prognosis after mild traumatic brain injury: a systematic analysis of the findings of the World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury and the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Arch Phys Med Rehabil.* 2016;97(2)(suppl):S5–S18. doi:10.1016/j.apmr.2014.11.028
37. Booker J, Sinha S, Choudhari K, Dawson J, Singh R. Description of the predictors of persistent postconcussion symptoms and disability after mild traumatic brain injury: the SHEFBIT cohort. *Br J Neurosurg.* 2019;33(4):367–375. doi:10.1080/02688697.2019.1598542
38. van der Vlegel M, Polinder S, Toet H, Panneman MJM, Haagsma JA. Prevalence of postconcussion-like symptoms in the general injury population and the association with health-related quality of life, health care use, and return to work. *J Clin Med.* 2021;10(4):806. doi:10.3390/jcm10040806
39. The Norwegian Government. Letter of Intent regarding a more inclusive working life (the IA Agreement). https://www.regjeringen.no/globalassets/departementene/asd/dokumenter/2016/ia_agreement_-2014_18.pdf. Updated January 25, 2017. Accessed June 20, 2021.
40. Hanvold TN, Kristensen P, Corbett K, Hasting RL, Mehlum IS. Long-term sickness absence among young and middle-aged workers in Norway: the impact of a population-level intervention. *BMC Public Health.* 2020;20(1):1157. doi:10.1186/s12889-020-09205-3
41. Foss L, Gravseth HM, Kristensen P, Claussen B, Mehlum IS, Skyberg K. "Inclusive working life in Norway": a registry-based five-year follow-up study. *J Occup Med Toxicol.* 2013;8(1):19. doi:10.1186/1745-6673-8-19
42. Nielsen ML, Rugulies R, Christensen KB, Smith-hansen L, Bjorner JB, Kristensen TS. Impact of the psychosocial work environment on registered absence from work: a two-year longitudinal study using the IPAW cohort. *Work Stress.* 2004;18(4):323–335. doi:10.1080/02678370412331324806
43. Lund T, Labriola M, Christensen KB, Bültmann U, Villadsen E, Burr H. Psychosocial work environment exposures as risk factors for long-term sickness absence among Danish employees: results from DWECS/DREAM. *J Occup Environ Med.* 2005;47(11):1141–1147. doi:10.1097/01.jom.0000174301.80318.f2
44. de Koning ME, Scheenen ME, van der Horn HJ, et al. Prediction of work resumption and sustainability up to 1 year after mild traumatic brain injury. *Neurology.* 2017;89(18):1908–1914. doi:10.1212/WNL.0000000000004604
45. Holm I, Friis A, Storheim K, Brox JI. Measuring self-reported functional status and pain in patients with chronic low back pain by postal questionnaires: a reliability study. *Spine (Phila Pa 1976).* 2003;28(8):828–833.