

# Preliminary Validation of the World Health Organization Disability Assessment Schedule 2.0 for Mild Traumatic Brain Injury

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## Abstract

The purpose of this study is to examine the reliability, factor structure, and validity of the World Health Organization Disability Assessment Schedule (WHODAS 2.0 12 item version) in a sample of patients who were slow to recover from a mild traumatic brain injury (mTBI). Participants were 79 adults with mTBI recruited from one of four specialty outpatient clinics in Vancouver, Canada. The WHODAS 2.0 12 item version is a disease-nonspecific measure of disability representing six International Classification of Disability, Functioning, and Health activity and participation domains including cognition, mobility, self-care, interpersonal functioning, life activities, and participation. Results of analyses showed that the WHODAS 2.0 had high internal consistency and adequate construct and concurrent validity. A three factor structure emerged in this sample. The scale differentiated between patients with good and those with poor outcomes based on post-concussion syndrome, psychiatric, and pain status. Participants with multiple comorbidities reported the most disability on the WHODAS. Concurrent validity was also supported by lower WHODAS scores in participants who had returned to work versus those who had not. To our knowledge, this is the first study to evaluate the psychometric properties of the WHODAS 2.0 in a sample of people with mTBI. In summary, the WHODAS was sensitive to post-concussion syndrome after mTBI, as well as to health conditions that commonly co-occur with mTBI (e.g., mental health problems and chronic pain).

**Keywords:** mTBI; outcome measures; 12 item WHODAS 2.0

## Introduction

MILD TRAUMATIC BRAIN INJURY (mTBI) is typically associated with a full and prompt clinical recovery.<sup>1,2</sup> However, a significant minority of patients have a slow or incomplete recovery after their injury,<sup>3–6</sup> and currently available assessment instruments do not adequately capture these outcomes. Clinical end-points designed for moderate and severe TBI, such as the Glasgow Outcome Scale–Extended,<sup>7</sup> lack sensitivity and granularity in mTBI samples,<sup>8</sup> especially in the post-acute stage. Symptom checklists have been widely used for plotting recovery and characterizing clinical outcome from mTBI.<sup>9</sup> Although clinically meaningful, symptom checklists have important limitations. They query subjective symptoms that are not necessarily specific to mTBI,<sup>10–12</sup> which may overestimate poor outcomes, especially as time passes after injury.<sup>13</sup>

Symptom scores generally do not correlate well with objective measures,<sup>14</sup> and can be influenced by situational factors such as life stress,<sup>15</sup> chronic bodily pain,<sup>10</sup> and poor sleep prior to assessment.<sup>16</sup> In addition, symptom checklists do not reflect the broader impacts of injury across wider domains and contexts that are likely to be relevant for the injured individual. For example, the International Classification of Disability, Functioning and Health (ICF)<sup>17</sup> underscores the importance of also considering activity and participation outcomes, and contextual factors such as environmental or personal factors.

The World Health Organization developed a generic measure of disability in an attempt to operationalize the ICF, and disseminated an early version, the World Health Organization Disability Assessment Schedule (WHODAS II), with the WHODAS 2.0 published in its final form in 2010.<sup>18,19</sup> The WHODAS 2.0 is a disease-nonspecific

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measure of disability representing six ICF activity and participation domains including cognition, mobility, self-care, interpersonal functioning, life activities, and participation.<sup>18,19</sup> Both long (36 items) and short (12 items) versions are available and involve five difficulty-level response options: None, Mild, Moderate, Severe, or Extreme/Cannot do. Responses can be scored using a simple-summed approach, and the WHODAS 2.0 can be administered as an interview or as a self-report questionnaire.<sup>18</sup>

The WHODAS 2.0 36 item version and, to a lesser extent, the 12 item version has been used widely and validated in psychiatry, neurology, rehabilitation, and chronic disease research,<sup>19–24</sup> and in general community samples,<sup>25–27</sup> but not in mTBI research. Considering participant burden, the shorter 12 item version has (1) good psychometric properties with high internal consistency, (2) a single disability factor evident in some samples<sup>23,26,28</sup> and a hierarchical factor structure in others,<sup>24</sup> (3) strong correlations with the parent measure, and (4) adequate to strong concurrent and construct validity.<sup>22,23</sup> The 12-item WHODAS 2.0 has potential as a short but robust global outcome measure for mTBI. However, it is prudent to be cautious in assuming cross-population utility and validity. The aim of this study is to conduct a preliminary evaluation of the psychometric properties of the 12 item WHODAS 2.0 (interview version) in an mTBI sample.

## Methods

Consecutive referrals between March 2015 and February 2017 to four outpatient concussion clinics in the greater Vancouver area were screened for eligibility, as part of a broader prospective cohort study. To be eligible, participants had to (1) be 18–65 years old, (2) have sustained an mTBI by the World Health Organization Neurotrauma Task Force operational definition<sup>29</sup> within the past 6 months, (3) be fluent in English, and (4) have been employed prior to injury. The study had ethics approvals from the University of British Columbia Behavioral Research Ethics Board, the Vancouver Coastal Health Research Institute, and the Fraser Health Research Institute.

Of the 230 patients screened for eligibility, 92 were eligible and consented, and 79 completed the follow-up telephone assessment. Participants were recruited at the time they presented to clinic (mean = 1.6, SD = 0.9 weeks post injury) and assessed by telephone 4–5 months after recruitment. On average, the telephone assessment occurred at 31.7 (SD = 6.1) weeks post-injury. Demographic information, pre-injury health history, and injury characteristics were obtained by structured interview in an initial in-person assessment, during their first visit, at the time of enrollment. The measures described below in addition to the 12-item WHODAS 2.0, were administered in the follow-up telephone assessment, along with an interview about return to work status.

### *British Columbia Post-Concussion Symptom Inventory (BC-PSI)*

Participants rated “how often” and “how bad” they had been experiencing 13 physical, cognitive, and emotional symptoms over the preceding week.<sup>30</sup> Participants who described symptoms as being of moderate severity or worse (i.e., item scores  $\geq 3$ ) in at least three categories of the International Classification of Diseases-10 (ICD-10) criteria for postconcussional syndrome (PCS) were classified as having PCS.

### *Mini International Neuropsychiatric Interview (MINI)*

The MINI (Version 6.0)<sup>31,32</sup> is a brief structured diagnostic interview based on the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition). Based on the MINI symptom queries

and algorithms, participants were identified as having a current major depressive episode and/or an anxiety disorder (any of the following: panic disorder, agoraphobia, specific phobia, post-traumatic stress disorder, or generalized anxiety disorder).

### *Bodily pain*

Participants were administered the Brief Pain Questionnaire (BPQ),<sup>33</sup> a five item Likert-type scale that inquired about their current pain intensity in various body regions, including the head/skull, neck, chest/abdomen/back, arms/shoulders, and pelvis/legs. To capture cases with chronic pain following a bodily injury sustained in the mTBI event, we calculated a total summed score and also classified participants as having a comorbid pain condition if they reported (1) requiring urgent medical attention for non-brain injuries associated with the index mTBI, and (2) experiencing moderate or worse current pain (i.e., item rating of 2 or 3 on a Likert scale that ranged from 0 to 3) in a body region other than the head when assessed at follow-up.

### *Statistical analysis*

Data were analyzed using SPSSv24.0 for Mac operating systems.<sup>34</sup> Participant characteristics were summarized using descriptive statistics. Overlapping subgroups were created by stratifying participants on presence/absence of PCS, depression, an anxiety disorder, or bodily pain, using the operational definitions described previously. Note that a given participant could have been included in more than one of these subgroups if that person had multiple comorbidities. Selected subgroups were also compared using non-parametric tests (Mann–Whitney *U*), because WHODAS 2.0 scores were not normally distributed in our sample (Shapiro–Wilk Test  $p = 0.01$ ). Internal consistency of the WHODAS 2.0 was calculated using Cronbach’s  $\alpha$ .

For item analyses, descriptive statistics were used to describe item characteristics such as variability, floor, and ceiling effects. The factor structure of the WHODAS 2.0 was examined using exploratory factor analysis (EFA), with principal axis factoring and varimax rotation, using eigenvalues  $> 1$  and the scree plot as criteria for the number of factors to extract.<sup>35</sup> The EFA was conducted to provide an indication of the potential dimensionality of the measure, and to consider whether any additional explanatory factors in the data set were present. This was considered an important step given that the WHODAS 2.0 has not previously been psychometrically evaluated with an mTBI sample. Participants provided full data sets, and there were no missing data across study measures.

## Results

### *Demographic and clinical characteristics of participants*

The average age of the sample was 41.5 years. There were slightly fewer men (44%) than women (56%). The sample was predominantly Caucasian (76%) and well educated, with 53% reporting having a post-secondary degree. Just over half (58%) had returned to work in some capacity at study follow up 6–8 months following injury. The predominant causes of injury were being struck by an object (33%), motor vehicle accidents (29%), and falls (28%). A summary of participant demographic and clinical characteristics is provided in Table 1.

### *Internal consistency and validity analyses*

Internal consistency of the WHODAS 2.0 assessed using Cronbach’s  $\alpha$  was high ( $\alpha = 0.92$ ). Figure 1 shows the mean WHODAS 2.0 scores for participants with various comorbid conditions, flanked

TABLE 1. DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF THE SAMPLE (N=79)

Demographic characteristics		
Age (Mean [SD], range)	41.5 (12.0)	19–64
Sex (men) (n [%])	35 (44.3)	
Ethnicity (n [%])		
• Caucasian	60 (75.9)	
• Hispanic	2 (2.5)	
• African American	1 (1.3)	
• Asian	11 (13.9)	
• First Nations	5 (6.3)	
Education – number with postsecondary degree (n [%])	42 (53.2)	
Return to work (n [%])		
• Full return to work	33 (41.8)	
• Partial return to work	13 (16.4)	
• Still off work	33 (41.8)	
Prior psychiatric history (yes) (n [%])	39 (49.4)	
Prior traumatic brain injury (yes) (n [%])	30 (38.0)	
Clinical characteristics		
Confusion or disorientation (yes) (n [%])	69 (87.3)	
Post-traumatic amnesia (yes) (n [%])	51 (64.6)	
Loss of consciousness (n [%])		
• Yes	27 (34.2)	
• No	36 (45.6)	
• Suspected	5 (6.3)	
• Unknown	11 (13.9)	
Injury mechanism (n [%])		
• Motor vehicle accident	23 (29.1)	
• Fall	22 (27.8)	
• Assault	2 (2.5)	
• Sport	2 (2.5)	
• Struck by object	26 (32.9)	
• Other	4 (5.1)	
Receiving or seeking compensation (n [%])	42 (53.2)	
Injury to assessment interval, weeks (mean [SD], range)	31.7 (6.2), 21–47	

by the full sample (leftmost bar) and a subgroup with no comorbid conditions (rightmost bar). We also considered the cumulative impact of multiple comorbidities. Higher WHODAS 2.0 scores were evident in association with having no comorbidities, one, or two or

more additional conditions ( $F [2, 76] = 24.35, p < 0.01$ ). It is of note that participants who met criteria for ICD-10 PCS, as operationalized previously, had significantly higher WHODAS 2.0 scores than those who did not ( $U = 221.00 [Z = 5.12]; p < 0.01$ ; Cohen's  $d = 1.37$ ). WHODAS scores were higher in participants who met criteria for a current major depressive disorder than in those who did not ( $U = 160.50 [Z = 5.23]; p < 0.01$ ; Cohen's  $d = 1.69$ ); those with any anxiety disorder (vs. no anxiety disorder;  $U = 302.00 [Z = 4.23]; p < 0.01$ ; Cohen's  $d = 1.13$ ); and those with bodily pain following orthopedic injury (vs. none to mild bodily pain;  $U = 427.00 [Z = 3.04]; p < 0.01$ ; Cohen's  $d = 0.73$ ). The WHODAS 2.0 also differentiated between participants who had returned to work (in any capacity) and those who had not ( $U = 426.50 [Z = 3.26]; p < 0.01$ , Cohen's  $d = 0.80$ ). WHODAS scores were higher for participants who were seeking or receiving compensation than for those who were not ( $U = 395.00 [Z = 3.76]; p < 0.01$ ; Cohen's  $d = 0.92$ ).

#### Exploratory factor analyses and descriptive information about WHODAS 2.0

Exploratory factor analysis produced a three factor solution, with the three factors together accounting for 72.61% of the total variance (Table 2). Seven items had high loadings (i.e.,  $> 0.5$ ) on the first factor. Inspection of the solution suggested that factor one appeared in general to reflect participation barriers and limitations, factor two appeared to represent physical activity limitations (such as standing and walking), and factor three represented self-care activity limitations (washing and dressing). Individual items are shown in Table 3.

Table 3 shows WHODAS 2.0 item means and variability, indicating slight skewing to lower levels of disability for most items, as might be expected 6–8 months following an mTBI. Two items showed floor effects (items 8 and 9) with mean responses close to the floor and low variability (item 8, mean = 1.2 [SD 0.5]; item 9, mean = 1.2 [SD 0.4]; response range 1–3). These items refer to difficulties with self-care activities such as washing and dressing that are not expected to be impaired in this population. The total score showed minimal floor and ceiling effects, with only 6.3% ( $n = 5$ ) of the sample scoring at floor levels and no participants reaching ceiling levels (score range 12–52).

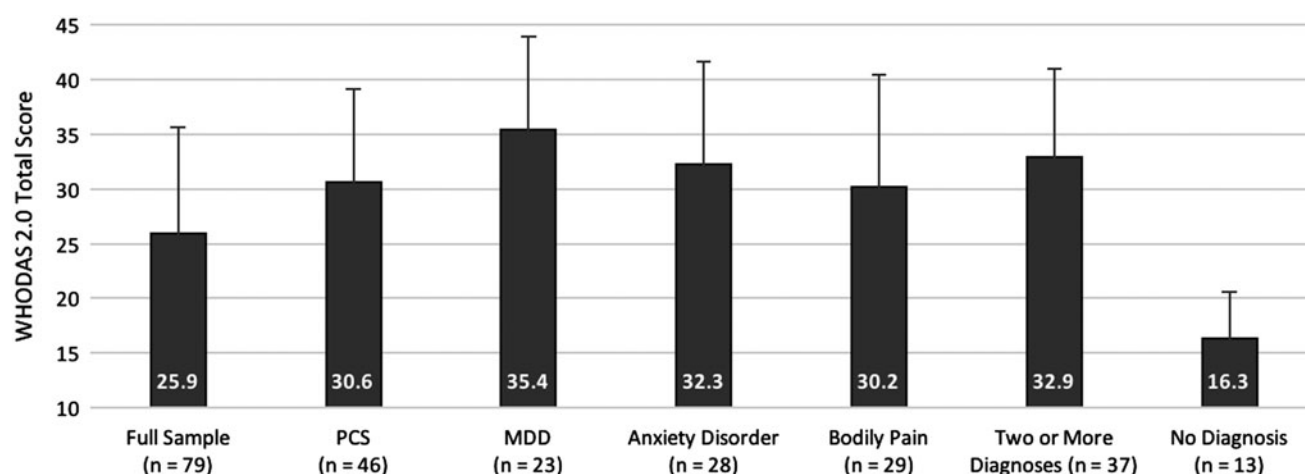


FIG. 1. Mean 12-item World Health Organization Disability Assessment Schedule (WHODAS) 2.0 scores ( $\pm 1$  SD) for overlapping clinical subgroups in the mild traumatic brain injury (mTBI) sample ( $n = 79$ ). The lowest score possible is 12. PCS, International Classification of Diseases (ICD)-10 Postconcussional Syndrome; MDD, major depressive disorder.

TABLE 2. ITEM FACTOR LOADINGS DERIVED FROM EFA OF 12 ITEM WHODAS 2.0 IN AN MTBI SAMPLE ( $N=79$ )

	<i>F1</i>	<i>F2</i>	<i>F3</i>
<i>Initial eigenvalue</i>	6.38	1.31	1.03
<i>Cumulative % variance explained</i>	53.13	64.07	72.61
Item 1 (Standing Long Periods)		0.84	
Item 2 (Household Responsibilities)		0.64	
Item 3 (Learning New Tasks)	0.75		
Item 4 (Community Activities)	0.76		
Item 5 (Emotionally Affected)	0.62		
Item 6 (Concentrating)	0.66		
Item 7 (Walking)		0.70	
Item 8 (Bathing)			0.69
Item 9 (Dressing)			0.86
Item 10 (Dealing with People)	0.72		
Item 11 (Friendships)	0.72		
Item 12 (Day-to-Day Work)	0.57		

Principal axis factoring with varimax rotation and Kaiser normalization. Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy 0.90. Bartlett's test of sphericity  $p < 0.001$ . Only item loadings  $> 0.5$  report.

WHODAS, World Health Organization Disability Assessment Schedule; mTBI, mild traumatic brain injury.

## Discussion

Some patients with mTBI experience persisting difficulties across multiple areas of functioning,<sup>36</sup> making it difficult to adequately capture “outcome” from mTBI with a single measure. In this study, we conducted a preliminary validation of the 12 item WHODAS 2.0, a brief nonspecific measure of disability that covers the activity and participation domains of the World Health Organization's ICF. We used traditional psychometric approaches to evaluate internal consistency and validity. This is the first study that we are aware of that has evaluated the psychometric properties of the WHODAS 2.0 in a cohort of people with mTBI.

The WHODAS 2.0 had high internal consistency and adequate construct and concurrent validity in our sample. It differentiated between patients with good and those with poor outcomes based on PCS, psychiatric, and pain status. WHODAS scores were greater for participants with multiple comorbidities. Concurrent validity was also supported by the finding of lower WHODAS scores in participants who had returned to work versus those who had not. In summary, the WHODAS was sensitive not only to PCS after mTBI, but also to health conditions that commonly co-occur with mTBI (e.g., mental health problems and chronic pain).<sup>12,36–38</sup> It is not surprising that patients with comorbid depression and anxiety had elevated WHODAS scores. The WHODAS 2.0 evolved from the the World Health Organization Psychiatric Disability Schedule, which was originally designed to assess the extent of disability associated with a psychiatric condition.<sup>19</sup>

The present study did not include a control group without MTBI but with chronic pain and/or psychiatric conditions. However, comparison with external samples suggests that mTBI may contribute to disability over and above psychiatric conditions alone. Mean WHODAS 2.0 scores in our sample of patients with mTBI and comorbid major depressive disorder or an anxiety disorder were greater than in a large Canadian community sample ( $n = 23,757$ )<sup>27</sup> of people with major depressive disorder or generalized anxiety disorder. These differences might reflect multiple factors, such as between-study differences in sampling strategy (e.g., recruitment from specialty clinics vs. a national survey), case ascertainment (e.g., with the MINI vs. the Composite International Diagnostic Interview), and other methodological features. It is possible that our data also reflect a cumulative impact of injury and psychiatric symptoms on activity and participation levels. Further investigation of this hypothesis is warranted.

Most research exploring the factor structure of the 12 item version suggests a strong single factor,<sup>19</sup> supporting a simple summed scoring option.<sup>25</sup> This preliminary examination of the factor structure of the measure in our mTBI sample suggested that three factors could be derived, potentially challenging a single summed scoring

TABLE 3. DESCRIPTIVE DATA FOR THE 12 ITEM WHODAS 2.0 IN A SAMPLE OF PEOPLE 6–8 MONTHS AFTER MTBI ( $N=79$ )<sup>a</sup>

<i>Item</i>	<i>Mean (SD)</i>	<i>Min-Max</i>	<i>Floor n (%)</i>	<i>Ceiling n (%)</i>
1 Standing for long periods such as 30 minutes?	2.2 (1.2)	1–5	33 (41.8)	3 (3.8)
2 Taking care of your household responsibilities?	2.3 (1.2)	1–5	24 (30.4)	6 (7.6)
3 Learning a new task, for example, learning how to get to a new place?	2.3 (1.2)	1–5	25 (31.6)	4 (5.1)
4 How much of a problem did you have joining in community activities (for example, festivities, religious or other activities) in the same way that anyone else can?	2.5 (1.4)	1–5	25 (31.6)	11 (13.9)
5 How much have you been emotionally affected by your health problems?	3.2 (1.1)	1–5	6 (7.6)	10 (12.7)
6 Concentrating on doing something for ten minutes?	2.4 (1.2)	1–5	22 (27.8)	4 (5.1)
7 Walking a long distance such as a kilometer (or equivalent)?	2.1 (1.3)	1–5	38 (48.1)	7 (8.9)
8 Washing your whole body?	1.2 (0.5)	1–3	64 (81.0)	0 (0)
9 Getting dressed?	1.2 (0.4)	1–3	68 (86.1)	0 (0)
10 Dealing with people you do not know?	2.1 (1.1)	1–5	31 (39.2)	2 (2.5)
11 Maintaining a friendship?	1.8 (0.9)	1–4	38 (48.1)	3 (3.8)
12 Your day-to-day work?	2.8 (1.5)	1–5	20 (25.3)	17 (21.5)
Total Scale Score	25.9 (9.7)	12–52	5 (6.3)	0 (0)
Factor 1: Participation barriers and limitations (number of items=7)	17.0 (6.7)	7–32	5 (6.3)	0 (0)
Factor 2: Physical activity limitations (number of items=3)	6.6 (3.3)	3–15	18 (22.8)	1 (1.3)
Factor 3: Self-care activity limitations (number of items=2)	2.38 (0.82)	2–6	61 (72.2)	0 (0)

<sup>a</sup>In the past 30 days, how much difficulty did you have in (item): Likert options: 1 = none, 2 = mild, 3 = moderate, 4 = severe, 5 = extreme/cannot do (high scores = greater disability).

WHODAS, World Health Organization Disability Assessment Schedule; mTBI, mild traumatic brain injury.

approach in this population. A strong first factor was identified that involved seven items associated with general activity limitations and participation restrictions (such as work, household activities, and social and cognitive functioning); whereas a second factor appeared to represent physical activity limitations (such as standing and walking) and a third factor represented self-care activity limitations (washing and dressing). The two items loading on the third factor had clear floor effects in our mTBI sample. This is a consistently reported finding in the WHODAS 2.0 literature, suggesting that self-care activities are minimally impaired in many health conditions.<sup>19</sup>

A study by Smedema and colleagues<sup>24</sup> examined the factor structure of the 12 item WHODAS 2.0 in a cohort ( $n=302$ ) of people with fibromyalgia. Two factors were identified by their EFA reflecting (1) social and cognitive aspects of disability and (2) self-care aspects. Similarly, two factors were evident in a sample of people ( $n=501$ ) with chronic pain,<sup>23</sup> with items 8, 9, and 10 forming a second factor using EFA, although the second factor seems difficult to interpret. These studies, together with our findings, suggest that the 12 item WHODAS 2.0 may detect population-specific nuances, and indicate that further work using more sophisticated methods is needed to be confident that a single summed score approach is appropriate for mTBI.

### *Clinical and research implications*

As a more granular measure of functional outcome than the Glasgow Outcome Scale–Extended, the WHODAS 2.0 may improve prognostic modelling in mTBI. The WHODAS 2.0 also has desirable properties of an end-point for mTBI clinical trials. Future research should investigate its responsiveness, or sensitivity to change. If widely adopted, the WHODAS 2.0 could enable synthesis of research evidence. Available mTBI research, although vast, is frequently contradictory and difficult to integrate, in part because of differences in outcome measurement.

### *Limitations of the study*

The main limitations of the current study are the sample size and cross-sectional study design, which limit the range of methods and approaches available for validation analyses. Modern psychometric approaches to evaluation of dimensionality and differential item functioning such as Rasch analyses would provide more detailed information about the measure, but require larger samples to produce robust results.<sup>39</sup> Because this study was a cross-sectional study, we cannot evaluate reliability of the 12 item WHODAS 2.0 across repeated administrations or sensitivity to change following natural recovery or treatment. Further work evaluating these aspects of reliability is warranted. We recruited from outpatient concussion clinics, where patients are referred (most often by family physicians, emergency medicine physicians, or disability claim managers) or self-referred because of a slow recovery. This sampling method likely explains the relatively high symptom burden and incidence of psychiatric comorbidity compared with unselected mTBI samples.<sup>40</sup> Our sample is likely to be representative of patients who present to outpatient specialty clinics after mTBI, but not of the broader mTBI population. Another limitation of the present study is that we did not have access to acute care medical records. We used a structured interview to retrospectively assess for indicators of mTBI (peri-injury amnesia, confusion/disorientation, and loss of consciousness), an approach with known shortcomings.<sup>41</sup> Details of participants' orthopedic injuries and severity metrics (e.g., Abbreviated Injury Scale) were also not available. Participants who self-reported requiring urgent medical attention for other bodily injuries

at the time of the mTBI and having ongoing bodily pain when assessed at follow-up were categorized in the present study as having a comorbid pain condition.

### **Conclusion**

Preliminary validation of the 12-item WHODAS 2.0 (interview version) suggests that this scale may provide the granularity required to evaluate outcomes after mTBI, encapsulating relevant domains including levels of activity and participation. The measure showed high levels of internal consistency, and scores were associated with other relevant outcomes such as post-concussion symptom burden, and presence or absence of psychiatric comorbidities and bodily pain, as well as return to work status. Further validation work is warranted, using more modern psychometric approaches with larger samples.

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Dr. Iverson has been reimbursed by the government, professional scientific bodies, and commercial organizations for discussing or presenting research relating to mTBI and sport-related concussion at meetings, scientific conferences, and symposiums. He has a clinical and consulting practice in forensic neuropsychology involving individuals who have sustained mTBIs. He has received research funding from several test publishing companies, including ImPACT Applications, Inc., CNS Vital Signs, and Psychological Assessment Resources (PAR, Inc.). He acknowledges unrestricted philanthropic support from the Mooney-Reed Charitable Foundation and ImPACT Applications, Inc. Dr. Panenka has a practice in forensic neuropsychiatry. Dr. Silverberg has a clinical practice in neuropsychology that includes paid consultation roles with professional sport organizations and disability insurance providers. Dr. Snell has a clinical practice in neuropsychology that includes paid consultation roles with professional sport organizations such as the New Zealand Rugby Union and disability insurance providers.

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