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## PHYSIOLOGY & REHABILITATION | RESEARCH ARTICLE

# Patient-specific functioning related to dizziness and balance problems after traumatic brain injury – A cross sectional study using an ICF perspective

Beate Storlås<sup>1</sup>, Kirsti Skavberg Roaldsen<sup>2,4,5</sup>, Helene Lundgaard Soberg<sup>3,4</sup> and Ingerid Kleffelgaard<sup>3</sup>

**Abstract:** To describe patient-specific problems in functioning related to dizziness and balance problems in patients with mild to moderate traumatic brain injury (TBI) in a biopsychosocial context. A cross-sectional study where data from the Patient-Specific Functional Scale (PSFS) was linked to the International Classification of Functioning, Disability and Health (ICF). Data from 60 patients were classified into second-level ICF categories, using the ICF linking rules. The 60 patients included 73% women; mean age, 39 (SD 12.9) years with mild to moderate TBI (mean GCS 14.5, SD 1.3). The patients predominantly reported problems representing the activities and participation components of the ICF; mobility-related problems were most frequently reported by 42%. In addition, vestibulo-ocular and hearing problems, attention functions, domestic activities, recreation, leisure and

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Equal contributions

### PUBLIC INTEREST STATEMENT

Dizziness and balance problems are common after traumatic brain injury (TBI) and interferes with activities and participation in daily life. Specific limitations in functioning that patients with dizziness and balance problems experience after mild to moderate TBI has however, not been fully explored.

This article describes patient-specific problems in functioning related to dizziness and balance problems after mild to moderate TBI using the International Classification of Functioning, Disability and Health (ICF) as a framework and classification tool.

The study shows that patients with dizziness and balance problems after mild to moderate TBI experience a diversity of functional limitations primarily related to mobility, vestibulo-ocular (inner-ears balance system) and hearing functions, attention functions and domestic activities, recreation and leisure functions. Environmental factors that were mainly physical barriers to functioning were also reported.

The patient-specific problems were all represented in the ICF, supporting a biopsychosocial perspective on problems related to dizziness and balance problems after mild to moderate TBI.

environmental factors were frequently ( $\geq 10\%$ ) reported as barriers to functioning. The median severity of problems on the PSFS Numeric Rating Scale (0–10 worst to best) was 3 (IQR 1–5) points. The PSFS provided a unique set of problems in functioning most relevant to each patient resulting in a diversity of functional limitations. The patient-specific problems were all represented in the ICF, supporting a biopsychosocial perspective on problems related to dizziness and balance problems after TBI.

**Subjects:** Rehabilitation Medicine; Neurological Rehabilitation; Physiotherapy

**Keywords:** Traumatic brain injury; dizziness; balance problems; patient-specific functional scale; international classification of disability; functioning and health

## 1. Introduction

Dizziness and balance problems are common complaints after mild to moderate traumatic brain injury (TBI), with a reported prevalence of 39% 6 weeks after the injury (Hartvigsen et al., 2014). Although the symptoms may reduce to 25% within 1 year of the injury (Hartvigsen et al., 2014), they can persist for more than 4 years (Kleffelgaard et al., 2012; Marcus et al., 2019). The aetiology of dizziness and balance problems is varied, and multiple causes are found in 46% of patients after TBI (Arshad et al., 2017). Thus, it represents a complex phenomenon that affects recovery after trauma (Cassidy et al., 2014; Chamelian & Feinstein, 2004; Marcus et al., 2019).

Dizziness and balance problems has been shown to interfere with activities and participation in daily life (Maskell et al., 2007), can prevent return to work, and can cause anxiety, depression and problems in psychosocial functioning after TBI (Chamelian & Feinstein, 2004; Marcus et al., 2019). Thus, dizziness and balance problems can have a negative impact on functioning and quality of life (Voormolen, Haagsma et al., 2019; Voormolen, Polinder et al., 2019). However, there is a lack of information on patient-specific functioning as a result of dizziness and balance problems after mild to moderate TBI. Performance-based measures combined with self-reported measures have been used to investigate dizziness and balance problems in patients with mild to moderate TBI (Alsalaheen et al., 2010; Kleffelgaard et al., 2017, 2019). However, standardized measures do not necessarily represent the actual functional limitations relevant to the individual patient. The patients' perspective is crucial to enhance an understanding of the limitations and restrictions related to the post-injury functioning and to facilitate individually tailored interventions.

The Patient-Specific Functional Scale (PSFS) is a patient-specific outcome measure, which asks the patients to identify problems in functioning due to a health condition (Stratford et al., 1995). This results in a unique set of problems in functioning from each patient. It focuses on issues most relevant to the patient and provides information explicitly from the patients' perspective. The PSFS is used increasingly in patients with neurological conditions (Evensen et al., 2020), however the patient-specific limitations in functioning that patients with dizziness and balance problems experience after mild to moderate TBI have not been explored.

The International Classification of Functioning, Disability and Health (ICF) is a useful framework and classification tool to construct a biopsychosocial perspective of post-injury functioning (International Classification of Functioning, Disability and Health (ICF) [updated, 2018; Laxe et al., 2013; Sveen et al., 2013]). To our knowledge, no study specifically applied a patient-specific measure to describe problems in functioning related to dizziness and/or balance problems after mild to moderate TBI in a biopsychosocial context. Hence, the primary aim of this study was to describe limitations and restrictions in patient-specific functioning related to dizziness and balance problems after mild to moderate TBI using ICF as a framework and classification tool. A secondary aim was to identify the severity of the limitations and restrictions in functioning due to dizziness and balance problems after mild to moderate TBI.

## 2. Methods

This was a cross-sectional study involving secondary analyses of data obtained from the baseline assessments in a randomized controlled trial designed to explore the effects of a vestibular rehabilitation programme on dizziness-related disability in patients with mild to moderate TBI (Clinical Trials registration number: NCT01695577) (Kleffegaard et al., 2019). The study was approved by the Regional Committee for Medical Research Ethics in Norway (no. 2012/195b 20,120,306). Written informed consent was obtained from all participants. The current study analysed problems in functioning reported on the PSFS by linking it to the ICF classification.

### 2.1. Participants

Data from 60 patients aged between 16 and 60 years with dizziness and/or balance problems at a mean of 3.8 months (SD, 2.1 months) after TBI (ICD-10 diagnosis S06.0–S06.9) were included. The patients were recruited from the outpatient clinic at the Department of Physical Medicine and Rehabilitation at Oslo University Hospital between January 2013 and October 2015. One physiotherapist (IK) administered the PSFS for all participants.

### 2.2. Measurements and procedures

The PSFS is a patient-specific measure whereby the patients identify activities they are unable to perform or have difficulty in performing related to their health condition; in the current study, the health issues were dizziness and balance problems after mild to moderate TBI (Evensen et al., 2020; Stratford et al., 1995). The patients were asked to rate the current level of difficulty associated with each activity by using a Numeric Rating Scale (NRS) ranging from 0 (unable to perform the activity) to 10 (able to perform the activity with no difficulty or as before the injury). The PSFS was used in an interview setting as part of the clinical subjective assessment at baseline in the original study.

The ICF classification system comprises the following components: body functions (b), body structures (s), activities and participation (d), environmental factors (e) (International Classification of Functioning, Disability and Health (ICF) [updated, 2018

Within each component there are chapters containing categories of functioning and environmental factors, altogether 1454 categories (International Classification of Functioning, Disability and Health (ICF) [updated, 2018]). Personal factors are presented in the ICF model, but not included in the classification system.

The text data consisting of meaningful units from the patients' problems on the PSFS forms were analysed according to the ICF linking rules as presented by Cieza et al. into main and additional concepts (Cieza et al., 2019, 2005). They were linked to the second-level ICF categories (Table 1). The ICF browser and manual (International Classification of Functioning, Disability and Health (ICF) [updated, 2018) were used to guide the coding process. The linking was performed by a physiotherapist (BS). To increase the reliability of the ICF linking, an experienced linker (HLS) undertook independent linking of 10% of the PSFS items, randomly selected by the Statistical Package for the Social Sciences (SPSS). The agreement between the two linkers on the ICF codes was 88%. Disagreements in linking were discussed and consensus was reached.

### 2.3. Data analysis

The patient demographics, clinical characteristics and injury-related data are presented by descriptive statistics. Relative proportions (%) of the ICF components (body functions, body structures, activities and participation, and environmental factors) represented in the PSFS were calculated. The main concepts identified according to the ICF linking rules were further analysed, and the second-level categories reported by  $\geq 10\%$  are presented as frequencies (n) and proportions (%) of the second-level ICF categories in descending order. The 10% cut-off was arbitrarily set, aiming at a broad presentation and preserving data richness. In addition, low frequency (reported by  $< 10\%$ ) second-level ICF categories are presented according to ICF chapters.

**Table 1. Example of the ICF linking procedure**

	<b>PSFS item extracted from identified problem</b>	<b>Main concept</b>	<b>Additional concept</b>
Step 1: extracting meaningful text units	Vacuum cleaning, avoiding bending over too far	Bending	Vacuum cleaning
Step 2: linking to the ICF		Chapter: d4 mobility (first-level category); d410 changing basic body position (second-level category)	Chapter: d6 domestic life (first-level category); d640 doing housework (second-level category)

ICF, International Classification of Functioning, Disability and Health; PSFS, Patient-Specific Functional Scale.

To highlight the more common problems reported on the PSFS related to dizziness and balance problems after TBI, the second-level ICF categories were pooled into five groups related to overarching intertwined aspects of functioning. The severity of the reported problems was analysed by calculating the median NRS and interquartile range (IQR) in each group.

IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, NY, USA) was used for the statistical analyses.

### 3. Results

Of the 60 patients with mild to moderate TBI included in this study, 73% were women, with a mean age of 39 (SD 12.9) years. Most had mild TBI with a mean Glasgow Coma Scale score of 14.5 (SD 1.3). Demographic and injury-related data are summarized in [Table 2](#).

The 60 patients reported a total of 240 PSFS activities they had problems performing (mean per patient, 3.9; SD 1.4). A total of 491 meaningful concepts were derived from the 240 PSFS items and could be linked to the ICF as main (n = 309 items) or additional concepts (n = 182). [Figure 1](#).

Within the main and additional concepts, the patients reported problems in body functions (b), activities and participation (d), and environmental factors (e). Problems related to activities and participation (d) were reported most frequently (65%), followed by body functions (b) (31%) and problems with environmental factors (e) (4%). [Figure 2](#).

Within the 309 main concepts, 17 second-level ICF categories were reported by >10% of the patients ([Table 3](#)). The four most frequent second-level ICF categories reported by more than 30% of the patients were moving around (d455), seeing functions (b210), watching (d110), and recreation and leisure (d920). Environmental factors that were considered problems in functioning were, for example, shopping centres, escalators and heights, and were identified in 10% of the patients ([Table 3](#)).

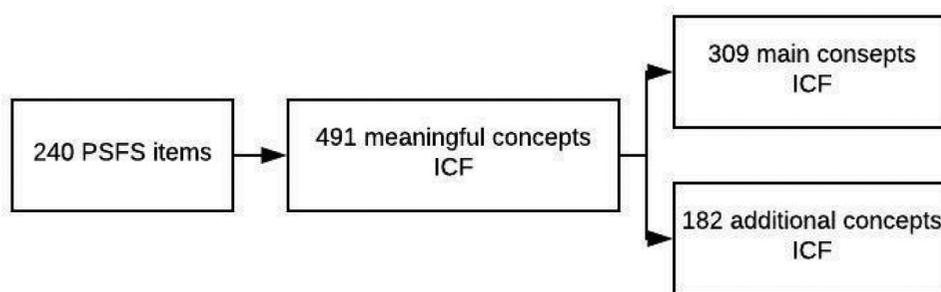
The most frequently reported categories which were described by ≥ 10% of the patients were pooled into five groups: mobility (chapters b4, d4, b7), vestibulo-ocular and hearing functions (chapter b2), attention functions (chapters b1, d1), domestic activities, recreation and leisure factors (chapters d6 and d9) and environmental factors (chapter e1). An overview of the most commonly reported problems in each group is presented in [Table 4](#). The severity of the problems reported on the PSFS across all five pooled group categories varied from a median score on the NRS of 2 to 4 points (IQR, 1–5 points) ([Table 4](#)), interpreted as moderate to severe difficulties in performing the patient-specific activities. The low frequency (reported by <10%) second-level ICF

**Table 2. Patient demographic and injury related characteristics (n = 60)**

Characteristics	Value
<b>Demographic characteristics (n = 60)</b>	
Age (years), mean (SD)	39 (12.9)
Female, n (%)	44 (73)
Education >12 years, n (%)	47 (78)
Pre-injury employment status, n (%)	
Employed/studying	55 (92)
Unemployed/social support	5 (8)
Post-injury sick leave, n (%)	
None/partial	27 (45)
Full time	33 (55)
<b>Characteristics of traumatic brain injury (n = 60)</b>	
Glasgow Coma Scale, mean (SD)	14.5 (1.3)
Loss of consciousness, n (%)	
No/unknown	19 (32)
Yes	41 (68)
Post-traumatic amnesia, n (%)	
No/unknown	23 (38)
Yes	37 (62)
CT/MRI scan, n (%)	
Negative/not performed	36 (60)
Positive	24 (40)
Mechanism of injury, n (%)	
Fall	41 (68)
Traffic accident	9 (15)
Violence	3 (5)
Other	7 (12)

CT, computed tomography; MRI, magnetic resonance imaging; SD, standard deviation.

**Figure 1. Main and additional concepts extracted from the items on the Patient-Specific Functional Scale (PSFS).**

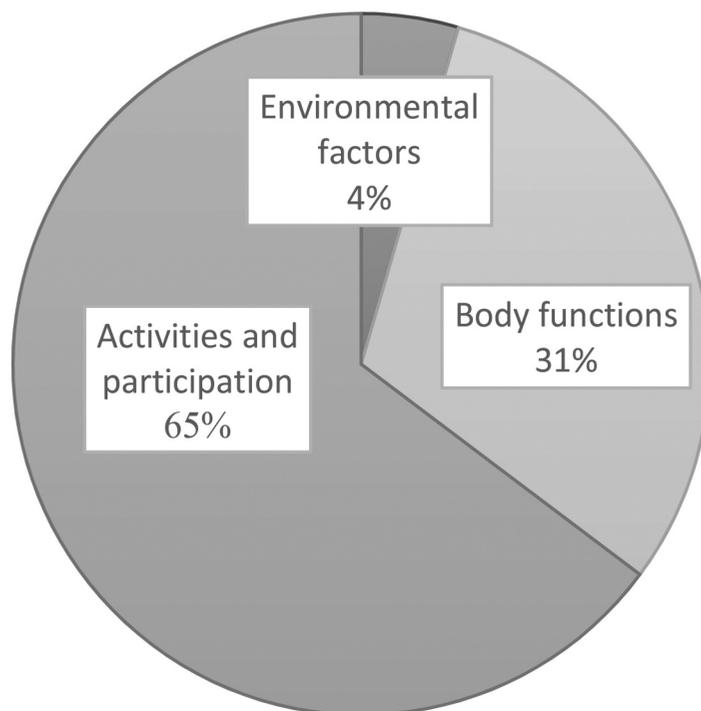


categories are presented in [Table 5](#) and shows the variability in the patient-specific problems reported by this group of patients.

#### 4. Discussion

In this study, we used the ICF as a framework and classification tool to explore patient-specific problems in functioning reported on the PSFS due to dizziness and balance problems after mild to moderate TBI. The main findings of the present study are that patients with dizziness and

**Figure 2. Proportions (%) of problems reported within the ICF components, extracted from the 309 main concepts.**



balance problems report problems particularly within the ICF components activities and participation. A range of difficulties were described and assessed as disabling, primarily related to four areas of functioning: 1) mobility (including control of movement and exercise tolerance functions); 2) vestibulo-ocular and hearing functions; 3) attention functions (including reading and watching); and 4) domestic activities, recreation and leisure functions. The problems with performing the patient-specific activity reported on the PSFS were moderate to severe.

The results of this study show that items of the PSFS can be mapped to the ICF and thereby inform on various aspects of problems in functioning in people with dizziness and balance problems after mild to moderate TBI. Interestingly, among the coded main concepts, only three categories (13%) (Attention functions, Recreation and leisure and Control of voluntary movement functions) are present in the Brief ICF Core Set for TBI, whereas most main concepts are present in the Comprehensive Core Set (World Health Organization ICF CORE SETS, 2021). In contrast, the Brief ICF Core Set for Vertigo entails one third (31%) of the ICF categories among the main concepts found in the current study. This points to the breadth of problems in functioning in patients with dizziness and balance problems after TBI, as the symptomatology is specific to both TBI and vertigo. The current study underscores the need for competence in assessment and treatment of TBI and vertigo/dizziness as described in a previous study by our group (Kleffelgaard et al., 2019).

In line with earlier research, limitations and restrictions reported on the PSFS were most frequently reported in the activities and participation domain of the ICF (Fairbairn et al., 2012; Sveen et al., 2013). The standardized phrasing in the PSFS may have contributed to this because the patients were specifically asked to describe activities. However, many of the assessments and outcome measures used for dizziness in the TBI population are standardized outcome measures focusing on symptoms and body function, therefore the results confirm that the PSFS is an important supplement to these instruments, representing mainly the activity and participation domains. Moreover, in accordance with a study by Maskell et al. (Maskell et al., 2007) the range of

**Table 3. Main concepts from the patient-specific functional scale items with high-to-moderate frequency (≥ 10%) linked to second-level ICF categories of problems in functioning and environmental factors**

ICF second-level categories		Number of patients (%) reporting ICF category (from the main concepts)	Example of problems in functioning reported by the patients
<b>d455<sup>m</sup></b>	Moving around	25 (42)	Going down stairs, running, swimming, dancing
<b>b210<sup>v</sup></b>	Seeing functions	20 (33)	Vision gets blurry at the end of the day
<b>d110<sup>a</sup></b>	Watching	19 (32)	Watching television
<b>d920<sup>d</sup></b>	Recreation and leisure	18 (30)	Going to the movies
<b>d475<sup>m</sup></b>	Driving	17 (28)	Driving a car, cycling
<b>d460<sup>m</sup></b>	Moving around in different locations	16 (27)	Walking the dog, going for a walk
<b>d640<sup>d</sup></b>	Doing housework	15 (25)	Emptying the dishwasher, vacuum cleaning
<b>d166<sup>a</sup></b>	Reading	15 (25)	Reading
<b>b235<sup>v</sup></b>	Vestibular functions	13 (22)	Head movements
<b>b760<sup>m</sup></b>	Control of voluntary movement functions	13 (22)	Pilates
<b>d410<sup>m</sup></b>	Changing basic body positions	11 (18)	Yoga: bending forward
<b>b455<sup>m</sup></b>	Exercise tolerance functions	11 (18)	Exercise
<b>b140<sup>a</sup></b>	Attention functions	9 (15)	Multi-tasking
<b>b230<sup>v</sup></b>	Hearing functions	8 (13)	Loud noise, music
<b>d430<sup>m</sup></b>	Lifting and carrying objects	8 (13)	Collecting objects from cupboard
<b>d465<sup>m</sup></b>	Moving around using equipment	7 (12)	Skiing
<b>e150<sup>e</sup></b>	Design, construction and building products and technology of buildings for public use	6 (10)	Shopping centres, escalators, heights

b, body functions; d, activities and participation; e, environmental factors. Superscripts indicate pooled group categories: <sup>m</sup>ICF category related to mobility, <sup>v</sup>ICF category related to vestibulo-ocular function and hearing, <sup>a</sup>ICF category related to attention, <sup>d</sup>ICF category related to domestic activities, and recreation and leisure, <sup>e</sup>environmental factors.

**Table 4. Commonly reported problems in the pooled group categories and severity of problems according to the PSFS Numeric Rating Scale (NRS)**

ICF chapter, first level	Groups of most frequently reported problems	Commonly reported problems within each group	PSFS NRS score, median (IQR)*
<b>d4, b7, b4</b>	Mobility	Running, swimming, driving a car, going for a walk, yoga, skiing	3 (1–5)
<b>b2</b>	Vestibulo-ocular function and hearing	Head movements, blurred vision, loud noise	3 (1.5–5)
<b>b1, d1</b>	Attention functions	Multi-tasking, reading, watching	2 (1–4)
<b>d6, d9</b>	Domestic activities, and recreation and leisure	Doing housework, going to the movies	3 (1–5)
<b>e1</b>	Environmental factors	Shopping centres, escalators, heights	4 (3–5)

b, body functions; d, activities and participation; e, environmental factors.

\*0 (unable to perform the activity) to 10 (able to perform the activity with no difficulty/as before the injury).

**Table 5. Low frequency (reported by <10%) second-level ICF categories presented according to ICF chapters**

ICF chapter		ICF categories reported
<b>b1</b>	Mental functions	b126 Temperament and personality functions, b130 Energy and drive functions, b152 Emotional functions, b156 Perceptual functions, b164 Higher-level cognitive functions, b180 Experience of self and time functions
<b>b7</b>	Neuromusculoskeletal and movement-related functions	b730 Muscle power functions
<b>d1</b>	Learning and applying knowledge	d155 Acquiring basic skills, d170 Writing
<b>d2</b>	General tasks and demands	d240 Handling stress and other psychological demands
<b>d3</b>	Communication	d335 Producing non-verbal messages, d355 Discussion
<b>d4</b>	Mobility	d415 Maintaining a body position, d450 Walking, d470 Using transportation
<b>d5</b>	Self-care	d510 Washing oneself
<b>d6</b>	Domestic life	d620 Acquisition of goods and services, d630 Preparing meals, d650 Caring for household objects
<b>d7</b>	Basic interpersonal interactions and relationships	d710 Basic interpersonal interactions, d770 Intimate relationships
<b>d8</b>	Major life areas	d830 Higher education, d850 Remunerative employment
<b>e1</b>	Products and technology	e140 Products and technology for culture, recreation and sport
<b>e2</b>	Natural environment and human-made changes to environment	e210 Physical geography, e240 Light, e250 Sound
<b>e3</b>	Support and relationship	e340 Personal care providers and personal assistants

b, body functions; d, activities and participation; e, environmental factors

problems confirms the diversity in reduced functioning in relation to dizziness and balance problems in this population. Some of the activities reported on the PSFS were common among several patients (e.g., running and going down stairs, vacuum cleaning and reading), whereas others were reported by only one patient (e.g., hair washing). Hence, the PSFS identifies specific and individualized problems experienced by patients with dizziness and balance problems after mild to moderate TBI and can be of great value in establishing meaningful rehabilitation goals and individually tailored (vestibular) rehabilitation programmes for the patients.

As shown in earlier research, the results of the current study confirms that dizziness and balance problems after mild to moderate TBI frequently lead to difficulties and challenges in mobility (Bland et al., 2011; Fino et al., 2018; Kleffegaard et al., 2017; Marcus et al., 2019). In addition, the current study shows the individual variation and range of the mobility problems these patients experience. Mobility problems varied from daily activities, such as descending stairs, carrying objects, and changing body position, to higher-level mobility functions such as running, exercising, and dancing. Activities with fast speed and rapidly changing visual inputs and head movements such as driving a car, or cycling were frequently reported as difficult. However, this might also pertain to injury and dysfunction of the vestibular and visual sensory systems, which are common after mild to moderate TBI (Marcus et al., 2019; Mucha et al., 2018; Wallace & Lifshitz, 2016), and also reflected in the ICF Core Sets of TBI and vertigo (World Health Organization ICF CORE SETS, 2021).

It was expected that problems in functioning related to vestibulo-ocular and hearing functions were frequently reported in the current study, a relationship also shown in other studies (Kleffegaard et al., 2017; Wallace & Lifshitz, 2016). The vestibulo-ocular and hearing functions are aspects of functioning of the sensory organs important for dizziness and balance problems and especially the vestibulo-ocular reflex (VOR). The VOR is known to be sensitive and vulnerable to all

severities of TBI (Wallace & Lifshitz, 2016). Normal VOR function is important when carrying out daily activities such as walking and driving a car, and especially in activities with higher demand such as sports-related activities (Wallace & Lifshitz, 2016). Visual and vestibular impairments are strong contributors to dizziness and balance problems and can often lead to problems with spatial orientation and gaze stability during movement, which in turn affects higher-level mobility (Peterson, 2010).

Attention problems have been related to dizziness in patients with TBI in earlier research (Maskell et al., 2007) and have also been connected to vestibulo-ocular dysfunction (Ventura et al., 2014). Attention is an essential component in the maintenance of balance, which is complex and requires the integration of information from multiple systems (Kleiner et al., 2018). Attention functions are important in dual- and multi-tasking, and also have a bi-directional effect on balance and dizziness. Problems in visual functioning, more specifically related to reading and use of computers or mobile phones, were also reported with high frequency and the visual dysfunction could further intensify the dizziness and balance problems.

Difficulties related to recreation, leisure and domestic activities were also frequently reported in the current study. Several patients reported physical exercising as a problem. This could also be related to aerobic capacity or tolerance of physical activity which is increasingly described in this patient population by Leddy et al. (Leddy et al., 2018). Patients with TBI are at risk of not maintaining optimal levels of physical activity, resulting in decreased cardio-vascular fitness (Hassett et al., 2017). Furthermore, avoiding exercising often equates to low participation in leisure and recreation and thereby risking reduced community re-integration (Hassett et al., 2016). The challenges reported on the PSFS also pertain to other activities, such as going to the movies, socializing, dancing and playing football. These findings are supported by the study of Maskell et al. (Maskell et al., 2007) suggesting that some patients would likely withdraw from participating at home and in the community due to dizziness and balance problems after TBI. In this context, problems with domestic activities, such as gardening or vacuum cleaning, were also reported. These activities require change of body positions and head movements, which suggest a connection to the vestibular system and dizziness as discussed earlier.

The fact that the patient-specific activities reported were interpreted as moderate to severe could partly be explained by the severity of the injuries, and many of the patients had complicated mild injuries with difficulties performing their regular pre-injury activities. It has been shown that more severe mild injuries report more symptoms post-injury (Voormolen, Haagsma et al., 2019). Furthermore, many of the participants were in a chronic phase post-injury, were still on sick leave and some had not yet returned to or tried their usual activities. However, in line with the results from the study by Maskell et al., many of the patients reported few activities that they absolutely could not do, but many activities that was harder for them to do or had to be modified (Maskell et al., 2007).

With regard to environmental factors, the patients typically reported problems related to busy and more complex environments outside their homes (e.g., shopping centres). This is in accordance with earlier research (Maskell et al., 2007). Moreover, elevators, escalators, heights, kerbs and uneven ground were reported as barriers to functioning due to dizziness. The self-reported difficulty related to environmental factors shows that these factors can be moderate barriers to functioning and is important to consider during assessment and rehabilitation of these patients.

#### **4.1. Limitations**

This study has some strengths and limitations that should be addressed. A strength of this study was that the ICF linking rules were followed (Cieza et al., 2019) and that a random 10% of the meaningful concepts were linked by an expert linker (HLS), which indicated 88% agreement in the linking process.

A limitation of the study is that the population was a selected cohort with dizziness and balance problems from a university hospital, representing a subgroup of the more severely injured population with mild TBI. Most of the participants were women (73%), which is in contrast to the gender distribution in the general TBI population. However, women are more likely to report dizziness and balance problems in general, and also after mild to moderate TBI (Styrke et al., 2013). These factors and the relatively small sample size limit the generalizability of the results.

Another limitation is that the PSFS has not yet undergone reliability and validity testing in patients with TBI. However, it is intended for use for a variety of conditions and has been shown to be applicable for patients with acquired brain injury (Evensen et al., 2020).

#### 4.1.1. Conclusion

In this study, the 60 patients predominantly reported problems representing activities and participation component of the ICF. Mobility-related problems were the most frequently reported. In addition, problems related to vestibulo-ocular and hearing functions, attention functions, domestic activities and recreation and leisure were frequently reported. Environmental factors that were mainly physical barriers to functioning were reported. The severity of problems on the PSFS were rated as moderate to severe, meaning that the patients still had difficulties performing activities important to them 3 months after injury. The results of this study indicate that patients with dizziness and balance problems experience difficulties in a wide range of activities after TBI. The functional limitations relevant to the individual patient described on the PSFS, were all represented in the ICF, supporting a biopsychosocial perspective on problems related to dizziness and balance problems after TBI. This indicates that clinicians could use the PSFS to get a more individual description of the functional limitations post-injury and use this in addition to other outcome measures to guide goal setting and individually adapted rehabilitation interventions. However, further research is required to fully understand the functional limitations experienced by this population.

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#### Declaration of interest statement

No potential conflict of interest was reported by the author(s).

#### Data availability statement

The data that support the findings of this study are available from the corresponding author, [I.K.], upon reasonable request.

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