Test-retest reliability of the functional mobility assessment (FMA): a pilot study

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Purpose: Functional mobility is necessary to perform activities of daily living and for community participation for everyone, but especially important for persons with disabilities (PWD). Therefore, functional mobility requires reliable measurement of consumer satisfaction and functional changes. The functional mobility assessment (FMA) instrument is a self-report outcomes tool designed to measure effectiveness of wheeled mobility and seating (WMS) interventions for PWD. This study examined the test-retest reliability of the FMA, and the stability of self-reported performance items. Method: A repeated-measures cohort study was conducted at the Center for Assistive Technology, at the University of Pittsburgh Medical Center. Participants (n = 41) completed an initial FMA questionnaire, and were re-administered the questionnaire within 7–21 days of the first questionnaire completion. The study sample included 20 participants who were non-WMS users but in the process of being evaluated for a device and 21 participants who were existing WMS users. Intra-Class Correlation coefficients (ICC) were computed to determine agreement between the two scores. Results: Test-retest reliability scores for all items and participants were above the acceptable value for a clinical assessment tool (≥0.80). Responses on the FMA of Existing WMS users and non-WMS users did not differ significantly at test or retest. Conclusions: Results indicate that the FMA was a reliable and stable tool for assessing the functional performance of individuals who use or need WMS interventions.

Keywords: Outcomes measure, wheelchair, assistive device, functional skills, test-retest, reliability, mobility

Functional mobility is necessary to perform daily activities and to enhance social or community participation [1,2]. Assistive technology, including wheeled mobility and seating (WMS) devices such as manual wheelchairs, power wheelchairs or scooters, are used to enhance functional performance and participation [3–6]. Thus, reliable, well fitted mobility devices and assistive technologies can reduce dependence on personal care assistants and caregivers, and improve the quality of life of the users [7]. Ameliorating disability and enhancing functional outcomes are integral parts of rehabilitation and require a reliable measure of consumer satisfaction and functional changes after prescription of WMS assistive devices.

Lack of research in mobility device interventions and the growing practice of direct-to-consumer marketing by certain mobility device suppliers outside the healthcare setting could lead to a high incidence of matching of consumers with inappropriate equipment [8]. Despite the potential advantages of assistive technology (AT), such devices are underused or abandoned prematurely for many reasons, including a mismatch between a consumer’s functional needs, mobility limitations, personal preferences, the environment, or any combination thereof and the WMS itself [9]. For example, a small group of Australian wheelchair users interviewed by Kittel et al. (2002) stated that an unsatisfactory interview...
process with the prescribing therapist led to the provision of inappropriate devices [10]. To improve feature matching and prescriptive practices, consideration must be given to the consumers' satisfaction and functional needs within the environment that the consumer uses the technology. High rates of abandonment are costly both in terms of money, therapist time, potential secondary injuries, and performance achievement [11]. Therefore, consumers need to be involved in the process of mobility device selection [12]. To facilitate such involvement, self-reported outcome tools may be used effectively to assist the clinician in understanding personal, health, and functional needs to accurately match technology with consumers' needs within the context and environments in which the technology is to be used.

The Center for Medicare and Medicaid Services (CMS) policies require function-based criteria for prescription of a mobility device, and for providing assistance for consumers to perform the mobility related activities of daily living [13]. Therefore, appropriate measurement of rehabilitation outcomes and evaluation of the effects of mobility device interventions for people with mobility related problems is necessary to inform clinicians, third party payers, consumers, manufacturers and policy makers [14,15]. With increasing demand for accountability of WMS device services, the need for research that focuses on psychometric properties of functional outcome measures has been strongly emphasized by policy makers [16,17]. Therefore, using reliable and valid outcome measurement tools is vital to the credibility, funding, and growth of rehabilitation technology [18]. The impact of outcome measures influences multiple stakeholders at various levels, including the consumer as the end-user at a personal level; clinician and supplier at the professional level; and third party payers such as private insurance companies at the funding level. Moreover, at the national level, government agencies can use the results of outcome measures to analyze the impact of policy and sustainability of related programs [17]. Therefore, clinicians need quantifiable outcomes that justify the costs and resources associated with mobility devices and services [19].

The current outcomes measurement tools in the area of WMS vary in scope of content and context including the wheelchair skills test [20], the Wheelchair User Functional Assessment [21] and the Wheelchair Physical Functional Performance Test [22]. Items on these performance-based tools measure include wheelchair skills such as propulsion, wheelies, negotiating obstacles, and power wheelchair operation. Other self-reported outcome tools include the Psychological Impact of Assistive Device Scales (PIADS) [23], which measures the psychosocial impact of assistive technology, and the Quebec Users Evaluation of Satisfaction with Assistive Technology (QUEST), which assesses the consumer's satisfaction with the assistive technology devices and service delivery processes [24]. However, items on these self-report tools are general, and not specific to functional performance when using a WMS. To date, no self-reported tool exists that focuses on performance of functional activities for both wheeled and non-wheeled mobility interventions in the consumer's natural environment.

The functioning everyday with a wheelchair (FEW) is a self-report tool developed from consumer-generated information to measure consumer satisfaction levels with respect to functional performance of everyday tasks while using a WMS [25]. The FEW is commonly used by clinicians and researchers to assess consumers during the wheelchair prescription process and when evaluating the functional performance of individuals who already use wheelchairs or scooters as their primary means of mobility as presented in Figure 1. The FEW has demonstrated good content validity and test-retest reliability [25], as well as high stability and reliability in measuring mobility goals over a 1-week interval. An ICC value of 0.86 and \( p < 0.001 \) was calculated for the FEW and it captured 98.5% of mobility related goals. Although the FEW is a valid and reliable tool to measure needs and functional performance, it is designed for people who have existing wheelchairs or scooters. However, the FEW does not address people who use non-WMS devices such as canes, crutches, walkers, orthotics, or prostheses. As a result, the tool is not sensitive to people transitioning from non-WMS to WMS interventions. Thus, the FEW was modified so that the revised instrument, the functional mobility assessment (FMA), would be applicable to assessing the needs of both existing WMS users and non-WMS users who do not have wheelchair or scooter experience.

The primary aim of this study was to establish the test-retest reliability of the FMA and examine the extent to which each performance item rating remained stable when participants responded to the same question on two separate occasions, with the same rater. Our first hypothesis was that test-retest reliability would be established at \( \geq 0.80 \) using the intra-class correlation coefficient (ICC). The secondary aim of this study was to compare test and retest responses of Existing WMS and non-WMS users. We also hypothesized that the Existing WMS users would show higher total scores (greater satisfaction) on the FMA than the non-WMS users who currently used a cane, crutch, walker or no mobility device.

**Method**

The study used a single cohort repeated-measures design to evaluate the test-retest reliability of the FMA. This study was approved by the University of Pittsburgh's Institutional Review Board (IRB). Prior to study enrollment, all potential participants were screened to determine if they met inclusion criteria. These potential participants were initially asked by the University of Pittsburgh Medical Center (UPMC) Center for Assistive Technology (CAT) clinicians during their face-to-face evaluations if they were interested in participating in this study. Informed consent was then obtained from all study participants.

**Participants**

A total of 42 participants were recruited initially, and 41 completed the two sets of FMA questionnaires. One participant did not respond to the researcher when he called to schedule an appointment to complete the FMA retest on the phone. Also, most participants were not available on day seven after the initial FMA test. Administration of the retest of FMA, therefore, varied from 7 days to 21 days, due to the limited availability of participants on day 7.
DIRECTIONS: Please answer the following 10 questions by placing an ‘X’ in the box under the response (completely agree, mostly agree, slightly agree, etc.) that best matches your ability to function while in your current means of mobility (i.e., walking, cane, crutch, walker, manual wheelchair, power wheelchair or scooter). All examples may not apply to you, and there may be tasks you perform that are not listed. Mark each question only one time. If you answer, *slightly, *mostly, or *completely disagree for any question, please write and specify the reason for your disagreement in the Comments section. Please determine your priorities, by rating the importance of the content in each of the 10 questions in the shaded box to the right of each question. Rate your highest priority as 10, and your lowest priority as 1.

Functioning Everyday with a Wheelchair (FEW)

<table>
<thead>
<tr>
<th>5. The size, fit, postural support and functional features of my wheelchair/scooter allow me to reach and carry out tasks at different surface heights as independently, safely, and efficiently as possible: (e.g., table, counters, floors, shelves)</th>
<th>Completely Agree</th>
<th>Mostly Agree</th>
<th>Slightly Disagree</th>
<th>Mostly Disagree</th>
<th>Completely Disagree</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments:</td>
<td></td>
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</tbody>
</table>

Functional Mobility Assessment (FMA)

<table>
<thead>
<tr>
<th>5. My current means of mobility allows me to reach and carry out tasks at different surface heights as independently, safely and efficiently as possible: (e.g., table, corners, floors, shelves)</th>
<th>Completely Agree</th>
<th>Mostly Agree</th>
<th>Slightly Disagree</th>
<th>Mostly Disagree</th>
<th>Completely Disagree</th>
<th>Does not apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>Walker</td>
<td>Cane</td>
<td>Crutch</td>
<td>Manual Wheelchair</td>
<td>Power Wheelchair</td>
<td>Scooter</td>
</tr>
<tr>
<td>Comments:</td>
<td></td>
<td></td>
<td></td>
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</table>

Figure 1. Sample word changes between the functioning everyday with a wheelchair (FEW) and the functional mobility assessment (FMA) tools.

**Instrumentation**

The FMA was adapted from the FEW questionnaire, so that items were relevant to individuals who used canes, crutches, walkers, wheelchairs or scooters as their primary mobility devices. Sample modifications in wording are shown in Figure 1.

The FMA consists of questions regarding the following 10 items:

1. carrying out my daily routine,
2. comfort needs,
3. health needs,
4. operate with independence & safety,
5. reaching and carrying out tasks at different surface heights,
6. transfers from one surface to another,
7. personal care tasks,
8. indoor mobility,
9. outdoor mobility,
10. personal and public transportation.

All items addressed the features of mobility devices, including wheelchairs, scooters, canes, crutches or walkers – devices that assist people with disabilities in functional mobility and allow them to perform functional tasks as independently, safely and efficiently as possible. All items are scored on a 7-point Likert scale in which 6 = completely agree, 5 = mostly agree, 4 = slightly agree, 3 = slightly disagree, 2 = mostly disagree, 1 = completely disagree, and 0 = does not apply to me.

**Procedures**

Prior to administration of the FMA, demographic and mobility specific data were collected. Participants were asked to rate their health and how they felt while performing their daily activities on the day of the study and in past three months. These questions were scored on a vertical visual analogue scale with values of 0–100, with 0 representing the worst participants felt over the last three months, and 100 representing the best they felt over the last 3 months. The first assessment of the FMA questionnaire (i.e. test) was completed on 20 participants from the non-WMS group, who were currently using canes, crutches, walkers, prostheses or no devices at the CAT, and 21 participants receiving a replacement device of some type. All participants were asked to respond to the FMA questions from the perspective of their means of mobility used at the time of their assessment. After obtaining the initial FMA assessment
data, an appointment was made for the second session (i.e. retest), to be conducted a minimum of 7 days later, over the telephone. At the first administration of the FMA, participants were provided with a blank copy of the FMA to refer to during the retest assessment. For the second assessment (retest), each participant was contacted by a trained researcher, and the FMA data were collected once again. Duration of time to complete administration of the first FMA (test) was approximately 15 min, and the second interview by telephone (retest) was completed in approximately 10 min. To avoid bias in the recruitment and prescription process, the first author was masked to the process, so he was not aware of which consumers were in each group.

**Data analyses**

ICC were computed to determine test-retest reliability between the two time points, test and retest. These calculations were repeated for all individual items, and for the total FMA score. We also computed the ICC for Existing WMS users and non-WMS users for individual items and the total score. Acceptable results for the reliability coefficient were set at a value greater than or equal to 0.80 *a priori*, which is considered 'good' reliability [26]. To identify differences in ratings of individual items for test-retest comparisons between Existing WMS users and non-WMS users, we used the Mann Whitney U test with a Bonferroni correction set *a priori* at \( p \leq 0.025 \) to compare these ordinal data. To examine health status impact ratings, we compared health status at test and retest administrations using a paired *t*-test. All statistical analyses were computed using the Statistical Package for the Social Sciences (SPSS) 16.0.

**Results**

The total sample consisted of 41 people (Existing WMS = 21; non-WMS = 20), of whom 24 were male (58.5%) and 17 were female (41.5%). Of the total 41 participants, 31.7% used manual wheelchairs, 17% used power wheelchairs, 2.4% used a scooter, 19.5% used canes, 19.5% used walkers, 4.8% used crutches, 2.4% had lower limb prostheses, and 2.4% did not use any mobility device, (see Table I). The average number of years of using a mobility device was 7.4 ± 9.1 years (range: 0–53 years). Health status data for all participants (perception of health well-being) averaged 65.5 out of 100 points at test (time 1) and 69.3 out of 100 points at retest (time 2). Results from a paired *t*-test indicated no significant differences existed between participants’ perception of well-being at test and retest, \( t = -1.6, \text{df} = 40 \) and \( p = 0.105 \).

**Table I.** Demographic and health-related characteristics of study participants.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>All  (n = 41)</th>
<th>Existing WMS Users (n = 21)</th>
<th>Non-WMS Users (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean; sd, min, max)</td>
<td>54 ± 16 (25.87)</td>
<td>49.3 ± 16 (28.81)</td>
<td>58.9 ± 14 (31.87)</td>
</tr>
<tr>
<td>Gender n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>24 (58.5)</td>
<td>12 (57.1)</td>
<td>12 (60)</td>
</tr>
<tr>
<td>Female</td>
<td>17 (41.5)</td>
<td>9 (42.9)</td>
<td>8 (40)</td>
</tr>
<tr>
<td>Type of current primary mobility device, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual wheelchair</td>
<td>13 (31.7)</td>
<td>13 (61.9)</td>
<td>—</td>
</tr>
<tr>
<td>Power wheelchair</td>
<td>7 (17)</td>
<td>7 (33.3)</td>
<td>—</td>
</tr>
<tr>
<td>Scooter</td>
<td>1 (2.4)</td>
<td>1 (4.8)</td>
<td>—</td>
</tr>
<tr>
<td>Cane</td>
<td>8 (19.5)</td>
<td>—</td>
<td>8 (40)</td>
</tr>
<tr>
<td>Crutch</td>
<td>2 (4.8)</td>
<td>—</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Walker</td>
<td>8 (19.5)</td>
<td>—</td>
<td>8 (40)</td>
</tr>
<tr>
<td>Prosthesis</td>
<td>1 (2.4)</td>
<td>—</td>
<td>1 (5)</td>
</tr>
<tr>
<td>No device</td>
<td>1 (2.4)</td>
<td>—</td>
<td>1 (5)</td>
</tr>
<tr>
<td>Years of mobility device use – mean ± sd (min, max)</td>
<td>7.4 ± 9.1 (53.0)</td>
<td>9.1 ± 5.9 (1.25)</td>
<td>5.7 ± 11 (0.53)</td>
</tr>
<tr>
<td>Age of mobility device – mean ± sd, (min, max)</td>
<td>3.5 ± 2.6 (10.0)</td>
<td>4.1 ± 2.4 (0.10)</td>
<td>2.8 ± 2.7 (0.9)</td>
</tr>
</tbody>
</table>

**Table II.** ICC values for all participants including Existing WMS & non-WMS users.

<table>
<thead>
<tr>
<th>Items</th>
<th>All users ICC (CI)</th>
<th>Existing WMS ICC (CI)</th>
<th>Non-WMS ICC (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1: Carry out</td>
<td>85 (0.73–0.91)</td>
<td>0.75 (0.49–0.89)</td>
<td>0.93 (0.84–0.97)</td>
</tr>
<tr>
<td>Item 2: Comfort</td>
<td>87 (0.77–0.92)</td>
<td>0.84 (0.66–0.93)</td>
<td>0.84 (0.64–0.93)</td>
</tr>
<tr>
<td>Item 3: Health</td>
<td>82 (0.70–0.90)</td>
<td>0.84 (0.64–0.93)</td>
<td>0.75 (0.47–0.89)</td>
</tr>
<tr>
<td>Item 4: Operate</td>
<td>87 (0.77–0.93)</td>
<td>0.89 (0.76–0.95)</td>
<td>0.83 (0.63–0.93)</td>
</tr>
<tr>
<td>Item 5: Reach</td>
<td>83 (0.71–0.91)</td>
<td>0.85 (0.66–0.93)</td>
<td>0.76 (0.49–0.89)</td>
</tr>
<tr>
<td>Item 6: Transfer</td>
<td>81 (0.68–0.89)</td>
<td>0.74 (0.46–0.88)</td>
<td>0.87 (0.71–0.94)</td>
</tr>
<tr>
<td>Item 7: Personal care</td>
<td>88 (0.79–0.93)</td>
<td>0.83 (0.63–0.92)</td>
<td>0.90 (0.77–0.96)</td>
</tr>
<tr>
<td>Item 8: Indoor mob</td>
<td>85 (0.74–0.92)</td>
<td>0.81 (0.60–0.92)</td>
<td>0.86 (0.69–0.94)</td>
</tr>
<tr>
<td>Item 9: Outdoor mob</td>
<td>88 (0.80–0.93)</td>
<td>0.88 (0.73–0.95)</td>
<td>0.82 (0.61–0.92)</td>
</tr>
<tr>
<td>Item 10: Transportation</td>
<td>96 (0.94–0.98)</td>
<td>0.95 (0.73–0.95)</td>
<td>0.98 (0.61–0.92)</td>
</tr>
<tr>
<td>All Items</td>
<td>87 (0.85–0.89)</td>
<td>0.85 (0.81–0.88)</td>
<td>0.87 (0.84–0.90)</td>
</tr>
</tbody>
</table>

*Disability and Rehabilitation: Assistive Technology*
Results of the test-retest reliability analysis yielded an ICC value of 0.87 (CI 0.85–0.89) for all FMA items, for all participants presented in Table II. Our results were above the recommended value of ≥0.80. As a result, we accepted our primary hypothesis that the test-retest reliability would be established at ≥0.80. For the Existing WMS users group, the overall ICC value was 0.85 (CI 0.81–0.88). For the non-WMS users group, the total score ICC value was 0.87 (CI 0.84–0.90).

Mann–Whitney U statistics were used to find the differences between test-retest responses of Existing WMS users and non-WMS users. A Bonferroni Correction was established a priori at \( p < 0.025 \). Median values of responses for WMS users and non-WMS users did not differ significantly at Time 1 (\( U = 208.5, p = 0.968 \)) or Time 2 (\( U = 130.5, p = 0.037 \)), and therefore the second hypothesis that Existing WMS users would show higher ratings than non-WMS users was rejected.

Discussion

Based on the results of our study, the FMA has been found to be a reliable tool for measuring the perceived functional status and outcomes of both Existing WMS and non-WMS users of mobility devices. High ICC (ICC ≥ 0.87) was achieved for the total sample scores. Within the Existing WMS user groups, the ICC value for each item was greater than or equal to 0.80 (ICC ≥ 0.80), with the exception of carrying out daily routines and transfers. Items that demonstrate stronger reliability included comfort, operation and outdoor mobility. The FMA was found to be an equally reliable tool for non-WMS users (i.e. not a user of a wheeled mobility device). Item ICC values are reported because, clinically, each item informs decisions about mobility interventions. Currently, no other self-report outcome tools are available to measure functional performance of both Existing WMS users and non-WMS users using canes, crutches or walkers, who are going to AT clinics for the first time for a new wheelchair or scooter. The FMA may fill this gap in outcome measures that can bridge the gap of comparing wheelchairs and other mobility related assistive devices.

The purpose of this study was to revise the FEW to meet the needs of not only of current wheeled mobility device users, but also of individuals who are not currently using a wheeled mobility device. The current version of the FEW was not designed to address the functional status and functional changes among new wheeled mobility device users. In trying to meet the need of assessing functional status, changes, or both among those consumers who are not yet using wheelchairs, the FMA items yielded higher reliability coefficients compared to the latest version of the FEW (0.41–0.83) [25].

The FMA test-retest results were compared with other self-report outcome measures tools used in AT practice. The QUEST is considered to be a global assessment tool for AT, measuring satisfaction related to an assistive device usage and the service delivery. The QUEST does not evaluate functional changes with respect to ADLs and IADLs in home or community settings. Comparatively, the FMA is designed to measure both functional performance and satisfaction related to mobility devices only. The FMA tool was as reliable as the QUEST (0.82–0.91); [27]. The outcome measure Psychosocial Affect of Assistive Devices (PIADS) assesses the impact of assistive devices on quality of life [23]. The PIADS places more emphasis on competence, adaptability, and self-esteem, and, unlike the FMA, is not designed to measure functional outcomes related to mobility device use. Demers et al. (2002) found the PIADS to have robust reliability (\( r = 0.92, 0.88 \) and 0.87) for the competence, adaptability and self-esteem scores, respectively.

The Wheelchair Seating Discomfort Assessment Tool (WcS-DAT) is a reliable and stable self-report tool for measuring discomfort while seated in a wheelchair [28]. Thus, the WcS-DAT does not assess functional performance during transfers, reaching to different surface heights, and indoor mobility while seated in a wheelchair, moreover; test-retest reliability was performed at an interval of only one hour, which increases the probability of carryover effects. Also, all the participants had intact sensation, so results obtained using this tool cannot be generalized to the population whose sensation was not within normal limits [28]. The other self reported tool, the Wheelchair Outcome Measure (WhOM) also contains questions regarding body structure, based on the ICF Model. Garden et al. (2009) found good test-retest reliability (based on an ICC value of 0.90) and inter-rater reliability (ICC of 0.89) when the tool was used with a population of individuals with spinal cord injuries who used wheelchairs [29]. Auger et al. (2010) also reported good test-retest reliability (ICC = 0.77–1.00) using the WhOM during telephone administration among middle-aged and older populations using power mobility devices [30]. Comparatively, the FMA is applicable to all kinds of mobility related device users, irrespective of age.

The test-retest reliability total score of the FMA across all users (ICC = 0.87) is consistent with the total score of the FEW (ICC = 0.86). Multiple factors could have influenced the test-retest reliability results leading to the FMA demonstrating better reliability than the FEW. For example, when the FMA was created from the FEW, an attempt was made to use more simple language that is easier to understand for both clinicians and consumers. For example, the language of first item in the FEW, “The stability, durability and dependability features of my wheelchairs/scooter contribute to my ability to carry out my daily routine as independently, safely, and efficiently as possible,” was simplified and shortened in the FMA to “My current means of mobility allows me to carry out my daily routine as independently, safely and efficiently as possible.” as shown in Figure 1. The language of the FEW excludes it being used with new users of mobility devices or consumers currently using canes, crutches, or walkers. Also, clinicians had to ensure that they explained the meaning of questions to consumers because consumers may have had difficulty understanding the contextual relationship of the stability, durability, and dependability features of their wheelchairs within their daily routines. Consumers may have also had a hard time understanding the contextual meaning of postural and functional features. This wording was simplified in the FMA to “My current means of mobility allows me.” This reduced the
Conclusion
The FMA was found to have excellent test-retest reliability, improving on its predecessor, the FEW, and was determined to be a reliable tool to collect data on consumer satisfaction with their current means of mobility. The findings of this study indicate that simplifying the language of the FMA questionnaire increased the reliability of the FMA, compared to the FEW. It also enabled collection of consumer satisfaction with functional mobility performance by Existing WMS users and non-WMS users. This study also suggests that measuring self-report outcomes by telephone was effective, which can be used in the future to reduce the workload of clinicians and the need for consumers to come to a clinic for a follow-up outcomes assessment. Information from this study may reduce the gap in consumer-relevant outcome data for consumers prior to receiving assistive device assessments.

Declaration of interest
The authors report no declarations of interest.

References


