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Development of a functional assessment measure for manual wheelchair users

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Abstract—This investigation developed the Wheelchair Users Functional Assessment (WUFA©). Because no functional outcome tools exist that include many of the daily activities that are needed to be independent by individuals using manual wheelchairs, development of an appropriate tool was deemed important. Although the Functional Independence Measure (FIM™) can be used to assess disability in those using a wheelchair, it only measures some aspects of basic activities of daily living (ADLs) and does not measure community independence. Therefore, both basic activities and community activities were included in the new tool. A panel of six rehabilitation experts, with input from manual wheelchair users, determined content of the instrument. The resulting WUFA scale includes 13 items. Interrater reliability and stability were established with the calculation of an intraclass correlation coefficient (ICC). ICC for interrater reliability was 0.96 and ICC for stability was 0.78. Further analysis was performed on the internal consistency of the 13-item tool using a sample of 101 tested subjects. This analysis was done using a Cronbach's Alpha. Results indicated excellent internal consistency of the 13 items. The standardized coefficient alpha was 0.96. The WUFA was shown to have content validity, promising interrater reliability and stability, and good internal consistency. Further research is warranted to determine the tool's sensitivity and capability to discriminate between levels of functional independence.

Key words: assessment, function, independence, wheelchair users.

INTRODUCTION

For individuals who use manual wheelchairs as their primary mode of ambulation, rehabilitation requires acquisition of specific skills if the wheelchair user is to function independently at home and in the community. Measurement of home and community functional ability

Abbreviations: ADL = activity of daily living, CUE = Capabilities of Upper Extremity, CVA = cerebral vascular accident, ICC = intraclass correlation coefficient, FIM = Functional Independence Measure, MBI = modified Barthel Index, MWCU = manual wheelchair users, QIF = Quadriplegia Index of Function, SCI = spinal cord injury, SCIM = Spinal Cord Independence Measure, WC-PFP = Wheelchair Physical Functional Performance, WST = Wheelchair Skills Test, WUFA© = Wheelchair Users Functional Assessment.

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is essential in evaluating the outcomes of rehabilitation. Two tools are known that were developed to specifically assess functional ability of the diverse group of individuals using a manual wheelchair. Cress et al. developed one tool called the Wheelchair Physical Functional Performance (WC-PFP) test [1]. The WC-PFP has 11 tasks that assess mobility for those using a manual wheelchair. Although reliability for total and domain scores range from intraclass correlation coefficient (ICC) 0.87 to 0.96, the use of the test is limited. The test does not measure many fundamental tasks required by manual wheelchair users (MWCU), such as the ability to maneuver up and down curbs and ramps, to completely dress oneself, to bath and toilet, and to maneuver in tight spaces and over uneven terrain.

The second tool identified is the Wheelchair Skills Test (WST) developed by Kirby and colleagues [2]. This tool determines performance on a set of manual wheelchair skills required for daily living. It includes 33 skills ranging from putting the brakes on and off to performing a wheelie. The limitation of this test is that it mainly requires manipulation of the wheelchair and its parts and does not necessarily require activities of daily living (ADLs). Although it assesses basic wheelchair skills, it does not include many skills needed to function at home and/or in the community.

Besides the WC-PFP and the WST, other tools have been developed to assess those individuals having spinal cord injury (SCI). These instruments include the Quadriplegia Index of Function (QIF), the short-form QIF, the Capabilities of Upper Extremity (CUE), and the Spinal Cord Independence Measure (SCIM) [3–5]. Although specific to assessing problems in performance of functional activities encountered by those having SCI, these tools are not comprehensive and do not include wheelchair skills that are required for community independence. In addition, scores are negatively affected if a wheelchair is used.

Two other tools that are often used to assess functional abilities of people who use wheelchairs are the modified Barthel Index (MBI) and the Functional Independence Measure (FIM™) [6,7]. These tools were developed to assess the degree of independence in diverse patient populations. Again, the MBI and FIM only assess basic ADL and mobility, and a lower score is given if the individual uses a wheelchair. The disadvantages to the available tools are that many were not designed to test specific skills necessary for functional independence for MWCU and/or to measure skills needed to be independent in the community.

Of the tools just mentioned, the FIM has been widely adopted by the rehabilitation industry as a tool to be used with diverse patient populations. Even so, skills needed for independence in the community are not adequately reflected by the FIM wheelchair locomotion item [8], and based on this gap in measurement specificity, recommendations for expansion of the existing FIM wheelchair item to include more advanced wheelchair mobility skills have been proposed. The aim of this research was to develop a performance-based functional measurement tool that is easy to administer and score, which can be applied to the wide range of individuals who use manual wheelchairs. Most importantly, the tool needed to—

1. Incorporate home and community wheelchair skills.
2. Be able to detect change in functional status.
3. Be able to differentiate between wheelchair users with varying levels of independence.

In addition, when we developed the Wheelchair Users Functional Assessment (WUFA©), our goal also was to develop a tool that correlated highly with the constructs of independence as judged by expert raters. The expert raters subjectively evaluated the overall independence of MWCU with various levels of physical impairment using a numerical category scale that assigned global independence ratings of 5 (very independent), 4 (independent with some limitations), 3 (moderately dependent), 2 (dependent with only minimal mobility), or 1 (total dependence) to each subject. In this preliminary work, the total WUFA score correlated highly using the Spearman rho ($r_s = 0.95$; $p < 0.05$) with the opinion of the expert raters [9]. The strength of this correlation suggested that, when used collectively, the constructs incorporated in the WUFA provided valid and discrete, quantitative information deemed to be important in determining a manual wheelchair user's level of independence. In this article, we report on the initial development of the WUFA, as well its content validity, reliability, and internal consistency of the items. The Institutional Review Board for research involving human subjects approved this study.

METHODS

Content Validity

Content validity is the "degree to which the items in an instrument adequately reflect the content domain

being measured" [10]. Because content validity is subjective, a panel of experts is often used in its determination. This subjective process is carried out until all of the experts reach a consensus regarding the content of the instrument.

For the initial development of the WUFA, a panel of six physical therapists was used. Before the panel was selected, the decision was made to consider an individual an expert if he or she was a clinician, researcher, or educator experienced in working specifically with those requiring the long-term use of a wheelchair and/or experienced in working with functional assessment or tool development. All participants were considered experts in rehabilitating MWCU and in identifying the levels of independence for individuals who use wheelchairs. The panel included three physical therapy faculty members and three clinicians. Of the three faculty members, one had 10 years of research experience with wheelchair users including SCI, one had 9 years of clinical experience and 5 years of research experience in geriatrics and functional assessment, and the other was certified by the American Physical Therapy Association as a Neurologic Certified Specialist. The three clinicians were certified FIM examiners, with experience in rehabilitation of MWCU. Initially, the panel members were informed of the purpose of the research and instructed to develop a list of items that were thought to be important for independent living in the home and community for those using a manual wheelchair. The group then came together, and from the six lists, the panel collectively agreed on 18 items that were important. During this process, all items were placed on a flip chart and openly discussed, and then the group through consensus decided which items were of the greatest importance.

Following the panel decision process and the development of the 18-item list, 30 MWCU completed surveys regarding opinions of skills necessary for wheelchair users to be independent in the home and community. The survey consisted of the 18 activities and the MWCU were asked to indicate "yes" or "no" if they were able to perform the tasks independently. They were then asked which items were important tasks to learn to be independent. The individuals were also asked to add any further items that were not included in the survey. The panel reviewed these surveys and selected items that were identified as important to include in the WUFA. Based on the comments of the MWCU, 4 of the original 18 items were eliminated and 2 items were modified. Items that were eliminated included performing wheelies, managing bowel and bladder, driving, and using escalators. Wheelies were eliminated because this skill was felt to be necessary to complete the curb and ramp tasks that were included on the final version. Managing bowel and bladder was dropped because the physical portion of the task is included in a toileting task. Driving and using escalators were dropped because the panel decided that people could be independent without the use of these skills. The tasks that were modified were cooking and house cleaning. Instead of formally having someone cook, a carrying and lifting task was modified to include reaching. To simulate cleaning, a sweeping task was used. The resulting WUFA scale included 15 items. Once these 15 items were determined, the expert panel again reviewed the test and through consensus decided to drop two additional items to make the WUFA a 13-item test. These two items were the stairs and the car transfer. The tasks included—

- Tight space.
- Uneven terrain.
- Door management.
- Street crossing.
- Ramp.
- Curb.
- Bed transfer.
- Toilet transfer.
- Floor transfer.
- Bathing.
- Upper and lower dressing.
- Reaching function.
- Picking up objects/sweeping.

Here too, the expert panel decided that people could be independent without being able to perform these tasks. Although some of the items on the WUFA are similar to items on the FIM, no item on the WUFA is identical to any item on the FIM.

In developing the scoring system for the WUFA, we used level of independence as our measure of interest. Assessment of independence can be based on dependence or the amount of assistance that is required to perform the task, the amount of time it takes to do the task, or perhaps whether the individual uses assistive devices while performing the task [11]. The WUFA incorporates all of these assessments when evaluating level of independence. Items are scored similarly to the FIM, ranging from 1 (total dependence) to 7 (completely independent). On the WUFA, a score of 6 or 7 includes a specific time requirement for task completion, which differs from the

FIM. This time requirement for each item was determined through the videotaping of one highly trained and functioning MWCU. This individual was male, 27 years old, had been in a wheelchair for 96 months, and had a complete T-9 SCI. He was considered to be quite independent by the expert panel. Each item was timed while the individual performed the task. The resulting time was then determined to be the cutoff for receiving a score of 6 or 7. To receive a score of 7, the person must score under the cutoff time and if over the person would receive a 6. In addition, the amount of assistance required and whether assistive devices are used are considered when the score for each item is determined. Then all items are summed to obtain a total score. The highest and lowest score possible are 91 and 13, respectively.

Following the development of items and the scoring system, the panel then evaluated this same individual performing the tasks on videotape. Modifications were made to the WUFA at this time. The first modification was not to have the individual obtain clothes from the closet before dressing but instead to have the clothes out and on the plinth or bed where the dressing task is performed. Second, some of the directions were reworded to provide more clarity. Third, what qualified as an assistive device for the bathroom toilet transfer and bathing tasks was redefined. Last, the maximum time requirement to complete the task for a score of independent for the dressing task was reestablished based on the decision that the individual would not be getting clothes from the closet.

Reliability

To evaluate interrater reliability and stability of the tool, six raters assessed five subjects on videotape performing the WUFA tasks. One month later, the six raters reassessed the same five videotaped subjects. Subject descriptions are provided in the **Table**.

Table.
Subject profile.

Subject	Age	Gender	Diagnosis	Time in Wheelchair
1	27	M	T9 complete SCI	9 years
2	45	F	Cerebral palsy	35 years
3	21	M	T9 complete SCI	1 month
4	43	M	Transverse myelitis	1 year
5	35	M	T11 complete SCI	10 months

Internal Consistency

Following finalization of the content of the WUFA and determination of reliability, the tool was administered one time to 101 subjects. Two researchers collected these data, and the initial developer of the tool trained them to administer the WUFA. These data were used to determine internal consistency of the 13-item test. Subjects were males and females between the ages of 18 and 67 who used a manual wheelchair for at least 80 percent of their home and community mobility. They were recruited from local support groups, the Baltimore Veterans Affairs Center, and other surrounding rehabilitation hospitals in the Baltimore, Maryland, area. Subjects included those living in the community and those living in residential facilities. Of the 101 subjects, 18 were female with a mean age of 45.7 ± 13.2 years and 83 were male with a mean age of 42.4 ± 12.0 years. The women had used a manual wheelchair for an average of 172.8 ± 169.9 months and the men 126.8 ± 119.0 months. Of the women, 16.7 percent each had a SCI, spina bifida, or cerebral palsy; 22 percent had a cerebral vascular accident (CVA); and 27.8 percent had other processes contributing to being in a wheelchair. Of the men, 66.2 percent had an SCI; 4.8 percent had a CVA; 3.6 percent each had multitrauma, multiple sclerosis, or an amputation; and 18.1 percent had other processes contributing to being in a wheelchair. The median score on the WUFA for the women was 77 (range 28 to 91) and 85 (33 to 91) for the men.

Data Analysis

Interrater reliability and stability were established using ICC. A Cronbach's Alpha was used to determine the internal consistency of the 13-item test.

RESULTS

Interrater reliability and stability were ICC = 0.96 and 0.78, respectively. The Cronbach's Alpha resulted in good internal consistency between the 13 items on the WUFA. The standardized coefficient alpha was 0.96.

DISCUSSION

Our primary goal was to develop an assessment tool to determine functional independence in MWCU. The final

outcome of this study is a 13-item performance-based test that a trained healthcare provider can administer. Although only physical therapists were involved in administering this test, other health professionals would be able to administer the WUFA if trained. Depending on the setup within the clinic and the involvement of the subject being tested, administering the WUFA takes approximately 1.0 to 1.5 hours. This time length could be a drawback because of the limited time available to spend with patients in today's healthcare environment. Even so, the test for internal consistency indicated that all the items are strongly associated, measuring 1 dimension. Therefore, each item is valuable in contributing to the Cronbach's Alpha. Because of these results, we decided to keep all 13 items in the test.

Equipment needed to administer this test can be found in most rehabilitation facilities. Equipment required includes a thick carpet, a doorway, an area for straight propulsion and curb cut, portable ramps and curbs, a bed or low-plinth, a toilet with grab bars, a mat for floor, a tub with bath bench, specific clothing items, an adjustable shelf, a water jug and cup, a broom with dust pan, kitty litter, a waste basket, two quarters, and an 8 lb sandbag.

Although extensive research in functional outcome measures has been performed, only two other tools are specific to MWCU. As stated in the introduction, the WC-PFP by Cress et al. appears to be valid and reliable but is limited because it does not include fundamental tasks deemed necessary by the panel of experts used to develop the WUFA, as well as the 30 MWCU surveyed [1]. The WST by Kirby et al. is also limited in items necessary to function at home and in the community [2]. The tool most frequently used to evaluate wheelchair users is the FIM. The FIM was developed as a disability indicator of "burden of care" [6]. It is a measure of disability regardless of nature or extent of pathology or impairment. The developers intended that the FIM be a general assessment tool that is applicable for patients with a variety of disabilities. Results of the FIM are beneficial for comparing outcomes of rehabilitation intervention across different facilities that serve a wide variety of patients. The level of assistance that is required by the person is used to determine functional status and is graded from total independence to total assistance [10]. Because there is no gold standard specific to MWCU, the FIM was used as the criterion standard in the development of the WUFA. One of the strengths for using the FIM as the criterion is that it has undergone numerous psychometric evaluations. The FIM has demonstrated excellent interrater reliability (FIM motor ICC = 0.91 and ICC = 0.96, respectively) as well as high internal consistency (overall admission = 0.93, discharge = 0.95) [12–14]. Granger and associates using the Delphi method determined face and content validity [15], and Dodds et al. determined construct validity [14]. The WUFA demonstrated comparable interrater reliability and internal consistency.

Although the FIM has been adopted by numerous professional organizations in the rehabilitation industry as a measure of disability, including endorsement by the Model System Spinal Cord Injury Center [13], it limits the score that a MWCU can attain. For example, a wheelchair-dependent individual cannot score a "7" in most areas of the FIM because he or she uses a wheelchair or other assistive device for independence. Although a wheelchair user possibly could score a "6" or "modified independence" on all areas of the motor FIM and still be completely independent with all self-care and home activities, as well as grocery shopping, driving, community propulsion, and carrying loads. Also, many of the tasks essential for independence as a MWCU are not reflected on the FIM. Consequently, the WUFA was developed because of the need for an outcome tool that accurately measures functional independence in MWCU, reflecting both home and community skills.

Like the FIM, the WUFA is a performance-based tool versus a capacity-based tool. This means the individuals actually perform the task versus just saying they could do it even if they usually do not. An advantage to this approach is that the observer can more accurately determine what the individual can actually do. As pointed out by Guralnik and associates, performance-based instruments have several other advantages [16]. These include face validity for the task being performed, better reproducibility, and greater sensitivity to change. Disadvantages include more time to administer the test, need for adequate space and special equipment, and training needed for examiners. Another disadvantage is that a standardized performance-based tool such as the WUFA does not consider that under normal circumstances, the individual may not perform that task or perform it in the standardized fashion. The individual either performs the task or does not and is scored accordingly. Although the individual may live independently in his or her environment, the WUFA may score him or her as being dependent in a particular task.

The WUFA was designed to be used with individuals who use a manual wheelchair for at least 80 percent of their home and community mobility. The reason for being in the wheelchair was not considered during the development of the tool. Therefore, the WUFA has been developed with respect to its heterogeneity and can be used with a variety of injury and disease processes that result in the individual having to use a wheelchair, i.e., SCI, stroke, multiple sclerosis. Advantages to this include content validity and sensitivity to change [17,18]. In addition, because the items were developed for wheelchair users, the use of a tool such as the WUFA may allow the rehabilitation specialist to differentiate specific areas of limitation that may be improved, thus guiding intervention strategies and discharge planning.

Limitations to this study include—

1. Only physical therapists were used to develop and test the WUFA.
2. We did not compare the WUFA to the FIM.
3. Some of the developers of the WUFA were also raters for determining reliability and internal consistency.
4. Only five subjects were used to determine reliability and stability
5. Only one subject was used to determine criteria for scoring.
6. A possible ceiling effect may exist.

In addressing the first issue, although only physical therapists were used to develop and test the WUFA, other professionals could administer the test. With proper training and equipment, they could use the tool easily. Second, we did not compare the WUFA to the FIM because not all the personnel administering the test were FIM-certified. Making this comparison would be important in strengthening construct validity. Third, using some of the developers as raters for reliability and internal consistency may have confounded the results. The developers of the tool may have had a better understanding in its administration therefore inflating the reliability and internal consistency. Future studies should have a larger sample size and use raters from different disciplines. In relation to using only one subject to determine scoring criteria, further studies will be conducted with additional subjects to refine the scoring system.

As the pressure to demonstrate efficacy of rehabilitation increases, the demand for appropriate outcome measures grows. A good understanding of the validity and reliability of such tools is necessary. The results of this study indicate that the interrater reliability and stability of the WUFA are promising and that internal consistency is good. Even so, further analysis for reliability and stability is warranted using a larger sample size to allow for greater generalizability to all MWCU.

Although initial content validity has been established, further study is warranted for tool validation such as comparing the WUFA to other measures of functional independence such as the FIM and MBI. Also important is determining the capability of the WUFA to detect change in function and to discriminate between levels of functional independence.

Further attempts to decrease the number of items on the test can be done by use of factor analysis. Because the subjects used to determine internal consistency were a relatively high-functioning group, further testing of subjects who are lower functioning should be added to the sample.

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