

RESEARCH PAPER

The Participation and Activity Measurement System: An example application among people who use wheeled mobility devices

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Abstract

Purpose. To present the Participation and Activity Measurement System (PAMS), a system designed to examine activity and participation among people who use wheeled mobility devices.

Methods. Description of PAMS' components and an example of its application among people who use tilt-in-space wheelchairs.

Results. PAMS combines objective and subjective descriptions of mobility-based activities within a person's home and community. By applying technologies such as wheel revolution counters, seat occupancy sensors and global positioning systems, PAMS captures diverse metrics of wheelchair use including destinations, wheeled distance, duration of occupancy and the use of specialised features such as tilt. These metrics also provide the basis for a prompted recall interview designed to elicit contextual data about wheelchair use within a person's home and community. A recent study among people who use tilt-in-space wheelchairs demonstrates the components and application of PAMS.

Conclusions. The combination of objective and subjective data afforded by the application of PAMS reflects a complex relationship between wheelchair use and the role of mobility as people go about their daily home and community activities. PAMS can be adapted to a variety of research questions and may be used as an alternative or supplement to self-report assessments of activity and participation.

Keywords: *Activity and participation, wheeled mobility*

Introduction

The measurement of 'activity and participation' has emerged in recent years as a key research priority [1–4]. The World Health Organization's International Classification of Functioning, Disability and Health (ICF) identifies 'activity and participation' as one of its two key components in its classificatory system [5]. The first component, 'body structures and functions,' represents the health and function-related features of disability, while, 'activity and participation,' describes actions of and involvement in life situations. Increased activity and participation is thought by researchers to reflect increased

community integration [2,6,7], greater functional independence and autonomy [8–10], less dependence on societal resources [11,12] and an increase in both a sense of individual wellness and perceived health.

The Participation and Activity Measurement System (PAMS) is a system designed to study the health, activity and participation of wheelchair users in a way that offers insight into their measurement as defined by the ICF. It combines objectively measured wheelchair usage with information gathered from a semi-structured interview. Although recent research has included one or more of these technologies to elaborate various dimensions of mobility aid

use [13,14], none has integrated these technologies as a methodology specific to people who use wheeled mobility devices.

Key features of PAMS are illustrated in its implementation during a pre-post study of powered tilt-in-space wheelchair users conducted between 2004 and 2006. PAMS' various components will be described and results will be discussed as they offer insight into both PAMS as a measurement system and the complexities of measuring activity and participation among wheeled mobility users.

Background and significance

It is well established that people with mobility disabilities confront challenges to participation in their daily activities. Increased participation has been a major goal of much international disability legislation [15]. In the United States, participation levels have not risen among people who use mobility devices. These individuals continue to make fewer trips outside the home, and engage in fewer activities than people without disabilities [16]. Ninety percent of all mobility device users in the United States report activity limitations, and only 14.7% are able to complete all activities of daily living (ADL) mobility tasks.

The ICF domains of 'activity and participation' range across an individual's diverse abilities, tasks and social responsibilities, including: learning and applying knowledge, general tasks and demands, communication, mobility activities, self care, domestic life areas, interpersonal interactions, major life areas such as work and education and community, social and civic life [5].

The ICF's authors acknowledge that distinguishing between activity and participation can be difficult [5]. Jette et al. [17], in an effort to provide conceptual clarity between the two for measurement purposes, posits a hierarchical relationship among mobility, daily and participation activities. Basic mobility activities (e.g., walking) provide the building blocks for more complex daily activities (e.g., ADLs), which, in turn, are necessary to perform the participatory-related behaviours reflected in such social roles as parenting. Thus, mobility activities are viewed as fundamental to all other activities. 'Participation' is expressed in the increasing complexity of activities as performed through the various social roles people play in their communities.

In addition to these key components, the ICF identifies 'contextual factors' as they may impact health, activity and participation. Contextual factors consist of first, environmental features *outside* the individual. These may include assistive technologies, aspects of the physical environment such as a hilly

terrain or curb cuts, social policies or cultural perspectives. Second, they may describe personal factors *within* an individual (e.g., gender, lifestyle choices and psychosocial features).

The ICF's effort to create a holistic representation of the disability experience presents an opportunity for stakeholders to create new conceptual models and measurement systems. As a taxonomy, its domains incorporate the functional and health aspects of disability as they are enacted within complex social, political, psychosocial and economic milieus. The breadth of its domains challenges researchers and other stakeholders to develop multi-disciplinary approaches and methods to investigate them in greater depth.

To date, the majority of participation measurement techniques rely on self-report instruments that may assess one or more activity and participation domains. They may target a specific disability type (e.g., the Community Integration Questionnaire is designed for traumatic brain injury subjects) [18] or be used across multiple disability diagnoses (e.g., CHART or LIFE-H) [19,20]. Although many include mobility activity-specific questions, only two – the CPPRS and PARTS/M – target the use of mobility devices in the context of performing activities [21,22].

However, self reports face numerous issues that can affect quality of data [23]. Question format, wording, closed responses and context may produce discrepancies among captured data [24]. In particular, frequency and rating scales – characteristic of many participation measures – invite systematic differences across subjects [23,25,26]. Although self reports remain the most efficient technique for measuring activity and participation within large populations, PAMS offers an alternative means for assessing these ICF domains.

PAMS

PAMS was developed for two purposes: (1) to provide an *objective* description of mobility-based activities within a person's home and community. These technologies capture diverse metrics of wheelchair use such as wheeled distance and duration of occupancy, and the use of specialised features such as tilt, recline and standing; (2) to provide *contextual* data gathered through the prompted recall interview (PRI). The PRI can contribute critical information about activities conducted at various locations, e.g., device(s) used, environmental facilitators and barriers, effectiveness, satisfaction, efficiency of activities and personal factors. PAMS is intended to supplement traditional self-report instruments of participation restriction and activity measurement such as the

CHART [20], PARTS/M [22] and IPA [27]. It achieves this by offering a set of flexible and versatile research options that can be adapted to individual research needs to examine the roles that mobility aid(s) play in the lives of people with disabilities.

Consistent with Jette et al., PAMS is grounded in the assumption that understanding the role of mobility is key to understanding activities and participation among people who use wheeled mobility devices. As a primary means of mobility, wheelchairs may serve people with disabilities in everyday activities in multiple ways: first, they can be used as a stationary means of support while engaged in another activity (e.g., as a chair); second, wheelchairs may provide the basis for the activity itself (e.g., recreational wheeling); third, they can act as transitions between activities (e.g., going from one room or location to another). The measurement of wheelchair use (discussed in greater detail elsewhere [28]) provides one method of objectively characterising activities in terms of metrics specific to wheelchair mobility patterns. PAMS can build on these basic mobility descriptions as they become nested within more complex participatory behaviours such as dining in a restaurant, visiting a doctor's office and within social roles such as parent or employee. In addition, when global positioning system (GPS) technologies are combined with a PRI, PAMS offers a contextual background within which to better evaluate objective measurements describing wheelchair use, activity and participation outcomes.

An example of PAMS: The study of health, activity and participation among people who use tilt-in-space wheelchairs

A pre-post study of a wheelchair intervention is presented to illustrate the key features of PAMS. PAMS' various components, as selected for this specific project, will be described. Results will be discussed as they offer insight into the complexities of measuring activity and participation among wheeled mobility users.

Background to the tilt-in-space wheelchair study. Recent advances in wheelchair and seating technology provide wheelchair users with greater equipment options. However, an increase in options may also complicate the prescription and reimbursement process. New technologies are often touted for their medical and functional benefits; yet, the claimed benefits have not been adequately studied and remain unsubstantiated, making reimbursement more difficult to justify.

This study focussed on power TIS wheelchairs since they are operable by the user (in contrast to

manual TIS which require an attendant). Among the claimed benefits of TIS are pressure relief (important to the prevention of pressure ulcers), pain relief, performance of ADLs and physiological benefits [29,30]. As with the other specialised technologies, the utility of TIS has a legitimate theoretical basis, but its claims have not been adequately studied.

Methods to the tilt-in-space wheelchair study. To document the outcomes of an intervention providing a TIS wheelchair, researchers carried out a pre-post study between 2004 and 2006 to evaluate the impact of TIS wheelchairs on the health, activity and participation of users. IRB approval was received from the university and local hospital, and subjects signed informed consent forms prior to enrollment in the study. A convenience sample of seven adults who used power wheelchairs as their primary mobility device was enrolled from an acute-care rehabilitation hospital. Inclusion criteria stipulated that only upright power wheelchair users who were prescribed a powered tilt-in-space wheelchair would be recruited. This was done to preclude the potential confounding effects of adapting to power wheelchair use from a manual wheelchair during the post assessment. However, only seven subjects met the inclusion criteria, of whom five completed the post assessment. Technologies and measurements will be explained first, followed by descriptions of the PRI and self-report instruments used.

Measurements and technologies used in PAMS

The objective measurement of wheelchair use and activity described here reflected our research goal (i.e., documenting the outcomes of the provision of a TIS wheelchair). Basic measures including wheelchair occupancy (the amount of time participants spent in their wheelchair) and distance wheeled were outputted from a single sensor, each with little manipulation or analysis. Additional basic measurements required greater involvement to produce data for analysis. These measures included time spent wheeling, number of bouts of mobility and number of tilts and pressure relieving tilts. Finally, mobility activity data – such as the number of destinations visited daily, the average time subjects spent outside the home, and number of unique destinations visited daily – were captured.

We also used derived measures of wheelchair use and activity that required the integration of multiple sensors. For example, to determine where the wheelchair was used (in-the-home or not-in-the-home), we broke down wheelchair occupancy, distance and bouts by location (i.e., time of wheelchair use in the home and outside of the home, percentage of bouts

occurring in the home, etc.). This required combining either the occupancy monitor or wheel revolution counter with a location monitor (i.e., GPS). In addition, percent mobility, or the percent of the total time the subject was seated in the wheelchair while moving required measurements from both the occupancy monitor and wheel revolution counter.

To achieve these measurements, technologies were employed including a multi-purpose data logger configured to log data from an occupancy switch, a wheel revolution counter and a seat position sensor. In addition, a GPS receiver and custom data logger were used. These are described in the following sections.

Occupancy. Thin pressure switches (TapeSwitch) were chosen because of low power consumption and cost, and their availability in different degrees of sensitivity allowed us to adjust for individual seating. The state of the switch was measured every 2 s, and noise was removed by filtering out unoccupied periods of less than 2 min. Because of the time required to transfer in and out of a power wheelchair, the research team felt that it was unlikely that a subject would leave the chair for less than two minutes.

Data were then corroborated with GPS, wheel revolution and tilt data. Data for any given day were included in the analysis only when we could corroborate $\geq 90\%$ of the data points on that day and when less than 10% of logged time had been affected by the filter. The accuracy was $> 95\%$.

Wheel revolution counter. Custom low profile reed switches (Reed Switch Developments) were attached to the wheelchair frame while neodymium magnets (KJ Magnetics) were mounted to the wheel. These strong magnets have a larger magnetic field and can be placed farther from the reed switch and still be effective. The summation of wheel counts was recorded every two seconds. From this, the distance wheeled was calculated according to the formula below:

$$\begin{aligned} & \text{Wheel Counts} \times \text{Wheel Diameter} \\ & \times \text{Pi/No. of Magnets} \end{aligned}$$

The accuracy of the wheel revolution counter exceeded 95% in controlled laboratory testing and on random indoor and outdoor paths. In addition, distances computed from wheel revolution data were corroborated against GPS trips when made outside while using the wheelchair.

A bout of mobility was defined to characterise travel between activities so both the beginning and end of a bout was anchored by stationary activities. [28]. A mobility bout was initiated when a subject traveled a minimum of 2 feet (0.61 m) within 5 s and

continued until the subject traveled less than 2.5 feet (0.76 m) over 15 s.

Tilt sensor. We used a uni-axial accelerometer (MTI) to measure orientation because it was both light-weight and consumed little power for an analog sensor. With the sensor mounted to the base of the seat, stationary acceleration data could be calibrated to describe the angle of the seat base with respect to the horizon, or tilt angle.

We calculated two variables for this study: (1) number of tilts defined as a position change of 5 degrees maintained for more than 20 s and (2) the percent of seated time spent in small ($0\text{--}14^\circ$), medium ($15\text{--}29^\circ$), large ($30\text{--}44^\circ$) and extreme ($> 45^\circ$) tilts.

Global positioning system and prompted recall interview.

We used a Garmin receiver and a custom data logger developed by GeoStats (Atlanta, GA). Data were sampled every 5 s and stored latitude, longitude, heading and time and date stamps. Power was drawn from the wheelchair battery making it unnecessary for subjects to charge the device directly. The accuracy of the Garmin receiver was approximately 3 meters in any direction under optimal conditions. Missed data occurred under a variety of conditions, for example, when subjects traveled in neighbourhoods with dense tree growth or tall buildings. However, we used the acceleration data to confirm GPS findings and to supplement the PRI. All GPS-based travel metrics (e.g., distance and speed of travel) were determined using custom GeoStats software.

Because GPS required a sky view to determine location, only outdoor travel and locations were studied using the GPS. Indoor movement relied on the wheel revolution counter.

GPS data were overlaid onto Geographic Information System (GIS) information. Maps were created depicting travel and destinations and were incorporated into web-based GPS recall interviews (Figure 1). The locations of habitual destinations, collected from subjects during instrumentation, were added to the maps to provide landmarks for the PRI.

A PRI was administered to subjects usually within 48–72 h of de-instrumentation of the wheelchair. Questions followed the format of standard travel GPS recall interviews [31–36]. Subjects were queried for the name of the destination and type of activity conducted at destinations. Activities were classified as follows: (1) work or school, (2) daily living task (e.g., grocery shopping), (3) social (e.g., attending church or having dinner with friends), (4) entertainment, recreation, leisure (e.g., attending a concert, baseball game, or visiting a park) and (5) travel (e.g., commuter travel which may involve several modes of transportation – car and train, for example.).

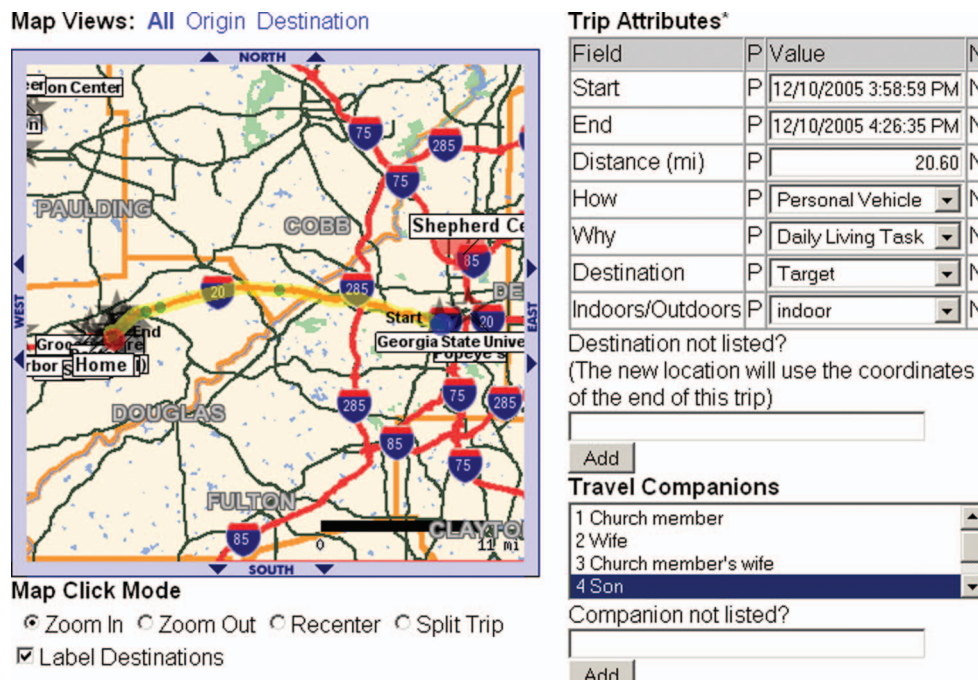


Figure 1. Screenshot of GPS map showing PRI data being collected on a single trip to a store.

If a subject's memory was unclear about a particular trip during the PRI, she/he was prompted with cross streets or nearby landmarks to recall the destination and activity. In addition to type of activity, subjects were queried about travelling companions and mode of transportation (e.g., personal vehicle, paratransit, trains/busses, taxi/shuttle or wheelchair only). Finally, subjects identified the activity at each destination as occurring predominantly indoors or outdoors. This information was synchronised with other measures to differentiate between indoor and outdoor wheelchair activity.

GPS data were analysed from a 'destination' perspective. That is to say, rather than focussing on travel routes, times and distances, as is common in GPS travel studies, the emphasis in this study was placed on where people were and what activities they were doing there. Therefore, we counted the number of destinations outside of the home, defined as places that the participants intentionally stopped to perform an activity. This meant that stops due to traffic jams, for example, would not count as destinations, but short stops to pick up a passenger would.

Self-report measures. We used a number of self-report measures including: the Community Participation and Perceived Receptivity Survey (CPPRS,) developed to measure factors that impact community participation among people with mobility impairments [21]; a study-specific survey that captured health, demographic and wheelchair data; and the SF 8, a widely used, reliable and valid measure that assesses physical, mental and emotional

self-perceived health in eight questions [37,38]. For the purpose of describing PAMS in the context of this pre-post study, only the results of the SF-8 will be presented here.

Procedures. Subjects were approached and consented by a research clinician at an acute rehabilitation hospital after being prescribed a powered tilt-in-space wheelchair. Immediately following consent, subjects were asked to complete a basic health questionnaire. A subsequent appointment was made to instrument subjects' current wheelchairs at either the hospital or in their homes. Subjects' wheelchairs were instrumented for approximately 14 days. PRIs were conducted by an experienced interviewer 48–72 h after subjects' wheelchairs were deinstrumented. The CPPRS and SF-8 were also administered at this time.

For the post assessment, the aforementioned procedures were repeated 3 months after subjects received a new tilt-in-space wheelchair. Three months was thought to be sufficient time for subjects to accustom themselves to a new wheelchair and the tilt mechanism. Subjects were contacted by the research clinician and appointments were scheduled to instrument their new wheelchair either at the hospital or their home.

Results

Subjects included one male and four females. Ages ranged from 36 to 60 years. Diagnoses included

spinal cord injury, cerebral palsy, dystonia, multiple sclerosis and muscular dystrophy.

Use of tilt feature

All subjects used their tilt system daily (Table I, Figure 2), Subjects A, C and E changed position more than four times per hour. Subject D used the tilt feature once per hour but stayed within the 0–14° range. Subject B used the tilt feature the least frequently but still changed position more than 10 times per day (Tables I and II).

Wheelchair usage

Wheelchair use varied across subjects and varied from day-to-day within subjects. Table II shows median daily values of occupancy time, distance

wheeled and bouts of mobility. Obtaining a tilt-in-space wheelchair did not change any single metric for all subjects in the group, but each individual's data did change over time. Distances wheeled increased in three of five subjects after receiving their new wheelchair. In contrast, Subject B wheeled 60% less distance after receipt of her new wheelchair but bouts of mobility only decreased 11%.

Community destinations

The number of community destinations visited over the 2 week instrumentation period ranged from 3 to 29 (Figure 3). However, for four of five subjects there was little difference in the number of destinations visited between pre- and post-assessments. Categorising destinations by type of activity permitted evaluation of destinations in a different manner. For example, the distribution of activity type visited by Subject B changed markedly between baseline and post assessments (Figure 4).

Table I. Typical angle and frequency of tilt for each subject.

Subject	Typical position (degrees)	Tilt freq (no. per occupancy hour)
A	7	8.2
B	16	0.7
C	8	5.7
D	1	1.2
E	27	4.2

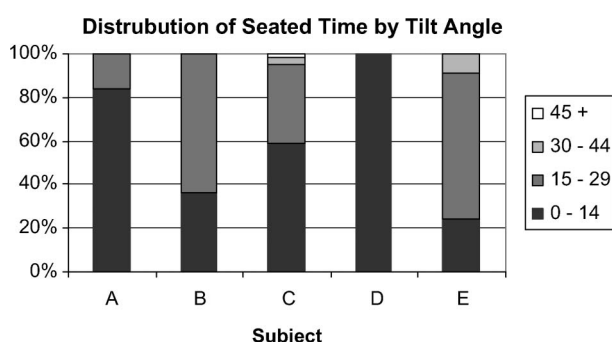


Figure 2. This figure reflects the frequency of specific tilt angles while subjects are seated in their wheelchairs.

SF-8 self-perceived health data

All five subjects showed improvement in perceived physical and/or mental health (Table III). Three subjects demonstrated improvements in both their physical and mental health scores while the remaining two subjects showed improvements in only one of the two categories. Paired *t*-test revealed no pre-post differences in physical, mental or total scores.

Discussion of study results

One criterion of the PAMS approach was that the activity and participation measurement should be mobility device specific. Activity measurement in this study was described in two ways: (1) the activities that occurred at a destination (e.g., going to church or visiting a friend) as identified through the PRI; and (2) as a metric of wheelchair use expressed quantitatively in terms of occupancy,

Table II. Differences in daily wheelchair use at baseline and at post receipt of a power tilt-in-space wheelchair.

Subject	Occupancy time (h)		Distance wheeled (m)		No. of bouts	
	Baseline	Post	Baseline	Post	Baseline	Post
A	11.9	10.2	1247	1439	212	189
B	n/a	15.7	3795	1395	119	106
C	n/a	12.6	999	1188	69	102
D	11.6	12.5	571	319	140	82
E	13.9	11.4	776	1151	100	133

wheeled distance and bouts of mobility. We hypothesised that provision of a tilt-in-space wheelchair would result in changes in wheelchair use and community activities.

Although the small sample size of this study prevents generalisation of results about the impact of TIS technology, it offers important insight into the challenges of measuring activity and participation in general. The introduction of a new technology – a

tilt-in-space wheelchair – did not result in any consistent change in wheelchair usage or community activities. Each subject differed in terms of diagnosis, number and type of activities, tilt use and self-reported health. For example, the overall improved health outcomes as measured with the SF-8 suggested a positive impact of their new wheelchairs in subjects’ self perception of health status. And objective measures of wheelchair usage and geolocation afforded interesting insights into wheelchair activity and community mobility. However, no discernible relationships existed among changes in perceived health, wheelchair usage and the type or number of community activities.

In fact, the overall stability of activities pre and post in all but one subject suggests that the change from an upright power to a power tilt-in-space wheelchair did not significantly impact activity or participation. Variation in wheelchair use metrics across subjects and the day-to-day variation within a single subject illustrate the complexities of measuring changes in activity in response to a new wheelchair or specialised wheelchair feature. This study recruited experienced and full-time wheelchair users who have a different relationship to activity and wheelchair use as compared with new users or users who are partially ambulatory.

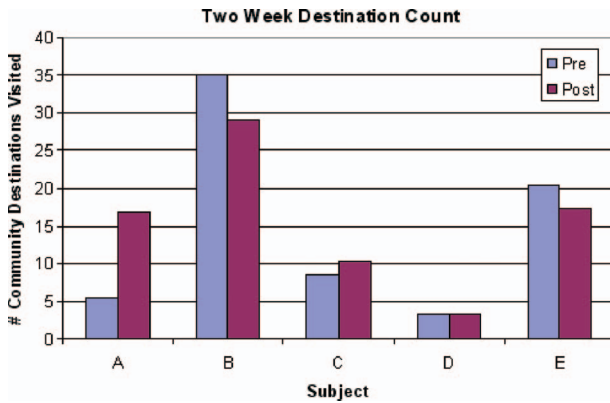


Figure 3. Differences in number of community destinations visited by subjects at baseline and at post receipt of a power tilt-in-space wheelchair.

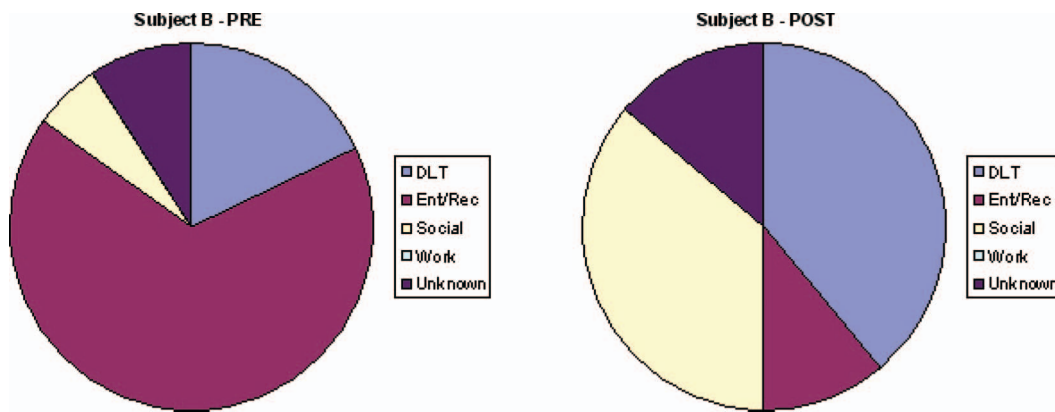


Figure 4. Breakdown of activity types for Subject B at baseline and at post-receipt of a power tilt-in-space wheelchair. DLT, daily living task; Ent/Rec, entertainment, recreation or leisure.

Table III. SF8 physical and mental scores per subject before and after receipt of a power tilt-in-space wheelchair.

	Physical score			Mental score		
	Baseline	Post	Change	Baseline	Post	Change
A	48.62	33.52	-15.10	54.50	48.51	-5.99
B	60.74	56.90	-3.84	54.14	54.09	-0.05
C	33.21	38.13	4.92	48.37	43.38	-4.98
D	32.62	30.94	-1.68	29.24	27.65	-1.59
E	32.87	32.72	-0.15	51.95	54.51	2.55

Lower score indicates improved health status.

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Experienced wheelchair users have already transitioned to participating in community and home activities. The success of that transition will not necessarily be reflected in the number or type of activities, destinations or wheelchair use metrics. More importantly for this study, outcomes may not be dramatically affected by the introduction of a specific wheelchair feature. This effect may be distinct from first-time users in whom a dramatic difference in outcomes as measured with or without a wheelchair would be apparent.

Full-time wheelchair users require their wheelchairs as a kind of prosthesis for all activities in the same way people without mobility disabilities rely on their legs. They have little choice to use or not use their wheeled mobility devices as they perform even the most basic daily activities. The *quantity* of activities performed may not be an appropriate measure of the effectiveness of a mobility device. Rather *effectiveness* with regards to its impact on activities appears more important. Effectiveness may be best evaluated through other qualifiers such as comfort, or ease of use, for example. Part-time wheelchair users have more choices in mobility devices or may face only a temporary impairment. Studying their outcomes may involve different metrics and methods compared to full-time wheelchair users.

The PRI in PAMS proved critical in contextualising objective measurements and for exploring more subjective experiences about participation and activities. For example, during the PRI all subjects reported being happy and ‘much more comfortable’ with their new tilt-in-space wheelchairs. This is consistent with previous literature in which users rated ‘comfort’ a key construct [39] of satisfaction with their wheelchairs. Additional comments by subjects generated through the PRI described the tilt feature as ‘very relaxing,’ ‘makes it easier to perform weight shifts,’ ‘can sit for longer periods in my wheelchair now’ and ‘helps to relieve pain.’ These comments are corroborated by the fact that all subjects used the tilt feature over 10 times per day.

However, as noted, even though all five subjects used the tilt feature regularly, there was no corresponding significant or consistent change in wheelchair use or activities. Here again, PRIs helped explain the differences in wheelchair occupancy metrics between pre- and post-assessments in three subjects. For instance, Subject E reported acquiring a reclining easy chair. Her chronic pain and discomfort were relieved by switching between the easy chair and her new wheelchair during the day, resulting in less wheelchair occupancy time during her post assessment. In another case, the post PRI revealed that Subject A was ill and remained in bed during the first week of her post assessment, resulting

in lower occupancy time. Subject D’s data indicated that she used the tilt feature about once per hour but always remained between 0 and 15° of tilt. During her PRI, she reported that her new wheelchair provided greater relief to increasing levels of pain and discomfort. In each of these examples, contextual data drew attention to the complexities of interpreting objective data describing wheelchair use.

Interpretation of changes in wheeled distance was also contextualised during the PRI. Although wheeled distances increased in three of five subjects, there was one notable exception. Subject B’s data showed a large (>60%) decrease in wheeled distance, but only an 11% decrease in mobility bouts. The PRI revealed that the colder weather during her post assessment in January impacted both her wheelchair use and mode of travel compared to her baseline assessment in June. In June, she wheeled 68% of her distance outdoors, mostly around her neighborhood for recreational purposes. In January, she wheeled less and relied more on her van for everyday activities, such as going to the grocery store, thus underscoring the impact of seasonal differences on measurement. However, during both assessments, the majority of the distance wheeled was in the community, while the largest percentage of bouts continued to be wheeled in the home. This may be because homes tend to contain small, purposeful spaces (e.g., kitchen) in which key daily activities occur. And the frequency of bouts – as reflecting transitions between activities – is less likely to be affected by changes in the external environment. As Sonenblum et al. [28] make clear that an accurate understanding of wheelchair use is reflected in a combination and contextualisation of mobility metrics, such as distance and number of bouts.

PAMS as a methodology to measure ‘activity and participation’

The use of both objective and subjective data in this study reflected the complexity of measuring participation. Participation is less well articulated as a measurable construct than activity. The ICF’s definition of participation is conceptually vague in terms of measurement. Participation may be considered a separate *construct* from activity or it can be employed as a *verb* – as in ‘participating in activities’ (in which case activity and participation become indistinguishable conceptually). As an illustration of PAMS, this study did *not* find a meaningful measurement of participation as distinct from activity. That is, mobility metrics described characteristics of wheelchair use in the context of activities and destinations, but did not reflect participation as a hierarchical measurement, i.e., as an increase in the

complexity of activity. For example, ‘social roles’ (generally thought to be one dimension of participation) were embedded in the activity type described during the PRI (e.g., as a parent, friend, church member or volunteer). Such roles were continuous from the baseline to post assessment – that is, there was no variation in activity roles (e.g., participating in more volunteer activities).

It may be more productive from a rehabilitation perspective to think of participation as an *aspect* of activity. That is to say, as a social construct participation may be embedded at the *intersection* of the ICF domains of context (e.g., environmental and personal factors), and health (body functions and structure) as they affect activity performance. In this sense, both environment and health factors could be viewed as the *context* in which activities are performed. For example, participation may be best measured qualitatively using PAMS through PRIs. Objective wheelchair mobility metrics could provide the basis or ‘prompt’ for contextual questions. These interviews can elicit the subjective experiences of social attitudes, the physical environment, spontaneity, barriers in the workplace and pain/fatigue – all of which impact activity performance for a wheelchair user. Conversely, participation might also be quantitatively assessed if researchers could develop an algorithm that reflected differential impacts of specific environmental features (psychosocial, physical, social, economic) that are hypothesised to impact the performance of key activities.

This study only considered such contextual factors as subjects chose to reveal during the PRI. However, by applying PAMS in future studies, a more systematic understanding of the specific contexts shaping a subject’s activities might enhance our understanding of participation for people with mobility disabilities.

Conclusion

The combination of objective and subjective data in PAMS leads to a fuller understanding of the complex relationship between wheelchair use and the role of mobility among people performing activities in their homes and communities. The addition of a PRI to objective measurements of wheelchair usage and mobility provides an opportunity to contextualise results. Future studies can use PAMS to investigate the relationship between contextual features in the physical, social and economic environment and objective measurements of wheelchair use. PAMS can supplement self reports measures, and in conjunction with established measures of capacity (e.g., FIM), track changes in outcomes such as functional status, quality of life, and participation.

Continued research is needed to determine trends and patterns of wheelchair use and participation in activities. PAMS provides valuable normative data about wheelchair use and activity. By capturing objectively derived mobility and activity data, clinicians can compare client perceptions of wheelchair use and functional performance in the clinic against data derived from wheelchair use in the everyday environment. Last, PAMS may help to inform a more rigorous conceptualisation of participation measurement as applied to wheeled mobility users.

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