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RESEARCH PAPER

The potential impact of intelligent power wheelchair use on social participation: perspectives of users, caregivers and clinicians

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Abstract

Purpose: To explore power wheelchair users', caregivers' and clinicians' perspectives regarding the potential impact of intelligent power wheelchair use on social participation. *Methods*: Semi-structured interviews were conducted with power wheelchair users ($n = 12$), caregivers ($n = 4$) and clinicians ($n = 12$). An illustrative video was used to facilitate discussion. The transcribed interviews were analyzed using thematic analysis. *Results*: Three main themes were identified based on the experiences of the power wheelchair users, caregivers and clinicians: (1) increased social participation opportunities, (2) changing how social participation is experienced and (3) decreased risk of accidents during social participation. *Conclusion*: Findings from this study suggest that an intelligent power wheelchair would enhance social participation in a variety of important ways, thereby providing support for continued design and development of this assistive technology.

➤ Implications for Rehabilitation

An intelligent power wheelchair has the potential to:
- Increase social participation opportunities by overcoming challenges associated with navigating through crowds and small spaces.
- Change how social participation is experienced through "normalizing" social interactions and decreasing the effort required to drive a power wheelchair.
- Decrease the risk of accidents during social participation by reducing the need for dangerous compensatory strategies and minimizing the impact of the physical environment.

Keywords

Intelligent power wheelchair, mobility, participation, qualitative methods

History

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Introduction

Participation is widely recognized as an important rehabilitation end goal. As one of the core components of the International Classification of Functioning, Disability, and Health (ICF), participation is defined as involvement in a life situation [1]. The ICF identifies that participation is an outcome of the interaction between an individual's health condition and their contextual factors, including both environmental (e.g. physical, social and attitudinal) and personal (e.g. gender, age, past and current experience, and coping behaviors). According to the World Health Organization [2], assistive technology interventions, such as provision of a power wheelchair (PW), are a means of enabling individuals with mobility disability to participate in their chosen activities (e.g. increase social participation).

A recent systematic review confirmed that mobility devices improve participation [3]. Shopping is one of the most common activities in which power wheelchair users (PWUs) have reported participating [4–9]. Other participation outcomes reported have included meeting up with friends and family [4–6,8–10], going for a walk/ride [5,8], sports/hobbies [5,7,9,10], household activities [4,5,7], volunteer/education/work [5,6,9], going to the library/cinema [5,6,8], going to church [5,8,9], gardening [5,7,8], walking the dog [6,9], attending appointments, going to the hairdresser, post office, bank, pharmacy [5], and going to cafes and restaurants [8]. Interestingly, Lofqvist et al. [5] found that while the frequency of participating in a variety of activities did not change over time after provision of a PW, the ease with which participants were able to perform both common and less commonly performed activities was improved.

While a PW may help to facilitate participation, there are also barriers associated with its use. Participation may be limited

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by environmental barriers, such as inaccessible buildings, uneven footpaths, uneven ground, curbs, narrow doorways and aisles, potholes, stairs, hills and slopes, crowded places, access to public transport [6], cold weather [8] and stigma [11]. Personal factors, including depression [12], impaired cognition [12,13], visual deficits [13], confidence [14], as well as the physical impairments that accompany different pathological conditions (e.g. fatigue, motor incoordination, slow reaction time, cerebellar ataxia or tremor) may also limit participation while using a PW. Further, technical aspects of the PW itself may also limit its use, such as learning to use the device [11] and difficulties associated with the battery life (e.g. distance the PW can travel without requiring a charge) [8].

The environmental, personal and technical barriers encountered by a PWU sometimes result in accidents, including tipping out of the PW [6,9], running into doors, walls or pedestrians, being hit by a car, and knocking into/over objects, such as shop displays [6]. Such accidents can cause damage to the user, others, the environment, and/or the PW itself. It is such safety issues that concern prescribers of PWs [14]. In fact, prescribers have identified specific factors that may contribute to the occurrence of an accident and/or a decision of whether or not to prescribe a PW, including anxiety and/or concerns about traffic lights, ascending and descending curbs, going too fast, and hitting another person [14].

An intelligent power wheelchair (IPW) is one solution to improve the fit between the person with mobility disability, their environmental challenges and the activities in which they choose to participate. A recent study explored the perceptions of PWUs, caregivers and clinicians regarding the design and utilization of collision avoidance technology [15]. Participants in this study felt that current challenges experienced when using a PW could be alleviated by use of collision avoidance. PWUs and caregivers shared this perspective in an evaluation of a prototype IPW developed by our team [16]. In addition to obstacle avoidance, our IPW prototype can be used to map the physical environment, orient the user and find the appropriate path in an interactive communication mode.

While previous IPW research has sought to obtain feedback regarding design issues and its general utility, none have yet explored the impact on participation, an important goal of PWUs. To that end, the objective of this study was to investigate the perceptions of PWUs, caregivers and clinicians on the potential impact of an IPW on social participation.

Methods

Design

To gain the perspectives of PWUs, caregivers and clinicians regarding the potential impact of an IPW on social participation, we conducted semi-structured qualitative interviews. This research was part of a larger project [16] designed to gain feedback on a prototype IPW developed by our team of researchers. For the purpose of this sub-study, only the data that addressed social participation are included in this report. Questions that related specifically to design and development (e.g. appearance, cost and design recommendations) are presented in another paper [16]. The study was approved by the Centre for Interdisciplinary Research in Rehabilitation of Greater Montréal (CRIR) Research Ethics Committee.

Sample and recruitment procedure

Convenience sampling was used to recruit PWUs, caregivers and clinicians. All participants were recruited from the wheelchair and seating departments of two rehabilitation centers in Montréal (Province of Québec, Canada). PWUs were eligible to participate if they were 18 years of age or older, had been using a PW in the community for at least 1 year, and had a musculoskeletal or neurological diagnosis resulting in a long-term severe mobility limitation. PWUs with dysarthria, hearing impairment, vision deficit, emotional/psychiatric problems or cognitive disabilities significantly limiting their ability to participate in the interviews were excluded from the study. Caregivers were eligible to participate if they were at least 18 years old and provided unpaid assistance to a PWU. Clinicians were eligible to participate if they were a clinician or technician of a seating and mobility department, and had at least 2 years of experience in prescribing PWs and/or training PWUs. The ability to express themselves in French or English was an eligibility criterion for all participants.

Data collection and analysis

The semi-structured interview guide was developed by our research team and modified as the interviews progressed to capture emerging themes. Separate interview guides were created for clinicians, PWUs and caregivers. The guides consisted of two groups of questions, separated by viewing of a video. Each question was open-ended and had a variety of possible probes. A trained occupational therapist conducted all interviews in the participants' primary language (French or English) and location of choice. Each participant was interviewed once. All interviews were digitally recorded and transcribed verbatim in the language of origin. Demographic information was also collected from each participant.

The focus of the first group of questions involved exploring experiences with PW use. Specifically, we were interested in the PW experiences of: users with respect to their day-to-day activities; caregivers in terms of providing assistance to users; and clinicians with respect to prescribing PWs, training PWUs and difficulties encountered by their PWU clients. Sample questions (from the user perspective) included ''In what activities do/don't you participate with your PW?'', ''What difficulties do you encounter when using your PW in shopping centers, stores or restaurants?'' and ''Do you have any concerns about safety when using your wheelchair?''. An example of a sample probe was ''Were there any activities that you avoided doing or situations that were uncomfortable for you?''.

Next, the participants viewed a 4-min video that illustrated the main features of the prototype IPW within the environment of a major shopping center. Using robotic and artificial intelligence technologies, the main functions of this semi-autonomous prototype included: (1) following a planned path (path following), (2) avoiding static and dynamic obstacles (obstacle avoidance), (3) negotiating through doorways and in between obstacles (path following/obstacle avoidance combination) and (4) following a given object such as a wall, a person or a group of people (target following). This IPW, which is among the most experimentally validated in realistic contexts, is described in further detail elsewhere [17].

After viewing the video, the second group of questions focused on obtaining feedback on the features of the IPW. Sample questions included ''What are your impressions of the technology that avoids obstacles, such as other people?'' and ''What are your impressions of the technology that allows the PW to follow a group of people?''. ''Can you tell me about situations or environments where this technology would be helpful to you?'' is an example of a probe for this group of questions.

In this study, the data collection and thematic analysis were interdependent processes whereby we engaged in an active analytical process throughout the interviews, which in turn

informed further data collection efforts. We documented initial impressions and used open and axial coding to generate categories and emerging themes as the interviews progressed [18]. Once each interview was analyzed individually, a more in-depth analysis of the codes across interviews was conducted and overarching themes were identified. The themes were developed in English, regardless of the language of the interview. Direct quotes included in this article were translated into English if the source transcript was French. NVivo 8 software was used for the analysis [19].

Results

Participants

The participant demographic data of the PWUs ($n = 12$), caregivers ($n = 4$) and clinicians ($n = 12$) are presented in Table 1. There was a wide age range for the PWUs (22–88 years), while the caregivers were mainly older adults (62–79 years). The clinicians ranged in age from 29 to 55 years. Males represented two-thirds of the PWUs, all of the caregivers and half of the clinicians. The vast majority of the sample spoke French as their first language. Half of this experienced, mainly independent, group of PWUs had a neurological diagnosis, most of which were degenerative in nature. All of the caregivers provided care for PWUs in the study. Most of the caregivers lived in the same residence as the PWU and ranged in the amount of assistance provided to the PWU from rarely to several times per week. The clinicians were mostly occupational therapists with many years of experience in working with individuals who use PWs.

Table 1. Participant characteristics.

Variables	PWUs ($n = 12$)	Caregivers ($n = 4$)	Clinicians ($n = 12$)
Age (years), mean ± SD	54.9 ± 21.2	66.7 ± 9.5	44.1 ± 8.3
Range	22–88	62–79	29–55
Sex (n)			
Female	4	0	6
Male	8	4	6
Mother tongue (n)			
French	9	3	12
English	1	1	0
Other	2	0	0
Primary diagnosis (n)			
Musculoskeletal	6		
Neurological	6		
Years of PW use, mean ± SD	14.2 ± 12.4		
Range	3–39		
Location of PW use (n)			
At home	9		
At work/volunteer	5		
At school	3		
In the community	12		
In a shopping center	11		
Recreation/sports	10		
Method of current PW control (n)			
Joystick	7		
Head control	2		
Other specialized control system	3		
Level of assistance required with the PW (n)			
None	6		
Supervision	1		
Physical assistance	0		
Assistance with transfers	5		
Relationship to PWU (n)			
Spouse		2	
Friend		2	
Caregiver living in same residence as PWU (n)		3	
Frequency of PW related help provided by the caregiver (n)			
Rarely		1	
Once a day		1	
Several times a week		1	
Unknown		1	
Profession (n)			
Occupational therapist			9
Orthotic and prosthetic technician			2
Special care counselor			1
Highest education level (n)			
College or trade school degree			3
Bachelor's degree			6
Master's degree			3
Years of experience, mean ± SD			18.7 ± 6.4
Range			7–27
Years of experience with PW, mean ± SD			11.6 ± 7.2
Range			2–26
Rehabilitation Center (n)			
First Rehabilitation Center			6
Second Rehabilitation Center			6

PWU, power wheelchair users; PW, power wheelchair; SD, standard deviation.

Findings

Three overarching themes, each with two sub-themes, resulted from our data analysis. The first theme, *increased social participation opportunities*, contained the sub-themes of overcoming barriers associated with ''intentionally'' and ''unintentionally'' missed social experiences. The second theme, *changing how social participation is experienced*, encompassed sub-themes of ''normalizing'' social interactions and decreasing physical, cognitive, and emotional effort. The final theme, *decreased risk of accidents during social participation*, involved sub-themes of decreased risk of accidents due to unchangeable factors and compensatory strategies.

Increased social participation opportunities

Approximately half of the participants in this study described how use of a PW limited participation in social activities and many directly expressed that the IPW would help to overcome the barriers associated with the challenges experienced. A range of situations were discussed, all of which theoretically have the potential to be overcome by the use of an IPW, thereby increasing social participation opportunities.

Overcoming barriers associated with ''intentionally'' missed social experiences. Many of the PWU participants reported that there are activities in which he/she intentionally does not participate due to using a PW. Crowds presented an insurmountable challenge for some users in attending social events. As described by one PWU, ''I don't go to the Jazz Festival for that very reason [crowds]... People always coming in front of you... they come around you and in front of you... they're inviting you to run right into their legs... you would need a truck horn or something like that to get them out of the way. Also when there is the street festival, the thing they do on Saint-Laurent [street] in summer they have these stalls out there... I just stay out of there.'' Most clinicians also described situations where clients intentionally avoided specific social situations. For example, one clinician participant corroborated the PWUs reaction to crowds when discussing her clients' perspectives on going to the mall, ''Sometimes people [PWUs] will avoid... or will prefer not to go to the mall when it's busy...'' Another clinician described how her clients are disadvantaged in terms of participating in community events where there are crowds when she said, ''I think there are many people who are deprived of

going to events where there are lots of people for fear of . . . not being able to cope if ever there was a disturbance . . . if ever there comes a rush, they are completely captive . . . they are unable to move as easily as someone who would stand.'' Caregiver participants expressed similar viewpoints related to PWUs avoiding busy stores and malls. Both PWUs and clinicians expressed perceptions that the IPW would help to overcome barriers related to intentionally missing social experiences. One PWU participant expressed how the obstacle avoidance feature of the IPW would enable her to attend social events where crowds are present when she said, ''. . . having a technology that would allow me to move within a crowd, free, by having more confidence that I will not break [others] legs. . .'' Another PWU participant reported how useful the obstacle avoidance feature would be ''. . . at banks and airports. . . the sky's the limit!''. This same participant described how the IPW would give her even more freedom to participate in social activities. Similarly, a clinician expressed that with an IPW, her client could ''. . . go out for a coffee when she wants . . .'' instead of waiting for her husband to accompany her. Another clinician described how an IPW would likely increase the chance that PWUs would go to the cinema, as it would be easier to navigate through crowds.

For other participants, navigating in small spaces presented a difficult challenge. For example, shopping in certain stores was not possible for some due to the inaccessibility of physical spaces, such as narrow aisles and inconveniently located displays. One participant said, ''. . . there are stores that have not really . . . the sense of having a customer who is in a wheelchair . . . it is obvious . . . they set up displays on each side . . . I told them, your displays are beautiful, but it frustrates me . . . there are shops that I avoid because of it.'' Participants described the use of the path following/obstacle avoidance combination feature in overcoming such navigational challenges in statements such as, ''. . . that's really impressive that you can . . . program it . . . to go to narrow places. Like, the fact that it can really calculate and see the distance and be able to get through, it helps a lot for somebody who has difficulty in controlling the chair in narrow places . . .'' Many clinicians spoke at length about clients who missed many social experiences due to difficulty navigating in small spaces. One clinician expressed her opinion that use of an IPW would decrease the under stimulation and isolation that occurs with individuals who have difficulty operating a PW due to neurological conditions.

Overcoming barriers associated with ''unintentionally'' missed social experiences. In contrast to the intentionally missed social experiences, PWUs also described social experiences that were unintentionally missed. The high level of concentration and focus required to drive a PW in social situations was clearly the reason for the missed opportunities for some participants. One participant described how he sometimes drove right by friends without noticing them when he said, ''. . . sometimes I go by people, because I'm so fixed when I'm driving in a wheelchair on where I'm going, that I just don't see what's going on around me . . . I've just missed' em, you know, I'd go whipping right by and . . . do not say hello. They think I'm mad at' em or something.'' In this example, the participant has inadvertently missed the opportunity to engage in a social interaction. Others spoke of not being able to simply enjoy their surrounding environment. For example, one participant spoke about how it would be nice to ''. . . watch the store windows without worrying too much . . . about the safety of everyone . . .'' Only a few of the PWUs spoke of the unintentionally missed social experiences and none directly commented on how the IPW would overcome these challenges related to unintentionally missing social experiences.

Changing how social participation is experienced

Many participants in this study described how using a PW in social situations sometimes changed the dynamic between themselves and the person with whom they were engaging in the activity. Participants also discussed how participating was challenging from a physical, cognitive and emotional standpoint. Many participants identified ways in which the IPW features could improve upon their social experiences.

''Normalizing'' social interactions. Most of the PWU participants expressed how the use of the IPW target following feature would have a positive impact on their social interactions. Specifically, PWUs felt that the ability of the IPW to adapt to the speed of and ensure proper distance from individuals with whom the PWU was travelling beside would help to overcome navigation challenges and enhance social interactions. For example, ''It would make it easier to have a conversation with a person you are walking beside . . . to not always have to focus so much on the driving . . .'' was the idea expressed by one user. Another user stated, ''. . . when I go out in groups . . . I find it would be great because . . . there'd be no problem, I'd be in step with everyone . . .'' Similarly, in describing being out with friends in a mall, a participant stated, ''Either I go too fast . . . when I'm with someone . . . or not fast enough . . . it would be much easier with this technology.'' Similarly, a caregiver described how his wife doesn't always drive the PW in a straight line secondary to distractions and how the target following feature would help to ''avoid the zigzagging''. Participants described this feature as being useful in environments such as malls, museums, amusement parks and at the cottage. A different viewpoint was offered by the clinicians in describing how certain features may decrease PWU-caregiver conflict. For instance, one clinician felt that the path following/obstacle avoidance combination may be helpful in this regard when discussing the damage that often happens at home to walls and furniture, ''I see it a lot at home too, all the people who have a hard time going to the bathroom . . . who tear the wall with the footrest . . . and it is often a source of conflict with the spouse or the caregivers there because it's destroying the furniture.'' These findings indicate that use of an IPW may serve to ''normalize'' social interactions in ways that able-bodied individuals take for granted, including walking along beside someone having a conversation without worrying about speed or distance from that person and moving around in a home without worrying about hitting a wall as the PW goes around a corner.

Decreasing physical, cognitive and emotional effort. According to most of the participants in this study, engaging in social activities requires much physical and cognitive effort, and is associated with feelings of anxiety, fear of injury and stress. The participants also described how features of the IPW could decrease the physical, cognitive and emotional effort, thereby changing how social participation is experienced.

Fatigue was described as a primary concern for PWUs. In fact, clinicians reported that it was so concerning that some users themselves would make a decision to stop using a PW for mobility, ''I've never had to remove the device [because of fatigue], usually it is the client, because it requires too much energy and it creates stress. . . the client himself will say. . . I feel like it's not in my priorities anymore . . . and they will request a manual wheelchair for someone else to push.'' The target following feature was described as an important feature in alleviating fatigue. For instance, one user said ''. . . when I go in groups . . . it wouldn't be tiring for me, I wouldn't need to always hold my joystick for half an hour's time.'' Another user described being able to continue participating in activities despite fatigue in

this comment, ''. . . in the summer when going out with my music group . . . I would be able to follow, even when fatigued.'' Clinicians also commented on how the IPW could benefit the user in this statement, ''There are people that are prevented from doing many things because they have high fatigue that is inherent to their condition . . . multiple sclerosis, ALS . . . having it [the IPW] can . . . give a sense of power . . . to have the opportunity when you're at the mall and you're really tired then you think, how am I going to go home? Having the security that you can have this technology available to assist you is, it's really good.'' The IPW may also decrease the fatigue of caregivers who assist with managing the environment by clearing crowds, as described by this caregiver, ''I don't think she's ever bumped in to anybody, but you know, it's come close, so I don't think she could maneuver by herself you know without me being in front of her clearing the path, I'm talking when it's [the mall] full of people.''

Cognitively, driving a PW requires focus and attention. Emotionally, the users and caregivers discussed often feeling anxious and stressed about the possibility of injury to themselves or others. The fear of injuring others was described well by this participant, ''I'll still go there, especially since I have a new girlfriend there, but I have fear of . . . it's like driving heavy equipment . . . there are kids everywhere, uh, I'm always afraid of injury.'' Many clinicians confirmed this finding. One clinician described the impact of decreased reaction time/reflexes of a client related to fear of injury, ''. . . it's a stroke he had, his reflexes are really slow . . . but he likes to go out . . . but with his chair, it is limited because there is fear . . . because he's afraid . . . of hitting someone in the legs. . .'' Another clinician more generally described the feelings her clients experience in going to the mall when it's crowded, ''. . . [fear of injury] makes them anxious, which makes them stressed when there are many people . . . it creates stress, it creates anxiety.'' Use of the IPW in this context was described as decreasing worry and increasing feelings of security and relaxation. One user generally commented on the target following feature, ''I could be relaxed when out with a group of people, for example at an amusement park.'' Another user described how the target following feature would change his visits to the cottage, ''We go to the cottage often with my brothers, my sisters, my friends . . . I would love being able to follow groups there . . . not necessarily have to worry, and them not having to worry. Everyone would go along and I would not have to worry about how I can manage my chair . . .'' Driving fast was important for another user who described that he would have an increased sense of security and safety with use of the collision avoidance feature. Caregivers also expressed thoughts that the IPW would decrease their worry, ''Well, I'd feel more secure that. . . you know if she makes a sudden movement that could cause a problem, then naturally it would be corrected . . .'' This caregiver further elaborated by saying ''I wouldn't have to worry about her going through a door and saying well a little bit right, a little bit left, you know what I mean?'' Similar thoughts were expressed by another caregiver, ''It would take a little worry out of it anyway, you know, especially going through doorways or where people are around . . . you know, it would take a little bit of the . . . anxiety I guess you can call it.''

Decreased risk of accidents while participating in social activities

Most of the PWUs in this study described being involved in an accident at some point in time. The fit between the user and the environmental challenges are often the cause of the accident and, in some cases, compensatory strategies developed by the users, were, in all likelihood, the primary cause of the accident. Some participants described how various IPW features might decrease the chance of becoming involved in an accident.

Accidents due to ''unchangeable'' factors. Participants in this study were involved in accidents while engaging in social activities both indoors and outdoors. One user described falling down steps when leaving a theatre, ''. . . there were a lot people, and the way the main entrance was made, it's very weird, because there are about three steps in the center of that room, so you go around the steps to go out in a wheelchair. But the side is not very wide . . . I dropped down the steps with the chair. We immediately called the ambulance . . . I had 8 stitches . . .'' Other participants described colliding with both stationary (e.g. windows and walls) and dynamic obstacles (e.g. people), falling off the sidewalk, both in summer and winter, and also falling in a ditch while using their PWs. These accidents resulted from factors that the PWU is not able to control (''unchangeable''), such as the physical environment and crowds. The perception of how the IPW would decrease accidents was highlighted by the participant who described dropping down the stairs when she stated, ''I think about the last accident I had . . . with technology like this, I would never have had an accident like that''.

Accidents due to compensatory strategies. Other PWUs described accidents resulting from the use of compensatory strategies used in order to overcome challenging aspects of the physical environment, such as crowds and curbs. A common compensatory strategy described by the PWU participants involved driving the PW in bike paths and bus lanes. One participant described an accident that she experienced in a bus lane, ''. . . there was a traffic jam and I was up against the curb, and a driver came up, she came up a little too close to me and she was going, trying to get by me, and she caught her rear bumper on something on my wheelchair . . . and swung me around . . . and the bumper fell off on the road beside me. Now, I just don't know what might have happened, had she been going faster, and . . . the bumper had been securely attached . . . whether it might have . . . thrown me out of my chair . . .'' This participant also highlighted how the obstacle avoidance feature of the IPW, ''. . . would be particularly helpful in avoiding people who stop or turn quickly in front you the PWC'', thereby decreasing accidents caused by collisions and possibly negating the need to use compensatory strategies to avoid crowds.

Discussion

In this study, we have explored the comparable perspectives of PWUs, caregivers and clinicians regarding the potential impact of an IPW on social participation. The three overarching themes of *increased social participation opportunities*, *changing how social participation is experienced* and *decreased risk of accidents during social participation* will be discussed below.

Increased social participation opportunities

Participants in this study identified a number of social situations in which their participation was limited secondary to using a PW. In some situations, the social experiences were missed intentionally, while in others unintentionally. Participating in social activities where crowds were present was a major barrier for most participants, however the obstacle avoidance feature of the IPW was recognized by some as a means of overcoming this barrier. Further, navigating in small spaces, such as elevators, narrow store aisles and public bathrooms, was also voiced as a challenge to social participation that may be mitigated by use of the path following/obstacle avoidance feature. Participants in the study by Wang et al. [15] shared these perspectives where collision avoidance was identified as being useful in busy and unpredictable environments, such as dining rooms, stores, hallways and sidewalks, as well as for the purpose of backing up.

By decreasing the discrepancy between the abilities of a PWU and the demands of the environment through use of an IPW, social participation for individuals with mobility disability could possibly be improved. In doing so, social isolation, anxiety and depression that often accompany impaired mobility could be minimized [20]. This premise is in keeping with results from a case study designed to evaluate the outcome of an anti-collision PW intervention on self-mobility with a long-term care resident [21]. In this study, despite the need for ongoing prompts to operate the wheelchair, the participant demonstrated a heightened level of alertness, frequency of smiling and attempts to make social contact with others while driving.

Changing how social participation is experienced

Challenges associated with adjusting to the speed of others and ensuring the proper distance between themselves and the person/people with whom the user is out appears to be a novel contribution to the literature. Further, the feelings of anxiety, fear of injury and stress related to the physical and cognitive efforts required to use a PW are important contributions to the literature. Typically, barriers to social participation while using a PW that have been reported in the literature to date are concerned with the characteristics of the PW [8,11] and the environmental context [6,8,11]. When personal factors are considered, cognition [12,13] and visual deficits [13] are the common considerations. Our findings highlight the need to consider how the PW influences function within a social context. These findings emphasize the importance of addressing the management of feelings of anxiety, fear and stress, especially since these results contradict other studies that highlight the positive feelings associated with provision of a PW [7]. Participants in this study suggested that use of the IPW would change how social participation was experienced by enabling users to overcome these challenges.

Decreased risk of accidents while participating in social activities

The accidents reported by the participants in this study are consistent with those reported in previous research [6,9]. Likewise, in relation to the accidents, the concerns regarding the potential danger to others, danger to oneself and concerns about property have also been reported in the literature [22]. A consequence of accidents and resultant safety concerns may result in health care professionals deciding to either remove the PW from the user or, in a case where it has yet to be recommended, to prescribe a ''simpler'' device [14]. For individuals with severe mobility disability, using a ''simpler'' device, such as a manual wheelchair, may mean becoming dependent on others for mobility. In turn, this dependency can have a negative impact on social participation. Many IPW features such as obstacle avoidance and path following may help to decrease accidents that occur during PW use. This notion is in keeping with previous research where participants in a long-term care facility recognized that collision avoidance would help to prevent accidents [23]. Interestingly, participants in another study suggested that an IPW could be used for training purposes for individuals who are having difficulty learning to drive a PW, which may improve skill and decrease accidents [15].

It has been projected that 61–91% of manual or PWUs could benefit from an intelligent wheelchair, at least some of the time [24]. The perceptions of our participants lend support to this idea from a social participation perspective, in that many felt that use of an IPW could increase opportunities for social participation, positively change the experience, and decrease the risk of accidents. We feel that enhancing social participation is an important outcome of the provision of a PW and that intelligent features will aid in achieving this rehabilitation goal. Our findings provide further rationale for continued design and development of IPWs.

There were limitations to this study. First, the participants were providing perspectives on an IPW that they did not have the opportunity to use. While the video shown to the participants illustrated the features of the prototype IPW within a social participation context (i.e. within a major shopping center), which in all likelihood minimized this limitation, the findings may change once the participants directly experience the IPW. Second, all participants were recruited from Montréal (Province of Québec, Canada) and therefore our results may not generalize to other geographical locations. Third, interviewer bias may have been present given the investigators' enthusiasm for the development of the IPW. However, if present, it was likely minimal as all interview questions were open-ended and neutrally worded. Finally, we interviewed only current PWUs and did not seek perspectives of those individuals who may have been denied a PW, had a PW removed from their use or were in the process of obtaining a PW. However, gaining the additional perspectives of caregivers and clinicians strengthened our study design.

In conclusion, this study provides valuable insights into the potential use of an IPW within the context of social participation from the perspectives of PWUs, caregivers and clinicians. Our findings suggest that an IPW would enhance social participation in a variety of important ways, thereby providing support for continued design and development of this assistive technology.

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Declaration of interest

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