Relationships between cognitive functioning and power wheelchair driving among adults: a cross sectional exploratory study

Alice. Pellichero[1,2,3], Krista L. Best[1,2,3], Jean. Leblond[3], Pauline. Coignard[4], Éric. Sorita[5], François. Routhier[1,2,3]

[1] *Department of Rehabilitation, Université Laval, Quebec City, QC, Canada*

[2] *Centre for interdisciplinary research in rehabilitation and social integration, Québec City, QC, Canada*

[3] *Centre intégré universitaire de santé et de services sociaux de la Capitale-Nationale, Québec City, QC, Canada*

[4] *Centre Mutualiste de Rééducation et de Réadaptation de Kerpape, Ploemeur, France*

[5] *Université de Bordeaux - Handicap Activité Cognition Santé (EA 4136 HACS), Bordeaux, France*

INTRODUCTION

Mobility is a fundamental and basic human right, as it is essential to health, quality of life, activity, and participation [1]. For individuals experiencing mobility limitations, power wheelchairs (PWC) can become a primary means of mobility. PWC prescription has increased substantially in the last few decades [2] partly due to an aging population and as older adults represent the largest cohort of PWC users [3]. In the coming years the prevalence of PWC users is expected to continue to increase [3]. Moving forward, it is critical to consider the complexities of PWC provision, including individual's diagnosis and prognostic, motor, cognitive and perceptual capacities, and the built and social environment [4]. Health care professionals reported cognitive functioning as their top concern when providing a PWC to individuals with cognitive disorders [5]. Indeed, intrinsic cognitive factors, such as being distracted, were reported as an intrinsic factor of origin of accident [6]. Anecdotal evidence that accidents among PWC users in a nursing home increased if the user had executive dysfunction has been reported [7]. Despite the fact that cognition and sensory perception troubles have been linked to problems with PWC driving capacities [8], the cognitive functions required for PWC driving remains unclear. Hence, individuals with dual motor and cognitive disabilities often experience restricted access to PWC and miss opportunities for self-directed mobility, autonomy, occupational engagement, and social participation.

Research aiming to understand the relationships between cognitive functioning and PWC driving are fundamental to ensuring best practices for PWC provision. Such research could help PWC prescribers in their decision making, selecting appropriate cognitive assessments. Thus, the hypothesis of the present study was that PWC performance would be related to cognitive functioning. The objectives were (1) to explore the relationships between cognitive functioning and PWC performance, and (2) to explore differences in PWC performance between level of cognitive impairment.

METHODS

Design

A cross sectional exploratory design was realized.

Population

PWC users (>18 years old), who could independently drive a PWC during the past three months or longer were included. Individuals were excluded if they could not communicate in English or French, if they were not able to attend two two-hour evaluations, or if they had significant behavioural disorders that could impact consent or ability to complete the evaluations. The sample was recruited through rehabilitation facilities and wheelchair seating programs in France and Canada. Ethical approval was received from the local institutional review boards and ethics committees at each site, Quebec City (Canada) (MP-13-2020-1841CA) and Lorient (France) (2019-A02554-53). All participants provided written informed consent.

Procedure

Two data collection sessions (two hours, one week maximum between each session) were performed. An occupational therapist administered the tests. During the first session, participants completed a sociodemographic form (i.e., age, sex, marital status, education, civil status) and were asked details about their PWC use (previous experience, hours using the PWC per day, previous accidents). They also completed the Montreal Cognitive Assessment (MoCA), a screening tool for cognitive impairment [9], the Motor-Free Visual Perception Test 3rd edition (MVPT-3), assessing visual perceptual abilities [10] and the Wheelchair Skills Test Questionnaire (WST-Q) version 5.0. evaluating perceived wheelchair skills capacity, performance, and confidence [11]. During the second session, participants completed the Life-Space Assessment (LSA), evaluating life space mobility [12], the Dysexecutive Questionnaire (DEX), assessing everyday manifestations of executive dysfunction [13] and the Power mobility Indoor Driving Assessment (PIDA), an objective wheelchair performance and safety assessment [14]. The tools used were all validated measures.

Data analysis

Descriptive statistics were used to summarize sociodemographic information, PWC characteristics and all outcomes. Pearson's correlations were used to explore relationships between cognitive and PWC driving scores, with correlations defined as: very strong (r=0.8), moderate (r=0.6 to 0.7) and fair (r< 0.5) [15]. A MANOVA (Bonferonni's posthoc test) was used to explore differences in PWC driving scores depending on severity of cognitive impairment. MoCA scores were used to differentiate groups according to their cognitive level (no cognitive impairment; mild cognitive impairment; moderate cognitive impairment; severe cognitive impairment). SPSS statistical software version 26 was used for analyses with an alpha level of .05.

RESULTS

Twenty participants were recruited (Canada n=3; France n=27), who were 58.4 ± 15.1 years of age, and 45% female (n=14). Participants had various diagnoses, including spinal cord injury (SCI) (n=16), multiple sclerosis (MS) (n=5), and others (n=9). They had on average 3.0 ± 5.0 years of experience using a PWC, six reported at least one accident since receiving their PWC, and 5 had a MoCA score higher than 24. Participants lived predominantly in the community (83%, n=25). Participants scored on average 22.1 ± 4.9 on the MoCA, 91.8 ± 25.3 on the MVPT (standard score), and 40.6 ± 9.9 on the DEX. They scored on average 77.4 ± 16.2 at the WST-Q (capacity), 76.8 ± 17.1 at the WST-Q (confidence), 77.3 ± 17.1 at the WST-Q (performance), 91.2 ± 6.4 at the PIDA and 39.2 ± 14.7 at the LSA.

Relationship between cognitive assessments and PWC driving assessment

There was a statistically significant moderate correlation between the MoCA scores and PIDA scores (r=0.696, *p*<0.001), and between WST-Q outcomes for capacity, confidence and performance (r=0.729, r=0.738, r=0.683, *p*<0.001, respectively). MoCA scores correlated statistically slightly with LSA scores (r=0.585, *p*<0.001). MVPT standard scores correlated slightly with PIDA scores (r=0.339, *p*=0.078), LSA scores (r=0.521, *p*=0.003) and WST-Q (capacity, confidence and performance) scores (r=0.443, *p*=0.016, r=0.435; *p*=0.018, r=0.461, *p*=0.012). There were no statistically significant correlations between the DEX and driving scores (PIDA, WST-Q and LSA). PWC driving scores were all correlated statistically with each other. WST (capacity, confidence and performance) scores were strongly correlated (r=0.969, r=0.944, r=0.906, *p*<0.001), thus only one WST score was used in subsequent analyses.

Differences in PWC performance between level of cognitive impairment

There was a statistically significant difference in PIDA, WST-Q-performance and LSA scores between participants with severe cognitive impairment, mild cognitive impairment and no cognitive impairment (Table 1. Comparison of PWC performance scores according to level of cognitive impairment).

Table 1. Comparison of PWC performance scores according to level of cognitive impairment

Cognitive level	**Table Column Heading**		
	PIDA	***WST-Q-perf***	***LSA***
no cognitive impairment (n=6)	97%	87%	45
mild cognitive impairment (n=16)	92%	83%	44
severe cognitive impairment (n=8)	87%	56%	24
p-value	.025	.004	.008

Post-hoc analyses indicated that there was a statistically significant difference in PIDA scores between the groups 'no cognitive impairment' and 'severe cognitive impairment' (*p*=0.029). There was also a statistically significant difference between the WST-Q-perf and the LSA between individuals with 'severe cognitive impairment', 'mild cognitive impairment', and 'no cognitive impairment' (*p*=0.006, *p*=0.012, *p*=0.003, *p*=0.001 respectively).

DISCUSSION

Correlations between cognitive functioning and PWC driving assessments support the hypothesis that PWC performance is related to cognitive functioning, and confirm previous research [16]. To our knowledge this is the first study to support explicit relationships between cognitive functioning and PWC performance among experimented PWC users.

The results of the present study may guide clinical practices related to PWC screening, provision and training. Based on severity of cognitive impairment as measured by the MoCA, the present study found a significant difference in PWC driving scores. One hypothesis is that users with moderate to severe cognitive impairment use their PWC differently than people with mild cognitive impairment or without cognitive impairment. Remarkably, users in the present study who reported previous accidents using their PWC also had higher cognitive levels. An explanation could be that users with higher cognitive level are more likely to try new experiences and to take risks. Highlighting the notion that people with higher cognition are given more freedom to assume risk. Moreover, users with cognitive impairment may not have opportunities to try new experiences or assume risk and are more likely to drive in safe contexts or to be assisted by others. While assumption of risk remains a controversial issue, it is clear that further research to understand how PWC users with diverse cognitive impairment use their PWC in daily life is required. In current practice, decisions around PWC provision for an individual with cognitive impairment are largely based on clinician perceived safety [5]. Establishing cognitive cut-points to guide clinical decision-making for PWC provision remains questionable as it can restrict individuals with cognitive impairment from trialling PWC mobility [17]. Precluding individuals with cognitive impairment to have access to a PWC can drastically restrict their independence and quality of life, even in their home [17]. A solution that empowers clinicians with tools to enforce safety concerns while promoting PWC provision may help balance the benefits and risks. This risk-benefit balance could be presented to potential future users and their families and can be discussed if acceptable or not for them in their own context. Another solution may be to combine appropriate cognitive assessments (such as the MoCA) and real practical situations for ongoing periods of time. Combining assessment tools and observation would help clinicians to apprehend functional cognitive abilities and secured practices, as indicated to assess car driving abilities after a traumatic brain injury [18]. However, this could add economic burden on an already strained healthcare system.

Due to the COVID-19 pandemic, the sample size was smaller than anticipated. However, all participants completed data collection at both time points with no missing data. This study included only PWC drivers who had experience. Future studies should include individuals who were precluded from PWC provision and novice users to fully explore cognition and safety concerns and the risk and benefits. This study took place in Canadian and French institutions. It is likely that the heterogeneity of settings added to the variability of the data. However, this heterogeneity strengthens the generalizability of our findings. The assessments were selected because they evaluate different aspects of cognitive function and because they evaluate PWC driving in a variety of ways (objective and subjective evaluation and in various environments). Other assessments tools, such as the Train Making Test [19], may also help to explain the relationship between cognition and PWC use. However, the number of assessments were limited to reduce burden of data collection. Finally, this study used bivariate statistical analysis. Such analysis does not consider multiple and complex factors associated in the process of PWC driving, limiting the acknowledgement of parallel processes implied in the processes of driving a PWC. Further research looking for covariates cognitive variables associated in PWC use would allow a deep understanding. Accordingly, cognition and mobility are two multifaceted concepts associated across the broad [20].

CONCLUSIONS

This study supports our hypothesis that cognitive functioning is related to PWC driving and may guide decision-making concerning PWC provision. A significant difference was found in PWC driving scores according to participants' cognitive level. However, participants reporting accident using their PWC had higher cognitive levels.

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