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Original Article

Exploration of the level of physical activity in individuals with Parkinson's disease and factors associated with related benefits and perceived barriers

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Abstract

Characteristics of physical activity have been studied in individuals with Parkinson's disease (PD) but the benefits and perceived barriers are not well understood. This study aimed to describe the level of physical activity and the factors associated with physical activity in individuals with PD in Thailand. 87 individuals with PD were recruited. Questionnaires considering demographics, physical activity, perceived benefits, perceived barriers, perceived self-efficacy, interpersonal influence and situational influence with physical activity were recorded. Descriptive statistics and Chi-square tests, odd-ratio (OR) with 95% confidence interval (CI) revealed that 48% of individuals with PD were taking part in recreational physical activity, with 40% of these travelling to and from the activity by walking or using a bicycle, and 12% performing the activities at work. Physical activity had a statistically significant association ($p<0.05$) greater with perceived benefits and self-efficacy and lower with perceived barriers which helps our understanding of the benefits and perceived barriers in Thailand.

Keywords: physical activity, Parkinson's disease, factors, benefits, barriers, self-efficacy

1. Introduction

Parkinson's disease (PD) is a neurodegenerative disorder, which is increasing within the ageing population in countries worldwide (Schootemeijer, van der Kolk, Bloem, & de Vries, 2020). The main histopathology findings, PD entails the loss of dopaminergic neurons from the substantia nigra pars compacta associated with the accumulation of α-synuclein in Lewy bodies and Lewy neurites (Bloem, Okun & Klein, 2021). In addition, the pathophysiology of PD appears to be due to abnormal α-synuclein aggregation, synaptic transport problems, mitochondrial dysfunction, lysosome or vesicle transport issues, and complex interactions of neuroinflammation (Bloem, Okun & Klein, 2021). Consequently, these mechanisms of PD collectively result in neuropathology of PD which involves loss of dopamine neurons in the striatum and an imbalance between direct (facili0tatory) and indirect (inhibitory) pathways through the basal ganglia and lead to less connected to corticostriatal circuits. The prevalence of PD is vastly increasing with an expectation of almost 13 million people being affected by 2040 (Rocca, 2018). A common type of PD is an idiopathic and progressive disease that significantly affects the patients' daily activities and quality of life. Main treatments for PD are dopaminergic replacement and exercise rehabilitation which both aim to alleviate symptoms (Choi *et al*., 2020; Tomlinson *et al*., 2014). There is strong evidence supporting the beneficial effects of exercise programs to relieve symptoms and improve wellbeing in individuals with PD (Choi *et al*., 2020; Radder *et al*., 2020; Tomlinson *et al*., 2014). The

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exercise program in terms of mobility and transfers, posture, upper limb function, strengthening, balance, gait and functional performance can be used for individuals with PD. Also, this can be achieved by wide range of techniques including treadmill training, exercising, cueing strategies, cognitive movement strategies, dancing and martial arts to optimize the patient's independence and maintain PD severity (Tomlinson *et al*., 2014).

Based on the physical activity recommendation with a dose of 30 minutes over several weeks, or having moderate to vigorous physical activity, has been suggested to positively impact the global motor and non-motor symptoms in individuals with PD (Choi *et al*., 2020; Moore G., 2016). Previous evidence has shown the benefits of regular physical activity which include an increased survival rate and the prevention of chronic disease. Physical activity has been shown to increase the regulation of the brain's neurochemistry and plasticity and various nerve growth factors, and reduce oxidative stress, enhancing energy production, and mitochondrial function which can contribute to exercise-induced neuroprotection (Bhalsing, Abbas, & Tan, 2018; Hughes *et al*., 2019; Mantri, Fullard, Duda, & Morley, 2018). In addition, a recent study showed that regular physical activity improved the physical and cognitive functional capacities in individuals with PD, especially exercise during the early stages of the disease which can decrease the risk of developing PD (Fayyaz *et al*., 2018). Thus, regular physical activity possibly leads to disease-modifying effects in addition to general improvements in the health of individuals with PD (Bhalsing *et al*., 2018; Mantri *et al*., 2018; Radder *et al*., 2020).

Schutzer *et al*. (2004) examined many factors that may influence physical activity adherence in older adults and identified the term **"**motivators**"** as the factors that promote adherence and the term **"**barriers**"** as the factors that limit adherence. For older adults, perceived barriers to exercise are more predictive of exercise behavior than perceived motivators (Schutzer & Graves, 2004). Sixty percent of older adults showed no adherence to the exercise while only 13% had good adherence, and they reported at least one barrier to the exercise (Schutzer & Graves, 2004). Well-documented perceived barriers to exercise in older adults include lack of interest, poor health, weakness, fear of falling, pain, bad weather, lack of time, and limited access to exercise resources (Schutzer & Graves, 2004). In addition, an association between poor outcome expectation from exercise (i.e., people did not expect to derive the benefit from exercise) and poor exercise adherence was demonstrated in older adults who had impaired balance (Forkan *et al*., 2006). A report showed that participation in regular physical activity declines with the increasing age, especially in women older than 65 years. Perceived barriers to exercise are varied according to gender and age group. Young adults commonly reported lack of time as the main perceived barrier to regular physical activity, whereas older adults frequently reported factors relating to a poor health condition (Schutzer & Graves, 2004). Schmidt, Gruman, King, & Wolfson (2000) described a community exercise intervention for people of 70 years of age or older in which participants who dropped out of the program early were distinguishable from participants who dropped out later or completed the program. Participants who dropped out early were characterized by poorer perceived health status, poorer physical performance, and greater disease burden (particularly musculoskeletal problems) than participants who dropped out later.

Few studies have examined factors to perform physical activity in individuals with PD (Keus *et al*., 2004; Mantri *et al*., 2018). Although individuals with PD may have barriers to exercise in common with older adults who are healthy, some barriers may be more relevant than others. Fear of falling may be an important factor in performing physical activity. There is evidence that suggests an association between restricted activity and fear of falling in individuals with PD (Nilsson, Drake, & Hagell, 2010). In addition, given the progressive nature of the disease and the associated decline in physical function, individuals with PD may not expect to derive a benefit from exercise or physiotherapy program (Chen *et al*., 2020; Radder *et al*., 2020). However, physical activity may vary depending on country and socioeconomic status, as well as differences in cultures, and beliefs. Therefore, the current study sought to explore the physical activity in individuals with PD in Siriraj Hospital, Thailand. Given that previous research identified age and gender as factors influencing participation in exercise among individuals with PD who tend to become less active with increasing disease severity, we conducted secondary analyses to determine whether these factors were important to consider in individuals with PD. This aimed to identify what factors may be modifiable, or perceived barriers which can influence the engagement with physical activity, and may help physiotherapists to develop strategies to promote both short- and long-term adherence to increase physical activity and exercise in individuals with PD.

2. Materials and Methods

2.1 Participants

One hundred and five outpatients diagnosed with PD by neurologists were recruited to this study, of which eighty-seven met the following inclusion criteria: clinical diagnosis of PD at all stages following the modified Hoehn and Yahr (H&Y) Scale assessment; able to read and understand Thai, and a Mini-Mental State Examination Score $\geq$ 24/30 (Muangpaisan, 2015). The exclusion criteria were: presenting with a clinical diagnosis of dementia, time problems resulting in non-completion of the questionnaires, and having other neurological, cardiopulmonary, or other problems that would affect exercise and physical activity. Participants were followed up after their usual care at the Movement Disorder Clinic, Division of Neurology, Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand, between May 2020 and January 2021. The protocol was explained prior to obtaining written informed consent, in keeping with the Declaration of Helsinki. The local Ethics Committee on Human Experimentation approved the study (COA. No. Si 626/2020).

2.2 Procedure

Research advertisements were posted at the Movement Disorder Clinic. Individuals with PD who met the inclusion and exclusion criteria were invited to participate in the study. Participants completed self-administered survey questionnaires. The original English questionnaire was constructed based on the "Global Physical Activity Questionnaire" (Organization, accessed December 28, 2019) and had been translated to Thai according to the method reported by Kuder-Richardson Formula 20 (Thongnopakul, Leelukkanavera, & Junprasert, 2019). The questionnaire assessed barrier perception to regular exercise behavior. The test-retest reliability (0.751, p<0.001) and internal consistency (alpha coefficient = 0.727) have been established for healthy adults (Thongnopakul, Leelukkanavera, & Junprasert, 2019). The questionnaire is mixed with the open-end in part 1 and closed-end in parts 2 and 3. Part 1 was the demographic data, including gender, age, education level, and occupation characteristics. Part 2 was the physical activity, which consisted of 4 main questions; activities at work, travel to and from places, recreational activities, and sedentary behavior, 16 questions in total. Finally, part 3 explored the perceived benefits of physical activity (12 items), perceived barriers (10 items), perceived self-efficacy (8 items), interpersonal influence (10 items), and situational influence (8 items). In addition, each item of part 3 has multiple ratings: 1 for very little, 2 for little, 3 for quite a lot, and 4 for a lot. The mean score was calculated for each topic of part 3 and the descriptive analysis was applied as follows; very high (3.51-4.0 scores), high (2.51-3.50 scores), low (1.51-2.50 scores), and very low (1.00-1.50 scores). The higher scores indicate more perceived of those aspect.

2.3 Statistical analysis

The Predictive Analytics SoftWare (PASW) statistical package (18.0) was used for analyses. Descriptive statistics were used to describe the characteristics of the participants, and the Chi-square test (odd-ratio, OR, and 95% confidence interval, CI) was applied to test the association between the independent variables including the demographic data (age, gender, education level, occupational and income) and the perceived benefits, perceived barriers, perceived self-efficacy, interpersonal influence and situational influenced with physical activity characteristics (activities at work, travel to and from places, recreational activities and total physical activities). An OR greater than one indicates an increased likelihood of the factor being associated between the independent variables, whereas an OR of less than one represents a decreased likelihood of the factor being associated. The statistical significance was set at p<0.05.

3. Results and Discussion

3.1 Results

3.1.1 Demographic data

Most of the participants of the study were male (n = 56; 64.4%). Their average age was 66.3 ± 9.6 years and PD onset duration was 7.9 ± 2.08 years. Most of them presented mild to moderate clinical symptoms, as noted by the Hoehn & Yahr score of 1.5-3 (Mild to moderate bilateral disease; some postural instability; physically independent) and had the averaged Mini-Mental State Examination Score of 28.6 ± 4.71. Approximately 82.8% of them were independently ambulant without using an assistive device. The most common comorbidities were hypertension (n = 30; 52.63%), followed by diabetes mellitus (n = 11; 19.30%), and dyslipidemia (n = 10; 17.54%), respectively. Most of the participants graduated from primary school level (n = 26; 29.9%) and continue working for their jobs (n = 63; 72.4%) with mean salary income of 22,5400 ± 2,390 Thai Baht (about $727), Table 1.

Table 1. Demographic data of individuals with Parkinson's disease participants

Characteristics	n = 87
Gender (n, %)	
- Male	56 (64.4%)
- Female	31 (35.6%)
Age (years): mean ± SD (range)	66.3 ± 9.6 (37, 88)
Duration onset (years): mean ± SD (range)	7.9 ± 2.1
Modified Hoehn & Yahr stage	
- 1.5 (n, %)	10 (4.3%)
- 2 (n, %)	10 (31.9%)
- 2.5 (n, %)	21 (23.2%)
- 3 (n, %)	29 (23.2%)
- 4 (n, %)	11 (13.0%)
- 5 (n, %)	6 (4.4%)
Mini-Mental State Examination Score (scores): mean ± SD (range)	28.6 ± 4.71 (28, 30)
Ambulation (n, %)	
- Independent without assistive device	72 (82.8%) 15 (17.2%)
- Assistive devices used (walker/three or one-point cane)	
Number of comorbidities (n, %)	57 (65.5%)
- Hypertension	30 (52.6%)
- Diabetes mellitus	11 (19.3%)
- Dyslipidemia	10 (17.5%)
- Heart disease	5 (8.8%)
- Cancer	1 (1.7%)
Marital status (n, %)	
- Single	2 (2.3%)
- Married	76 (87.4%)
- Divorce/Widow	9 (10.3%)
Education levels (n, %)	
- Uneducated	2 (2.3%)
- Primary school	26 (29.9%)
- Secondary school	12 (13.8%)
- Diploma degree	15 (17.2%)
- Bachelor degree	22 (25.3%)
- Master/Doctoral degree	10 (11.5%)
Occupation (n, %)	
- Unemployed	24 (27.6%)
- Employed	63 (72.4%)
- Household shored	
Yes	48 (55.2%)
No	39 (44.8%)
Income (n, %)	
- None	32 (36.8%)
- Yes	55 (63.2%)
mean ± SD of the salary	22,540 ± 2,390

3.1.2 Physical activity engagement

Forty-eight percent of participants engaged in recreational activities, with 40% travelling to and from the activity by walking or using a bicycle (pedal cycle), and 12%

performing the activities at work (Figure 1). For those engaged in recreational activities, 40 participants performed moderate-intensity sports over seven days for 30 minutes per day, whereas only two participants performed vigorous-intensity sports for two days for 75 minutes per day. For the activity at work, none of the participants performed vigorous-intensity activities and only 11.15% of participants performed moderate-intensity activities. For those that travelled to and from the activity by walking or using a bicycle (pedal cycle), 40.2% walked for at least 10 minutes continuously. For those that were sedentary behavior occurs in our participants' average of 180 minutes a day.

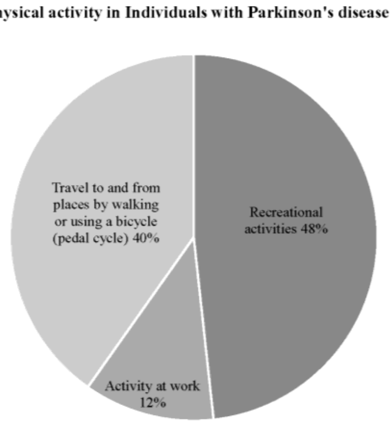

Figure 1. Physical activity reports from individuals with PD.

3.1.3 The perceived benefits, barriers, self-efficacy, interpersonal influence, and situational influence for engagement in physical activity.

The results of the perceived benefits, perceived barriers, perceived self-efficacy, interpersonal influence, and situational influence for physical activity and exercise for the 87 participants are shown in Figure 2. The level of perceived benefits and perceived self-efficacy was high, indicating greater perceived benefits and self-efficacy (mean ± SD = 3.64 ± 0.53 and 3.13 ± 0.81, respectively), the interpersonal influence and situational influence of physical activity and exercise was fairly high (mean ± SD = 2.78 (1.07) and 3.00 (0.78), respectively), and the perceived barriers were low (mean ± SD = 1.45 (0.63), showing low perceived barriers in individuals with PD.

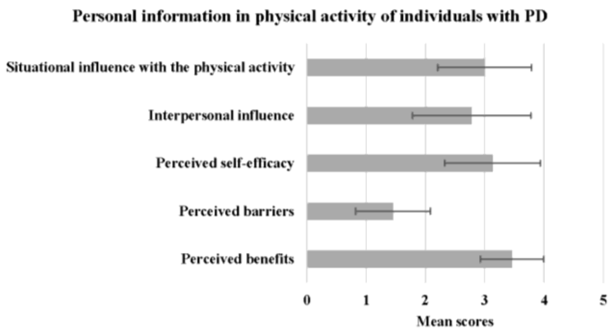

Figure 2. The perceived benefits, barriers, self-efficacy, inter personal influence, and situation influence of physical activity in individuals with PD.

3.1.4 Factors associated with physical activity

Factors associated with physical activity were recreational activities and total physical activity in 87 individuals with PD (Table 2). Participants who performed moderate-intensity sports, fitness or recreational activities had higher perceived benefits (OR = 3.13, 95% CI = 1.26-7.78), lowest perceived barriers (OR = 0.34, 95% CI = 0.14-0.86), and highest perceived self-efficacy (OR = 7.48, 95% CI = 2.81-19.96). In addition, the results demonstrate that the participants in total physical activities had a higher perceived self-efficacy 6.63 times (OR = 6.63, 95% CI = 1.70-25.29) than those performing activities at work, and travel to and from places (Table 2).

3.2 Discussion

Individuals with PD are extensively presumed to follow a sedentary lifestyle due to their progressive motor and non-motor impairments. We have accrued evidence about the levels of physical activity and have investigated the factors influencing participation in physical activity among individuals with PD. Most participants in this study were older individuals with PD with a mean age of 66.3 ± 9.6 years. They had the mean duration onset of 7.9 ± 2.08 years, covering all stages of PD (the majority being at the moderate (Choi *et al*., 2020; Radder *et al*., 2020; Tomlinson *et al*., 2014) Hoehn and Yarh stage of PD). For these Hoehn and Yarh stages, participants had balance impairment and postural instability, which affect functions and physical activities. Previous evidence reported that individuals with PD who had greater impairment of functional mobility could affect a person's activity and social participation and can further reduce their quality of life (van Nimwegen *et al*., 2011). When considering the level of physical activity, 48% of individuals with PD demonstrated that they carried out recreational activity, 40% demonstrated that they were traveling to and from place to place by walking or using a bicycle (pedal cycle) and 12% were actively at work. Most of the participants participated in moderate-intensity sports, fitness, or recreational (*leisure*) activities, with sedentary behavior reported for about 180 minutes a day. The findings from this current study were different from those for individuals with PD in developing countries. For example, a study by Mantri *et al*. (2018) found that 37.3% of individuals with PD were active at work and 43.3% were active through leisure activities (Mantri *et al*., 2018).

The analysis of the factors related to physical activity in individuals with PD showed that perceived benefits, perceived barriers, and perceived self-efficacy are the factors related to physical activity. The findings are summarized below.

Perceived benefits of physical activity: Individuals with PD with a significantly high perception of the benefits of physical activity are 3.13 times of those with low perception (95% CI = 1.26-7.78). This is possible because society gives precedence to health care, resulting in a higher perception of information of the benefits of physical activities. Individuals with PD were aware of such benefits, i.e., physical activity from work, from travel, or from leisure activities through exercise or sports. Specifically, physical activity from work could be performed in their daily life, so they tended to

Table 2. Factors associated with physical activity and exercise

Factors	Activity at work	Travel to and from places	Recreational activities	Total
	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)
Gender				
Male	1.00	1.00	1.00	1.00
Female	1.96 (0.52, 7.39)	1.37 (0.56, 3.34)	0.71 (0.29, 1.75)	1.47 (0.42, 5.14)
Age (years)				
<60	1.00	1.00	1.00	1.00
≥60	3.60 (0.43, 30.12)	0.66 (0.25, 1.71)	1.47 (0.56, 3.88)	0.72 (0.18, 2.86)
Status				
Single/widowed/divorced/separate	1.00	1.00	1.00	1.00
Married	1.34 (0.15, 11.77)	1.21 (0.33, 4.47)	2.31 (0.64, 8.28)	2.22 (0.51, 9.66)
Education				
Non-Primary school	1.00	1.00	1.00	1.00
Secondary school – Vocational	0.37 (0.07, 2.09)	1.07 (0.37, 3.10)	3.50 (1.09, 11.29)	2.67 (0.61, 11.64)
Bachelor-higher than bachelor	0.48 (0.10, 2.20)	0.70 (0.25, 1.99)	1.67 (0.60, 4.67)	2.33 (0.60, 9.02)
Occupation				
No	1.00	1.00	1.00	1.00
Yes	1.14 (0.27, 4.84)	2.20 (0.85, 5.73)	1.23 (0.46, 3.31)	5.98 (0.74, 48.50)
Job description				
No	1.00	1.00	1.00	1.00
Housework	2.33 (0.47, 11.49)	1.83 (0.64, 5.26)	0.46 (0.16, 1.32)	1.01 (0.29, 3.56)
others	1.59 (0.29, 8.59)	2.00 (0.71, 5.66)	0.98 (0.33, 2.90)	6.40 (0.75, 54.78)
Incomes				
No	1.00	1.00	1.00	1.00
≤20,000	0.35 (0.06, 1.94)	2.03 (0.75, 5.51)	0.55 (0.20, 1.50)	1.29 (0.35, 4.75)
>20,000	0.85 (0.18, 4.01)	0.89 (0.28, 2.83)	0.97 (0.30, 3.13)	1.46 (0.32, 6.59)
Perceived benefits				
Low (1.00 – 3.46)	1.00	1.00	1.00*	1.00
High (3.47 – 4.00)	0.23 (0.06, 1.02)	1.41 (0.58, 3.42)	3.13 (1.26, 7.78)	1.70 (0.54, 5.38)
Perceived barriers				
Low (1.00 – 1.45)	1.00	1.00	1.00*	1.00
High (1.46 – 4.00)	1.31 (0.34, 5.05)	1.22 (0.50, 2.99)	0.34 (0.14, 0.86)	0.46 (0.14, 1.47)
Perceived self-efficacy				
Low (1.00 – 3.12)	1.00	1.00	1.00*	1.00*
High (3.13 – 4.00)	0.27 (0.07, 1.14)	0.98 (0.41, 2.33)	7.48 (2.81, 19.96)	6.63 (1.70, 25.92)
Interpersonal influence				
Low (1.00 – 2.78)	1.00	1.00	1.00	1.00
High (2.79 – 4.00)	0.88 (0.24, 3.28)	0.91 (0.39, 2.14)	2.19 (0.90, 5.33)	1.62 (0.51, 5.13)
Situational influence				
Low (1.00 – 3.00)	1.00	1.00	1.00	1.00
High (3.01 – 4.00)	0.75 (0.20, 2.81)	0.87 (0.37, 2.06)	2.25 (0.925, 5.47)	1.36 (0.43, 4.26)

*Statistical significance at $p<0.05$ from the Chi-square test.

perform more physical activity (Bhalsing *et al*., 2018). Perceived benefits of physical activity brought attentiveness and mental drive to perform those activities (Bhalsing *et al*., 2018). Another explanation may come from the social support from family (Hughes *et al*., 2019). However, our study did not explore this aspect. A previous study showed forms of support for physical activity provided by the individuals′ families were instrumental support (e.g. spouses participating in physical activities alongside their partner with PD) and emotional support (e.g. encouragement to participate in physical activity) (Fang *et al*., 2018; Hughes *et al*., 2019). Taken together, this information shows that positive effects of physical activity and physical activity training can be advantageous in individuals with PD.

Perceived barriers: This factor was significantly related to the physical activity of individuals with PD, which showed that participants who performed moderate-intensity sports, fitness or recreational activities had lowest perceived barriers (OR = 0.34, 95% CI = 0.14-0.86) and rather low dispersion (mean ± SD = 1.45 ± 0.63). Previous studies have examined many factors which may influence exercise adherence in older adults as well as referring to individuals with PD and have identified perceived barriers to exercise are more predictive of physical activity behavior than perceived motivators (Ellis *et al*., 2013; van Nimwegen *et al*., 2011). Well-documented perceived barriers to physical activity in older adults and neurological disease include educational level. However, in this study, the spread of education level is quite broad, particularly between primary and bachelor degree level so would possible not give definitive outcomes. In addition, barriers to physical activity in individuals with PD were found to be low outcome expectations, lack of time, fear of falling, lack of motivation, depression, and fatigue (Afshari, Yang, & Bega, 2017; Ellis *et al*., 2013). These were not included in this study but be valuable inclusions in future investigations.

Perceived self-efficacy: This factor was significantly related to physical activity in individuals with PD. Those with high perceptions of self-efficacy tended to show more physical activity, 7.48 times (95% CI = 2.81-19.96) and 6.63 times (95% CI = 1.70-25.92) than those with low perceived self-efficacy from leisure activities and total physical activity, respectively (Table 2). These findings can explain that perceived self-efficacy could overcome barriers, resulting in an increased of the implementation of plans and to make decisions regarding suitable physical activities. Previous studies reported an association between self-efficacy and physical activity participation in individuals with chronic disabilities and individuals with PD (Ellis *et al*., 2013; Keus *et al*., 2004). Perceived self-efficacy is related to people's judgment of their capability to exercise successfully which indicates that people with high self-efficacy are more likely to engage in physical activity and shows promise as potential effective interventions in individuals with PD (Ellis *et al*., 2013; Keus *et al*., 2004). A previous study showed that higher self-efficacy results in a greater commitment to achieving established goals but self-efficacy for exercise does not explain the low level of physical activity in more sedentary individuals with PD (Dontje *et al*., 2013).

Gender: This factor did not relate to physical activity in individuals with PD. Different body structures usually result in different physical activities, for example, the male body structure is frequently stronger than the female (Urell, Zetterberg, Hellström, & Anens, 2021). In our study, we compared individuals with PD using a male-to-female ratio (1.7:1), but no gender differences were found in the study. One possible explanation for the gender factor could be that there was no difference in physical activity level as a larger amount of activities were carried out at a lower intensity where the mobility restrictions were not restricted by gender (Urell *et al*., 2021).

Occupation: This factor did not relate to physical activity in this study. People in jobs that required high physical energy certainly had more physical activities than those with low physical energy (O'Neill & Reid, 1991). The majority, 72%, of the individuals with PD had jobs that required physical energy, e.g. farming, caregivers, construction, and machine operators. These activities necessitated higher physical energy than was required by unemployed people. These findings were similar to those reported in the study by Fayyaz *et al*. (2018) who found that job characteristics in individuals with PD were significantly related to the level of physical activity (Fayyaz *et al*., 2018).

Age: This factor did not relate to the physical activity of the working-age population. The age range of the participants in this study was 37 to 88 years. Older age was consistently associated with a lower level of physical activity (Fayyaz *et al*., 2018). This was expected and is in line with the findings of several other studies in the general population (> 65 years of age) and in individuals with PD (Dontje *et al*., 2013; Fang *et al*., 2018; Göttgens *et al*., 2020; Urell *et al*., 2021). In addition, the age difference certainly resulted in different perceptions and experiences in life (O'Neill & Reid, 1991; van Nimwegen *et al*., 2011). These findings were also in line with the study by Urell *et al*. in 2021 which found that age was not related to their physical activities (Urell *et al*., 2021). The authors concluded that age was not related to exercise in individuals with PD.

Education level: This factor did not relate to the physical activity of individuals with PD, possibly because poorly educated people had high physical activities associated with their work so had to be active to keep their jobs. To the contrary many well-educated people had low levels of physical activity at work because their jobs did not require much physical energy but then had greater levels in leisure activities from exercise and sports than the poorly educated ones. In general, well-educated people basically have better-selected behavior as regards health than poorly educated people, as they have developed a body of knowledge, understanding, and attitudes over the course of their lives resulting in more positive behaviors. There is a tendency for greater participation in physical activities from leisure activities than poorly educated people (Mantri *et al*., 2018). A previous study found that educational achievement before the onset of PD is associated with the severity of the burden of the motor disease from the PD (Mantri *et al*., 2018).

Income: This factor did not relate to the physical activities of the individuals with PD, possibly because most PD patients included in the study had a low income (63%). Until present, there was no study into the role of economic status concerning physical activity in PD. However, income would influence the standard of living in terms of fulfilling basic human needs and self-care capability (Yang *et al*., 2016). Working to accrue more income possibly increased the level of physical activity in people with low income. In contrast, those on a higher income possibly had greater physical activity from leisure activities. Therefore, the two aspects would potentially equate and explain why the physical activities of our participants were not different, resulting in the lack of relationship between income and physical activities.

Perceived interpersonal influences: No association was found between perceived interpersonal influences and the physical activity of individuals with PD. It was found that the support was high across the board, apart from financial support, which was low. Part of the physical activity was associated with work in compliance with rules & regulations asset. To date, there have been no studies to investigate this factor in PD. However, this theory is supported by two previous studies that found that perceived interpersonal influences were not related to exercise in working age people in Thailand (Thongnopakul, Leelukkanavera, & Junprasert, 2019; Thanamee *et al*., 2017).

Perceived situational influences: This factor did not relate to the physical activities of the individuals with PD, possibly because the individuals lived in environments with a similar situation or context of their PD disease. To clarify, they lived in the same municipality. Therefore, the data associated with this factor might not vary sufficiently, resulting in no relationship being found between the variables.

The results of this study may have been influenced by differences in the level of severity of PD which has the potential to affect the mental health and cognitive function in relation to the level of physical activity. A further study into the impact of the deterioration in mental health in relation to perceptions of the patients pertinent to independent living, restrictions in physical activity and self-efficacy would be illuminating. In this study our results show that there were 6 individuals with PD (4.4%) who were classified as stage 5 of the modified Hoehn & Yahr stage with scores of 28 or 29 on the Mini-Mental State Examination (MMSE), which resulted in the mean scores of all participants and standard deviation 28.6 ± 4.71 (Table 1). This MMSE score has been recommended as a screening test for dementia or cognitive impairment in healthy adults with scores less than 24 (Muangpaisan, 2015) whereas in individuals with PD dementia and cognitive impairment with scores of less than 26, indicating the possibility of dementia (Burdick *et al*., 2014). In our study, there did not appear to be any impact of mental status or cognitive impairment on the level of physical activity. However, previous research showed that mental status, including cognitive impairment and mood disturbance, significantly affects physical activity in individuals with PD, even in the early stages of the disease for whatever reason, contributing to poorer quality of life of the individual and also to caregiver burden (Bhalsing *et al*., 2018). From our research and a review of peer work we are making a recommendation that clinicians must be aware of the limitations of the MMSE in detecting cognitive impairment in individuals with PD due to the wide range of cognitive impairment that can be found in PD patients. The MMSE and the Montreal Cognitive Assessment (MoCA) are intended for use as screening measures for cognitive function in individuals with PD. The results from this will indicate a potential problem in individuals with PD which could be addressed by support from psychology specialists limiting the deterioration of the disease and the level of physical activity associated with PD.

There are limitations in this study. Firstly, the sample was from only a single site PD clinic and this finding was possibly due to participants were only one group. Future research should recruit a larger sample size from several places to apply in general. Secondly, most of participants in the present study were mild to moderate stage of PD and they were active and participated in social activities; these factors may have led to potential selection bias. Future work should be conducted using a larger sample size with equal amount of all stages of PD and more detailed statistics to give a clearer indication of how individuals with PD may be able to achieve greater information of levels of physical activity in individuals with PD.

4. Conclusions

This study showed that individuals with PD carried out reasonable levels of exercise and activity than was originally hypothesized, due to the greater work-based activity included in their daily assessment. In addition, there were 3 main factors related to physical activity in individuals with PD which included perceived benefits, perceived barriers, and perceived self-efficacy. Healthcare multidisciplinary teams should assess physical activity in the PD population and then use all aspects of their lives to put forward suitable suggestions to each individual with different physical energy levels and capabilities to maximize their levels of activity. Those with moderate physical energy but not sufficient for the maintenance of their health should be given straightforward suggestions regarding extra activities including walking or cycling in daily life. Those with low physical energy should be targeted to increase their activity levels to boost their energy with achievable exercises such as walking or cycling. Various exercise skills should also be practiced to enable choice in exercise methods that suit time and opportunities.

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