ORIGINAL ARTICLE

Predictors of physical activity levels in individuals with Parkinson's disease: a cross-sectional study

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Abstract

Background To investigate whether modifiable predictors (depressive symptoms, impairment in behavior and mood, balance impairments, and knee extensor muscle strength) are determinants of the physical activity level in Parkinson's disease.

Materials and methods A cross-sectional study with individuals diagnosed with idiopathic Parkinson's disease. Regression analysis of the data was used to investigate whether depressive symptoms, impairments in behavior and mood, balance impairments, or dominant knee extensor muscle strength are predictors of physical activity levels in Parkinson's disease.

Results A total of 50 individuals with mild to moderate Parkinson's disease participated in this study, with a mean age of 67 ± 8 years and 68% male. Balance impairments explained 29% of the variation in the physical activity levels. The explained variance increased to 34% when depressive symptoms were included in the model.

Conclusion Among the predictor variables investigated in our study, only balance impairments and depressive symptoms explained the variance in physical activity levels in individuals with Parkinson's disease.

Keywords Depressive symptoms · Parkinson's disease · Physical activity · Postural balance · Sedentary behavior

Introduction

Individuals with Parkinson's disease have motor and non-motor symptoms which can cause disabilities which in turn affect their physical activity levels (PAL) [1]. PAL is defined as any body movement generated by skeletal muscles resulting in energy expenditure [2, 3]. The main recognized motor symptoms referred to as cardinal signs of Parkinson's disease are resting tremor, bradykinesia, rigidity, and postural instability [4]. In addition, individuals with Parkinson's disease usually present depressive symptoms, impairment in behavior and mood, balance impairments, and lower limb muscle weakness [5–8]. Although muscle weakness is not a primary sign of Parkinson's disease, weakness is observed in several muscle groups [6]. However, it is not known what the influence of these variables is on the physical activity levels of these individuals.

Previous studies have shown that regular physical activity is an effective way of controlling the motor symptoms of the disease and depressive symptoms and improves the functionality of individuals [9, 10]. Furthermore, it is known that physical activity has a neuroprotective effect and can reduce vulnerability to dopamine aggressors and promote neuroplasticity [11]. Thus, staying active is of paramount importance to minimize the functional impairments of Parkinson's disease and delay its evolution [10–12].

Some studies have already evaluated potential determinants of physical activity in Parkinson's disease and have suggested that maintaining high physical activity levels would be associated with age, gender, income, social support, education, lower bradykinesia, and higher severity of the disease, among other non-modifiable variables [13–16]. However, there are few studies in the literature investigating modifiable variables as predictors of physical activity practice in Parkinson's disease [6, 8] which can be addressed in rehabilitation programs.

In order to contribute to formulating new intervention strategies, we seek to understand the influence of modifiable predictors on the physical activity level in individuals with Parkinson's disease. Considering that a portion of these remain poorly explained [13, 15], the present study aimed to

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investigate whether modifiable predictors (depressive symptoms, impairment in behavior and mood, balance impairments, and knee extensor muscle strength) are determinants of the physical activity level in Parkinson's disease.

Design and methods

Study design and ethical considerations

This is a cross-sectional study approved by the Ethics Committee of the Faculdade Ciências Médicas de Minas Gerais (CAAE:10047219.2.0000.5134), with individuals diagnosed with idiopathic Parkinson's disease, from April 2019 to January 2020. All participants signed an informed consent form.

Participants

Participants in this study were individuals diagnosed with idiopathic Parkinson's disease, recruited by phone from a previous research contact database. Individuals were contacted at their home. As inclusion criteria, the individuals were to be older than 50 years and able to walk independently. Individuals who had other neurological diseases or who did not obtain an adequate score on the Mini Mental State Examination according to pre-established cut-off points in the literature (13 for individuals with illiteracy, 18 for those with elementary and middle education, and 26 for those with high education) [17] considering the years of schooling were excluded.

The sample size of at least 50 participants was based upon the formula proposed by Dohoo, Martin, and Stryhn [18], sample size = $(n + 1)*10$, where n = number of independent variables. Thus, four independent variables were included in the multiple regression model for this calculation.

Procedures

Sociodemographic and clinical data were collected in an interview format through a questionnaire developed by the research team. All tests and questionnaires designed to collect the variable of interest and predictors present adequate measurement properties. The questionnaires used in our study were applied individually in order to avoid potential conflicts and external influences.

The dependent variable (physical activity level) was assessed with the Human Activity Profile (HAP), which is a questionnaire consisting of 94 items of routine activities with different functional levels, sorted in order of increasing energy costs. We considered the adjusted score activity (AAS) with cut-offs defined for stratification of individuals as inactive (< 53), moderately active (53 to 74), and active (> 74) [19, 20].

The following four potential predictors were included: depressive symptoms, behavioral and mood, balance impairments, and dominant knee extensor muscle strength.

Depressive symptoms were investigated by the Patient Health Questionnaire-9 (PHQ-9), a questionnaire consisting of 9 items used to screen for symptoms such as depressed mood, anhedonia, change in appetite, and feeling of guilt. The regularity of these symptoms in the past 2 weeks was assessed on a scale of 0 to 3 corresponding to the answers "not once," "several days," "more than half the days," and "almost every day", respectively, where a score equal to or greater than 10 indicates the presence of depressive symptoms [21].

The assessment of the behavior and mood was performed by subpart I of Unified Parkinson's Disease Rating Scale (UPDRS), which includes cognitive behavioral disorders, neuropsychiatric disorders (caused by dementia or drug toxicity), presence of depression, and reduction in motivation [22]. It consists of 4 items with a score ranging from 0 to 4, which 0 being the least compromised and 4 being the highest [23].

The assessment of balance impairments was performed with the MiniBESTest, which is a quick test application containing 14 items scored ranging from 0 to 2 and involves evaluating four areas of dynamic balance: anticipatory postural adjustments, reactive postural control, sensory orientation, and gait dynamics [24]. The application time varies between 10 and 15 min [25].

The muscle strength of the dominant knee extensor was measured in mmHg and was performed by researchers trained on the Modified Sphygmomanometer Test (MST). The cuff was inflated to 100 mmHg to remove all possible folds and then deflated to 20 mmHg, resulting in a measuring range of 20–304 mmHg [26]. The individuals and instruments were positioned according to previous recommendations [27]. Two measures were taken, one for familiarization and the other for measuring strength. Standardized verbal stimuli were given during the test to sustain a maximum isometric contraction against the device for 5 s and instructed to not perform the valsalva maneuver [26, 27].

Blood pressure, heart rate, and oxygen saturation of the individuals were continually monitored during tests.

Statistical analysis

Descriptive statistics, tests for normality (Kolmogorov-Smirnov), and equality of variances (Levene) were calculated for all outcomes. Stepwise multiple regression analysis was performed to identify which of the independent variables would significantly predict physical activity. Variable entry for the regression was set at 0.05, and removal was set at 0.10. The data were evaluated prior to performing regression to determine if they fulfill all requirements for regression

analyses, such as linearity, homoscedasticity, independence, and normality of the residuals, as well as multicollinearity and outliers. All analyses were carried out with the SPSS software (version 17.0) with a significance level of 5%.

Results

From a list of 112 individuals, 51 (46%) of potential participants were excluded due to death ($n = 3$), incorrect contact information ($n = 15$), and refusals ($n = 21$). The most frequent reasons for refusal were disinterest ($n = 5$) and unavailability ($n = 16$). Of the 73 individuals who agreed to participate, 12 did not attend even with prior confirmation, and 11 were excluded for not reaching the cut-off score on the Mini Mental State Examination. A final sample of 50 individuals remained in the study, as shown in Fig. 1.

The mean age was 67 ± 8.0 years, with a predominance of 68% male. In addition, 90% of the individuals reported physical activity practice and/or rehabilitation at least once a week, and 63% reported having some fear of falling. The adjusted activity score of the Human Activity Profile test revealed that 26% of the individuals were considered active, 52% moderately active, and 22% inactive. The sociodemographic and clinical characteristics of the sample are described in Table 1.

Regression analysis revealed that deficits in balance explain 29% of the variation of the physical activity level assessed by the adjusted activity score of the Human Activity Profile. The explained variance increased to 34% when depressive symptoms were included in the model. These results indicate that individuals with Parkinson's

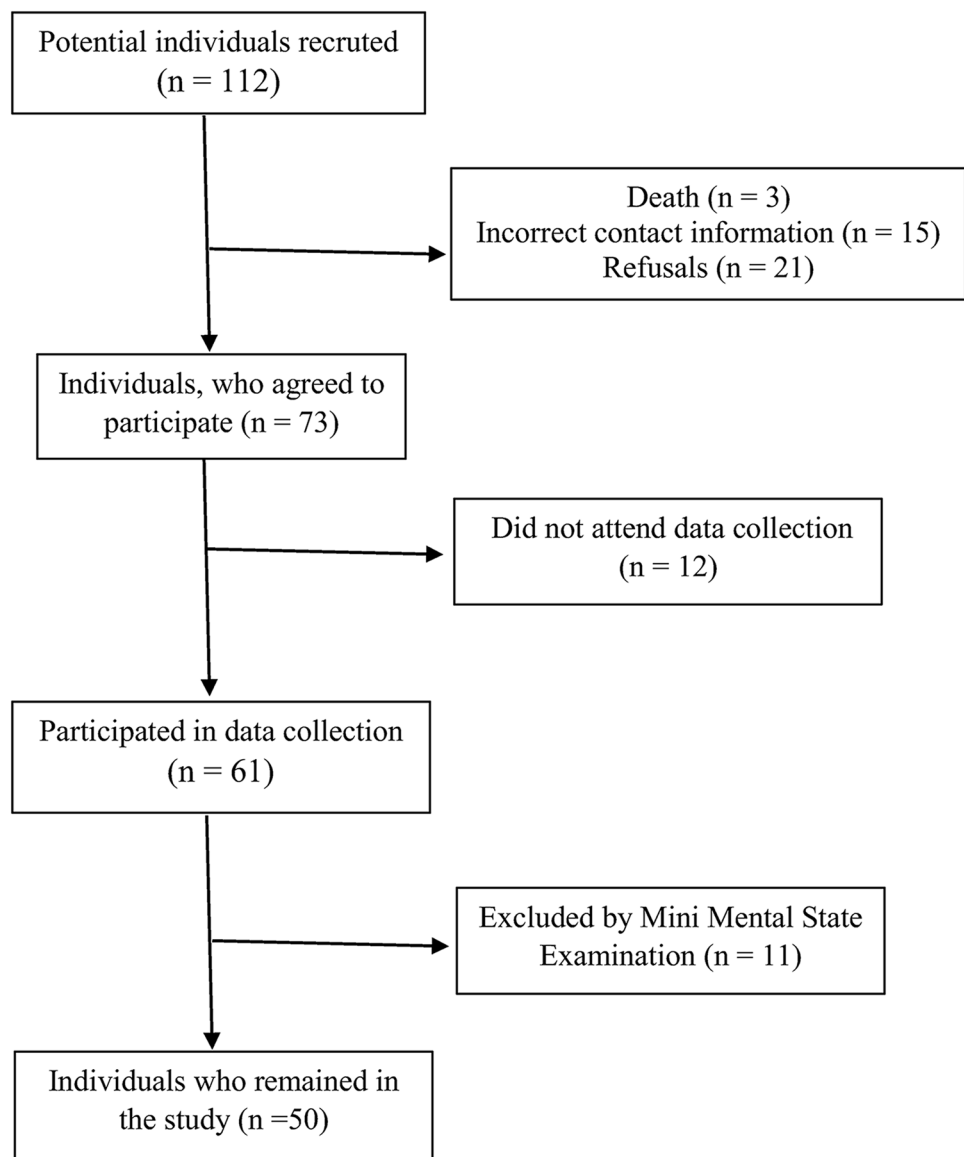**Fig. 1** Recruitment of the participants

Table 1 Characteristics of the participants

Characteristics	$n = 50$
Age (years), mean (SD)	67 (8)
Sex (men), n (%)	34 (68)
Diagnosis time (months), mean (SD)	84 (63)
Hoehn and Yahr (0–4), mean (SD)	2.5 (0.6)
Fear of falling (yes), n (%)	30 (62.5)
Human activity profile (AAS scores), mean (SD)	61 (18.4)
Patient Health Questionnaire-9 (0–27), mean (SD)	7 (5.2)
UPDRS part I scores (0–16), mean (SD)	2 (2.4)
MiniBESTest (0–28), mean (SD)	20 (5.4)
Dominant knee extensor strength (mmHg), mean (SD)	139 (45)

SD standard deviation, *MMS* Mini Mental State Examination, *AAS* adjusted activity score, *UPDRS* unified Parkinson's disease rating scale

disease who had balance impairments and depressive symptoms have a lower physical activity level.

Knee extensor muscle strength and behavior and mood impairment did not enter the model and did not significantly correlate with the physical activity level. Table 2 presents the regression analysis results.

Discussion

Balance impairments explained 29% of the physical activity level of individuals with Parkinson's disease in our study, and this variance increased to 34% when added to depressive symptoms. These results indicate that individuals who present better balance and had lower levels of depressive symptoms were less likely to present lower physical activity levels.

A study carried out with a sample of characteristics similar to ours found no difference in the balance between active and inactive individuals [28]. In contrast, the findings of our study relate balance impairments to individuals with lower physical activity levels. In addition, about 35 to 75% of individuals with Parkinson's disease have balance deficits with consequent fear of falling [29, 30], which was shown in a previous

study to be a major barrier to adherence to exercise [8]. Data from a meta-analysis reinforced the evidence that the practice of exercise and motor training have a positive effect on balance and should therefore be included in rehabilitation programs as a strategy to reduce physical inactivity [31].

The literature supports that non-motor symptoms such as depression affect 44 to 52% of all individuals with Parkinson's disease, and this is considered a risk factor for the development of a less active lifestyle [1]. The presence of depressive symptoms in our study explained 5% of the variation in the physical activity level of these individuals. In a recent systematic review which investigated the effects of physical activity on depressive symptoms and quality of life, a reduction was found in depression scores and in the incidence of various non-motor symptoms in active groups [32]. Also, a previous study found a relationship of depression, cognition, and quality of life in individuals with Parkinson's disease [33]. On the other hand, evidence points out that balance and aerobic exercises have effective results which minimize worsening of depressive symptoms in Parkinson's disease [34]. Therefore, a multiprofessional intervention can effectively contribute to changing the lifestyle of these individuals.

Although more than 70% of the activities described in HAP mainly involve lower limbs, dominant knee extensor strength could not predict physical activity. This finding may be explained by the fact that our sample obtained an average strength equal to 75% of the predicted value for age and gender considering healthy individuals [27]. Thus, muscle strength and maintenance of basic motor functions are essential for independence in Parkinson's disease [7, 35]. Moreover, previous studies reinforce that strength training is a complementary approach of paramount importance in rehabilitation which provides benefits to other deficits related to Parkinson's disease, such as balance [36, 37].

As far as we know, this study is the first to propose impairment in behavior and mood as variables which could influence the physical activity level in Parkinson's disease. However, these variables did not present statistically significant values to enter the regression model. In any case, it is well known that

Table 2 Results of the regression analysis ($n = 50$)

Variable	B	95% CI for b	β	R^2	*SEE*
Step 1					
Constant	22.40 ± 8.73	4.84 to 39.96	–	–	–
Balance	1.89 ± 0.41	1.10 to 2.72	0.29		15.49
Step 2					
Constant	40.50 ± 11.85	16.67 to 64.34	–	–	–
Balance	1.38 ± 0.46	0.46 to 2.31	–	–	
Depressive symptoms	-1.02 ± 0.47	-1.97 to -0.08	0.34		14.93

B, regression coefficients, followed by the respective standard error; CI, confidence interval; β, standardized regression coefficient; R^2, coefficient of determination; SEE, standard error of the estimate

impairments in behavior and mood, such as apathy and anxiety, are common symptoms in Parkinson's disease and are dissociable from depression [38]. The literature suggests that non-motor symptoms in advanced cases are associated with disability and decreased quality of life [39]. Findings also suggest that individuals who have cognitive changes are more affected by impairment in behavior and mood [40]. Considering that our sample was predominantly composed of individuals with a mean of 2.5 on the Hoehn and Yahr and with preserved cognition, this may have influenced our results. Bearing in mind that there are few studies which have investigated the relationship between impairment in behavior and mood with the physical activity level in individuals with Parkinson's disease [32, 41, 42], further studies are necessary.

The present study is not without limitations. One such limitation is related to the recruitment process, which was based upon a convenience sample. Also, although the sample size was sufficient according to the sample size calculation, it could be considered a small sample. All the implemented tests have valid and reliable measurement properties for older adults and individuals with Parkinson's disease [19–21, 23, 24, 27]. The findings regarding muscle strength of the dominant knee extensor strength may have been limited due to the sample profile of this study. This is because most of the individuals reported that they were already inserted in rehabilitation programs and/or performing some physical activity, which may justify the absence of weakness of the mentioned muscle group [7, 27]. Furthermore, these changes reinforce that impairment in behavior and mood and muscle strength, as well as other variables related to Parkinson's disease, should be investigated in future studies in order to determine their possible influence on the physical activity level.

It was reported that age, gender, marital status, disease severity, walking speed, and lower limb bradykinesia predict and explain a relevant percentage of the variance of physical activity level in individuals with Parkinson's disease [13, 15, 16]. However, it is understood that age, gender, and marital status are variables which cannot be modified. Our study found modifiable variables such as balance impairments and depressive symptoms which explained a 34% variance in the physical activity level in individuals with Parkinson's disease and can therefore be used as multiprofessional therapeutic intervention strategies. Based on this, the depressive symptoms should not be neglected, but evaluated with caution for rehabilitation. Balance also needs to be approached and included in rehabilitation programs so that better physical activity levels can be promoted in individuals and reduce their fear of falling.

Conclusion

Among the possible predictive variables investigated in our study, balance impairments and depressive symptoms explained the variance in the physical activity level in individuals with Parkinson's disease. The other variables of impairment in behavior and mood and muscle strength of the dominant knee extensor did not present significant values in our sample, indicating the need for further studies.

Data availability Not applicable.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethics approval This study was approved by the ethics and Institutional Research Committee on April 4, 2019 (CAAE: 10047219.2.0000.5134).

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Consent for publication Patients signed informed consent regarding publishing their data.

Code availability Not applicable.

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