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Regular exercise and related factors in patients with Parkinson's disease: Applying zero-inflated negative binomial modeling of exercise count data

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ABSTRACT

Purpose: This study was conducted to identify risk factors that influence regular exercise among patients with Parkinson's disease in Korea. Parkinson's disease is prevalent in the elderly, and may lead to a sedentary lifestyle. Exercise can enhance physical and psychological health. However, patients with Parkinson's disease are less likely to exercise than are other populations due to physical disability.

Methods: A secondary data analysis and cross-sectional descriptive study were conducted. A convenience sample of 106 patients with Parkinson's disease was recruited at an outpatient neurology clinic of a tertiary hospital in Korea. Demographic characteristics, disease-related characteristics (including disease duration and motor symptoms), self-efficacy for exercise, balance, and exercise level were investigated. Negative binomial regression and zero-inflated negative binomial regression for exercise count data were utilized to determine factors involved in exercise.

Results: The mean age of participants was 65.85 ± 8.77 years, and the mean duration of Parkinson's disease was 7.23 ± 6.02 years. Most participants indicated that they engaged in regular exercise (80.19%). Approximately half of participants exercised at least 5 days per week for 30 min, as recommended (51.9%). Motor symptoms were a significant predictor of exercise in the count model, and self-efficacy for exercise was a significant predictor of exercise in the zero model.

Conclusion: Severity of motor symptoms was related to frequency of exercise. Self-efficacy contributed to the probability of exercise. Symptom management and improvement of self-efficacy for exercise are important to encourage regular exercise in patients with Parkinson's disease.

1. Background

Regular exercise is known to have many benefits, including enhanced physical fitness and decreased risk of vascular or metabolic disease (Rahl, 2010). Exercise is a concept distinct from physical activity. Caspersen, Powell, and Christenson (1985) defined exercise as follows: "Exercise is a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness (p.126)." Exercise has been reported to have effects on physical fitness such as muscle strength, cardiopulmonary endurance, mobility, and balance in patients with Parkinson's disease (PD) (Gobbi et al., 2009; Hackney & Earhart, 2009; Lauhoff, Murphy, Doherty, & Horgan, 2013). In addition, exercise is known to enhance not only physical health, but also psychosocial health in PD (Choi & Sohng, 2008; Pretzer-Aboff, Galik, & Resnick, 2011). It is recommended that patients with PD perform 30 min of moderate to vigorous physical exercise per day, at least five days per week (Rahl, 2010). As the number of patients with PD increased from approximately 32,000 in 2002 to 76,000 in 2009 in Korea (National Health Insurance Service, 2011), the importance of exercise in improving physical independence and health-related quality of life has been highlighted in several studies in Korea (Cheon, Chae, Sung, Lee, & Kim, 2013; Choi & Sohng, 2008). Although the impact of exercise has been recognized, it was reported that patients with PD are less likely to participate in exercise than are other populations (Skidmore et al., 2008; van Nimwegen et al., 2011). Thus, there is a need to identify factors influencing regular exercise in patients with PD.

Older adults with chronic disease generally have difficulty in adherence to exercise because of poor health. Barriers to exercise have been reported as decreased physical functional ability, physical exertion, and fatigue in disabled people (Kayes, McPherson, Taylor, Schluter, & Kolt, 2011; Malone, Barfield, & Brasher, 2012; Zalewski & Dvorak, 2011). Patients with PD experience physical disabilities because of characteristic PD motor symptoms, which result in physical inactivity

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(Schenkman et al., 2011; van Nimwegen et al., 2011). As PD progresses, the risk of falling increases due to loss of balance and freezing of gait (Gazibara et al., 2015; Matinolli et al., 2009). Fear of falling also limits physical activity of patients with PD (Ellis et al., 2013). Age, gender, educational background, disease severity, motor symptoms, and physical fitness are known variables that influence physical activity in PD (Dontje et al., 2013; Ellis et al., 2011; van Nimwegen et al., 2011). Moreover, the self-efficacy of patients with PD was reported to be more strongly associated with exercise behavior than disability (Ellis et al., 2011; Simpson, Eng, & Tawashy, 2011). Self-efficacy is a concept related to behavior change for desirable outcomes, so it is thought to be a predictor of regular exercise as a health-promoting behavior (Bandura, 1989).

Exercise is an important component of comprehensive treatment for PD (Rahl, 2010). There is a need to identify more sensitive and predictive factors related to exercise in patients with PD. In the present study, participants were asked how many times a week they participated in at least 30 min of exercise, to identify their performance of regular exercise. The count data of events that occur at a low frequency, such as disabled patients' exercise, may not be normally distributed (Hutchinson & Holtman, 2005). Linear regression and logistic regression are often used to examine the relationship between independent variables and a dependent variable in nursing research. However, the statistical validity of conclusions based on these methods can be of concern. As linear regression is based upon an assumption of a normal distribution; it is not appropriate when the dependent variable is highly skewed count data. Logistic regression, which requires the dichotomization of a continuous dependent variable, is also inappropriate for frequency data. Thus, a valid method for analyzing count data is needed. Examples of count data in nursing research include measures of falls, abuse, drinking, smoking, and so on. Negative binomial regression (NBR) and zero-inflated negative binomial regression (ZINBR) are appropriate for use with this type of count data.

The findings of this study are expected to aid in the development of interventions to facilitate adherence to regular exercise among patients with PD. The purpose of this study was to examine factors related to regular exercise in Korean patients with PD, using NBR and ZINBR as the statistical methods.

2. Methods

2.1. Design and sample

A secondary analysis was conducted of data derived from a cross-sectional survey evaluating health-related quality of life of patients with PD (Lee, Choi, Jung, Sohn, & Hong, 2015). Patients with PD from a tertiary hospital who were cognitively intact and able to stand alone were evaluated in terms of disease-related characteristics, and functional and psychosocial domains of health-related quality of life (N = 220). Out of 220 participants, those who did not have all data for exercise and related factors were excluded from the analysis. Data for 106 individuals were included in the statistical analysis of the study. Details regarding sampling, data collection, and methods have previously been reported (Lee et al., 2015). The present study examined regular exercise behavior and related factors among patients with PD in Korea.

2.2. Ethical considerations

Approval for this study was obtained from the institutional review board of a university hospital, Seoul, Korea (IRB number 4-2013-0562). Exemption from consent was approved, because this secondary analysis used existing coded data without collecting new information.

2.3. Measures

2.3.1. General characteristics

Demographic characteristics (age, gender, educational background, employment status, and perceived economic status) were collected.

2.3.2. Disease-related characteristics

The motor portion of the Unified Parkinson's Disease Rating Scale (UPDRSIII), PD duration (years), age of PD onset, and Levodopa equivalent daily dose (LEDD; mg/day) were collected in terms of clinical information. UPDRSIII was obtained from medical records based on a doctor's clinical evaluation. UPDRSIII consists of 27 items, and each item is scored from zero to four. Higher scores on the UPDRSIII indicate more severe motor symptoms.

2.3.3. Self-efficacy

Self-efficacy was evaluated with the self-efficacy for exercise (SEE) tool, developed by Resnick and Jenkins (Resnick & Jenkins, 2000). SEE is a 9-item self-report assessment with a 10-point Likert-type response scale. This scale evaluates how confident a participant is that he or she could exercise three times per week for 20 min in unfavorable circumstances. Each item indicates situations such as "the weather was bothering you," "you were bothered by the program or activity," "you felt pain when exercising," "you had to exercise alone," "you did not enjoy it," "you were too busy with other activities," "you felt tired," "you felt stressed," and "you felt depressed". The sum of scores for each item is divided by the number of items (nine); the total score ranges from 0 to 10. Higher scores indicate better perceived self-efficacy for engaging in regular exercise. Cronbach's alpha for internal consistency of the original version was reported to be .92 (Resnick & Jenkins, 2000). In this study, internal consistency was .89 using Cronbach's alpha.

2.3.4. Functional balance

Balance, a form of physical fitness, was measured using the Korean version of the Berg Balance Scale (BBS; Jung et al., 2006). The BBS consists of 14 items assessing the performance of balance-related functional tasks including sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with eyes closed, standing with feet together, reaching forward with outstretched arms, retrieving an object from the floor, turning to look behind, turning around, placing the alternate foot on a stool, standing with one foot in front, and standing on one foot (Berg, Wood-Dauphinee, & Williams, 1995). Scores for each item range from 0 (unable) to 4 (independent), with higher scores indicating better performance of the task. Total scores between 41 and 56, 21 and 40, and 0 and 20 are interpreted as low fall risk, medium fall risk, and high fall risk, respectively. Internal consistency using Cronbach's alpha was .97 for stroke patients in Berg and colleagues' study (Berg et al., 1995). In this study, Cronbach's alpha was .94, showing strong internal consistency.

2.3.5. Exercise level

The question "How many times a week do you participate in at least 30 min of exercise?" was asked of participants. Regular exercise during leisure time was included, with housework and job labor excluded. Participants who performed 30 min of exercise a day, at least five days a week (Rahl, 2010) were classified as "exercisers." Those who did not meet the guideline were classified as "non-exercisers."

2.4. Statistical analysis

Statistical analysis was conducted using SPSS Version 20.0 and STATA Version 7.0. Descriptive statistics were employed to analyze participants' general characteristics, disease-related characteristics, self-efficacy, and functional balance. Chi-square tests and t-tests were employed to identify significantly different characteristics between exercisers and non-exercisers. Each SEE item was analyzed in terms of means and standard deviations. The effect of the independent variables on frequency of exercise was analyzed using NBR and ZINBR.

As the outcome variable was a form of count data with highly skewed distributions, NBR analysis was conducted. NBR is not based on assumptions of equidispersion, so no adjustments are necessary when over-dispersion is present (Elhai, Calhoun, & Ford, 2008;