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The effects of social isolation on gait parameters of older people with Parkinson's disease

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HIGHLIGHTS
- The SI period negatively affected the mobility of people with PD.
- Stride length and velocity are the main parameters reduced after SI period.
- People with PD decrease their functionality after a period of SI.

ABBREVIATIONS

CNS	Central nervous system
COVID-19	Coronavirus disease
H&Y	Hoehn & Yahr scale
MDS – UPDRS III	Movement Disorder Society - Unified Parkinson's Disease Rating Scale
MMSE	Mini-Mental State Examination
PD	Parkinson's disease
pwPD	People with Parkinson's disease
SI	Social isolation
WHO	World Health Organization

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BACKGROUND: The COVID-19 disease acquired pandemic proportions in 2020. To deal with the scenario, social isolation (SI) was adopted, which configures a lack of contact with people and places. The impediments of this measure, however, can bring risks to older people with Parkinson's disease (PD), such as impairments in gait parameters.
AIM: To verify the effects of SI on gait parameters in people with Parkinson's disease.
METHOD: Thirty-three people with PD were recruited. Gait assessment was conducted in two periods: February 2020 and March 2022 (before and after the SI, respectively). For that, participants were invited to walk on a 5.74m mat with pressure sensors under two conditions: preferred walking speed and fast walking speed. Three trials were performed for each condition. The gait parameters analyzed were Stride Length, Stride Time, Double Support Time, Stride Velocity, Stride Width, and Cadence. Statistical Analysis was performed by paired t-tests for the comparison of gait parameters between moments (pre and post-SI).
RESULTS: In the preferred walking speed condition, the participants reduced their Stride Length (t_{15} = 3.88, p = 0.001) and Stride Velocity (t_{15} = 3.63, p = 0.002) in the post-SI period. In the fast-walking speed condition, the participants also reduced their Stride Length (t_{15} = 3.73, p = 0.002) and Stride Velocity (t_{15} = 2.86, p = 0.012) in the post-SI period.
INTERPRETATION: The SI period reduced the stride length and velocity of people with PD. A possible explanation is the lack of physical activity resulting from this public safety measure.

KEYWORDS: Walking | COVID-19 | Neurodegenerative disease

INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus that took pandemic proportions in 2020. COVID-19 led to more than 761 million cases of infection, which resulted in ~6.8 million deaths worldwide until March 2023 [1]. COVID-19 primarily affects the respiratory system, causing symptoms such as breathing difficulties, headaches, dry cough, and fever [2]. At the moment, several vaccines have been approved by the World Health Organization (WHO) and regulatory agencies; moreover, the vaccination process is ongoing in several countries, thus, helping to prevent more infections as well as the aggravation [3] of symptoms. However, at the beginning of the pandemic, when vaccines were not available and COVID-19 spread rapidly in many countries, public health measures, such as social isolation (SI), had to be adopted in 2020.

The SI is an imposing measure generally implemented to stop certain threats to the population, such as the virus responsible for COVID-19 [4]. This type of isolation is defined as a state in which an individual refrains from being in any social group and certain places, regarding proximity or physical contact. Therefore, SI leads to difficulties in maintaining several activities as well as quality relationships [5]. Despite being an effective measure against the SARS-CoV-2 virus spread, the SI presents some risks, especially in older populations [5,6], such as the decline in motor function [7] and an increase of mortality [6], dementia [8], gait impairments [9], and in the number of falls [10]. Although several studies have verified the effects of SI on physical health components of older people [11], studies that focus on the effects of SI on gait parameters, especially in populations such as older people who have mobility impairments (e.g., people with Parkinson's disease - PD), are still necessary.

PD is the second most common neurodegenerative disease in the world [12], ranging from 57 (0.057%) to 230 (0.23%) cases for each group of 100,000 people [13], mainly affecting the population over 50 years of age [14]. PD is a pathology that affects the central nervous system (CNS), caused by progressive and asymmetrical degeneration of dopaminergic neurons in the substantia nigra pars compacta [15]. These neurons are responsible for the production of dopamine – a neurotransmitter that regulates cortex activity [16]. Such degeneration causes abnormalities in the neurotransmission from the basal ganglia to the different cortical and subcortical areas, such as the motor cortex [17]. As a result, people with Parkinson's Disease (PwPD) present motor symptoms, which include tremor, rigidity, bradykinesia, hypometria, and postural instability [18]. In addition, previous studies have reported gait impairments in PwPD – for example, a decrease in step length and gait speed, and a longer double support time [19-22].

Due to the progressive nature of the disease, it is expected that walking impairments in PwPD become worse over time. Although SI was necessary as a public health measure, this may reduce the physical activity level in PwPD, which may contribute to the disease progression and lead to negative motor behavior outcomes, including in the gait parameters. In fact, previous studies have revealed that physical inactivity/sedentary behavior are associated with slower gait speed [23,24]. In addition, the analysis of walking under different conditions has shown promising results. For example, an analysis of preferred walking speed may estimate physical function, risk for adverse events (e.g., hospitalization, falls, fractures, or death), and chronic diseases [25-27], while an analysis of fast walking speed may estimate the individual's overall health, skeletal muscle mass quantity, and risk of falls [25]. Thus, studies that verify the effects of SI on the gait parameters, especially under different conditions, are necessary to deepen the knowledge of this type of situation (lockdown) and to prevent the worsening of some motor deficits. In this context, the present study aimed at analyzing the effect of SI on the gait parameters during preferred and fast waking speed in PwPD. Furthermore, in order to identify the factors such as clinical/cognitive characteristics and physical activity levels that may influence the decline in gait parameters, we also investigated the association between the change in gait parameters and clinical, cognitive, and physical activity levels characteristics of PwPD. We expected that PwPD with worse clinical and cognitive characteristics as well as a lower level of physical activity would present a higher decline in gait parameters.

METHODS

Participants

Thirty-three individuals diagnosed with PD who regularly attended the Physical Activity Program for Patients with Parkinson's Disease (PROPARKI) prior to the COVID-19 pandemic were selected for this study. For inclusion criteria, the individuals should have a PD diagnosis based on UK Brain Bank criteria, be of age >50 years, take their PD medication, and have independent locomotion. The exclusion criteria were: to present musculoskeletal, vestibular, or visual impairments that could affect the performance in the experimental protocol; to present a score above III in the adapted Hoehn & Yahr scale (H&Y); and cognitive decline indicated by a score <24 in Mini-Mental State Examination (MMSE) [28]. Seventeen PwPD did not participate in the experimental protocol after the SI. Thus, 16 participants were analyzed before and after SI (Figure 1). Study approval was obtained from the research ethics committee at São Paulo State University (n. 3936). All participants gave their signed informed consent before their participation.

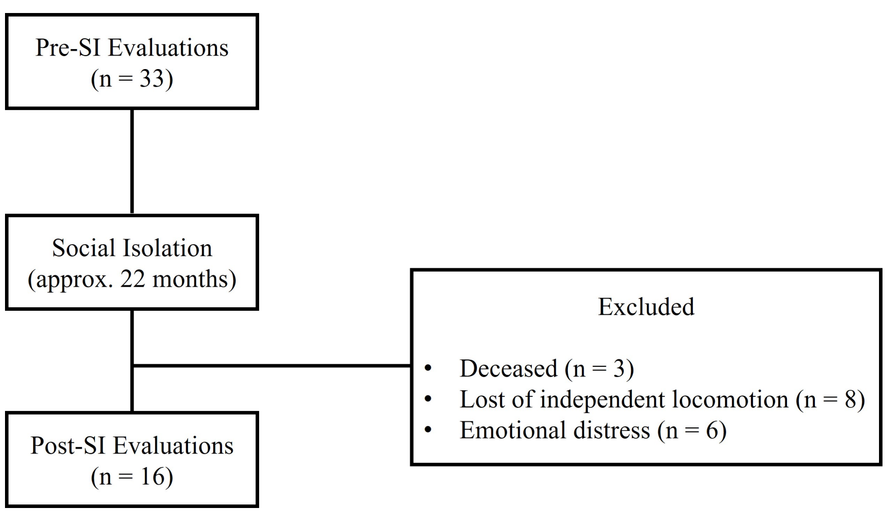

Figure 1. Study flowchart.

Experimental procedures

All experimental procedures were performed at the Posture and Gait Studies Laboratory (LEPLO), Sao Paulo State University (Unesp), Rio Claro. Clinical, cognitive, and gait assessments were performed before (i.e., February 2020) and after SI (i.e., March 2022). In addition, the physical activity level was measured at the post-SI moment. Participants were tested during the 'ON' state of dopaminergic medication in both periods.

Clinical, cognitive, and physical activity level assessments

Firstly, the participants answered an anamnesis, and anthropometric data was obtained for characterization. An experienced researcher assessed the motor severity and the stage of PD using the motor section of the Movement Disorder Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS III) and the adapted Hoehn and Yahr scale, respectively. The MMSE was used as a screening tool for cognitive assessment. To evaluate the physical activity levels of the participants during SI, the Modified Baecke Questionnaire [29] was applied in the post-SI period. This questionnaire considered the habitual physical activity in the last 12 months in three dimensions: occupational physical activity, physical exercises/sports in leisure, and leisure and commuting activities.

Gait evaluation

Each individual was asked to walk 8m in a straight line in two conditions: (i) preferred and (ii) fast walking speed. Three trials were performed for each condition. A 5.74m long carpet with pressure sensors (GAITRite®, CIR Systems Inc., Sparta, USA), with a sampling frequency of 200 Hz, was placed in the middle of the straight line to record the gait parameters. All steps recorded by the system were considered for the calculation of the dependent variables, which included stride length, stride time, double support time, stride velocity, stride width, and cadence.

Statistical analysis

SPSS 26.0 (SPSS, Inc) was used for statistical analysis. The level of significance was set at $p<0.05$ for all analyses. The Shapiro-Wilk and Levene's tests were applied to verify the normality and homogeneity of the data, respectively. Paired t-tests were used for the gait parameters comparison between moments (pre vs. post-SI). Cohen's d statistic provided estimates of the effect sizes for the t-test (d: 0.2 = small, 0.5 = moderate, 0.8 = large) [30]. Pearson's correlation coefficient was used between gait parameters (considering the difference between post- and pre-SI; Δ) and the scores from MDS-UPDRS III, MMSE, and The Modified Baecke Questionnaire to verify if there were significant relations between gait parameters and clinical, cognitive, and physical activity level data.

RESULTS

The demographics and clinical characteristics of the participants are shown in Table 1.

Table 1. Participants characteristics. The parametric variables are shown as mean and standard deviations, and the non-parametric variables as medians and 25-75 percentile.

	Sample size = 16
Age (years)	69.37±7.79
Weight (kg)	72.46±12.10
Height (cm)	165.02±7.35
MDS-UPDRS III (0-132)	33.5 (26.75-40.25)
H&Y stage (1/1.5/2/2.5/3)	0/0/9/4/3
MMSE (0-30)	28 (25.00-29.00)
Baecke (score)	7.66 (6.41-10.12)

MDS-UPDRS III: Movement Disorder Society Unified Parkinson's Disease Rating Scale part III; H&Y: Hoehn & Yahr Scale; MMSE: Mini-Mental State Examination.

In the Preferred Walking Speed condition, the t-test revealed that the participants decreased stride length (t_{15} = 3.88, p = 0.001, d = 0.614; Figure 2A) and stride velocity (t_{15} = 3.63, p = 0.002, d = 0.647; Figure 2B) after the SI. No significant statistic was shown for stride time (t_{15} = -1.61, p = 0.128), double support time (t_{15} = -1.49, p = 0.156), stride width (t_{15} = -1.46, p = 0.166) or cadence (t_{15} = 1.9, p = 0.077) (Table 2).

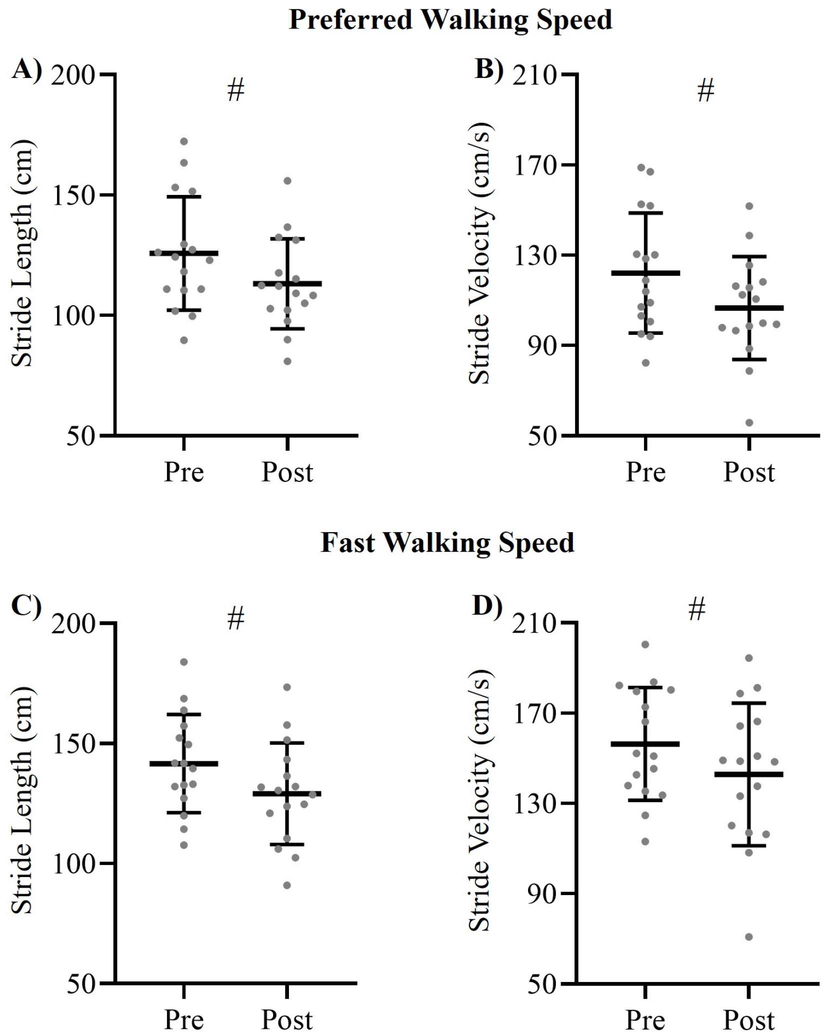

Figure 2. Pre and post-SI stride length and stride velocity in both preferred and fast walking speed conditions.

Table 2. Mean and standard deviations of gait parameters during Preferred Walking Speed condition.

	Preferred Walking Speed		
	Pre-SI	**Post-SI**	**Cohen's *d***
Stride Time (s)	1.04 ± 0.07	1.08 ± 0.12	0.348
Double Support (%)	30 ± 5.23	31.8 ± 5.38	0.373
Stride Width (cm)	11.92 ± 2.66	12.73 ± 3.7	0.252
Cadence (step/min)	115.99 ± 7.68	112.31 ± 11.15	0.384

SI: Social Isolation.

In the Fast-Walking Speed condition, the t-test revealed that the participants also decreased stride length (t_{15} = 3.74, p = 0.002, d = 0.624; Figure 2C) and stride velocity (t_{15} = 2.87, p = 0.012, d = 0.489; Figure 2D) after the SI period. No significant statistic was shown for stride time (t_{15} = 0.29, p = 0.775), double support time (t_{15} = -2.01, p = 0.062), stride width (t_{15} = -1.38, p = 0.189) or cadence (t_{15} = 0.36, p = 0.727) (Table 3).

There were no correlations between the delta (Post – Pre-SI) of gait parameters in both preferred and fast walking speed conditions and the scores of MDS-UPDRS III, MMSE, and The Modified Baecke Questionnaire (Table 4).

Table 3. Mean and standard deviations of gait parameters during Fast Walking Speed condition.

	Fast Walking Speed		
	Pre-SI	**Post-SI**	**Cohen's *d***
Stride Time (s)	0.92 ± 0.09	0.92 ± 0.13	0.050
Double Support (%)	25.3 ± 3.86	27.6 ± 5.27	0.364
Stride Width (cm)	12.1 ± 2.94	12.77 ± 3.63	0.202
Cadence (step/min)	131.21 ± 13.8	132.12 ± 16.98	0.059

SI: Social Isolation.

Table 4. Correlations between gait parameters and clinical, cognitive, and physical activity level.

Gait Parameters	MDS-UPDRSIII	MMSE	Baecke
Preferred Walking Speed			
∆Stride Length	r= -0.010; p= 0.971	r= -0.126; p= 0.641	r= 0.015; p= 0.956
∆Stride Velocity	r= -0.037; p= 0.893	r= -0.102; p= 0.708	r= 0.011; p= 0.967
Fast Walking Speed			
∆Stride Lenght	r= -0.152; p= 0.575	r= 0.141; p= 0.603	r= 0.157; p= 0.562
∆Stride Velocity	r= -0.217; p= 0.420	r= 0.324; p= 0.221	r= 0.016; p= 0.953

∆: post – pre-Social Isolation; MDS-UPDRS III: Movement Disorder Society Unified Parkinson’s Disease Rating Scale part III; MMSE: Mini-Mental State Examination; Baecke: The Modified Baecke Questionnaire.

DISCUSSION

We aimed at verifying the effects of SI as a public safety measure on the gait parameters of PwPD. Our findings revealed that the participants presented a decrease of 10% and 8.8% in stride length and 12.7% and 8.6% in stride velocity during Preferred and Fast Walking Speed, respectively, after approx. 22 months of SI (Figures 2A-2D). This impairment of gait parameters in PwPD by SI is relevant, as walking can be a predictor of loss of functionality and of an increase in the number of falls, hospitalizations, and deaths [7,31]. However, changes in gait parameters were not associated with participant characteristics.

Our results corroborate previous studies that have shown a decrease in functionality of older adults after a period of SI [7,11]. A study by Fastame et al. (2021) assessed functional components (e.g., gait parameters) of older people with and without cognitive decline before and past two months of lockdown. This study demonstrates a decrease in stride length and walking speed after the SI in people with preserved cognition, who were also more physically active prior to the lockdown [32]. With regard to PwPD, previous studies have also demonstrated similar effects of the SI on the mobility of this specific group [9,33]. A study conducted by Wolff et al. (2023) verified the effects of the COVID-19 pandemic on parkinsonian symptoms of 342 PwPD through online, nationwide surveys. In addition, the number of individuals reporting worsening of symptoms or the development of new ones has increased during the pandemic, and the most commonly affected symptoms were rigidity, gait impairments, and bradykinesia [9].

A possible explanation for the decrease in stride length and stride velocity shown in this study is the relationship between SI and physical activity. Older adults tend to increase the time in sedentary behavior when they are deprived of access to places that stimulate the practice of physical activity (e.g., gym, parks, and clubs), as well as the support of people working as mediators of this practice [32,34,35]. This corroborates The Modified Baecke Questionnaire scores of this study's sample, which ranged from low to moderate levels of physical activity [36]. This period of low or even inexistent practice of physical activity may bring negative consequences, such as loss of muscle mass and muscle strength [7,34,37], lack of joint mobility [35], loss of dynamic balance [38], and worse neuromuscular performance, contributing to the observed deficits in such gait parameters [32,39]. Thus, the adoption of interventions that contribute to an improvement of gait parameters of PwPD is important even in the SI context. Actions that overcome the lack of access of these individuals to certain places, such as the adoption of digital tools, and the use of a training program for a wide range of motor and non-motor components (e.g., muscle strength, balance, coordination, executive function, and attention), can be beneficial for PwPD [7,40,41].

We can also speculate that the SI fragmentation of social relationships may increase the symptoms of depression [7], which impact the mobility of PwPD [42]. Higher levels of depression are associated with poor practice of physical activity [43], and they also produce a feeling of insecurity, leading to changes in motor behavior, characterized by a slower walking speed and a shorter step length. In cognition, depression levels may cause attention and executive function deficits, which are also factors intrinsically linked to gait parameters [42,44]. In PwPD who already have a depletion of neurotransmitters, such as dopamine and serotonin, the increase in depression levels may be more pronounced [32,34], thus, affecting the gait parameters. Therefore, the association of a training program with greater social support, such as dance, not only increases physical activity levels, which is beneficial for motor impairments, but also can better handle depression levels linked to SI as well, contributing to the health of PwPD in general [35,45].

It is also worth mentioning that, despite not having participated in the second part of the research, 17 eligible individuals from the pre-SI period were found in negative situations such as loss of independent locomotion or death, making it impossible to continue in the present study. This could indicate a worsening of some motor deficits due to the SI impediments.

Unexpectedly, the declined gait parameters were not associated with participant characteristics. Although previous studies have demonstrated the role of physical activity level and cognition/clinical features for gait parameters [46], our results showed that the gait progression was not related to these variables. Gait is a complex task, which depends on several factors, not only cognition, clinical features, and physical activity level. There are several studies that found an association between gait parameters and depression, anxiety, PD medication, atrophy/loss of muscle strength, and sensorial functions, among other factors [42]. Therefore, further studies should consider such factors to understand which variables are associated with changes in gait parameters.

The current findings should be carefully interpreted, as this study presented some limitations, such as a great loss of participants during the pandemic and a limited number of non-motor parameters. Despite the small sample size, this study moves towards a better understanding of the SI as a protective measure in public health, considering its risks to more vulnerable populations such as those with gait impairments, in order to collaborate on the creation of appropriate interventions to deal with this scenario.

CONCLUSION

The SI period caused by the COVID-19 pandemic negatively affected the mobility of PwPD, reducing stride length and stride velocity.

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