Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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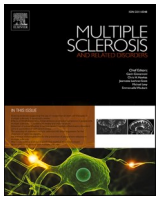

Frequency and characteristics of falls in people living with and without multiple sclerosis during the COVID-19 pandemic: A cross-sectional online survey

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ABSTRACT

Background: Public health responses to Coronavirus Disease 2019 (COVID-19) including lockdowns may negatively impact physical and mental functioning in clinical populations. People living with multiple sclerosis (MS) may be more susceptible to physical function deterioration while practicing social distancing. Recent reports have suggested that about 50% of people with MS (pwMS) decreased their leisure physical activity during COVID-19, and upwards of 30% reported decreased physical fitness levels. However, the impact of social distancing on adverse health-related outcomes such as falls has not received much scrutiny. Therefore, we explored the frequency and characteristics of falls experienced by people living with and without MS during the COVID-19 pandemic.

Methods: Two-hundred and thirty-nine individuals, including 106 pwMS (median age: 59 years) and 133 people living without MS (median age: 66 years) were recruited for this cross-sectional study. A snowball sampling strategy was used for online recruitment. Participants completed a customized falls questionnaire and the number of falls experienced (if any) during COVID-19 was recorded. Fall-related characteristics such as the timing, locations, activities undertaken before falling and consequences, as well as self-reported physical activity were also recorded.

Results: Overall, participants reported 232 falls (1.67 falls/person in pwMS and 0.41 falls/person in non-MS participants). People living with MS (pwMS) had a significantly higher frequency of falls (58.5% vs 21.8%; $p < 0.001$) and recurrent falls (45.3% vs 9.8%; $p < 0.001$) compared to non-MS participants. Additionally, pwMS reported a significantly higher proportion of in-home falls (83.9% vs 54.2%; $p = 0.004$), as well as a higher proportion of overall injuries (44.3% vs 12.5%, $p < 0.001$), fractures (5.7% vs 0.8%, $p = 0.048$), and healthcare utilization (9.4% vs 1.6%, $p = 0.007$) compared to non-MS participants. A similar proportion of pwMS (49.1%) and non-MS participants (52.2%) reported lower physical activity levels during COVID-19.

Conclusion: This cross-sectional study revealed that pwMS remain at high risk of falls and fall-related outcomes during COVID-19. The high number of falls experienced by pwMS is of clinical concern considering the current strain on the healthcare system. Findings from this study highlight the importance of monitoring falls and the potential for telerehabilitation in persons with MS during COVID-19.

Abbreviations: PwMS, people living with multiple sclerosis; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SR-EDSS, self-reported expanded disability status scale; WHO, World Health Organization.

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1. Introduction

Coronavirus disease 2019 (COVID-19), resulting from novel coronavirus SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), began in late 2019 in Wuhan, China. The World Health Organization (WHO) declared a global health emergency on January 30, 2020 and a pandemic on March 11, 2020 (WHO, 2020). As of January 2021, there are over 92 million individuals who have been diagnosed with COVID-19 worldwide. COVID-19 was first reported in the United States (U.S.) on January 21, 2020 and, to date (January 2021), it has caused the highest death toll worldwide, with more than 390,000 deaths.

Prior to the wide-spread availability of a vaccine, the limited medical interventions for COVID-19 and its high infection rate have led to the recommendation and adaptation of social distancing measures. Although social distancing is an effective infection risk mitigation strategy, it potentially has unintended consequences on physical and mental functioning. For instance, a recent large-scale descriptive study (> 455,000 participants) revealed that, within 10 days of the WHO pandemic declaration, people reduced the number of daily steps by 5.5%, and within 30 days, the number of steps was reduced by 27.3% (Tison et al., 2020). This reduction in physical activity raises potential concerns due to the well-established detrimental effects of sedentary behavior on multiple domains of physical health and function (Cecchini et al., 2010).

It has been recently proposed that people living with neurological impairments, such as multiple sclerosis (MS), may be more susceptible to physical function deterioration while practicing social distancing (Pelicioni et al., 2020). Although MS and disease modifying therapies do not appear to increase COVID-19 infection risk (Willis and Robertson, 2020), the significant comorbidity burden in people living with MS (pwMS) seemingly places this population at greater risk of severe COVID-19 related outcomes and decreased well-being (Brownlee et al., 2020; Motl et al., 2020). Recent reports have also suggested that about 50% of pwMS decreased their leisure physical activity during COVID-19, and upwards of 30% reported decreased physical fitness levels (Kalron et al., 2020). Despite the preliminary evidence of decreased physical activity observed in pwMS during COVID-19, the impact of social distancing on adverse health-related outcomes such as falls has not received much scrutiny.

People with MS (pwMS) are at high risk of falls and adverse consequences (Nilsagård et al., 2015). Previous research has suggested that most falls (62%) experienced by pwMS occur inside (Gunn et al., 2014). The domestic environment poses several potential environmental hazards for falls and, more importantly, an altered interaction of physiological, cognitive and environmental stressors can lead to higher risk of falling inside the house (Lord et al., 2006). It is logical to speculate that adoption of social distancing practices recommended during COVID-19, such as the commonly named "lockdown", could cause a perturbation of such interaction due to physical function deterioration, worsening of depressive symptoms (Motl et al., 2020) and modification of activity-related behaviors (Kalron et al., 2020). In turn, these relatively sudden changes could result in a higher risk of falling and fall-related outcomes. Therefore, understanding the indirect impact of COVID-19 on fall-prevalence and fall-related circumstances would be paramount to mitigate the potential risks for falls during the COVID-19 pandemic. The relevance of this research is even stronger in light of the current strain on the healthcare system, which has led to the reduction of non-essential services including rehabilitation and community-based fall prevention.

The objective of this study was to provide data on frequency and characteristics (i.e. timing, location, precipitating activities and consequences) of falls in people living with and without MS during the COVID-19 pandemic in the U.S. As a secondary objective, we aimed to explore the relationship between self-reported physical activity during the lockdown and falls in pwMS. We hypothesized that self-reported reductions in physical activity would be associated with falls/fall-related injuries.

2. Methods

2.1. Study design and setting

In this study, we implemented a cross-sectional online survey aiming to explore the frequency and characteristics of falls during COVID-19 in a convenience sample of people living with and without MS. The survey was conducted between mid-June 2020 and August 2020 in the U.S (Fig. 1). We utilized this timeline to 1) examine falls experienced during the first U.S. lockdown, or stay-at-home orders, which occurred between March 2020 and June 2020, following the WHO pandemic declaration on March 11, 2020 and 2) to limit the recall bias on retrospective fall-reporting (Ganz et al., 2005). The ethics of the study were reviewed and approved by the Office for the Protection of Research Subjects at the University of Illinois by means of Exempt Determination (#20,894).

2.2. Participants

Participants were invited to take part in the study if they were over 18 years of age, male or female, and fluent in English. Participants were excluded if they were not living in the U.S. between January 2020 and June 2020.

2.3. Procedures

Participants without MS were recruited through a combination of online announcements and email distribution while pwMS were recruited online with the support of relevant organizations. Supporting organizations based in the U.S. were contacted via e-mail and those who agreed to help with recruitment advertised the study on their social media channels and websites. A snowball sampling approach was used to further boost recruitment online. The survey was hosted by Qualtrics (Qualtrics International Inc, Provo, UT) and was accessible by clicking a link to the survey website. People wishing to take part in the study were asked to provide consent by clicking on the "Agree" box, confirming they read and understood the participant information sheet and met the inclusion criteria. The following pages included sociodemographic (e.g. age, gender, education, marital and occupational status) and clinical (e.g. medications, comorbidities) questions as well as other physical activity- and fall-related questionnaires.

Participants completed a customized falls questionnaire (Supplementary information file 1) asking about the number of falls experienced (if any) during COVID-19. Falls were operationally defined as unintentional events in which one comes to rest on the ground or other lower level (Lamb et al., 2005). In addition to the number of falls, participants were asked to report fall-related circumstances such as the timing, locations and activities undertaken before falling. The consequences of falls (i.e. injuries and healthcare utilization) were also recorded. Overall injuries were defined as occurrence of bruising and/or cuts/lacerations and/or ligament sprains and/or head injury and/or fractures as a result of falling (Gunn et al., 2014). In order to determine whether falls were experienced before or after the WHO pandemic declaration, participants were also asked to provide the date(s) around which they fell. Participants were classified as "fallers" if they reported at least one fall in the survey and as "recurrent fallers" if they experienced two or more falls (Vassallo et al., 2002; Dai et al., 2018; Bartosch et al., 2020).

In addition to the sociodemographic and clinical questions, pwMS also completed the self-reported expanded disability status scale (SR-EDSS) as a measure of disability (Learmonth et al., 2013). Information on the type of MS (e.g. relapsing-remitting, primary or secondary progressive) and year of MS diagnosis were also recorded. Lastly, we examined the impact of COVID-19 on physical activity status by asking participants to indicate whether their physical activity levels during COVID-19 were lower, higher or about the same as their normal activity

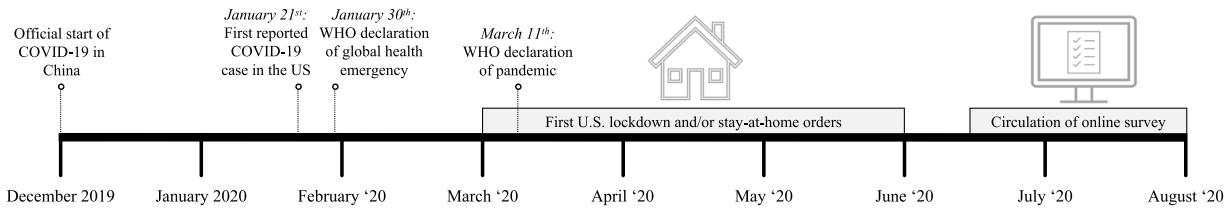

Fig. 1. Online survey: study design and research timeline.

levels (Kalron et al., 2020). Self-reported reduction in physical activity was dummy coded as: "about the same or higher physical activity during COVID-19″= 0 and "lower physical activity during COVID-19″= 1.

2.4. Data analyses

Statistical analyses were performed with SPSS (Version 26 for Windows, SPSS Inc., Chicago, IL). The Kolmogorov-Smirnov test was used to assess whether data were normally distributed. Individual missing data were excluded on a case-by-case basis from the analysis. Falls experienced before January 2020 (i.e. prior to COVID-19) were excluded from the calculation of fall-frequency. Sociodemographic and clinical data are presented as mean ± standard deviation or median and interquartile range based on normal distribution assumptions. Differences between pwMS and non-MS participants were explored by means of Independent t-tests and Mann-Whitney U for continuous variables, as appropriate, or through Chi-square tests/Fisher's exact test for categorical variables. Negative binomial and logistic regression analyses were used to explore the relationship between self-reported reduction in physical activity and the number of falls/overall fall-related injuries (yes or no). Statistical limits for interpretation of all analyses were set at an alpha level of $p = 0.05$.

3. Results

3.1. Participants

Two-hundred and seventy-nine individuals agreed to participate and completed the online survey. Forty (14.3%) participants had multiple missing items and were therefore removed from the final analyses by means of listwise deletion. A total number of 239 individuals, including 106 (44.4%) pwMS and 133 (55.6%) non-MS participants, provided complete answers to the survey and were therefore included in the study. The sociodemographic and clinical characteristics of these 239 participants are summarized in Table 1 and Table 2 respectively. Overall, participants from 40 States took part in the study, with Illinois being the most represented in both pwMS (24.5%) and non-MS participants (67.7%).

3.2. Frequency of falls

The distribution of falls reported by participants is displayed in Fig. 2. Overall, participants reported 232 falls, out of which 177 (76.3%) were experienced by pwMS and 55 (23.7%) by non-MS participants. The crude fall-rates for pwMS and non-MS participants were 1.67 falls/person and 0.41 falls/person respectively. Considering the whole sample, 91 (38.1%) participants reported at least one fall and were classified as fallers. People living with MS had a significantly higher proportion of fallers ($n = 62$, 58.5% vs $n = 29$, 21.8%; $p < 0.001$) and recurrent fallers ($n = 48$, 45.3% vs $n = 13$, 9.8%; $p < 0.001$) compared to non-MS participants. Overall, 18 (19.8%) fallers could not remember the date around which they fell, while the majority of fallers (80.2%) reported that falls were experienced between late January 2020 and mid-June 2020. Five (5.5%) participants reported falling at least once between late January and February 2020, while 71 (78%) reported falling between March and mid-June 2020.

Table 1
Sociodemographic characteristics of study participants: results are expressed as frequencies and percentages for categorical variables and median [IQR] for continuous variables.

Sociodemographic characteristics	All participants (239)	pwMS (106)	Non-MS (133)	P-value
Sex (% F)	178(74.5%)	83 (78.3%)	95 (71.4%)	0.226
Age (years)	62[17]	59[13]	66[18]	<0.001
Weight (kg)	72.6[25.9]	72.6 [27.2]	72.6[25]	0.858
Height (cm)	1.65[0.13]	1.65 [0.10]	1.68 [0.13]	0.473
BMI (kg * m^{-2})	25.7[7.1]	26.6[7.1]	25.1[7]	0.373
Education (%)				
Less than high school	1(0.4%)	1(0.4%)	0(0%)	1.000
High school graduate	24(10%)	12 (11.3%)	12(9%)	0.557
In-progress college	37(15.5%)	24 (22.6%)	13(9.8%)	0.006
Bachelor's degree	61(25.5%)	35(33%)	26 (19.5%)	0.018
Postgraduate degree	116(48.5%)	34 (32.1%)	82 (61.7%)	<0.001
Marital status (%)				
Single	40(16.7%)	13 (12.3%)	27 (20.3%)	0.098
Married	147(61.5%)	70(66%)	77 (57.9%)	0.199
Divorced	27(11.3%)	15 (14.2%)	12(9%)	0.213
Widowed	17(7.1%)	4(3.8%)	13(9.8%)	0.073
Partnership	6(2.5%)	3(2.8%)	3(2.3%)	1.000
Information refused	2(0.8%)	1(0.9%)	1(0.8%)	1.000
Racial group (%)				
White	223(93.3%)	100 (94.3%)	123(92.5)	0.568
Black or African American	5(2.1%)	3(2.8%)	2(1.5%)	0.658
Asian	2(0.8%)	0(0%)	2(1.5%)	0.504
Mixed	4(1.7%)	1(0.9%)	3(2.3%)	0.632
Information refused	5(2.1%)	2(1.9%)	3(2.3%)	1.000
Occupational status (%)				
Unemployed	9(3.8%)	4(3.8%)	5(3.8%)	1.000
Employed full-time	60(25.2%)	19 (17.9%)	41 (30.8%)	0.022
Employed part-time	16(6.7%)	6(5.7%)	10(7.5%)	0.568
Student	6(2.5%)	1(0.9%)	5(3.8%)	0.231
Homemaker	3(1.3%)	3(2.8%)	0(0%)	0.086
Retired	114(47.9%)	44 (41.5%)	70 (52.6%)	0.087
Maternity/sick leave or disabled	30(12.6%)	28 (26.4%)	2(1.5%)	<0.001

Abbreviations: IQR: interquartile range; pwMS: people with multiple sclerosis; Non-MS: participants without multiple sclerosis; BMI: body mass index.

3.3. Characteristics of falls

Out of 91 participants who reported falls, five (5.5%) did not provide information on the characteristics of these falls and were therefore

Table 2
Clinical characteristics of study participants: results are expressed as frequencies and percentages for categorical variables and median [IQR] for continuous variables.

Sociodemographic characteristics	All participants (239)	pwMS (106)	Non-MS (133)	P-value
Comorbidities (%)				
Diabetes	14(5.9%)	8(7.5%)	6(4.5%)	0.321
Renal disease	7(2.9%)	2(1.9%)	5(3.8%)	0.467
Cerebrovascular disease	7(2.9%)	1(0.9%)	6(4.5%)	0.136
Cardiovascular disease	11(4.6%)	4(3.8%)	7(5.3%)	0.759
Chronic pulmonary disease	7(2.9%)	0(0%)	7(5.3%)	0.018
Peripheral neuropathy	17(7.1%)	14 (13.2%)	3(2.3%)	0.001
Cancer	25(10.5%)	6(5.7%)	19 (14.3%)	0.030
Prescribed medications (n°)	3[4]	4[5]	2[4]	<0.001
Alcohol use (%)				
Never/monthly or less	138(57.7%)	73 (68.9%)	65(48.9)	0.002
2–4 times/month	44(18.4%)	17(16%)	27 (20.3%)	0.398
2–3 times/week	20(8.4%)	7(6.6%)	13(9.8%)	0.379
≥4 times/week	35(14.6%)	9(8.5%)	26 (19.5%)	0.016
Cannabis use (%)				
Never/monthly or less	218(91.2%)	96 (90.6%)	122 (91.7%)	0.752
2–4 times/month	2(0.8%)	0(0%)	2(1.5%)	0.504
2–3 times/week	7(2.9%)	3(2.8%)	4(3%)	1.000
≥4 times/week	12(5%)	7(6.6%)	5(3.8%)	0.317
Type of MS (%)				
Primary progressive	–	14 (13.2%)	–	N/A
Secondary progressive	–	32 (30.2%)	–	N/A
Relapsing-remitting	–	52 (49.1%)	–	N/A
Unsure	–	8(7.5%)	–	N/A
MS vintage (years)	–	16[17]	–	N/A
SR-EDSS	–	4[3]	–	N/A

Abbreviations: IQR: interquartile range; pwMS: people with multiple sclerosis; Non-MS: participants without multiple sclerosis; MS: multiple sclerosis; SR-EDSS: self-reported expanded disability status scale.

excluded from this sub-analysis. The characteristics of falls experienced by the included 86 participants are fully summarized in Table 3. With regard to fall-timing, 31 (36%) fallers reported falling at least once in the morning, 54 (62.8%) in the afternoon, 37 (43%) in the evening and 19 (22.1%) at night. A Chi-square test revealed no significant differences in fall-timing between pwMS and non-MS participants ($0.106 \leq p$-values ≤ 0.744).

The majority of fallers reported falling at home at least once ($n = 65$, 75.6%), with pwMS reporting a significantly higher proportion of in-home falls compared to non-MS participants ($n = 52$, 83.9% vs $n = 13$, 54.2%; $p = 0.004$, $\phi_c = 0.31$). Seven (8.1%) participants reported falling inside other types of buildings, while 35 (40.7%) reported falling outside. People living with MS and non-MS participants did not differ in the proportion of such falls ($0.275 \leq p$-values ≤ 1.000).

The most common activities undertaken before falling were associated with ambulation, as 63 (73.3%) participants reported falling at least once while walking or turning. Other activities frequently reported by participants included transferring ($n = 17$, 19.8%), stair climbing ($n = 13$, 15.1%), and standing ($n = 12$, 14%). No differences between pwMS and non-MS participants in terms of activities undertaken before falling were detected ($0.100 \leq p$-values ≤ 1.000).

Most fallers reported at least a minor fall-related injury such as bruising ($n = 53$, 61.6%), or cuts/scrapes ($n = 34$, 39.5%). Five (5.8%) fallers also reported ligament sprains as a result of falling. Severe

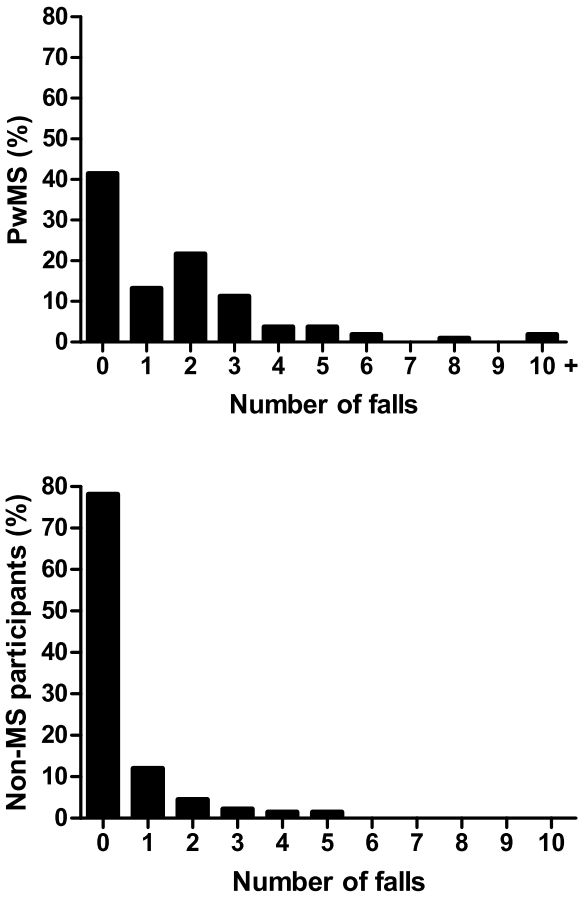

Fig. 2. Distribution of number of falls experienced by study participants.

Table 3
Characteristics of falls during COVID-19. Differences between pwMS and non-MS participants: sub-analysis of fallers. Results are expressed as frequencies and percentages.

Characteristics of falls	All fallers (86)	pwMS (62)	Non-MS (24)	P-value
Fall-timing (%)				
Morning	31(36%)	23(37.1%)	8(33.3%)	0.744
Afternoon	54(62.8%)	40(64.5%)	14(58.3%)	0.595
Evening	37(43%)	30(48.4%)	7(29.2%)	0.106
Night	19(22.1%)	13(21%)	6(25%)	0.686
Location of falls (%)				
Home	65(75.6%)	52(83.9%)	13(54.2%)	0.004
Other building	7(8.1%)	5(8.1%)	2(8.3%)	1.000
Outside	35(40.7%)	23(37.1%)	12(50%)	0.275
Activities before falling (%)				
Walking or turning	63(73.3%)	48(77.4%)	15(62.5%)	0.161
Transferring	17(19.8%)	12(19.4%)	5(20.8%)	1.000
Standing	12(14%)	10(16.1%)	2(8.3%)	0.496
Stair climbing	13(15.1%)	12(19.4%)	1(4.2%)	0.100
Other	16(18.6%)	11(17.7%)	5(20.8%)	0.763
Consequences of falls (%)				
No injury	25(29.1%)	17(27.4%)	8(33.3%)	0.588
Bruising	53(61.6%)	41(66.1%)	12(50%)	0.168
Cuts/scrapes/tears	34(39.5%)	26(41.9%)	8(33.3%)	0.464
Ligament sprains	5(5.8%)	4(6.5%)	1(4.2%)	1.000
Head injuries	3(3.5%)	2(3.2%)	1(4.2%)	1.000
Fractures	7(8.1%)	6(9.7%)	1(4.2%)	0.668
Healthcare sought	12(14%)	10(16.1%)	2(8.3%)	0.496

Abbreviations: PwMS: people with multiple sclerosis; Non-MS: participants without multiple sclerosis; MS: multiple sclerosis.

injuries included fractures and head injuries, which were experienced by 7 (8.1%) and 3 (3.5%) participants respectively. In addition, 12 (14%) fallers reported they required healthcare advise/treatment for the falls experienced. Considering the whole sample (n = 234), pwMS had a higher proportion of overall injuries (44.3% vs 12.5%, p< 0.001, ϕ_c= 0.36), fractures (5.7% vs 0.8%, p = 0.048, ϕ_c= 0.14), and healthcare utilization (9.4% vs 1.6%, p = 0.007, ϕ_c= 0.18) compared to non-MS participants.

3.4. Self-reported physical activity

Fifty-two out of 106 (49.1%) pwMS reported lower physical activity levels during COVID-19, while 54 (50.9%) reported their activity levels were about the same or higher than usual. 52.2% of non-MS participants reported lower physical activity levels during COVID-19. The negative binomial regression analysis did not reveal any significant associations between self-reported reduction in physical activity and number of falls in either pwMS (RR= 2.21, 95% CI: 0.97–5.02, p = 0.058) or non-MS participants (RR= 1.16, 95% CI= 1.07–1.40, p = 0.177). Additionally, in logistic regression analysis, there were no significant associations between self-reported reduction in physical activity and overall fall-related injuries in pwMS (OR= 2.15, 95% CI: 0.99–4.69, p = 0.055) and in non-MS participants (OR= 1.32, 95% CI: 0.39–4.43, p = 0.654).

4. Discussion

In this cross-sectional study, we aimed to explore frequency and characteristics of falls experienced by people living with and without MS during the COVID-19 pandemic. The online survey revealed a higher proportion of fallers among pwMS compared to non-MS participants (58.5% vs 21.8%). In addition, pwMS reported a higher number of falls (Fig. 2) and had a crude fall-rate about four times higher than those living without MS. Moreover, pwMS experienced more adverse outcomes, as evidenced by the higher proportion of overall injuries (44.3% vs 12.5%), fractures (5.7% vs 0.8%), and fall-related healthcare utilization (9.4% vs 1.6%).

Notably, the prevalence of fallers among pwMS seems to be aligned with the meta-analysis by Nilsagard et al. (2015) who concluded that about 56% of pwMS fall at least once in any three-month period. Additionally, the crude fall-rate observed in pwMS (1.67 falls/person) is also in agreement with the current literature on falls in the general MS population (range between 1.6 falls/person-year (Kasser et al., 2011) and 18.4 falls/person-year (Gunn et al., 2014)). In this regard, our findings are more similar to those of Kasser et al. (2011) while the apparent discrepancy with the study by Gunn et al. (2014) is probably ascribable to the lower SR-EDSS scores and proportion of patients with primary or secondary progressive MS in our study (43.4% vs 69.6%). Moreover, the high fall-rate reported by Gunn et al. (2014) is potentially inflated as a result of the relatively short follow-up of falls (three months) used in their study. Overall, the current observations do not seem to suggest that COVID-19 pandemic at least during the sampled time-period has impacted fall prevalence in persons with MS.

Overall, pwMS and non-MS participants exhibited similar characteristics for sociodemographic and clinical variables that could be linked to an increased fall-risk, such as female gender and comorbidities (Tables 1 and 2). Interestingly, pwMS were significantly younger than non-MS participants (median age= 59 vs 66 years old, p<0.001). This reinforces previous observations that, regardless of age, individuals with MS experience a higher number of falls compared to people living without MS (Mazumder et al., 2014). Importantly, the current MS sample seemed to be representative of the worldwide MS population in terms of clinical subtype (Table 2), with 49.1% of participants reporting relapsing-remitting MS and a median MS vintage of 16 years (Wallin et al., 2020).

The sub-analysis of fallers (Table 3) revealed that a significantly higher proportion of pwMS reported in-home falling compared to non-MS participants. On the one hand, this observation reflects the higher prevalence of disability in pwMS (Table 1) and subsequent limitation in terms of activities undertaken outside the house. On the other hand, it is plausible that, due to their greater vulnerability, pwMS tended to spend more time at home to increase the effectiveness of social distancing and decrease the risk of COVID-19 infection. About 49% of pwMS reported lower levels of physical activity since the beginning of the pandemic, which is in agreement with the findings by Kalron et al. (2020). Although we did not observe a significant association between self-reported reduction of physical activity and falls/fall-related injuries in either group, the borderline p-values highlighted by the negative binomial (RR= 2.21, 95% CI: 0.97–5.02, p = 0.058) and logistic regression analysis (OR= 2.15, 95% CI: 0.99–4.69, p = 0.055) in pwMS raise the question as to whether the non-significant findings may be related to the limited accuracy of self-reported physical activity data and limited statistical power. Therefore, we cannot ultimately exclude that a relationship between COVID-related physical activity curtailment and falls may exist. Pelicioni et al. (2020) recently postulated that sedentary behavior during COVID-19 may contribute to falls through physical deconditioning in pwMS. Conversely, experiencing a fall-related injury while practicing social distancing at home may lead to fear of falling syndrome, which could be responsible for further reductions of physical activity (Pelicioni et al., 2020). It should also be noted that our survey was circulated during the early stages of COVID-19 pandemic in the U.S. (June through August 2020). It is quite possible that unmitigated physical deterioration arising from prolonged inactivity during COVID-19 may place pwMS at higher risk of severe fall-related outcomes in the longer term.

Overall, findings from this study suggest that, during COVID-19, falls remain of clinical concern in pwMS, which is worrisome in light of the current strain on the healthcare system. At the same time, the observation that about one in two participants decreased their normal physical activity levels during the pandemic reiterate the importance of sitting less and adopting an active lifestyle during and after COVID-19 (Motl et al., 2020; Kalb et al., 2020). Additionally, the use of telehealth rehabilitation has shown great potential as an alternative platform for exercise delivery (Tuckson et al., 2017) and has recently gained popularity in response to the need to practice social distancing (Motl et al., 2020). Nevertheless, the utility and safety of this approach require further research in people with neurological impairment (Pelicioni et al., 2020).

4.1. Study limitations

The current study is not without limitations. First of all, we should acknowledge that, due to the cross-sectional design, participants were asked to report falls experienced up to seven months earlier, which can increase the recall bias and lead to misreporting of falls (Ganz et al., 2005). Another limitation related to the study design is that we could not provide more detailed information on the characteristics of falls experienced by participants. Specifically, we recorded information as to which proportion of participants reported predefined fall characteristics (e.g. location, activities etc.) rather than providing a detailed account of fall-related characteristics for every single fall experienced. We should also acknowledge that data concerning physical activity status were limited in our study. Particularly, we did not collect more detailed information such as frequency and duration of activities performed in the last week, which would have been useful to more reliably describe physical activity levels in pwMS and non-MS participants as well as to evaluate the impact of activity behaviors on fall-rates during the lockdown. Lastly, due to the relatively small sample size achieved, we did not explore the effects of possible COVID-19 infection on fall-rates in the study participants. As some researchers have postulated, people who suffered from COVID-19 infection may be at higher risk of falls due to mobility and balance deterioration (Pelicioni et al., 2021).

5. Conclusions

This cross-sectional study revealed that, despite the physical activity reduction, pwMS remain at high risk of falls and fall-related outcomes during the COVID-19 pandemic. People living with MS had a four-time higher fall-rate, a higher proportion of in-home falls and fall-related injuries/healthcare utilization compared to non-MS participants. The high number of falls experienced by pwMS is of clinical concern considering the current strain on the healthcare system. We recommend that providers emphasize fall-monitoring during the COVID-19 pandemic, as part of standard care, and engage patients in developing a tailored plan to ensure adherence to current active lifestyle recommendations.

CRediT authorship contribution statement

Tobia Zanotto: Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Visualization, Project administration. **Mikaela L Frechette:** Methodology, Investigation, Writing – review & editing, Visualization. **Stephen R Koziel:** Formal analysis, Data curation, Writing – review & editing, Visualization. **Katherine L Hsieh:** Methodology, Investigation, Writing – review & editing. **Jacob J Sosnoff:** Methodology, Writing – review & editing, Project administration, Supervision.

Declaration of Competing Interest

None.

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Supplementary materials

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References

Bartosch, P.S., Kristensson, J., McGuigan, F.E., Akesson, K.E., 2020. Frailty and prediction of recurrent falls over 10 years in a community cohort of 75-year-old women. Aging Clin. Exp. Res. 32, 2241–2250. https://doi.org/10.1007/s40520-019-01467-1.

Brownlee, W., Bourdette, D., Broadley, S., Killestein, J., Ciccarelli, O., 2020. Treating multiple sclerosis and neuromyelitis optica spectrum disorder during the COVID-19 pandemic. Neurology 94, 949–952. https://doi.org/10.1212/WNL.0000000000009507.

Cecchini, M., Sassi, F., Lauer, J.A., Lee, Y.Y., Guajardo-Barron, V., Chisholm, D., 2010. Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. Lancet 376, 1775–1784. https://doi.org/10.1016/S0140-6736(10)61514-0.

Dai, W., Tham, Y.C., Chee, M.L., Tan, N.Y.Q., Wong, K.H., Majithia, S., Sabanayagam, C., Lamoureux, E., Wong, T.Y., Cheng, C.Y., 2018. Falls and recurrent falls among adults in a multi-ethnic asian population: the singapore epidemiology of eye diseases study. Sci. Rep. 8, 7575. https://doi.org/10.1038/s41598-018-25894-8.

Ganz, D.A., Higashi, T., Rubenstein, L.Z., 2005. Monitoring falls in cohort studies of community-dwelling older people: effect of the recall interval. J. Am. Geriatr. Soc. 53, 2190–2194. https://doi.org/10.1111/j.1532-5415.2005.00509.x.

Gunn, H., Creanor, S., Haas, B., Marsden, J., Freeman, J., 2014. Frequency, characteristics, and consequences of falls in multiple sclerosis: findings from a cohort study. Arch. Phys. Med. Rehabil. 95, 538–545. https://doi.org/10.1016/j.apmr.2013.08.244.

Kalb, R., Brown, T.R., Coote, S., Costello, K., Dalgas, U., Garmon, E., Giesser, B., Halper, J., Karpatkin, H., Keller, J., Ng, A.V., Pilutti, L.A., Rohrig, A., Van Asch, P., Zackowski, K., Motl, R.W., 2020. Exercise and lifestyle physical activity recommendations for people with multiple sclerosis throughout the disease course. Mult. Scler. 26, 1459–1469. https://doi.org/10.1177/1352458520915629.

Kalron, A., Dolev, M., Greenberg-Abrahami, M., Menascu, S., Frid, L., Avrech-Shezifi, S., Harari, G., Magalashvili, D., Achiron, A., 2020. Physical activity behavior in people with multiple sclerosis during the COVID-19 pandemic in Israel: results of an online survey. Mult. Scler. Relat. Disord. 47, 102603 https://doi.org/10.1016/j.msard.2020.102603.

Kasser, S.L., Jacobs, J.V., Foley, J.T., Cardinal, B.J., Maddalozzo, G.F., 2011. A prospective evaluation of balance, gait, and strength to predict falling in women with multiple sclerosis. Arch. Phys. Med. Rehabil. 92, 1840–1846. https://doi.org/10.1016/j.apmr.2011.06.004.

Lamb, S.E., Jørstad-Stein, E.C., Hauer, K., Becker, C., Prevention of Falls Network Europe and Outcomes Consensus Group, 2005. Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. J. Am. Geriatr. Soc. 53, 1618–1622. https://doi.org/10.1111/j.1532-5415.2005.53455.x.

Learmonth, Y.C., Motl, R.W., Sandroff, B.M., Pula, J.H., Cadavid, D., 2013. Validation of patient determined disease steps (PDDS) scale scores in persons with multiple sclerosis. BMC Neurol. 13, 37. https://doi.org/10.1186/1471-2377-13-37.

Lord, S.R., Menz, H.B., Sherrington, C., 2006. Home environment risk factors for falls in older people and the efficacy of home modifications. Age Ageing 35. https://doi.org/10.1093/ageing/afl088 ii55-59.

Mazumder, R., Murchison, C., Bourdette, D., Cameron, M., 2014. Falls in people with multiple sclerosis compared with falls in healthy controls. PLoS ONE 9, e107620. https://doi.org/10.1371/journal.pone.0107620.

Motl, R., Ehde, D., Shinto, L., Fernhall, B., LaRocca, N., Zackowski, K., 2020. Health behaviors, wellness, and multiple sclerosis amid COVID-19. Arch. Phys. Med. Rehabil. 101, 1839–1841. https://doi.org/10.1016/j.apmr.2020.06.001.

Nilsagård, Y., Gunn, H., Freeman, J., Hoang, P., Lord, S., Mazumder, R., Cameron, M., 2015. Falls in people with MS–an individual data meta-analysis from studies from Australia, Sweden, United Kingdom and the United States. Mult. Scler. 21, 92–100. https://doi.org/10.1177/1352458514538884.

Pelicioni, P.H.S., Schulz-Moore, J.S., Hale, L., Canning, C.G., Lord, S.R., 2020. Lockdown during COVID-19 and the increase of frailty in people with neurological conditions. Front. Neurol. 11, 604299 https://doi.org/10.3389/fneur.2020.604299.

Pelicioni, P.H.S., Santos, A.D., Tako, K.V., Santos, P.C.R., 2021. COVID-19 and its impact on human motor control. Brazilian J. Motor Behav. 15, 9–19. https://doi.org/10.20338/bjmb.v15i1.196.

Tison, G.H., Avram, R., Kuhar, P., Abreau, S., Marcus, G.M., Pletcher, M.J., Olgin, J.E., 2020. Worldwide Effect of COVID-19 on Physical Activity: a Descriptive Study. Ann. Intern. Med. 173, 767–770. https://doi.org/10.7326/M20-2665.

Tuckson, R.V., Edmunds, M., Hodgkins, M.L., 2017. Telehealth. N Engl. J. Med. 377, 1585–1592. https://doi.org/10.1056/NEJMsr1503323.

Vassallo, M., Sharma, J.C., Allen, S.C., 2002. Characteristics of single fallers and recurrent fallers among hospital in-patients. Gerontology 48, 147–150. https://doi.org/10.1159/000052833.

Wallin, M.T., Culpepper, W.J., Campbell, J.D., Nelson, L.M., Langer-Gould, A., Marrie, R.A., Cutter, G.R., Kaye, W.E., Wagner, L., Tremlett, H., Buka, S.L., Dilokthornsakul, P., Topol, B., Chen, L.H., LaRocca, N.G., 2020. US Multiple Sclerosis Prevalence Workgroup., 2019. The prevalence of MS in the United States: a population-based estimate using health claims data. Neurology 92. https://doi.org/10.1212/WNL.0000000000007035 e1029-1040.

W.H.O. World Health Organization., 2020.

Willis, M.D., Robertson, N.P., 2020. Multiple sclerosis and the risk of infection: considerations in the threat of the novel coronavirus. COVID-19/SARS-CoV-2. J. Neurol. 267, 1567–1569. https://doi.org/10.1007/s00415-020-09822-3.