

# Physical Activity in Multiple Sclerosis: Meeting the Guidelines at the Time of the COVID-19 Pandemic

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**Background and Purpose:** Regular physical activity (PA) helps to reduce the severity of physical and mental symptoms and improves quality of life in people with multiple sclerosis (PwMS). Based on

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current evidence and expert opinion, the recent multiple sclerosis guidelines recommend at least 150 minutes/week of PA. This study presents the results of a survey analyzing whether and how PwMS met the guidelines before and during the pandemic.

**Methods:** We developed and disseminated an international online survey between December 2020 and July 2021, investigating changes in self-reported PA type, duration, frequency, and intensity due to the COVID-19 outbreak in PwMS with differing disability levels.

**Results:** Among respondents (n = 3810), 3725 were eligible. The proportion of those who conducted at least one activity decreased with increasing disability level at both time points (pre and during). Overall 60% of respondents met the guidelines before the pandemic (mild: 64.43%; moderate: 51.53%; severe: 39.34%;  $\chi^2_{(2)} = 109.13$ ,  $P < 0.01$ ); a reduction of approximately 10% occurred during the pandemic in all disability groups (mild: 54.76%; moderate: 42.47%; severe: 29.48%;  $\chi^2_{(2)} = 109.67$ ,  $P < 0.01$ ). Respondents with higher disability participated more in physical therapy and less in walking, cycling, and running at both time points. Most respondents reported practicing PA at a moderate intensity at both time points; frequency and duration of sessions decreased as disability level increased.

**Discussion and Conclusions:** The percentage of those meeting the guidelines reduced with increasing disability level and during the pandemic. PA type and intensity varied widely across the disability categories. Interventions accounting for disability level are required to enable more PwMS to reap the benefits of PA.

**Video Abstract available** for more insights from the authors (see the Video, Supplemental Digital Content 1, <http://links.lww.com/JNPT/A415>).

**Key words:** COVID-19, multiple sclerosis, online survey, physical activity, recommendation

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## INTRODUCTION

The COVID-19 outbreak had a strong impact on all domains of our health care systems. Since March 2020, many countries imposed restrictions to avoid the spread of the virus, and people with chronic neurological diseases, such as multiple sclerosis (MS), had to deal with the challenge of maintaining their physical activity (PA) as their usual activities were unavailable during the lockdown.<sup>1,2</sup>

The importance of regular PA in the management of chronic neurological diseases is well documented in the literature.<sup>3,4</sup> PA comprises any bodily movement produced by skeletal muscle contraction resulting in a substantial increase in energy expenditure over resting levels, and includes lifestyle PA and exercise.<sup>5</sup> In people with MS (PwMS), PA helps to reduce symptom severity<sup>6</sup> and improves quality of life.<sup>7</sup> There is also strong evidence for the positive effects of PA for physical and mental health outcomes.<sup>8-11</sup> Exercise, a subset of PA, has a moderate positive effect on relapse rate<sup>12</sup> and is acknowledged as a safe treatment for PwMS.<sup>12,13</sup>

Regular PA is recommended for PwMS to maintain good physical fitness and prevent symptoms such as muscle weakness, fatigue, pain, and depression.<sup>6,14,15</sup> Specific prescriptions should be based on individual preferences, lifestyle, and neurological disability level. Indeed, PwMS at more advanced disease stages also benefit from regular PA to maintain fitness, to prevent pain and secondary complications of inactivity, and to treat or reduce symptoms.<sup>16</sup>

Prior to the COVID-19 pandemic, it was evident that PwMS were significantly less active than the general population,<sup>17</sup> and concerns arose that the restrictions associated with the pandemic may have further reduced already decreased PA levels in PwMS. Studies have demonstrated reductions in PA as a result of the pandemic in the general population<sup>18</sup> and in those with physical disabilities.<sup>19,20</sup> One small study in Israel suggested significant reductions in PA in PwMS; nevertheless, some respondents stated they had more time to do PA during pandemic lockdowns and, consequently, began to practice more.<sup>21</sup>

MS is a heterogeneous condition with varying levels of disability that may result in the need to adapt the type and modality (ie, intensity, frequency, and duration) of PA. Based on current evidence and expert opinion, the recent MS guidelines<sup>22</sup> recommend at least 150 minutes/week of exercise and/or 150 minutes/week of lifestyle PA throughout the disease course. We note that these new guidelines stratify PA recommendations according to Expanded Disability Status Scale (EDSS) disability levels<sup>22</sup> and that the type and intensity of activity recommended also varies across the disease spectrum. Whether and how these guidelines are met by PwMS at each level of disability is unknown. It is also unclear how the pandemic and associated social restrictions impacted the type, duration, and intensity of PA by PwMS. These questions are the subject of a large international survey organized by the Special Interest Group for Mobility (SIG Mobility) of the Rehabilitation in Multiple Sclerosis (RIMS) network.<sup>23</sup> In this article, we report the results of the survey to establish whether PwMS met the PA guidelines for MS<sup>22</sup> before and during the COVID-19 pandemic, as well as whether the type and modality of PA changed according to disability level.

## METHODS

Between December 2020 and July 2021, the SIG Mobility developed and disseminated an online survey, to ascertain the experience of PwMS concerning PA participation before and during (ie, at the time of responding to the questionnaire) the COVID-19 pandemic. The design, conducting, and reporting of the study are informed by the CHERRIES reporting guideline.<sup>24</sup>

### Project Phases

Following an open call for expressions of interest across the network, a primary investigator (PI) for each country was identified to be locally responsible for all the project phases and ensure communication with local participants, other PIs, and the coordinator. Eleven countries took part in the study: Australia, Belgium, Czech Republic, Ireland, Israel, Italy, Norway, Serbia, Spain, Turkey, and the UK. The PIs were 8 physical therapists, 1 human movement scientist, 1 psychologist, and 1 physician (9 had a PhD).

A small working group of 4 PIs (all physical therapists with PhD) met frequently online between December 2020 and May 2021, drafted the survey, piloted the English version with 2 to 3 people with MS in 4 countries, and then refined and finalized the survey for translation. The final survey was then translated from English into local languages (ie, a translation/back-translation process). The PI in each country uploaded the survey to the relevant online platform and completed usability testing. Minor adaptations, if needed, have been performed based on this testing.

Ethics approval to conduct the study and share pseudonymized data within the project group was obtained for each country (see Supplemental Digital Content 1, <http://links.lww.com/JNPT/A413>).

Between May and July 2021, the survey was launched in all countries and disseminated using relevant local networks and media. The recruitment channels comprised local MS centers and hospitals (through Web sites, social media, and direct mailing to neurologists), national MS registries, physiotherapy MS associations, neurologists, and networks involved in MS research or clinical care, as well as the PI's or national MS organizations' professional social media (LinkedIn, Facebook, Instagram, and Twitter). The survey was also disseminated through the Web site of RIMS, where the national MS societies and the European networks' initiatives are usually promoted for patients, clinicians, and researchers. Completing the survey was voluntary, no incentives were offered to the respondents, and no identifying information was collected.

### The Survey

The survey consisted of 74 questions and took approximately 30 minutes to complete (see Supplemental Digital Content 2, <http://links.lww.com/JNPT/A413>). The order of the questions was consistent for all participants and followed "skip logic" principles to ensure participants were presented with logical questions depending on their previous response. All information related to the study purpose, target population, ethics approval, data collection, storage, and privacy were described in the first page of the survey.

Following this information, respondents provided their consent online for their data to be used by the respective institution associated with their country, and to the SIG Mobility working group for analysis and reporting (see Supplemental Digital Content 2, <http://links.lww.com/JNPT/A413>).

A preliminary section included demographics (ie, age, gender, and country) and clinical information (ie, years since onset and diagnosis, disability level, COVID-19 symptoms, COVID-19 infection, and level of concern about contracting COVID-19). The level of disability was collected using the Patient Determined Disease Steps (PDDS),<sup>25</sup> a surrogate measure of the EDSS, scored ordinarily from 0 (no disability) to 8 (bed bound).<sup>26</sup> Respondents scored their PDDS level before and during the pandemic.

The core sections of the survey were dedicated to collecting information about the physical activities practiced before (*pre*) and during (*during*) the pandemic. For both time points, respondents reported details of up to 3 activities selected from a list of 16 activities. For each activity, information on (i) the type of activity, (ii) frequency (days/week), (iii) duration (average minutes/session), and (iv) intensity (light, moderate, or strenuous) was collected. A further section on the reasons for stopping or reducing PA (ie, potential barriers) was also included.

### Data Analysis

Data analysis was performed in 3 steps. First, to categorize respondents according to disability we used the EDSS ranges adopted in Kalb et al<sup>22</sup> and mapped them to the PDDS using the conversion table from Kobelt et al<sup>25</sup> resulting in 3 disability levels: mild (PDDS: 0-3), moderate (PDDS: 4-6), and severe (PDDS: 7-8).

Second, for the whole sample and for each disability level, at both *pre* and *during* time points, we characterized the 4 components of PA: type, intensity, frequency, and duration. Similarly, for each disability level we also characterized the potential barriers to practicing PA during the pandemic.

To evaluate the most frequent *types* of activity practiced by respondents, we calculated how many times each activity had been reported and the corresponding percentage on whole number of reported activities. Intensity, frequency, and duration for all reported activities were then calculated.

*Intensity* was initially derived for each disability category for all 16 activities together (light, moderate, and strenuous), and this parameter was also analyzed in greater detail for the 4 most frequently reported activities in each disability category. The following explanation was provided to define intensity in the survey: light—you can do this activity and sing a song; moderate—you can do this activity and have a conversation but not sing; and strenuous—you can only utter a few words while doing this activity.<sup>27</sup>

Similarly, *frequency* of PA sessions was initially calculated for all activities together (ie, sum of the sessions of each activity reported by a respondent). *Duration* of PA was calculated in minutes.

Third, to evaluate whether respondents met the PA recommendations at *pre* and *during* time points, we based our analysis on the specific recommendation<sup>22</sup> to practice 150

minutes/week or longer of exercise and/or 150 minutes/week or longer of lifestyle PA using a cut-off of 150 minutes/week.

After calculating the PA minutes/week of each respondent (sum of *minutes* × *frequency* of all activities reported by a respondent), we used the cut-off of 150 minutes to divide the sample into those meeting and not meeting the recommendations.

Since we were interested in investigating the percentage of PwMS meeting the PA guidelines before and during the pandemic, and because part of the sample reported a change in disability level from *pre* to *during*, separate  $\chi^2$  tests were conducted at each time point to compare differences across disability groups. Similarly,  $\chi^2$  tests were also used to test differences among disability groups in the other variables expressed in percentages. The Shapiro-Wilk test was used to test the normality of frequency and duration and parametric (analysis of variance) or nonparametric (Kruskal-Wallis test) tests were used to evaluate significance at the 2 time points. Significance was considered for  $P < 0.05$ . Data analysis was performed by using STATISTICA 7.1. Data are expressed as counts, total number of cases, percentages, mean, and median.

## RESULTS

### Participants

There were 3810 respondents from 11 countries; among those, 3725 (Australia  $n = 91$ , Belgium  $n = 26$ , Czech Republic  $n = 264$ , Ireland  $n = 153$ , Israel  $n = 52$ , Italy  $n = 585$ , Norway  $n = 2218$ , Serbia  $n = 27$ , Spain  $n = 230$ , Turkey  $n = 35$ , and the UK  $n = 44$ ) were eligible for the study (27 did not tick all the eligibility boxes, such as accounting for MS diagnosis or for an age  $> 18$  years; 58 did not answer the *pre* PA questions). A further 3 were omitted as their PDDS categorization was not available at both *pre* and *during* time points and a further 21 were omitted at *pre* time points because they did not report the PDDS score before the pandemic. The analysis was conducted on 3701 and 3722 responders for *pre* and *during* time points, respectively.

Based on the PDDS, the number of respondents in the moderate and severe disability categories increased during the pandemic—mild:  $N_{Pre} = 2291$  (61.90%),  $N_{During} = 2239$  (60.16%); moderate:  $N_{Pre} = 1044$  (28.21%),  $N_{During} = 1076$  (28.91%); and severe:  $N_{Pre} = 366$  (9.89%),  $N_{During} = 407$  (10.93%).

Table 1 shows demographic and clinical information for the entire sample and 3 disability categories. From mild to severe disability levels, there was a progressive shift toward older ages and less recent disease onset and diagnosis.

Most of the respondents had not experienced COVID-19 symptoms ( $> 85\%$ ) and had never tested positive for COVID-19 ( $> 90\%$ ); similar percentages were found across the disability groups ( $\chi^2_{(2)} = 4.46$ ,  $P = 0.11$ , and  $\chi^2_{(2)} = 4.17$ ,  $P = 0.12$ , respectively).

Overall, the majority of respondents had some element of concern about contracting COVID-19, with 21.45% of the whole sample either moderately or extremely concerned; this proportion significantly increased with the increment of the disability level (mild = 19.16%, moderate = 24.72%, and severe = 26.51%;  $\chi^2_{(2)} = 35.77$ ,  $P < 0.01$ ).

**Table 1. Demographic and Clinical Information for the Entire Sample and 3 Disability Categories<sup>a</sup>**

	All	Mild	Moderate	Severe
<b>Age</b>				
18-34 y	11.92 (n = 441)	16.89 (n = 387)	4.31 (n = 45)	2.46 (n = 9)
35-44 y	21.05 (n = 779)	26.23 (n = 601)	15.04 (n = 157)	5.74 (n = 21)
45-54 y	29.15 (n = 1079)	29.86 (n = 684)	29.69 (n = 310)	23.22 (n = 85)
55-64 y	25.34 (n = 938)	19.86 (n = 455)	33.52 (n = 350)	36.34 (n = 133)
≥65 y	12.54 (n = 464)	7.16 (n = 164)	17.43 (n = 182)	32.24 (n = 118)
<b>Gender</b>				
Male	28.48 (n = 1054)	23.96 (n = 549)	34.67 (n = 362)	39.07 (n = 143)
Female	71.39 (n = 2642)	75.86 (n = 1738)	65.33 (n = 682)	60.66 (n = 222)
Nonbinary	0.03 (n = 1)	0 (n = 0)	0 (n = 0)	0.27 (n = 1)
Prefer not to disclose	0.08 (n = 3)	0.13 (n = 3)	0 (n = 0)	0 (n = 0)
Prefer to self-describe	0.03 (n = 1)	0.04 (n = 1)	0 (n = 0)	0 (n = 0)
<b>Onset</b>				
<1 y	3.97 (n = 147)	4.32 (n = 99)	3.35 (n = 35)	3.55 (n = 13)
1-4 y	11.40 (n = 422)	15.67 (n = 359)	5.56 (n = 58)	1.37 (n = 5)
5-10 y	19.97 (n = 739)	24.05 (n = 551)	14.85 (n = 155)	9.02 (n = 33)
11-15 y	16.59 (n = 614)	16.94 (n = 388)	17.24 (n = 180)	12.57 (n = 46)
16-20 y	14.27 (n = 528)	13.66 (n = 313)	15.80 (n = 165)	13.66 (n = 50)
>20 y	28.29 (n = 1047)	21.34 (n = 489)	34.77 (n = 363)	53.28 (n = 195)
<b>Diagnosis</b>				
<1 y	3.30 (n = 122)	4.28 (n = 98)	2.11 (n = 22)	0.55 (n = 2)
1-4 y	18.99 (n = 703)	23.57 (n = 540)	14.27 (n = 149)	3.83 (n = 14)
5-10 y	24.40 (n = 903)	27.76 (n = 636)	20.79 (n = 217)	13.66 (n = 50)
11-15 y	17.75 (n = 657)	17.94 (n = 411)	18.30 (n = 191)	15.03 (n = 55)
16-20 y	12.73 (n = 471)	11.22 (n = 257)	15.04 (n = 157)	15.57 (n = 57)
>20 y	22.83 (n = 845)	15.23 (n = 349)	29.50 (n = 308)	51.37 (n = 188)
<b>Experienced COVID-19 symptoms</b>				
Yes	8.21 (n = 304)	8.68 (n = 199)	7.86 (n = 82)	6.29 (n = 23)
No	85.95 (n = 3181)	85.90 (n = 1968)	85.06 (n = 888)	88.80 (n = 325)
Not sure	5.84 (n = 216)	5.41 (n = 124)	7.09 (n = 74)	4.92 (n = 18)
<b>Tested positive for COVID-19</b>				
Yes	5.84 (n = 216)	5.98 (n = 137)	5.27 (n = 55)	6.56 (n = 24)
No	93.84 (n = 3473)	93.85 (n = 2150)	94.16 (n = 983)	92.90 (n = 340)
Prefer not to say	0.32 (n = 12)	0.17 (n = 4)	0.57 (n = 6)	0.54 (n = 2)
<b>Concerns about contracting COVID</b>				
Not at all	19.48 (n = 721)	19.03 (n = 436)	17.05 (n = 178)	29.23 (n = 107)
Slightly	31.53 (n = 1167)	33.44 (n = 766)	29.60 (n = 309)	25.14 (n = 92)
Somewhat	25.32 (n = 937)	26.80 (n = 614)	25.00 (n = 261)	16.94 (n = 62)
Moderately	15.48 (n = 573)	14.49 (n = 332)	16.67 (n = 174)	18.31 (n = 67)
Extremely	5.97 (n = 221)	4.67 (n = 107)	8.05 (n = 84)	8.20 (n = 30)
I don't know	2.22 (n = 82)	1.57 (n = 36)	3.64 (n = 38)	2.19 (n = 8)

<sup>a</sup>Distribution of respondents concerning each demographic and clinical parameter is expressed as percentage of the total sample (all, n = 3701) or subgroups based on disability level (mild: Patient Determined Disease Steps [PDDS] 0-3, n = 2291; moderate: PDDS 4-6, n = 1044; severe: PDDS 7-8, n = 366).

Most respondents (57.90%) reported at least 1 potential barrier that could cause them to stop or do less PA. Significant differences were found across the disability groups, with a higher percentage of respondents with moderate and severe disability reporting at least 1 barrier to PA (mild: 53.91%; moderate: 65.15%; and severe: 60.69%;  $\chi^2_{(2)} = 39.13$ ,  $P < 0.01$ ) (see also Supplemental Digital Content 3, <http://links.lww.com/JNPT/A414>).

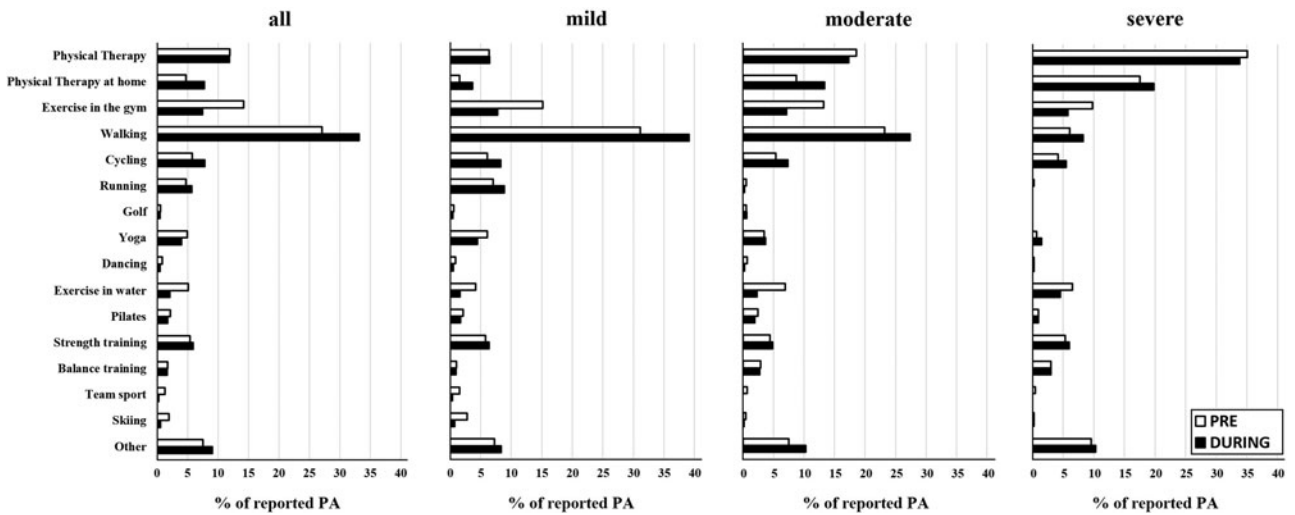
### Which Types of PA Did Respondents Do Before and During the Pandemic?

Before the pandemic, 17.43% (n = 645) of the respondents did not perform any activities, while 82.57% (n = 3056) practiced at least 1 activity (1 activity: n = 1208; 2 activities: n = 1007; 3 activities: n = 841; and 4 or more activities: n=379). The percentage of those doing at least 1 activity differed between disability levels, with higher percentages in the mild and moderate disability levels (mild:

84.29%; moderate: 82.38%; and severe: 72.40%;  $\chi^2_{(2)} = 30.44$ ,  $P < 0.01$ ). Similar differences across groups were found at the time of responding to the questionnaire; however, percentages of those doing at least 1 activity were lower than the *pre* time point reflecting an overall decrease of PA in the entire sample (all: 74.21%; mild: 77.13%; moderate: 72.86%; and severe: 61.67%;  $\chi^2_{(2)} = 44.45$ ,  $P < 0.01$ ).

Figure 1 shows percentages of activities reported by all respondents and by 3 disability groups. Although walking was the most reported activity at both time points in the entire sample, differences emerged when the disability level was considered. With increasing disability, the proportion of respondents receiving physical therapy increased while the proportion taking part in walking, cycling, and running reduced. Higher percentages of walking, cycling, and running were found at the *during* time point compared with *pre* for the sample as a whole.

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**Figure 1.** Percentages of different activities reported by all the responders and 3 disability groups. Respondents could choose 3 among 16 options: physical therapy at clinic, physical therapy at home, exercise in the gym, walking, cycling, running, golf, yoga, dancing, exercise in water, Pilates, strength training, balance training, team sports, skiing, and other.

### How Often, How Often, and How Long Did Respondents Practice PA Before and During the Pandemic?

Most respondents reported practicing PA at a moderate intensity at both time points; however, only at the pre-pandemic time point were the differences among disability groups significant (*pre*:  $\chi^2_{(2)} = 10.99, P < 0.01$ ; and *during*:  $\chi^2_{(2)} = 6.66, P = 0.10$ ) (Table 2). For participants with a severe level of disability, the percentage of strenuous-intensity PA practice increased at the *during* time point compared with the *pre* time point. As expected, the sub analysis of the 4 most reported activities shows that a higher proportion of the mild disability group participated in strenuous-intensity exercise compared with other groups (Figure 2).

Frequency and duration were not normally distributed, and for this reason significant differences among groups at the *pre* and *during* time points were evaluated through the Kruskal-Wallis test. The number of sessions a week significantly decreased as disability levels increased at both time points (*pre*:  $\chi^2_{(2)} = 6.04, P < 0.05$ ; and *during*:  $\chi^2_{(2)} = 7.90, P < 0.05$ ) (Table 2). Similarly, the mean duration of a session also significantly decreased from low to higher disability at both time points (*pre*:  $\chi^2_{(2)} = 52.33, P < 0.01$ ; and *during*:  $\chi^2_{(2)} = 76.04, P < 0.01$ ) (Table 2). Total amount of PA (frequency  $\times$  duration) differed across disability groups at both time points (*pre*:  $\chi^2_{(2)} = 99.69, P < 0.01$ ; and *during*:  $\chi^2_{(2)} = 69.36, P < 0.01$ ). The number of participants performing low (up to 1.5 hours) and medium (1.6-3 hours) levels of PA was larger for higher levels of disability. Conversely, high levels of PA (<3 hours) were more frequently reported in the mild group with respect to the moderate and severe groups (Table 2).

### Did PwMS Meet PA Recommendations Before and During the Pandemic?

Figure 3 shows percentages of those who met the recommendations at *pre* and *during* time points. Only 60% of

the total sample met the minimum guideline amount of 150 minutes or more prior to the pandemic, with the lowest percentage shown in the severe disability group (mild: 64.43%; moderate: 51.53%; and severe: 39.34%;  $\chi^2_{(2)} = 109.13, P < 0.01$ ). Respondents reduced their participation in PA during the pandemic (mild: 54.76%; moderate: 42.47%; and severe: 29.48%;  $\chi^2_{(2)} = 109.67, P < 0.01$ ) by approximately 10%, and this reduction was similar in all 3 disability groups (mild: 9.67%; moderate: 9.06%; and severe: 9.86%).

### DISCUSSION

In this large international online survey study in PwMS, we found that the number of respondents who are physically active was reduced during the COVID-19 pandemic and that this reduction was similar across disability levels. Most of the respondents had not experienced COVID-19 symptoms and had never tested positive and this was independent of the disability level. However, more concerns about contracting COVID-19 emerged with increasing disability levels.

The types of activity performed changed during the pandemic; generally, all the groups practiced PA at moderate intensity with similar percentages at both time points. As expected, strenuous intensity was reported more frequently by the group with a minimal level of disability.

Despite the vast majority of the sample reporting being active, *during* the pandemic only 50% of the sample met the minimum duration of PA recommended in the recent guidelines.<sup>8-11</sup>

The low proportion meeting the PA guidelines, and the further reduction of this during the pandemic, is cause for concern, particularly given the strong evidence for the positive benefits of PA for physical and mental health and on MS disease activity.<sup>28</sup> Similar to previous literature we showed that PA in PwMS is further reduced in those with more severe disease and that disease severity is associated with physical inactivity.<sup>29</sup> Much of the literature on PA and exercise for PwMS to date has focused on lower disability levels, with

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**Table 2. Intensity, Frequency, and Duration of Physical Activity Practice<sup>a</sup>**

	Pre			During		
	All	Mild	Severe	All	Mild	Severe
Intensity, %						
Light	19.50	20.53	20.05	22.80	24.11	17.50
Moderate	63.87	61.68	67.13	63.94	61.94	67.75
Strenuous	16.63	17.78	12.82	13.26	13.95	14.75
Frequency, median [min, max], min sessions/wk	5 [1, 20]	5 [1, 20]	4 [1, 17]	5 [1, 19]	5 [1, 19]	4 [1, 16]
Duration, median [min, max], min	60 [10, 300]	60 [10, 300]	45 [10, 240]	55 [10, 300]	60 [10, 300]	45 [10, 180]
Frequency × duration, %						
Up to 1.5 h	16.70	12.66	27.91	18.65	15.24	30.38
1.6-3 h	22.74	20.78	29.46	24.75	22.95	31.65
> 3 h	60.56	66.56	42.64	56.60	61.80	37.97

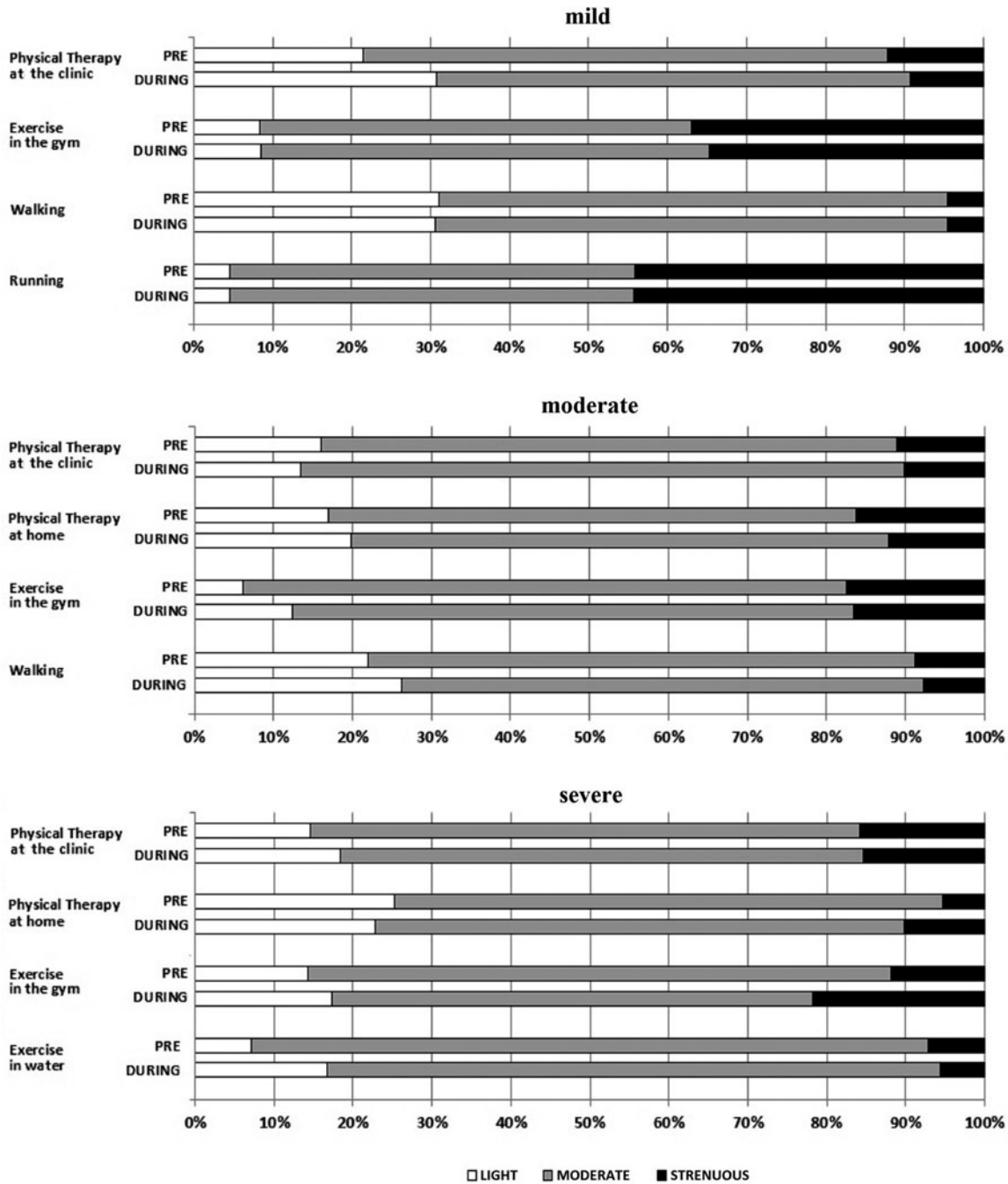
<sup>a</sup>Intensity, frequency, duration, and total amount (frequency × duration) of physical activity practice for the whole sample and different disability subgroups. P values refer to separate  $\chi^2$  tests conducted at each time point (pre and during the COVID-19 pandemic) to compare differences across disability groups.

most of the studies including patients with an EDSS of 6 less<sup>30-33</sup> (ie., addressing the intervention for PwMS who are able to walk without assistance or with unilateral aid).

This confirms the need to extend this work to those with greater disability. On one hand, providing more opportunities for those unable to walk to be physically active in the community (eg, use of arm ergometers, remote-assisted core and posture classes, and individual approaches focusing on the basis for walking),<sup>34</sup> as well as a wider and more comprehensive promotion of those opportunities, would be desirable. On the other hand, within a framework of preventive care, reductions in PA should be considered by health professionals as “red flags” from the initial stages of the disease course. Indeed, about 40% of PwMS with mild disability did not meet the recommendations. Further research could be addressed to identify PA indicators able to predict disability worsening and to develop methods to adapt PA programs maximizing PA amount to meet the guidelines.

In our study, walking was the most frequently reported activity for the sample; however, differences in type of activity were apparent, with those with greater disability reporting doing more physical therapy while those with lower disability reported doing more walking, cycling, and running. This variation in activity type confirms the finding of Hale et al,<sup>35</sup> who emphasize the need for therapists and exercise professionals to provide choice and guidance for PwMS over their type of activity to enhance PA participation. The importance of physical therapies for those with greater disability to reach the guideline amount of PA is apparent in this study making access to that service especially important for that population. It is worth mentioning that, since we were interested in gathering information on any kind of PA, ranging from physical therapy to sports, the choice of the questionnaire was challenging. For this reason, a customized survey was developed by a professional body of rehabilitation scientists across the world. However, we should acknowledge that the use of validated tools such as the International Physical Activity Questionnaires<sup>36</sup> and the Godin Leisure-Time Exercise Questionnaire,<sup>37</sup> in addition to the survey, could be of advantage to compare our findings with other studies.

We found that the proportion of people reporting any PA and the proportion meeting the minimum guideline amount reduced by 10% during the pandemic. Arguably, this could be considered a positive finding, given the restrictions during the pandemic and the high percentage of respondents in our study reporting at least 1 potential barrier that could contribute to stopping or reducing PA. Of note, results showed that individual (eg, fear of contracting COVID and being unwell with COVID) and environmental barriers (eg, class cancellation) were the most prevalent barriers reported by PwMS with moderate and severe disability levels (see Supplemental Digital Content 3, <http://links.lww.com/JNPT/A414>). Moreover, in the light of previous data, we assumed that there would be a higher reduction in PA. Indeed, a recent review by Abasiyanik et al<sup>38</sup> highlighted the negative indirect impact of the COVID-19 pandemic on PA levels in different neurological populations with evidence of reductions greater than 20% (eg Parkinson disease >20%, dementia >60%, hereditary spastic paraplegia >70%, and epilepsy >30%).

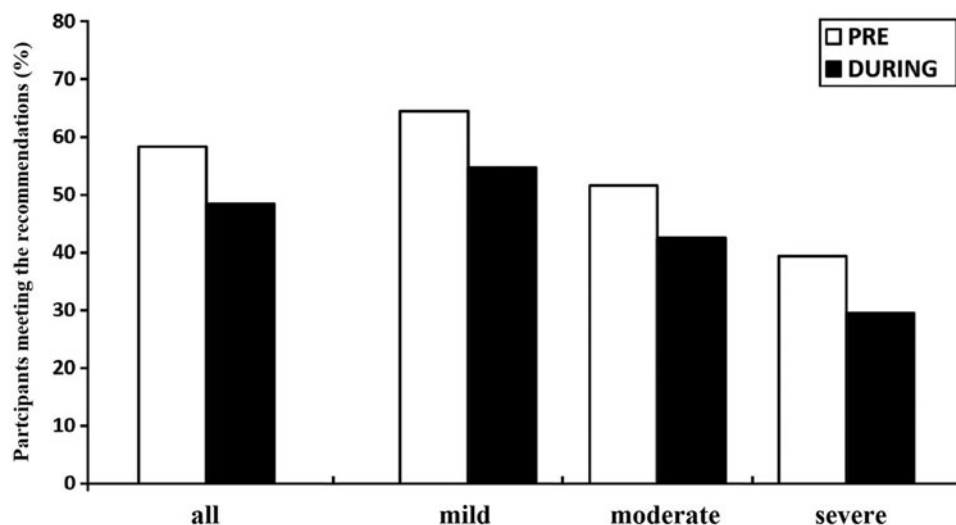


**Figure 2.** Percentages of light, moderate, and strenuous intensity reported by respondents for the most reported 4 activities in 3 disability groups.

The authors suggested that this may be mainly due to the reorganization of the health system worldwide during the COVID-19 pandemic, which particularly affected in-person sessions considering the close interaction between the therapist and the patient. Also, Kalron et al<sup>21</sup> reported that 17.5% of the PwMS participating to an online survey in Israel stopped performing and 33.3% reduced PA during the pandemic.

It is possible that our results reflect the efforts of health care professionals and services to stimulate PwMS to perform PA during the pandemic, not yet visible at the time of the studies included in the review by Abasıyanık et al<sup>38</sup> but present at the time of our survey. Moreover, PwMS may have implemented personal resources to face the restrictions to maintain an adequate level of PA. For example, one recent study examined, by means of semistructured interviews,

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**Figure 3.** Percentages of respondents meeting the recommendations before and during the pandemic for the whole sample (pre 58.32%; during 48.54%) and for different disability groups (mild—PDDS 0-3: pre 64.43%; during 54.76%; moderate—PDDS 4-6: pre 51.53%; during 42.47%; severe—PDDS 7-8: pre 39.34%; during 29.48%). PDDS, Patient Determined Disease Steps.

barriers and facilitators of PA during the pandemic, based on the lived experiences of PwMS.<sup>39</sup> They found that PA experiences during COVID-19 were marked by creativity and adaptation involving at-home activity, online classes, or getting outside where close-contact interaction was minimal. This adaptability during times of stress is possibly a pre-existing hallmark of living with a chronic disabling disease such as MS and could contribute to explain our results.

The frequency of performing PA was reduced with increasing disability levels. At higher disability levels, it may be necessary to consider thermos-sensitivity, reduced mobility, weakness, and fear and risk of falling, factors that have been described as potential barriers to lifestyle PA for PwMS. Furthermore, the need for social support and assistance during PA is essential.<sup>40</sup>

Notably, additional factors such as restrictions aimed at reducing the spread of COVID-19 may have influenced PA behavior. However, the analysis of the association between stopping and reducing PA participation and restrictions is beyond the scope of the present study and will be explored and reported elsewhere.<sup>27</sup>

**Strengths and Limitations**

Although among the strengths of this study is the large international sample, the inability to calculate the response rate and the characteristics of nonresponders, which was not available due to the nature of the survey (ie, open web-based survey), may limit the external validity of the findings. For example, a low response rate may reflect bias in terms of who took the survey. In addition, we do not know which variables affected the survey rate of success (eg, ease of taking the survey, quality of the recruitment process, reminder emails, and follow-up). An additional limitation is the reliance on recall for respondents to report on *pre* pandemic PA. Nevertheless, the negative consequences of these limitations were mitigated by the large sample size and broad representative-

ness of the MS population in terms of varying disability levels, demographics, and multinational participation.

We relied on subjective reporting of the frequency, intensity, duration, and type of PA, preventing full access to PA information, and limiting our analysis with regard to the recommendations; indeed, although full MS exercise and lifestyle PA guidelines recommend articulated exercise strategies (eg, alternating aerobic and resistance sessions during the week), we could only focus on the amount of PA (ie, using the cut-off of 150 minutes/week of PA).

We find it unlikely that the high proportion of Norwegian respondents has skewed the data of this international sample, as previous findings from the same survey project<sup>27</sup> show that the change in PA behavior of the Norwegian respondents was not markedly different from that seen in the other countries.

**Recommendations**

According to the results of the present study, we suggest several strategies for PwMS and for health care professionals, rehabilitative services, gym and health centers to optimize PA and exercise treatments in terms of frequency, duration, and intensity at the time of the pandemic (Table 3). This may lead to an increased number of PwMS meeting the guidelines not only *during* the pandemic but also in the years following the initial COVID-19 outbreak when our data were collected.

**CONCLUSIONS**

The vast majority of PwMS report performing some PA; however, only 50% of those reporting participation in PA were reaching the minimum guideline amount for PA during the COVID-19 pandemic. There was a small reduction (10%) in performance of any PA, and in the proportion reaching the minimum guideline amount compared with the level reported before the pandemic. The type and intensity of activities varied widely and not unexpectedly differed across the disability

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**Table 3. PA Recommendation for PwMS and for Health Care Providers at the Time of the Pandemic and Beyond<sup>a</sup>**

	Mild	Moderate	Severe
PwMS	<p><i>What can do<sup>b</sup></i> Walking, running, cycling.</p> <p><i>What should try<sup>c</sup></i> Resistance training with bands, free or body weights Online exercise lessons (Pilates, dancing, yoga, tai chi) <i>Indications on modalities<sup>d</sup></i> Spontaneous walking: <math>\geq 7500</math> steps/d; increase 15%/d Aerobic activity: 2-4x/wk, 10-40 min, 40%-80% of maximum HR (calculated as <math>220 - \text{age}</math>); correct intensity is if rating of perceived exertion is 11-15 on a 20-point scale Resistance training: 2-3x/wk, 1-3 sets for each exercise, 8-15 repetitions/set, 5-10 exercises Online lessons: 3-6x/wk, 20-60 min, individualized intensity</p>	<p><i>What can do</i> Walking, cycling, physical therapy at home, including resistance training <i>What should try</i> Recumbent stepper (consider rent or buy), Nordic walking Online exercise lessons (Pilates, seated dancing, yoga, tai chi) <i>Indications on modalities</i> Spontaneous walking: <math>\geq 7500</math> steps/d; increase 15%/d Aerobic activity: 2-4x/wk, 10-40 min, 40%-80% of maximum HR (calculated as <math>220 - \text{age}</math>); correct intensity is if rating of perceived exertion is 8-12 on a 20-point scale Resistance training: 2-3x/wk, 1-3 sets for each exercise, 8-15 repetitions/set, 5-10 exercises Online lessons: 3-6x/wk, 20-60 min, individualized intensity</p>	<p><i>What can do</i> Physical therapy at home, walking and cycling (when possible), yoga <i>What should try</i> Arm ergometer, recumbent stepper (consider rent or buy) Online exercise lessons (seated dancing, adaptive sports) <i>Indications on modalities</i> Overground walking with walker as able Exercise on ergometers: six 3-min intervals at 70% of maximum HR (calculated as <math>220 - \text{age}</math>) Upper/lower extremities and core exercises: 2-3x/wk, 3 sets of 10 repetitions/set, 3-5 exercises Add lifestyle PA, such as manual wheelchair propulsion, active weight shifting, pressure relief (front/lateral press-ups), bed mobility. Try to reach 7x/wk, up to 30 min, with rest breaks and gradual progression toward the goal</p>
HC providers (operators, centers, etc) <sup>e</sup>	<p>Include walking, running, or cycling programs in the rehabilitative treatment Disseminate video tutorials for PA<sup>f</sup></p>	<p>Include walking or cycling programs in the rehabilitative treatment Offer alternative ways for PA and exercise (eg, organize Nordic walking experiences, stimulate use of different ergometers, propose telerehabilitation programs and/or yoga or Pilates classes) Disseminate video tutorials for PA<sup>f</sup></p>	<p>Offer alternative ways for PA and exercise (eg, stimulate use of different ergometers, propose telerehabilitation programs and/or yoga or Pilates classes) Provide materials for PwMS and their families with instructions for home exercises (brochures, video tutorials, etc)<sup>f</sup></p>

Abbreviations: HC, health care; HR, heart rate; MS, multiple sclerosis; PA, physical activity; PwMS, people with multiple sclerosis.  
<sup>a</sup>Strategies presented here aim at optimizing PA and exercise treatments in terms of type of activity, frequency, duration, and intensity at the time of the pandemic and in the years following the initial COVID-19 outbreak. They have been integrated with the complete exercise and lifestyle recommendation for PwMS presented in Kalb et al.<sup>22</sup>  
<sup>b</sup>*What can do* section includes the most common activities performed during the pandemic by the interviewed PwMS and represent valid PA options that they can consider to maintain/increase PA in autonomy with respect to the different disability levels.  
<sup>c</sup>*What should try* section includes activities that should be tried by PwMS in order to increase the plethora of alternative types of PA according to the individual condition. These are based on literature evidence and experts' opinion.  
<sup>d</sup>*Indications on modalities* offer some suggestions to succeed on reaching the PA amount and intensity recommended by the guidelines in order to mitigate the most common deviations observed during the pandemic.  
<sup>e</sup>HC providers' recommendations are presented accordingly with the results observed in the present survey, in order to maximize adherence to those activities that are commonly performed by PwMS and increase access to those that are often neglected. In general, HC providers are encouraged to disseminate information and recommendations about the relevance of PA in MS and support behavioral change across all disability levels.  
<sup>f</sup>Examples of tutorials for PA can be found on the Web sites of national MS societies or international organizations, such as the MS International Federation (<https://www.msif.org/>) or the European MS Platform (<https://emsp.org/>).

categories. Individually tailored interventions accounting for disability level and choice of activity are required to enable more PwMS to reap the benefits of PA on physical and mental health and disease activity.

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