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RESEARCH ARTICLE

An Observational Study on Exercise Perception, Depression, and Physical Activity Levels in Individuals with Multiple Sclerosis

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Abstract

Objective: Individuals with multiple sclerosis (MS) often exhibit reduced levels of physical activity (PA), which are influenced by psychological factors, including depression and perceptions of exercise. Accordingly, this study aimed to assess PA levels among individuals with MS and to examine the associations between depression, exercise perception, and PA levels.

Materials and Methods: A total of 80 individuals with MS (mean age: 32.71±9.22 years) participated in this cross-sectional study. Depression was evaluated using the Beck Depression Inventory, exercise perception was measured with the Exercise Benefits/Barriers Scale, and PA levels was determined through the International Physical Activity Questionnaire-Short Form.

Results: The majority of participants were classified as minimally active (72.5%), whereas 8.8% were inactive and 18.8% were very active. A weak but positive correlation was identified between depression and exercise barriers ($r=0.443$, $p<0.001$), as well as between depression and body mass index ($r=0.314$, $p=0.005$). No significant correlation was observed between depression and total PA level. Participants most frequently cited physical effort and environmental limitations as major barriers to exercise.

Conclusion: Although most individuals with MS acknowledge the advantages of exercise, depression, and perceived barriers can impede their participation in PA. Addressing both psychological and environmental factors may enhance exercise adherence and overall disease management in this population.

Keywords: Multiple sclerosis, physical activity, depression, exercise perception, IPAQ, EBBS

Introduction

Multiple sclerosis (MS) is a progressive, chronic, demyelinating disease that affects the white matter and subcortical structures of the central nervous system (CNS). Individuals with MS experience symptoms such as balance disorders, fatigue, muscle weakness, and sensory disturbances in the early stages, and widespread disability resulting from spasticity, bladder dysfunction, depression, pain, and cognitive impairment in the later stages (1,2). Nearly 2.5 million people worldwide are affected by this disease (3). MS causes progressive damage to the CNS, leading to symptoms including pain, fatigue, depression, mobility limitations, and reduced quality of life (QOL) (4-6). The neurodegenerative process associated with axonal and neuronal loss contributes to disease progression and various forms of CNS damage (6). Such CNS damage can result in pain, fatigue, depression, ambulatory and cognitive dysfunction, deconditioning, and diminished QOL (4).

Over the past decade, increasing evidence has shown that engaging in physical activity (PA) alleviates the aforementioned problems in individuals with MS and

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enhances their QOL. However, compared with the general population, individuals with MS engage in insufficient PA (1,7). PA has been demonstrated to reduce fatigue, depression, impairment, cognitive and walking difficulties, and to improve cardiorespiratory fitness, muscle strength, balance, endurance, and QOL (8,9). Recent studies published in 2025 have further highlighted these associations, examining internet-based PA promotion programs, aerobic exercise interventions, and perceived benefits and barriers among MS populations (10-12). Consequently, PA has been recognized as one of the most effective therapeutic strategies for comprehensive MS care (7), and guidelines have been established to promote PA within this population (13). Depression is one of the most common comorbidities in MS and is known to decrease motivation and adherence to PA. Moreover, patient's perceptions of the benefits and barriers of exercise strongly influence their willingness to engage in regular activity. Because both psychological and perceptual factors can determine exercise behavior, examining their interaction offers clinically relevant insights that can inform the design of more effective rehabilitation strategies aimed at increasing participation in PA and improving QOL in individuals with MS. The present study aimed to determine the PA levels of individuals with MS and to investigate the relationship between depression, exercise perception, and PA levels. We hypothesized that higher depression levels would be associated with greater perceived barriers to exercise and lower PA levels in individuals with MS.

Materials and Methods

Study Design

The study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology statement (Supplementary Table 1). A descriptive study design was employed.

Participants

The inclusion criteria for the study were a diagnosis of MS, literacy, and the absence of hearing or vision problems. The exclusion criteria included cognitive impairment and being in the active attack phase. The demographic information collected at registration included age, height, weight, and sex, along with self-reported data on marital status, education level, active employment status, and regular exercise habits. In addition, disease type and disability level [Expended Disability Status score (EDSS)] were determined by a neurologist. Ethical approval for the study was obtained from the Ethics Committee of Fenerbahce University (decision no: 6, date: 01.09.2021). Participant recruitment occurred between September 3, 2021 and March 3, 2022, following ethics approval granted on September 1, 2021. Questionnaires created using Google Forms were distributed to a total of 189 individuals with MS. Based on the inclusion criteria, 80 participants with MS (57 women and 23 men) were included in the study (Figure 1). A power analysis determined that a minimum of 78 participants was required to detect correlations among Beck Depression Inventory (BDI), Exercise Benefits/Barriers Scale (EBBS), and International Physical Activity Questionnaire (IPAQ) scores with a medium effect size (p=0.30), power of 0.80, and α=0.05 (14). Similar sample sizes have been reported in previous MS studies investigating PA, psychological factors, and exercise perception [Stroud et al. (15), n=84; Husu et al. (16), n=62]. Therefore, our final sample of 80 participants met the calculated requirement and was consistent with previous literature. Written informed consent for the use of data in research was obtained from all participants at enrollment.

Outcome Measures

The EBBS was used to assess exercise perception (17,18). The BDI (19) was used to evaluate depression levels, and the IPAQ was used to measure PA levels (20).

Expended Disability Status Score

The EDSS is widely used worldwide to evaluate and monitor neurological examinations in patients with demyelinating diseases such as MS and neuromyelitis optica. It assesses functional status on a scale from 0 to 10, where 0 indicates normal function and 10 indicates death due to MS. Lower scores represent less disability (21).

International Physical Activity Questionnaire

The IPAQ is available in long and short forms. The short form, introduced in 1996 by Michael Booth MD, was designed to determine the relationship between health and PA levels in adults. Saglam et al. (20) confirmed the validity and reliability of the Turkish version, with a Cronbach's alpha coefficient of 0.75. The short form includes seven items that collect information on time

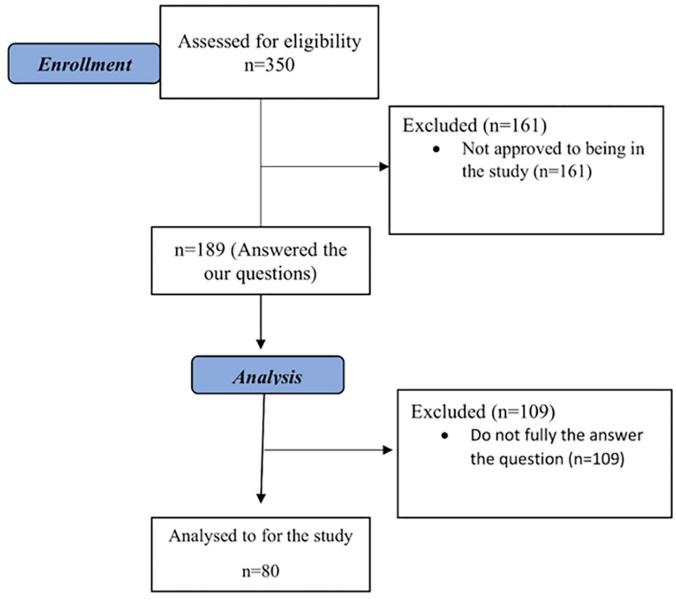

Figure 1. Flow chart of the study

spent walking, and engaging in moderate-to-vigorous or intense activities. Participants report the number of days and duration of vigorous PA, moderate-intensity PA, and walking during the previous week. The time spent in sedentary behavior (sitting, lying down) is also recorded. PA level is expressed in metabolic equivalent task (MET)-minutes. One MET is defined as 3.5 mL/kg per min, representing the amount of oxygen consumed per kilogram of body weight per minute at rest. Standard MET values in the IPAQ are 8.0 for vigorous activity, 4.0 for moderate activity, and 3.3 for walking. Total MET values are calculated based on the number of days and duration of PA performed during the past week (22). PA levels are categorized into three groups (23):

Inactive (category 1): The lowest level of PA; activities not meeting the criteria for categories 2 and 3.

Minimally Active (category 2): Individuals who meet one of the following criteria: a) vigorous activity for at least 20 minutes on 3 or more days, b) moderate-intensity activity or walking for at least 30 minutes per day on 5 or more days, c) moderate-intensity activity and walking totaling to at least 600 MET-min/week across 5 or more days.

Very Active (category 3): Equivalent to about one hour or more of moderate-intensity activity per day, sufficient for health benefits. a) vigorous activity on at least 3 days, yielding a minimum of 1500 MET-min/week, or b) a combination of 7 or more days of walking, moderate, or vigorous activity totaling at least 3000 MET-min/week.

The following MET values were used for IPAQ data analysis:

Walking=3.3 METs

Moderate PA=4.0 METs

Intense PA=8.0 METs

Exercise Benefits/Barriers Scale

The EBBS, developed by Sechrist et al. (17), assesses individuals' perceptions of the benefits and barriers associated with exercise. Higher total EBBS scores indicate greater recognition of exercise benefits. The Turkish version of the scale was validated by Ortabag et al. (18), with a Cronbach's alpha coefficient of 0.95. The scale consists of 43 Likert-type items rated as "1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree." The total score range for the benefits scale is 29-116, and for the barriers scale, 14-56. Higher Benefit scores reflect greater perceived exercise benefits, whereas higher barriers scores indicate stronger perceived exercise Barriers (Table 1) (18).

Table 1. Subscales of the Exercise Benefits/Barriers Scale

Exercise Benefits Scale subdimensions (29 items)	
Life enhancement	(25,26,29,32,34,35,36,41)
Physical performance	(7,15,17,18,22,23,31,43)
Psychological view	(1,2,3,8,10,20)
Social interaction	(11,30,38,39)
Preventive health	(5,13,27)
Exercise Barriers Scale subdimensions (14 items)	
Exercise environment	(9,12,14,16,28,42)
Spending time	(4,24,37)
Physical effort	(6,19,40)
Family barrier	(21,33)

Beck Depression Inventory

The BDI was developed by Beck in 1961 to measure depression risk and the severity and progression of depressive symptoms in adults. The Turkish version's reliability and validity were confirmed by Hisli (24), with a Cronbach's alpha coefficient of 0.80 and validity coefficient of 0.74. It is a one-dimensional, 4-point Likert-type scale consisting of 21 items, each scored from 0 and 3 according to symptom severity. The pathological cut-off point is 17, with total scores ranging from 0 to 63. Score ranges are defined as follows: 0-9, no depression; 10-16, mild depression; 17-24, moderate depression; 25 and above, severe depressive symptoms (24). The BDI has been translated into multiple languages and shown strong cross-cultural reliability and validity. It has been used in Turkiye by Hisli (24) and Aktürk et al. (19) in various research and clinical settings, with Cronbach's alpha values of 0.80 and 0.85, respectively.

Statistical Analysis

Data analysis was performed using SPSS 22.0. Sample size was determined by power analysis. Descriptive characteristics of the participants were analyzed using percentage and frequency distributions. Mean and standard deviation (SD) values were calculated for scale analyses. Effect size was determined using Cohen's (d) and eta-squared (η^2) coefficients. Comparisons by demographic variables (sex, marital status, education) were exploratory and analyzed using frequency/percentage distributions and chi-square tests where applicable. No formal correction for multiple testing was applied.

Results

Key Characteristics of the Patients

The study initially included 189 individuals with MS and an EDSS score between 1 and 5. However, based on the exclusion criteria, data from 80 patients who completed the survey were analyzed. The participants' ages ranged from 18 to 63 years, with a mean of 32.71±9.22 years. The mean disease duration ranged from 1 to 40 years, with an average of 3.81±5.46 years. Detailed information on key characteristics is provided in Table 2.

The mean ± SD, minimum, and maximum scores of participants for the EBBS, IPAQ, and BDI are presented in Table 3. As shown in Table 3, the total IPAQ scores demonstrated high variability (mean ± SD=2116±1825 MET-min/week), indicating a skewed distribution of self-reported PA.

The frequency and percentage distribution of participants' PA

Table 2. Characteristics of the patients		
Groups	**Frequency (n)**	**Percentage (%)**
Sex		
Male	23	28.7
Female	57	71.2
Marital status		
Single	46	57.5
Married	34	42.5
Education status		
High school or lower	18	22.5
University	48	60.0
Post-graduate	14	17.5
Active working status		
Yes	35	43.8
No	45	56.2
Regular exercise status		
Yes	23	28.7
No	57	71.2
	Mean	**SD**
Age (year)	32.710	9.222
Weight (kg)	67.800	17.390
Height (cm)	168.340	8.999
BMI	23.749	4.784
EDSS	2.210	1.187
Disease duration (year)	3.810	5.468

EDSS: Expended Disability Status Score, BMI: Body mass index, SD: Standard deviation

levels are shown in Figure 2. Based on the PA classification, 7 participants (8.8%) were inactive, 58 (72.5%) were minimally active, and 15 (18.8%) were very active.

The parameters examined and the results of the correlation analyses are presented in Table 4.

The correlation between age, body mass index (BMI), EDSS, disease duration, total benefits, total barriers, total EBBS, depression, and IPAQ scores revealed the following: a positive weak correlation between EDSS and age ($r=0.433$, $p<0.001$); a positive moderate correlation between disease duration and age ($r=0.537$, $p<0.001$); a positive moderate correlation between disease duration and EDSS ($r=0.535$, $p<0.001$); a positive weak correlation between total barriers and BMI ($r=0.347$, $p=0.002$); a positive very high correlation between EBBS total and total benefits ($r=0.949$, $p<0.001$); a positive weak correlation between depression and BMI ($r=0.314$, $p=0.005$); and a positive weak correlation between depression and total barriers ($r=0.443$, $p<0.001$). No other correlations were statistically significant ($p>0.05$).

The results of all analyses comparing scale scores according to descriptive characteristics are provided in Table 5. Total benefits, barriers, EBBS total, depression, and PA scores did not differ significantly by sex ($p>0.05$). Total benefits, EBBS total, and depression scores showed no significant differences by marital status ($p>0.05$). Similarly, total benefits, barriers, EBBS total, depression, and PA scores did not differ significantly by education level ($p>0.05$). Benefits, barriers, EBBS total, depression, and PA scores were also not significantly different according to active employment status ($p>0.05$). Finally, EBBS total and depression scores showed no significant difference according to regular exercise status ($p>0.05$).

Table 3. Mean scores of the EBBS, IPAQ and depression					
	n	**Mean**	**SD**	**Min**	**Max**
Life enhancement	80	24.225	5.313	8.000	32.000
Physical performance	80	26.575	5.334	8.000	32.000
Psychological view	80	18.838	4.232	6.000	24.000
Social interaction	80	10.550	2.599	4.000	16.000
Preventive health	80	9.200	2.113	3.000	12.000
Total benefits	80	89.388	17.765	32.000	116.000
Exercise environment	80	11.413	2.745	6.000	21.000
Spending time	80	5.788	1.429	3.000	10.000
Physical effort	80	7.588	2.353	3.000	12.000
Family barrier	80	3.638	1.478	2.000	8.000
Total barriers	80	28.425	5.708	14.000	44.000
EBBS total	80	117.813	17.898	59.000	145.000
Depression	80	15.600	9.853	1.000	51.000
IPAQ physical activity	80	2116.181	1825.311	450.000	9513.000

EBBS: Exercise Benefits and Barriers Scale, IPAQ: International Physical Activity Questionnaire, SD: Standard deviation

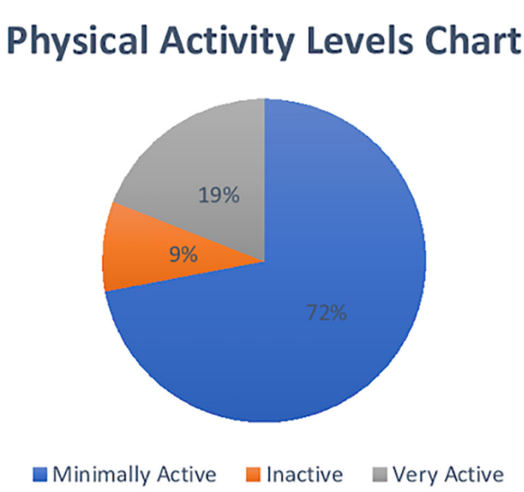

Figure 2. Physical activity levels chart

Discussion

The main finding of this study is that individuals with MS recognize the benefits of exercise; however, they consider depression, lack of physical effort, and environmental factors as major barriers to participation. Although participants believed that depression negatively affected their PA levels, this relationship was not statistically significant.

The present study aimed to determine whether depression influences exercise perception and PA levels in individuals with MS. The mean age of the 80 participants was 32.71 years, and most were university graduates. The mean EDSS score of 2.21 indicates that participants had mild disability. Studies in the literature using this scale have shown a positive correlation between EDSS score and age (25). The positive correlations observed in our study between EDSS, age, and disease duration are consistent with these findings.

MS is a chronic neurodegenerative disease with diverse symptoms and an unpredictable course that can severely affect patient's QOL. Among these symptoms, depression is the prevalent psychiatric disorder (28). Although it is generally mild, the proportion of patients with moderate and severe depression is quite high (8,29). In our study, the mean BDI of 15.60 supports previous findings that MS patients commonly experience mild depression symptoms. Depression negatively affects QOL and is influenced by various factors, including socio-economic status, education level, and physical condition.

Sebastião and Motl (30) reported that a high BMI is associated with increased disease risk and longer disease duration in individuals with MS. They also identified links between elevated BMI and comorbidities such as cardiovascular diseases, musculoskeletal pain, arthritis, and hypertension (30). Cambil-Martín et al. (31) found that overweight MS patients had higher levels of depression, reduced functional capacity, and poorer health compared to those of normal weight. In our study, a

Table 4. Correlation analysis of the data

		Age	BMI	EDSS	Disease duration	Total benefit	Total barriers	EBBS total	Depression	IPAQ physical activity
Age	r	1.000								
	p	0.000								
BMI	r	-0.059	1.000							
	p	0.603	0.000							
EDSS	r	0.433**	-0.013	1.000						
	p	0.000	0.908	0.000						
Disease duration	r	0.537**	0.048	0.535**	1.000					
	p	0.000	0.672	0.000	0.000					
Total benefits	r	-0.076	-0.127	-0.204	-0.023	1.000				
	p	0.503	0.262	0.069	0.840	0.000				
Total barriers	r	0.115	0.347**	0.156	0.065	-0.137	1.000			
	p	0.309	0.002	0.166	0.568	0.224	0.000			
EBBS total	r	-0.039	-0.015	-0.153	-0.002	0.949**	0.183	1.000		
	p	0.733	0.892	0.176	0.986	0.000	0.105	0.000		
Depression	r	-0.019	0.314**	0.092	0.089	-0.123	0.443**	0.020	1.000	
	p	0.867	0.005	0.418	0.432	0.279	0.000	0.863	0.000	
IPAQ physical activity	r	0.123	0.091	-0.072	0.151	0.148	-0.142	0.102	-0.195	1.000
	p	0.277	0.421	0.524	0.182	0.190	0.208	0.370	0.083	0.000

*: <0.05, **: <0.01, pearson correlation analysis, EDSS: Expended Disability Status Score, EBBS: Exercise Benefits and Barriers Scale, IPAQ: International Physical Activity Questionnaire, BMI: Body mass index

Table 5. Differentiation of scale scores according to descriptive characteristics

Demographic characteristics	n	Total benefits	Total barriers	EBBS total	Depression	IPAQ physical activity
Sex		**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**
Male	23	89.478±17.835	27.609±5.868	117.087±16.790	16.261±10.082	2623.804±2243.637
Female	57	89.351±17.896	28.754±5.661	118.105±18.462	15.333±9.837	1911.351±1604.374
t		0.029	-0.811	-0.229	0.379	1.595
p		0.977	0.420	0.820	0.706	0.115
Marital status		**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**
Single	46	92.478±16.408	27.370±5.975	119.848±16.101	14.739±8.755	2520.011±2008.784
Married	34	85.206±18.897	29.853±5.064	115.059±19.994	16.765±11.201	1569.824±1392.334
t		1.837	-1.958	1.186	-0.908	2.368
p		0.070	0.054	0.239	0.367	0.020
Education status		**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**
High school or lower	18	85.389±24.222	28.889±5.132	114.278±25.584	18.000±12.291	1822.417±1635.941
University	48	89.938±16.614	28.625±5.945	118.563±16.066	15.396±9.165	2227.844±1863.068
Post-graduate	14	92.643±10.867	27.143±5.789	119.786±11.570	13.214±8.631	2111.036±2008.090
F		0.709	0.436	0.472	0.954	0.317
p		0.495	0.648	0.626	0.390	0.729
Active working status		**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**
Yes	35	90.229±16.863	28.314±5.285	118.543±17.631	13.371±7.963	2177.000±1930.418
No	45	88.733±18.599	28.511±6.074	117.244±18.281	17.333±10.875	2068.878±1759.890
t		0.371	–0.152	0.320	-1.810	0.261
p		0.711	0.880	0.750	0.064	0.795
Regular exercise status		**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**	**mean ± SD**
Yes	23	97.087±12.894	25.130±5.463	122.217±14.164	12.304±7.289	3216.696±2511.862
No	57	86.281±18.594	29.754±5.289	116.035±19.023	16.930±10.479	1672.114±1234.221
t		2.546	-3.506	1.407	-1.933	3.689
p		0.013	0.001	0.163	0.057	0.009

EBBS: Exercise Benefits and Barriers Scale, IPAQ: International Physical Activity Questionnaire, F: Analysis of variance test; t: Independent groups t-test , post-hoc: Tukey, least significant difference

positive correlation was observed between BMI and BDI scores, indicating that higher BMI was associated with higher levels of depression. Furthermore, individuals with higher depression scores demonstrated lower perceptions of exercise benefits and reported greater barriers to exercise.

Because effective strategies for preventing MS remain unclear, current research increasingly focuses on managing the disease and alleviating its symptoms. PA has been shown to yield both general and specific benefits for individuals with MS (9). Numerous studies have demonstrated that PA lays a crucial role in managing MS and meeting its physical challenges (9,15). Despite these benefits, individuals with MS tend to lead more sedentary lifestyles compared with the general populations (3,32,33). Multiple studies have confirmed that individuals with MS engage in less PA than healthy controls and fail to achieve sufficient PA levels despite increased efforts to promote its (3,9). In the present study, the IPAQ results showed that most participants were inactive or minimally active, consistent with previous findings. However, the extent to which this inactivity is associated with depression remains inadequately understood. Psychological distress in individuals with MS may contribute to inactivity, yet it remains uncertain whether this stems from limited awareness of PA benefits and reduced physical energy. Only a few studies using the EBBS scale have examined these parameters together in MS populations (15,29).

The EBBS, with includes benefit and barrier subdimensions, is a comprehensive tool assessing adults' perceptions of exercise benefits and barriers (18-88) (34). By identifying perceived deficiencies, this scale an help enhance motivation and improve attitudes toward exercise participation. In a study conducted to

examine perspective on PA and exercise using the EBBS, it was found that individuals' awareness was insufficient to promote exercise participation, and that the most significant barrier was related to physical effort (15). Zunft et al. (32) reported that one of the key parameters preventing exercise participation is time. In our study, lack of physical effort and environmental limitations were identified as the main factors preventing exercise. Participants stated that exercising caused physical fatigue, was difficult to perform, and that lacked the appropriate environment and financial resources to overcome these challenges. They also reported that family- and time-related problems were lower-level barriers to exercise. In addition, our study revealed that depression levels constitute a major obstacle to engaging in exercise. Plow et al. (33) investigated factors limiting PA by interviewing 13 individuals with MS and found that physical factors (such as access to facilities and weather conditions), social factors (including lack of support from family and friends), and health factors (such as fatigue or depression) were influential, findings consistent with those of the present study. Likewise, our results align with those of Kayes et al. (35) who surveyed 282 individuals with MS and found that the primary barriers to PA were self-efficacy and mental fatigue. In line with these findings, Ozden et al. (12) also emphasized that individuals with MS encounter significant barriers to PA, including environmental limitations, fatigue, and depressive symptoms. Their research confirmed the predictive role of exercise perception and kinesiophobia in physical inactivity, highlighting the multidimensional nature of exercise avoidance in this population. These findings further validate the importance of assessing both physical and psychological barriers when designing rehabilitation strategies for individuals with MS.

Many factors have been cited in the literature as contributing to PA deficiencies. These factors were also observed in our study, which demonstrated the relationship between depression and scores on the exercise barrier/benefit questionnaire. The most significant determinants were internal, particularly an individual's mental perception, sense of self-efficacy, and motivation level. Fifolt et al. (36) examined the relationship between exercise and self-efficacy in individuals with MS and reported that, although individuals believe in their own abilities, this perception may fluctuate over time. Enhancing self-efficacy and demonstrating individual's capacity for success may be an effective approach to increase PA levels among individuals with MS.

Strengthening self-efficacy and reinforcing individuals' confidence in their ability to succeed may thus represent an effective strategy for enhancing PA participation in MS. Furthermore, exercises with family members and friends may increase motivation and help make PA a sustainable part of daily life. Our findings contribute significantly to this field by showing that participants with low PA levels identified both perceived benefits and barriers to exercise. Specifically, on the exercise benefits scale, the highest mean score was observed for the physical performance subscale, while the lowest was recorded for the social interaction subscale. Participants emphasized improvements in muscle strength, physical fitness, flexibility, cardiovascular function, and endurance as the most important exercise-related benefits. Consistent with our findings, a study conducted among university students also reported the highest values for the physical performance subscale and the lowest for the social interaction subscale (37). Dalibaltaa and Davison (38) likewise found the same pattern for these subscales. Other results reported in the literature are consistent with our findings, and our study is particularly significant as it is the first to classify the EBBS according to subscales in individuals with MS. In recent years, studies have increasingly emphasizing the importance of identifying behavioral patterns and providing interventions to address deficiencies in order to increase PA levels and promote activity among individuals with MS (39). In this context, it is crucial to define depression and PA levels in MS patients and to explore their perspectives on exercise, as demonstrated in the present study. It is recommended that professionals working with individuals with MS conduct evaluations prior to implementing programs that include exercise and PA, taking into account the depression status of participants, and design interventions accordingly.

Study Limitations

Due to the length of the questionnaires, individuals with MS experienced difficulty completing them. A larger number of participants could potentially have been included through the use of shorter forms. Given the high variability observed in IPAQ scores, reporting both the mean ± SD and the median (interquartile range) would provide a more comprehensive description of the data. Although only mean ± SD values were available in the present study, this consideration should be addressed in future research. Another limitation of the study is the absence of detailed information regarding MS subtypes (RRMS, PPMS, SPMS). Since MS types may influence depression and PA levels, future studies should report and analyze subtype-specific outcomes. Additionally, because multiple subgroup comparisons were conducted without adjustments for multiple testing, the potential for type I error should be acknowledged, and these findings interpreted with caution. All outcome measures in this study were based on self-report questionnaires, which may be affected by recall and response bias. Furthermore, the cross-sectional design precludes drawing causal inferences between depression, exercise perception, and PA levels. Although the sample size met the calculated requirement, it remains relatively small and may limit the generalizability of the findings.

Conclusions

Depression influences PA levels and exercise perception in individuals with MS, highlighting the need for targeted interventions. Psychological problems may negatively affect exercise perception, leading to reduced participation in PA. Further studies are warranted in this area, as early interventions may positively influence disease prognosis. Future research should employ longitudinal designs to clarify causal relationships between depression, exercise perception, and PA. Moreover, intervention studies addressing both psychological (e.g., self-efficacy, depressive symptoms) and environmental (e.g., accessibility, social support) barriers could yield valuable insights for developing more effective rehabilitation strategies.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the Ethics Committee of Fenerbahce University (decision no: 6, date: 01.09.2021).

Informed consent: Was obtained from all individual participants included in the study. Participants completed electronic informed consent forms prior to enrollment.

Footnotes

Authorship Contributions

Concept: A.T.T., C.I., Data Collection or Processing: M.Y., Writing: A.T.T., C.I., D.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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Supplamentary Table 1. STROBE statement-checklist of items that should be included in reports of observational studies

	Item no	Recommendation	Page no	Relevant text from manuscript
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Title page
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Abstract
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3	
Objectives	3	State specific objectives, including any prespecified hypotheses	3	End of the third page
Methods				
Study design	4	Present key elements of study design early in the paper	4	Participants part
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4	Participants part
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	4	Participants part
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed Case-control study—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4	Outcome measures part
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4-5-6-7	Outcome measure part to end of the sixth page
Bias	9	Describe any efforts to address potential sources of bias	N/A	
Study size	10	Explain how the study size was arrived at	7	Data analysis

Supplamentary Table 1. Continued				
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7	Data analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7	Data analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	
		(c) Explain how missing data were addressed	N/A	
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed Case-control study—If applicable, explain how matching of cases and controls was addressed Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	N/A	
		(e) Describe any sensitivity analyses	N/A	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8	Key charecteristics of the patients
		(b) Give reasons for non-participation at each stage	8	Key charecteristics of the patients
		(c) Consider use of a flow diagram	4	Participants part/Figure 2
Descriptive data	14*	(a) Give characteristics of study participants (eg., demographic, clinical, social) and information on exposures and potential confounders	Table 1 and Table 2	
		(b) Indicate number of participants with missing data for each variable of interest	8	Key charecteristics of the patients
		(c) Cohort study—Summarise follow-up time (eg., average and total amount)	N/A	
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9 and Tables of the study	
		(b) Report category boundaries when continuous variables were categorized	Table 2	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	
Other analyses	17	Report other analyses done—eg., analyses of subgroups and interactions, and sensitivity analyses	N/A	

Supplamentary Table 1. Continued				
Discussion				
Key results	18	Summarise key results with reference to study objectives	9	First part of nineth page
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-10-11-12-13	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-10-11-12-13	
Generalisability	21	Discuss the generalisability (external validity) of the study results	9-10-11-12-13	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14	

*: Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies, STROBE: Strengthening the Reporting of Observational studies in Epidemiology, N/A: Not applicable

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org