Prevalence and Associated Factors of Falls in Persons with Multiple Sclerosis: A Cross-Sectional Study

Prévalence et Facteurs Associés aux Chutes chez les Personnes Atteintes de Sclérose en Plaques: Étude Transversale

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ABSTRACT

Introduction: Multiple sclerosis (MS) is a potentially disabling disease of the brain and spinal cord. Falls are a serious health concern for persons with MS (PwMS).

Aim: To determine the frequency and associated factors of falls in PwMS.

Methods: A cross-sectional study was conducted in the Physical Medicine and Rehabilitation and Neurological Departments at the Military Hospital of Tunis between July and December 2022. Participants meeting the inclusion criteria completed a survey focusing on the prevalence and related factors of falls. In addition to the survey and a thorough clinical and functional examination, we used the 12-item MS Walking Scale (MSWS-12), the Fall Efficacy Scale International (FES-I), the Short Physical Performance Battery (SPPB), and the 10-meter walk test for clinical assessment of balance. A baropodometric platform was employed for instrumental assessment.

Results: Thirty individuals with an average age of 33,6 [SD: 7,7], completed the survey with a mean Expanded Disability Status Scale = 2,5. Twenty-one patients reported falling at least once since the diagnosis. The MSWS-12 mean score was 61 % and the FES-I scored an average of 33.8. The average total score of the SPPB was 8. Total boli of corticosteroids prescribed during disease flare-ups (p=0,022), magnetic resonance imaging lesions of the basal ganglia (p=0,047), vestibular syndrome (p=0,048), MSWS-12 score (p=0,022), and the chair lift test of SPPB (p=0,018) were significantly associated with the prevalence of falling. No significant differences were observed for the instrumental assessment.

Conclusion: Falls are frequent in PwMS. MSWS-12, the FES-I, and the SPPB, can be used by clinicians to predict potential fallers of the PwMS.

Key words: Multiple sclerosis, Falls, Balance, Disability, Baropodometric Analysis, health concern

RÉSUMÉ

Introduction: La sclérose en plaques (SEP) est une maladie potentiellement invalidante du cerveau et de la moelle épinière. Les chutes représentent une préoccupation majeure pour la santé des personnes atteintes de SEP (PwMS).

Objectif: Déterminer la fréquence et les facteurs associés aux chutes chez les PwMS.

Méthodes: Une étude transversale a été menée dans les départements de Médecine Physique et de Réadaptation et de Neurologie de l'Hôpital Militaire de Tunis entre juillet et décembre 2022. Les participants répondant aux critères d'inclusion ont complété une enquête portant sur la prévalence et les facteurs liés aux chutes. En plus de l'enquête et d'un examen clinique et fonctionnel approfondi, nous avons utilisé l'échelle 12-item MS Walking Scale (MSWS-12), Fall Efficacy Scale International (FES-I), the Short Physical Performance Battery (SPPB) et le test de marche de 10 mètres pour une évaluation clinique de l'équilibre. Une plateforme baropodométrique a été utilisée pour l'évaluation instrumentale.

Résultats: Trente individus âgés en moyenne de 33,6 ans [SD : 7,7], ont complété l'enquête avec un score moyen à l'échelle Expanded Disability Status Scale (EDSS) de 2,5. Vingt et un patients ont déclaré être tombés au moins une fois depuis le diagnostic. Le score moyen du MSWS-12 était de 61 % et celui du FES-I était de 33,8 en moyenne. Le score total moyen du SPPB était de 8. Le nombre total de bolus de corticostéroïdes prescrits lors des poussées de la maladie (p=0,022), les lésions du ganglion basal à l'imagerie par résonance magnétique (p=0,047), le syndrome vestibulaire (p=0,048), le score MSWS-12 (p=0,022) et le test de levée de chaise du SPPB (p=0,018) étaient significativement associés à la prévalence des chutes. Aucune différence significative n'a été observée pour l'évaluation instrumentale.

Conclusion: Les chutes sont fréquentes chez les PwMS. Le MSWS-12, le FES-I et le SPPB peuvent être utilisés par les cliniciens pour les prédire dans cette population.

Mots clés: Sclérose en plaques, Chutes, Équilibre, Invalidité, Analyse baropodométrique, Préoccupation de santé

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INTRODUCTION

Multiple sclerosis (MS) is a chronic inflammatory demyelinating autoimmune disease of the central nervous system (CNS). It's not a homogeneous disease in terms of symptom expression. The most frequent form (85% of cases) is the relapsing-remitting (RR) form, which progresses in relapses [1]. With the repetition of relapses, residual disability may appear and progressively evolve. This is known as the secondary-progressive (SP) form of the disease (1).

This neurological condition often leads to various physical impairments, among which balance disorders, and consequent falls are of significant concern in persons with multiple sclerosis (PwMS) compared to healthy age-matched controls (2). Indeed, it is estimated, that approximately 50% of PwMS have experienced a fall within the past six months, with 30-50% of these individuals falling on multiple occasions (3). It not only contributes to a decline in physical health but also impose a substantial psychological burden, impacting their overall quality of life.

This study aimed to measure the frequency of falls in patients followed for MS at the Neurology and Physical Medicine and Functional Rehabilitation departments of the Military Hospital of Tunis and to identify associated factors contributing to falls within in PwMS.

METHODS

An observational, descriptive study with cross-sectional data collection was conducted on a series of cases at the Physical Medicine and Functional Rehabilitation Department, in collaboration with the Neurology Department, at the Tunis Military Hospital (Tunisia) between July and December 2022.

Participants

Patients diagnosed with multiple sclerosis based on the 2017 McDonald clinico-radiological criteria, aged between 18 and 50 years, and with an Expanded Disability Status Scale (EDSS) score of ≤ 6 were included. Exclusion criteria encompassed patients with cognitive impairment that hindered their ability to follow instructions, those who had experienced a relapse in the past month or a recent change in long-term treatment, individuals with other conditions causing gait disorders (e.g., orthopedic or traumatic conditions), and pregnant women.

Procedure

Patients were interviewed and assessed individually. Socio-demographic data, clinical characteristics of MS, current medical treatments, and both clinical and instrumental assessments of balance were recorded.

Measures

Falls and Falls-related questions

A fall has been defined by the Prevention of Falls Network Europe (ProFaNE) as "an unexpected event in which participants come to rest on the ground, floor or lower level" (4).

The characteristics of the falls were investigated by specifying the evolution, the number of falls in the last 12 months, the repercussions of the falls and the severity using The Hopkins Falls Grading Scale (HFGS) (5), time and place of falls, and circumstances leading to the fall.

The 12 Item Multiple Sclerosis Walking Scale (MSWS-12)

This 12-item survey requested patients to assess the impact of MS on their walking and walking-related activities over the previous two weeks and it included questions on running, stair climbing, effort, speed, quality, balance, and need for assistance. Its score can be transformed into a scale from 0 to 100 (6). The higher this score was, the greater was the disability for activities of daily living.

The Falls Efficacy Scale International (FES-I)

It is a valid and reliable self-assessment scale recommended by ProFane as the preferred tool for measuring fall-related concerns and fear of falling (fall apprehension) in 16 everyday situations (maximum score = 64). It has been designed for both clinical and research use, thanks to its speed and ease of completion (7-9). Patients with a score >20 were defined as subjects with a fear of falling and those with a score ≤20 were defined as not afraid of falling.

The Short Physical Performance Battery (SPPB)

The SPPB assesses lower limb function based on standing balance, walking speed, and lower limb strength (10,11). Standing balance was assessed by asking participants to maintain an upright posture while standing with feet side by side, in semi-tandem and tandem, for 10 seconds per position. Walking speed was assessed based on the time required for a participant to cover 4 meters at a normal pace. Lower limb strength was assessed using a test consisting of sitting on a chair and rising from it completely 5 times as fast as possible, without using the arms for support. Participants were first asked to try sitting down and getting up once, before starting the whole test.

The 10-meter walk test with and without task

The 10-meter timed walk test has been recommended for measuring disability and evaluating the effect of physiotherapeutic interventions aimed at restoring mobility in MS patients (12). It is considered valid, reliable, and sensitive to change (13,14). The double task was to count backward from 20 to 0.

Expanded Disability Status Scale (EDSS)

This scale is based on a neurological examination of eight functional parameters (FPs). The four major ones are pyramidal function, cerebellar function, sensory function, and brainstem function. The four minor ones are intestinal and urinary function, visual function, cerebral function, and other functions. A score of increasing severity (from

0 to 6 or 7) is assigned to each of these eight PF. The final score is rated from 0 to 10, and there are 20 possible levels (as it evolves in half-point increments).

The Functional Independence Measure (FIM)
It assesses 6 functional aspects (Self-care, sphincter control, mobility / transfers, locomotion, communication, and social behavior), grouped into two Domains (Motor and cognitive) (15).

The Hospital Anxiety and Depression Scale (HAD)
It's a validated scale in Arabic, which, through its two parts: anxiety and depression, measures a person's level of mental suffering (16).

Baropodometric examination
The platform used for this work is the *FreeMed®*, from *SensorMedica, Italy*. It evaluated static and dynamic analysis of stabilometric and baropodometric variables. The parameters assessed are the projection of the center of gravity within the sustentation polygon, and the balance of support distribution between the 2 lower limbs. Static and dynamic plantar statics are also assessed. When walking, the support time per limb is also recorded.

Statistical analysis

Data were entered and analyzed using SPSS version 22.0 (Statistical Package for the Social Sciences, SPSS Inc., IBM).
Comparisons of 2 means on independent series were performed using Student's t-test for independent series and Mann-Whitney test for variables not following a normal distribution.
Comparisons of percentages on independent series were carried out using Pearson's chi-square test, and in the event of non-validity of this test, and comparison of 2 percentages, using Fisher's two-tailed exact test.
Binary logistic regression was used to determine the relationship between the various parameters and the frequency of falls and to identify the factors associated with falls.

RESULTS

During our study, we invited 72 patients following up for MS and meeting the inclusion criteria to participate. Among them, 32 patients were not included, and 10 patients were excluded from the study. We therefore included 30 patients in our study. The flow chart is shown in Figure 1.

Sociodemographic features

Thirty individuals with an average age of 33,6 [SD: 7,7], completed the survey. Most of them were female, with a sex ratio of 3.3.
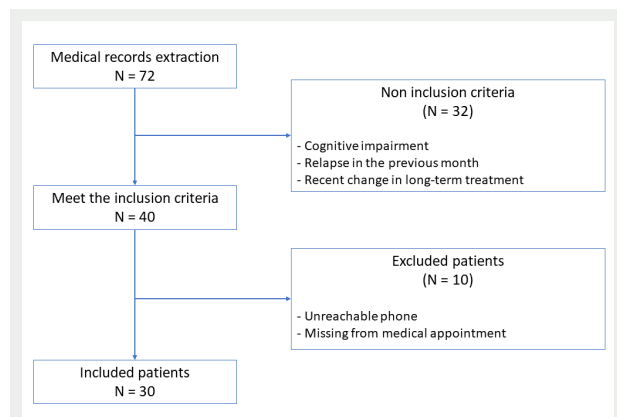

Figure 1. Flow chart

Fall frequency and characteristics

Among 30 patients, 21 (70%) had experienced a fall since the diagnosis of MS. 67% of these fallers had had more than 2 falls in the previous 12 months. Only three patients (10%) consulted a doctor or the emergency room after the fall.
Table 1 summarizes the characteristics of falls in the study population.

Table 1. Characteristics of falls in the study population

Item		Results
Falls frequency		70 %
Number of falls in the past 12 months		2,0 [Q25= 1; Q75= 3,5]
Falls Schedule	Nocturnal	5 % of fallers
	Diurnal	95 % of fallers
Falls location	Exterior	62 % of fallers
	Interior	38 % of fallers
Circumstances leading to falls	Going to the toilet for urinary urgency/nycturia	10%
	Obstacle when walking	52%
	Double task when walking	24%
	Fall during transfer	5%
	Change of surface (stairs, steps)	62%
HFGS score (median)		2
Consequences of falls	Sprain	7%
	Dermabrasions	17 %
	Fracture	0%
Rising from the ground after a fall	Duration	1,5 min [0-15min]
	Alone	53 %
	With help	17 %
Feeling after a fall	Humiliation	13%
	Fear	23%
	Insecurity	17%
	Sadness	3%

Balance evaluation

Clinical assessment of balance revealed a mean MSWS-12 score of 61% ± 22, indicating difficulties in daily, social, and professional life. A mean FES-I score of 33.8, highlighted the patients' fear of falling. A mean total SPPB score of 8 ± 2.7 indicated an average risk of developing disability in the future.

In the 10-meter walk test, 97% of tested patients had a pathological walking speed without an associated task, compared with 90% when walking with a double task.

A psychological evaluation revealed a mean HAD score (depression) of 7.4 ± 4.1 and a mean HAD score (anxiety) of 9 ± 5.2, consistent with a suspected state of anxiety.

Baropodometric examination showed an offset of the center of gravity in the sustentation polygon in 83% of patients, a dynamic support on the right of 66% ± 9% of the gait cycle, and on the left of 66% ± 8% of the gait cycle on average. In addition, 77% of patients had a cavus foot, compared with 17% with a flat foot.

Associated factors

The univariate analytical study showed a significant association between falling and total corticosteroid boli prescribed during disease flare-ups (p= 0.022), radiological lesions of the UCS noted on the last brain MRI performed (p= 0.047), vestibular syndrome (p= 0.048), the MSWS-12 scale (p= 0.022) and the chair-lift test forming part of the SPPB score (p=0.018).

Table 2 summarize characteristics of the study population relating to falls.

Table 2. characteristics of the study population relating to falls

Anamnestic characteristics			Fallers (n)	Non-fallers (n)	p
Average age			35	31	0,194
Clinical form	recurrent remitting		70 %	30 %	1,0
	secondary progressive		67 %	33 %	
Disease progression in months			90,9 ± 59,5	89,1 ± 89,2	0,691
Distribution of lesions on cerebral MRI	Cerebellum		62 %	38 %	0,44
	Brain stem		54 %	46 %	0,123
	Central Grey Nuclei		**100 %**	**0 %**	**0,047**
	Cortical		73 %	27 %	1,0
	Subcortical		69 %	31 %	1,0
	Medullary		67 %	33 %	0,637
Medical treatment received	Long term treatment		65 %	35 %	0,287
	Total corticosteroid boli		**5,4 ± 3,7**	**3,1 ± 1,5**	**0,022**
	Antispastic treatment		100 %	0 %	0,534
	Treatment of neuropathic pain		0 %	100 %	0,3
Technical assistance	Canadian cane		50 %	50 %	0,677
	4-wheel walker		100 %	0 %	
	average use in years		4	2	
Neurological evaluation	Pyramidal syndrome		71 %	29 %	0,842
	Posterior cord syndrome		100 %	0 %	0,160
	Cerebellar syndrome		64 %	36 %	0,523
	Vestibular syndrome		**100 %**	**0 %**	**0,048**
	Visual disorders		71 %	29 %	0,925
	Oculomotor disorders		100 %	0 %	1,0
	Psychiatric disorders		100 %	0 %	0,534
Fatigue			68 %	32 %	0,338
Spasticity of triceps surae on average			1	0	0,305
Motor Deficit	Lower limb		73 %	27 %	0,738
	Upper limb		80 %	20 %	
	Proximal		76 %	24 %	0,711
	Distal		70 %	30 %	
MSWS-12			**67 % ± 17**	**47 % ± 28**	**0,025**
FES-I			35,7 ± 9,6	29,4 ± 14,6	0,08
SPPB	Balance test		2,7 ± 1,3	3,3 ± 1,0	0,250
	Walking Speed Test		3,1 ± 1	3,3 ± 1	0,640
	Chair Lifting Test		**1,6 ± 0,8**	**2,4 ± 0,7**	**0,018**
	Total		7,5 ± 2,6	9,1 ± 2,5	0,139
10-meter walk test	Without task	Speed	1 ± 0,2	1,1 ± 0,3	0,070
		Number of steps	16,9 ± 4,6	15,7 ± 3,7	0,512
		Step length	0,6 ± 0,1	0,6 ± 0,2	0,763
	With task	Speed	0,9 ± 0,2	1,1 ± 0,3	0,083
		Number of steps	19,3 ± 6,3	17,9 ± 5,5	0,571
		Step length	0,5 ± 0,2	0,6 ± 0,1	0,736
EDSS			2,8 ± 1,6	1,9 ± 1,6	0,163
MFI			123,2 ± 3,4	124,3 ± 2,5	0,380

MSWS-12: The 12 Item Multiple Sclerosis Walking Scale, FES-1: The Falls Efficacy Scale International, SPPB: The Short Physical Performance Battery, EDSS: Expanded Disability Status Scale, MFI: The Functional Independence Measure

DISCUSSION

Falls Frequency

In our study, 70% of patients were fallers, with more than 2 falls in the last 12 months in 67% of fallers.

These results are consistent with those found in the literature (Table 3).

Table 3. Prevalence of falls in MS patients in the literature

Author	Country	Year	Population	Prevalence
Cattaneo and al. (3)	Italy	2002	50	54 %
Nilsagård and al. (17)	Sweden	2006	76	63 %
Matsuda and al. (18)	United States	2008-2011	455	58,2 %
Gunn and al. (19)	United Kingdom	2012	148	70,3 %
Hoang and al. (20)	Australia	2013	209	60,3 %
Cameron and al. (21)	United States	2013	52	71 %
Carling and al. (22)	Sweden	2015	67	85 %
Zelaya and al. (23)	United States	2017	51	63 %
Zanotto and al. (24)	United States	2020	106	76,3 %
Edwards and al. (25)	United States	2020	38	72,7 %
Block and al. (26)	United States	2021	94	53 %
Our study	Tunisia	**2022**	**30**	**70 %**

Circumstances and seriousness of these falls have been widely discussed in international studies. In our study, for almost half of all fallers, the fall was not recorded in the medical record, which is in line with previous literature (18,27,28). Many falls go undetected unless specific and frequent questions are asked about them (26).

Respondents to this study reported that falls occurred most frequently during transfer or ambulation activities, with fall-related stumbles reported. This result is similar to Nilsagård et al, Matsuda et al, and Zanotto et al. (18,24,29).

Associated factors contributing to falls

In our study, the factors significantly associated with the prevalence of falls were total corticosteroid boli prescribed during disease relapses (p= 0.022), radiological lesions of the basal ganglia noted on the last performed brain MRI (p= 0.047), clinical vestibular syndrome (p= 0.048), the MSWS-12 scale score (p= 0.022) and the chair-lift test of the SPPB score (p=0.018).

These results are partly consistent with earlier studies (17,29-33). Indeed, primary progressive (PP) and secondary progressive (SP) forms of multiple sclerosis (MS) present with more vestibular disorders compared to relapsing-remitting (RR) forms. Consequently, progressive forms of MS are associated with a higher incidence of falls than RR forms (32).

Our results align with those of Gunn et al. and Cameron et al. (19,31), showing a significant association between ongoing medical treatment and falls in MS patients. Conversely, some other authors found no such association (17,30). In fact, a high number of corticosteroids boli indicates the severity of the disease, as it reflects an increased number of relapses in cases of recurrent remittent forms. Additionally, high cumulative doses of corticosteroids are a risk factor for secondary osteoporosis, which can lead to fractures if the patient falls.

Despite our negative results regarding lower limb motor deficit (using MRC muscle testing), our bibliographical research found that lower limb strength asymmetries were associated with impaired standing sway and walking speed in women with MS who had experienced an average of three falls in the previous year. This suggest that such strength asymmetries may play a role in gait and postural stability and could predispose women with MS to imbalance and recurrent falls (34). However, our significant chair-lift score test of the SPPB results could be an indirect reflection of this muscular weakness in the lower limbs and make it consistent with the conclusions of the international literature.

Although we found no significant association between triceps surae spasticity and the prevalence of falls, Nilsagård and al. assessed spasticity in the quadriceps and triceps surae and using the sum of spasticity in both lower limbs, they were able to detect an association with falls (17).

As for the FES-I scale, previous studies have shown that fear of falling is an important psychological factor linked to an increased risk of falls. Given that the development of the fear of falling triggers a cascade leading to an escalation in the risk of functional decline, it is not surprising that gait modifications are linked to the fear of falling (35,36). These results were also found for PwMS, independent of age, EDSS score, and gender. It was previously demonstrated that for each point increase in the total 7-item FES-I score, the odds of recurrent falls in the following three and six months increased by 22% and 14%, respectively (37). After adjustment for previous recurrent falls, the 7-item total FES-I score was also found to be significantly associated with recurrent falls in the following three months (9,37).

Lately, the speed of backward walking emerged as one of the main physical examination tests to predict falls in PwMS, and the length of the backward walking stride emerged as the second assessment parameter when all variables were considered in the multifactorial discriminant model (25,38). Its use should be considered for future research.

Both our study and that of Tajali and al. (39) did not identify a significant relationship between the performance of a dual task and the risk of falling. Overall, the controversy between the results of our study and those of previous studies concerning the dual task may be due to differences in study design, study variables, experimental conditions (floor walking vs. treadmill walking), or the level of difficulty of the cognitive task used in previous experiments.

Furthermore, it is suggested that this score alone may not be sufficient to estimate the risk of falls for at least three reasons:

(i) reliability is considerably lower in the lower part of the scale (i.e., scores below 3.0), with a variability level of 40% even assuming a difference of one point (40).

(ii) scores for fallers and non-fallers may overlap (from

3.6 to 5.4 and from 2.6 to 4.7, respectively), according to data from included studies (17,34,41–47).

(iii) patients with multiple sclerosis who are primarily wheelchair-bound (i.e., with a score equal to or greater than 7.0) may have a reduced risk of accidental falls simply because they are not able to walk (48,49).

Our study highlighted the fact that even though the EDSS score was low (2,8 ± 1,6), showing minimal or moderate disability, falls were frequent. It should be deduced that the falls in these patients could be seen early in the disease. For higher scores on the scale, patients are not able to walk and fall. Consequently, a reliable correlation between fall status and the EDSS scale can only be found at the intermediate levels of the scale (50).

In our research work, even if the scores of the HAD scale showed a suspected state of anxiety, we did not find a significant association between it and the occurrence of falls. Previous studies have found that depression is widespread in MS, with between 30% and 50% of PwMS presenting clinically significant symptoms (51,52). Patients who had fallen reported more severe depressive symptoms than those who had not fallen in their study, and that higher depressive symptoms were associated with an increased likelihood of falls in the past year (53). The effects of MS on dynamic gait stability were also examined. The main findings were that PwMS are less stable than their healthy counterparts during the two critical gait events (i.e. the stance phase and the swing phase) (54).

Study strenghts

The subject is insufficiently addressed at the national level, with no Tunisian publications, yet its repercussions can have disastrous consequences for our patients.

The study of factors associated with falls was conducted comprehensively, covering clinical, paraclinical, and functional aspects, using seven different scales to ensure coherent and complete results.

Study limits

The small number of participants was a significant limitation. This was due to the stringent non-inclusion and exclusion criteria applied to an already small initial population. Participants were particularly susceptible to relapses triggered by slight changes in climate or stressful situations.

The absence of a control group prevented us from drawing definitive conclusions about the impact of various associated factors on the prevalence of falls. This limitation hinders the ability to establish causality and fully understand the relationship between these factors and fall risk in PwMS.

CONCLUSION

This study highlights the significant prevalence of falls among persons with multiple sclerosis (PwMS), with 70% of participants reporting at least one fall since their diagnosis. Our findings underscore the utility of the 12-item MS Walking Scale (MSWS-12), the Fall Efficacy Scale International (FES-I), the Short Physical Performance Battery (SPPB), and meticulous clinical and baropodometric examinations in predicting fall risk in this population.

Notably, the association between fall prevalence and factors such as corticosteroid use during relapse, MRI lesions, vestibular syndrome, MSWS-12 scores, and chair lift test performance offers valuable insights for clinicians. These assessments can be instrumental in identifying individuals at higher risk of falls, enabling the implementation of targeted interventions to enhance balance and prevent falls, ultimately improving the quality of life for PwMS.

In conclusion, multimodal comprehensive clinical and instrumental assessments are crucial in managing fall risk among PwMS, and their integration into routine clinical practice is recommended to better predict and prevent falls in this vulnerable population. It may enable early intervention, including referral to specialized physical rehabilitation services, for the implementation of a prevention and correction strategy.

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