CLINICAL IMPLICATIONS OF BASIC RESEARCH

Self-Reported Fatigue and Energy Cost During Walking Are Not Related in Patients With Multiple Sclerosis

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ABSTRACT. Kempen JCE, de Groot V, Knol DL, Lankhorst GJ, Beckerman H. Self-reported fatigue and energy cost during walking are not related in patients with multiple sclerosis. Arch Phys Med Rehabil 2012;93:889-95.

Objectives: To determine whether there is a relationship between self-reported fatigue and the energy cost of walking (ECw), and how self-reported fatigue and ECw relate to physical functioning in patients with multiple sclerosis (MS).

Design: Cross-sectional cohort study, using structural equation modeling.

Setting: Home environment and at a university medical center.

Participants: Patients (N=75) were obtained from a longitudinal study on outcome measurement and functional prognosis in early MS. Patients were included if they were able to walk for 6 minutes without being assisted by a person. The age range was between 28.0 and 69.7 years and the median Expanded Disability Status Scale was 2.5 (range, 1.0–6.5).

Interventions: Not applicable.

Main Outcome Measures: Self-reported fatigue was measured with the Fatigue Severity Scale, the vitality subscale of the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36), and a visual analog scale. Physical functioning was determined with the physical functioning subscale of the SF-36, fast walking speed, and comfortable walking speed. The ECw ($J \cdot kg^{-1} \cdot m^{-1}$) was measured with the energy cost of the walking test.

Results: The relationship between ECw and latent variable fatigue had a $\beta = -.188$ ($P = .236$), that between ECw and physical functioning (SF-36 physical functioning) had a $\beta = -.344$ ($P = .001$), and that between fatigue and physical functioning had a $\beta = -.448$ ($P = .000$).

Conclusions: Fatigue and ECw are not related in patients with MS with mild to moderate walking problems. ECw and fatigue are independent determinants of physical functioning.

Key Words: Fatigue; Multiple sclerosis; Rehabilitation.

FATIGUE IS ONE OF THE most common disabling symptoms in patients with multiple sclerosis (MS).[1-5] Approximately 65% to 97% of the patients have significant fatigue, and between 15% and 60% describe fatigue as the most disabling symptom, with a great impact on daily activities, quality of life, and socioeconomic situation.[4,6-11]

Although much research has been done on MS-related fatigue, its etiology remains unclear.[2,4-6,12,13] An important reason for this is the lack of consensus on defining fatigue.[4,6,14] According to Chaudhuri and Behan,[14] there is overlap between the lay notion of tiredness and the clinically relevant symptom of fatigue, making an exact definition difficult to establish. For clinical use, fatigue is best defined as difficulty in initiating or sustaining voluntary activities.[14] Comi et al[8] described fatigue as an overwhelming sense of tiredness, lack of energy, or feeling of exhaustion, which is even present at rest. It has been shown that the average level of physical activity in patients with MS is lower than that in healthy individuals, but it is not clear whether this is because of neurologic symptoms (motor dysfunction, ataxia, or spasticity) or is related directly to fatigue.[7,15]

MS research has mostly used self-reported questionnaires about MS-related fatigue,[1,16,17] which assess the severity of fatigue symptoms and their impact on an individual's daily functioning. Several scales to measure fatigue have been developed in recent years, but the Fatigue Severity Scale (FSS) has been the most widely used in studies of MS fatigue.[1,7] The FSS has proved to be a valid and highly reproducible self-report questionnaire to measure perceived fatigue in patients with MS.[4,6,7,12] Krupp et al[4] and Whitehead[12] also reported that

List of Abbreviations

CFI	comparative fit index
CI	confidence interval
CWS	comfortable walking speed
ECS	energy consumption
ECw	energy cost of walking
ECWT	energy cost of walking test
EDSS	Expanded Disability Status Scale
FSS	Fatigue Severity Scale
MLR	maximum-likelihood with robust standard errors
MS	multiple sclerosis
RMSEA	root mean square error of approximation
SEM	structural equation modeling
SF-36	Medical Outcomes Study 36-Item Short-Form Health Survey
SF-36 PF	Medical Outcomes Study 36-Item Short-Form Health Survey physical functioning scale
SF-36 VI	The Medical Outcomes Study 36-Item Short-Form Health Survey vitality scale
TLI	Tucker-Lewis Index
VAS	visual analog scale

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the FSS is responsive to changes. Despite the good psychometric properties of the FSS, self-reported questionnaires have their acknowledged limitations, like retrospective bias and social desirability effects.[4,8,13,14]

In other patient groups, such as children with cerebral palsy or persons with postpoliomyelitis syndrome, who frequently mention fatigue and inactivity in everyday life as their symptoms, energy expenditure during walking has been used to investigate whether the fatigue is caused by physical inefficiency.[18,19] If the same relation between physical functioning, energy expenditure, and fatigue is found in MS patients, this would explain a substantial part of the experienced fatigue. Furthermore, energy expenditure could then be used as a more objective outcome measurement related to fatigue. Olgiati,[20] Motl,[21] and colleagues found higher energy expenditure during walking in MS patients than in healthy subjects, which they attributed to locomotor impairments. They did not investigate the relationship with fatigue. Franceschini et al[22] did investigate the relationship between energy expenditure during walking and fatigue, and found that MS patients had increased energy expenditure during walking, but this was not a determinant of fatigue. Their study did not include physical functioning.

The purpose of the present study was to determine whether there is a relationship between self-reported fatigue and energy expenditure during walking, and how self-reported fatigue and energy expenditure during walking relate to physical functioning.

METHODS

Participants

The data in this study were obtained from patients participating in a longitudinal cohort study on outcome measurement and functional prognosis in early MS.[23] An inception cohort of 156 recently (<6mo previously) diagnosed patients, aged 16 to 59 years, was recruited between 1998 and 2000 and followed prospectively for 10 years. For the measurement at 10 years, 137 patients from the original cohort were approached and 109 patients were willing to participate. The measurements at 10 years were supplemented with additional physical performance tests concentrating on walking ability. Measurements were performed during a visit to the patient's home and at the Department of Rehabilitation Medicine of VU University Medical Center, Amsterdam, the Netherlands. For these supplementary tests, patients had to be able to walk 10m without being assisted by a person. Fifteen patients did not have the physical ability to do these measurements, and 13 patients decided not to travel to the outpatient clinic of the VU University Medical Center. Eighty-one patients participated in this part of the measurements.

The Ethics Committee of the VU University Medical Center granted ethical approval for this study.

Measurements

Fatigue. We used 3 different fatigue measurements (table 1). The FSS is a 9-item, self-administered questionnaire to assess the severity of fatigue and its impact on daily functioning during the past week.[3] The participants have to indicate the extent to which the 9 statements apply to them. They can rate their agreement ranging from 1 point, reflecting strongly disagree, to 7 points, indicating strongly agree. The total sum score is then calculated. A visual analog scale (VAS) was used to quantify the patients' fatigue before they started the 6-minute walking test. The patients had to draw a vertical line on a 100-mm horizontal line to indicate how fatigued they were at that moment. One end of the line denoted very tired, while the other end indicated not tired at all. The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) vitality scale (SF-36 VI) is 1 of the 8 subscales in the SF-36[24] to assess

Table 1: Description of the Observed Measurement Scales and Scores in 75 Patients With MS

Name	Description	Scoring Range	Interpretation	Measurement Results, Mean ± SD (range)
Fatigue				
FSS	Fatigue Severity Scale	9–63	Higher values indicate more experienced fatigue	42.2±12.3 (10–63)
VAS	Visual analog scale	0–100	Higher values indicate more fatigue	34.2±22.6 (0–81)
SF-36 VI	Medical Outcomes Study 36-Item Short-Form Health Survey Vitality scale	0–100	Higher values indicate better vitality	56.3±20.2 (0–100)
Physical functioning				
FWS	Fast walking speed (m/s)	0–∞	Higher values indicate a faster walking speed	1.60±0.41 (0.37–2.56)
CWS	Comfortable walking speed (m/s)	0–∞	Higher values indicate a faster walking speed	1.19±0.28 (0.23–1.63)
SF-36 PF	Medical Outcomes Study 36-Item Short-Form Health Survey Physical Functioning scale	0–100	Higher values indicate less limitation in physical functioning	71.9±24.8 (5–100)
Energy expenditure				
ECw	Energy cost of walking ($J \cdot kg^{-1} \cdot m^{-1}$)	0–∞	Higher values indicate more oxygen intake per meter	0.15±0.05 (0.08–0.41)
ECS	Energy consumption during walking ($J \cdot kg^{-1} \cdot min^{-1}$)	0–∞	Higher values indicate more oxygen intake per minute	13.13±2.59 (7.85–21.05)