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RESEARCH REPORT

DOES HOME EXERCISE IMPROVE THE QUALITY OF LIFE, BALANCE, AND FUNCTIONAL EFFICIENCY OF MULTIPLE SCLEROSIS PATIENTS?

CZY ĆWICZENIA WYKONYWANE W DOMU POPRAWIAJĄ JAKOŚĆ ŻYCIA, RÓWNOWAGĘ I SPRAWNOŚĆ FUNKCJONALNĄ PACJENTÓW ZE STWARDNIENIEM ROZSIANYM?

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ABSTRACT

Introduction

Multiple sclerosis (MS) is described as a progressive inflammatory chronic disease affecting central nervous system and resulting in severe cognitive and physical disabilities as well as neurological disturbances.

Aim

The aim of this study was to evaluate the impact of home exercises performed by MS patients (individually adjusted by a physiotherapist) on their quality of life, balance, and functional performance.

Material and methods

Fifteen patients with MS participated in the study. They were assessed using questionnaires (IADL, WHOQOL-BREF, AIS, MFIS) and functional scales (tandem and single leg stance tests, TUG, 3-Meter Walk Test, The Step Test, 30 s Chair Stand Test, The Five Times Sit-to-Stand Test and Functional Reach Test) before starting the exercises and after several months of self-home exercises.

Results

A significant improvement in the WHOQOL-BREF domain 4 scores (environmental health, p = 0.031) was observed in the second study. Improvement was also seen in the Timed Up&Go test (p = 0.027), the 3m walk test (p <0.001), and the Five Times Sit-to-Stand Test (p <0.001).

Conclusions

Self-home exercises by MS patients may improve their functional performance but have little effect on fatigue and disease acceptance. Home exercises should complement traditional rehabilitation.

Keywords: functional assessment, balance, multiple sclerosis

STRESZCZENIE

Wstęp

Stwardnienie rozsiane (SM) to postępująca zapalna choroba przewlekła wpływająca na ośrodkowy układ nerwowy (OUN) oraz powodująca poważne upośledzenie funkcji poznawczych i fizycznych, a także zaburzenia neurologiczne.

Cel

Celem pracy była ocena wpływu ćwiczeń wykonywanych samodzielnie w domu przez pacjentów z SM (dostosowanych indywidualnie przez fizjoterapeutę) na ich jakość życia, równowagę oraz sprawność funkcjonalną.

Materiał i Metody

W badaniu wzięło udział 15 pacjentów z SM. Zostali oni ocenieni przy pomocy kwestionariuszy (IADL, WHOQOL-BREF, AIS, MFIS) oraz skal funkcjonalnych (tandem test, test stania na 1 nodze, test „wstań i idź”, test chodu na dystansie 3m, step test, test wstawania z krzesła przez 30s, test wstawania z krzesła 5 razy, test sięgania w przód) przed rozpoczęciem ćwiczeń oraz po kilku miesiącach samodzielnego wykonywania ćwiczeń w domu.

Wyniki

Zaobserwowano istotna poprawę wyniku domeny 4 skali WHOQOL-BREF ($p=0.031$) w drugim badaniu. Poprawę zaobserwowano również w teście wstań i idź ($p=0.027$), w teście chodu na dystansie 3m ($p<0.001$) oraz w próbie wstawania z krzesła 5 razy ($p<0.001$).

Wnioski

Ćwiczenia wykonywane samodzielnie w domu przez pacjentów ze stwardnieniem rozsianym mogą poprawić ich sprawność funkcjonalną, mają jednak niewielki wpływ na poziom zmęczenia i poziom akceptacji choroby. Ćwiczenia w domu powinny stanowić uzupełnienie tradycyjnej rehabilitacji.

Słowa kluczowe: stwardnienie rozsiane, równowaga, ocena funkcjonalna.

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Introduction

Multiple Sclerosis (MS) is described as a progressive inflammatory chronic disease affecting central nervous system (CNS) and resulting in severe cognitive and physical disabilities as well as neurological disturbances with unclear etiology and pathogenetic mechanisms. In most cases (approximately 87% of patients) manifests clinically in the relapsing-remitting course (RRMS) in the third or fourth decade, then usually in nearly 65% of patients with RRMS within the following 5 to 15 years transfers into the secondary progressive MS (SPMS) which is considered the second phase of this disease. Approximately 10-15% of patients take on the dimension of a primary progressive course (PPMS) immediately, characterized by a gradual but continuous worsening of the disease over time. Progressive-relapsing MS (PRMS) occurs rarely, in approximately 5% of patients and relates usually to vision dysfunctions and depression (Ghasemi et al., 2017).

Since multiple sclerosis can affect by demyelinating any part of CNS, regardless the onset and course, predicting the symptoms is a major challenge (Polman et Uitdehaag, 2000). Nevertheless, it has been submitted, that common ways that MS discloses and manifests are weakness or numbness in the limbs, vertigo, optic neuritis, sense of fatigue, bladder and bowel disturbance and cognitive dysfunctions (Ghasemi et al., 2017). It is suggested that spasticity, tremor, ataxia and sensory disturbance, as well as balance disruption in approximately 50% of patients result in mobility loss that require the use of walking aid within 15-25 years since the diagnosis (Hogan et al., 2014).

For many years, MS patients had been advised against exercise as it has been found to lead to worsen symptoms or fatigue. However, over the past two decades, it has become commonly accepted to recommend exercise for patients, because exercise is well tolerated and induces relevant improvements in both physical and mental functioning of persons with MS. It has been suggested that exercise may reverse the effects of an inactive lifestyle adopted by many patients and might have an impact on slowing down a progression process and induce improvements. Regular physical training provides a better gate pattern, muscle strength, range of motion in the joints or balance, which translates to a greater physical participation and finally results in more satisfying mental functioning and quality of life (Dalgas et Stenager, 2012).

Considering inhabitants of rural and low-income areas, lack of accessibility to clinics determined by distance, facing Covid-19 pandemic, and limitations in mobility, long-term rehabilitation for MS patients becomes an issue. In order to reach those patients, a necessity for home physiotherapy and telerehabilitation and consequently judgment of its effectiveness in relation to direct rehabilitation interventions increased.

Aim

The aim of this study was to evaluate the impact of home exercises performed by MS patients (individually adjusted by a physiotherapist) on their quality of life, balance, and functional performance.

Material and methods

Participants

This observational study included 15 subjects (age, 48.2±8.3) and was conducted from November 2019 to October 2020 at W. Dega Orthopedic and Rehabilitation Clinical Hospital in Poznań. The evaluation was performed on multiple sclerosis patients, 8 women and 7 men, presenting a similar clinical condition measured firstly by the Expanded Disability Status Scale (EDDS 3-4). An average time after diagnosis was 12.3±4.9 years (Table 1). All of the subjects included in the pilot study were recipients of medication treatment and were treated by a neurologist. Covid-19 pandemic interrupted the recruitment. The inclusion criteria for were: scoring 3 or 4 points in EDSS scale, medication treatment (patients included in a drug program) for a minimum 1 year, motivation to exercise at home. All participants were motivated to exercise at home.

Table 1. Characteristics of the group

variable	**mean±SD**	**median**	**min-max**
age	48.2±8.3	49.0	36.0-66.0
weight (kg)	68.6±14.3	70.0	50.0-102.0
height (cm)	173.2±10.7	172.0	157.0-194.0
BMI	22.7±2.6	22.1	19.4-27.1
duration of the disease (years)	12.3±4.9	13.0	1.0-18.0

All subjects expressed written consent to participate in the study. The study was conducted in compliance with the Declaration of Helsinki and with the approval of the

Bioethics Committee of Poznan University of Medical Sciences (reference number 44/20). Data were anonymized before analysis.

Methods

All patients were examined twice. The first assessment took place at the beginning of this trial, during the first meeting with the physiotherapist before the exercise. Evaluation began with an interview questionnaire, then was followed by Instrumental Activities of Daily Living Scale (IADL), World Health Organization Quality of Life Scale (WHOQOL-BREF), Acceptance of Illness Scale (AIS), Modified Fatigue Impact Scale (MFIS) and finally finished with functional tests. Physical examination included static tests (tandem and single leg stance tests with the distinction between opened and closed eyes) and dynamic tests such as Timed Up&Go (TUG), 3-Meter Walk Test (3m), The Step Test (ST), 30 s Chair Stand Test (CST), The Five Times Sit-to-Stand Test (FTSST) and Functional Reach Test (FRT). At first visit patients were instructed to train independently at home (at least 3 times a week), completing a personally adjusted rehabilitation program with the use of exercise balls and elastic bands. Programs were personalized based on individual abilities and expressed goals. All patient's programs included exercises to improve range of motion in the joints, balance exercises, coordination exercises, and strengthening exercises. Participants also received exercise prescriptions in paper hand-out form (with photos). A second assessment was performed at the beginning of the second visit (after approximately three months of home exercises).

Scales

Instrumental Activities of Daily Living (IADL)

This scale assesses the patient's ability to perform complex tasks necessary for independent functioning. The scale consists of 8 questions with a maximum of 24 points available. Lower scores indicate greater disability and are only relevant for a specific patient (cut-points for these subscales do not exist). A decrease in this number over time indicates a regression in the general condition of the patient (Gobbens, 2018).

World Health Organization Quality of Life Scale (WHOQOL-BREF)

The WHOQOL-BREF questionnaire was used to assess the quality of life of MS patients. WHOQOL-BREF questionnaire is focused on individuals' views of their life satisfaction. There are 26 questions, rated on a 5-point response scale, divided into 4 domains: physical health with 7 items (DOM1), psychological health with 6 items (DOM2), social relationships with 3 items (DOM3), and environmental health with 8 items (DOM4). The higher the mean score in each sector is achieved, the better the patients' quality of life is denoted. The final results are transformed linearly into a 1-100 scale (Gholami et al., 2013).

Acceptance of Illness Scale (AIS) AIS Scale contains 8 statements characterizing the consequences of poor health, with 5 possible answers specifying each of them. Therefore total score ranges from 8 to 40. A high score means that the respondent fully accepts his illness, whereas a low number of points indicates strong mental discomfort imposed by the health condition (Chabowski et al., 2017).

Modified Fatigue Impact Scale (MFIS) MFIS is addressed to patients suffering from chronic diseases to assess level of fatigue influencing the quality and participation in life. It contains 21 statements: 9 physical, 10 cognitive and 2 psychosocial with 5 possible frequency determinants to be specified by the patient. The maximum possible score is 84. The higher the score, the greater the impact of fatigue on quality of life (Larson, 2013).

Functional tests: Tandem leg stance During the test, the subject was to stand unassisted in tandem position with the left (LF) or right (RF) leg in front. The time in seconds was measured from taking the correct position without any support to the moment of losing balance, moving the feet, or reaching the time limit of 30 seconds (Posa et al., 2020). These tests were performed with both eyes open (EO) and closed (EC). The mean result for both foot placements (LF and RF) was analyzed.

Single leg stance

The participant was asked to stand unassisted on one leg with eyes open. The time in seconds was measured from taking the correct position without any support to the moment of losing balance, moving the foot, or reaching the time limit of 60 seconds. The patients performed the tests both on the left and right limbs. The mean result from both trials was analyzed (Ageberg et al., 2003).

Timed Up&Go (TUG)

During the test, the participant was asked to rise from a chair, walk a distance of 3 meters, make a turn of 180° having crossed a designated line and return to the chair. The timing in seconds starts from a “go” command and ends when a patient returns to a correct starting position. One trial for each MS patient was performed during the trial (Kear et al., 2017).

3-Meter Walk Test (3M)

The test was performed to evaluate the speed of walking. To perform a test, a 3-meterlong, flat course is necessary. The subject began the test in a vertical position in front of the marked line. The time in seconds was measured from the moment the first foot crosses the starting line to the moment both feet cross the finish line (Wareńczak et Lisiński, 2020). In this study, one trial was conducted for each participant.

The Step Test (ST)

The participant, within 15 seconds, was supposed to put repeatedly entire foot on the 7.5- cm-high step and place it back on the ground as fast and as many times as possible. The score was the number of steps completed for each lower extremity (Mercer et al., 2009). Both sides were tested once during the study.

30 s Chair Stand Test (CST)

Starting position in this trial was seated on a chair with arms over the chest and with a back in an upright position. The subject stood up and sat down from a chair within 30 seconds as many times as possible (Millor et al., 2013). During every assessment, only one trial was performed.

The Five Times Sit-to-Stand Test (FTSST)

The subject was asked to perform 5 repetitions of standing up and sitting on the chair with their back against the backrest of the chair as rapidly as possible. The arms during the test were crossed over the chest (Melo et al., 2019). The task completion time was measured, and only one attempt was made.

Functional Reach Test (FRT)

During the test, the patient stood against the wall with one arm bent up to 90° and the other along the body. There was a ruler attached to the wall. Patients were instructed to lean as far forward as possible without moving their feet or losing balance and returned to the starting position. The achieved distance was measured (Kage et al., 2009). Two trials were performed, and the mean result was further analyzed.

Statistical analysis

The statistical analysis was performed with Statistica version 13.1. The descriptive statistic was reported as mean value with standard deviation, median, minimum and maximum (min-max) or quartile range (Q1-Q3), depending on the distribution of variables. The Shapiro-Wilk test was used to assess the normality of distributions in the test score. Nonparametric analyses were used when the data did not meet the assumptions for parametric analysis. The dependent Student's t-test or Wilcoxon signedrank tests were conducted to compare the differences between the results obtained before and after exercise period. A p-value of less than 0.05 was considered statistically significant.

Results

Interview questionnaire

There were no statistically significant differences in the IADL, AIS, MFIS, and sum of the WHOQOL-BREF questionnaire between results obtained before and after the exercise period by the participants (Table 2). Analyzing the results obtained in the domains of the WHOQOL-BREF scale, we observed significant differences in the fourth domain (environmental health) after treatment (p=0.031). Participants in the second evaluation obtained higher scores than during the first evaluation.

Table 2. Results of questionnaires (IADL, AIS, MFIS, WHOQOL-BREF) obtained at the first and second assessment

TEST	**First assessment**			**Second assessment**			**p**
	mean±SD	**median**	**min-max/ Q1-Q3****	**mean±SD**	**median**	**min-max/ Q1-Q3****	
IADL	23.3±1.2	24	22-24**	23.4±1.6	24	24-24**	0.789*
AIS	25.0±5.3	26	15-33	26.3±6.0	26	16-38	0.521
MFIS	38.4±13.5	36	16-64	33.9±15.5	32	7-68	0.250
W-B DOM 1	21.5±2.3	21	17-26	20.9±2.3	21	16-24	0.189
W-B DOM 2	20.7±3.0	21	16-25	20.8±2.5	22	16-24	0.850
W-B DOM 3	11.1±1.9	12	8-14	11.9±2.0	12	8-15	0.111
W-B DOM 4	28.4±3.0	29	23-33	30.6±4.2	32	20-37	**0.031**
W-B score	81.7±7.9	83	68-94	84.3±7.6	86	86-93	0.152

Student's t - test for independent variables, *the Wilcoxon signed-rank test

Static tests

There was no statistically significant difference between the results of the static balance tests (tandem with eyes open and closed and single-leg stance) performed before and after the exercise period (Table 3).

Table 3. Results of the static balance tests (tandem, tandem with eyes closed and single leg stance) obtained at the first and second assessment

TEST	**First assessment**			**Second assessment**			**p**
	mean±SD	**median**	**Q1-Q3**	**mean±SD**	**median**	**Q1-Q3**	

Tandem EO	15.44±9.97	16.38	5.52-23.63	15.41±10.97	18.79	3.93-25.50	0.733*
Tandem EC	2.86±2.36	2.75	1.40-3.52	3.99±6.13	2.07	1.25-5.0	0.772*
Single leg stance	12.46±10.90	6.43	2.95-22.06	14.72±15.82	7.86	2.03-21.91	0.638*

*the Wilcoxon signed-rank test

Dynamic tests

There was a significant difference in TUG, 3 m, and FTSST between the first and second assessments (Table 3). Both tests assessing gait in patients with MS showed that they completed the task faster than during the first trial on the second assessment. Completing the TUG test on the second assessment took on average 1.57 seconds faster (median difference was 0.36 seconds; p=0.027), whereas the walking time over the distance of 3 meters was 0.72 seconds faster (median difference was 0.63 seconds; p <0.001). The subjects also performed the FTSST test faster during the second examination (p<0.001).
We did not find statistically significant differences in the FRT, the step test, and CTS test (Table 4).

Table 4. Results of the dynamic balance tests (FRT, TUG, 3m, ST, CTS and FTSST) obtained at the first and second assessment

TEST	**First assessment**			**Second assessment**			**p**
	mean±SD	**median**	**min-max/ Q1-Q3****	**mean±SD**	**median**	**min-max/ Q1-Q3****	
FRT	32.0±7.2	34.0	14.5-44.0	34.6±6.9	36.5	19.0-45.5	0.135
TUG	14.48±9.09	10.75	8.70-16.98**	12.91±8.06	10.39	7.52-16.90**	**0.027***
3M	4.69±2.49	3.69	2.84-5.47**	3.97±1.94	3.06	2.54-5.38**	**<0.001***
ST Left	8.9±4.4	8.5	5.5-12.0**	9.6±3.2	10.0	7.0-13.0**	0.093*
ST Right	8.8±4.5	8.0	5.0-12.0**	9.4±3.4	9.0	7.0-13.0**	0.142*
CTS	10.8±2.9	11.0	7.0-17.5	11.6±3.0	12.0	6.0-16.0	0.106
FTSST	15.81±4.92	14.20	10.10-26.69	12.18±4.36	10.90	6.83-23.48	**<0.001**

Student’s t - test for independent variables, *the Wilcoxon signed-rank test

Discussion

Multiple sclerosis (MS) is characterized by a wide range of symptoms and a highly unpredictable prognosis, and it can severely affect patients' quality of life by interfering with their ability to work, pursue leisurely activities, and execute daily life tasks (Ysrraelit et al., 2018; Gil-González et al., 2020). The factors that decline the quality of life include: functional impairment (assessed by EDSS), disease duration, severity and number of symptoms, fatigue, sensory and motor dysfunction including paralysis, walking difficulties, balance problems, stiffness, pain, spasticity, and sensory problems (GilGonzález et al., 2020). Data on the impact of exercise on quality of life in MS patients are not consistent (Giesser, 2015). However, many studies have shown that physical exercise significantly reduces fatigue in patients with MS (Razazian et al., 2020). Also, exercise may diminish spasticity, improve cardiorespiratory fitness, muscle strength, flexibility, stability and balance, cognition, and respiratory function (Halabchi et al., 2017), which may indirectly impact the patient's quality of life. In our study, we did not observe any statistically significant differences in the total score of the WHOQOL-BREF questionnaire, which assessed the quality of life, and the MFIS scale, which assessed fatigue and in Acceptance of Illness Scale before and after the indicated time of home exercises. However, we have noticed a significant change in the 4 domain of the WHOQOL-BREF questionnaire (DOM 4), which include environmental health (facets incorporated within 4 domain are financial resources, freedom, physical safety and security, health and social care, home environment, opportunities for acquiring new information and skills, participation in and opportunities for recreation/leisure activities, physical environment, transport). We supposed that some of the results were influenced by the fact that more than half of people with MS took the second assessment after announcing the covid-19 pandemic, which exacerbated stress and limited their ability to function normally. Similar conclusions were presented by Motolese et al., (2020), who evaluated the impact of the COVID-19 pandemic lockdown on MS patients. They showed that MS patients presented a higher burden of depressive symptoms, a worse sleep quality, and perceived an increase in fatigue level compared with the general population.

There are now many reports showing that exercises are safe and well-tolerated by people with MS, have the same health benefits as the general population, and may also be valuable in alleviating some symptoms and preventing complications (Giesser, 2015). Dalgas and Stenager (2012) asked whether exercise can reverse impairments caused by the disease per se or whether exercise reverses the effects caused by inactivity secondary to the disease. They suggested that exercise may most likely reverse the effects of an inactive lifestyle adopted by many patients, and it might have the potential to impact MS disease progression by slowing down the disease process itself.

The influence of exercises performed independently by patients with SM at home has not been clearly described in the literature (Ghahfarrokhi et al., 2021). In our study, we assessed the effect of exercise on patients' performance using commonly reported scales. We assessed static balance in the tandem test and 1-leg standing and dynamic balance and efficiency of the lower limbs with the TUG, 3m, ST, CST, FRT and FTSST tests described in the method section. We did not show significant improvement in static balance; however, we did see a significant improvement in walking speed and partially in balance (TUG test and 3m), and improvement in lower limb strength during sit to stand movements (FTSST). The results of the indicated tests (TUG, 3m and FTSST) seem to be related to each other. Melo et al. (2019) have described use of FTSSTT test as a measure of lower limb strength, balance control, fall risk, and exercise capacity. Slower sit-to-stand times have been linked to an increased risk for recurrent falls, slow gait speed and deficits in other ADLs living. Results different from ours were obtained by Conroy et al. (2018). The authors saw no significant improvement in gait and balance assessed in the timed 25- foot-walk test (T25FW), six-minute walk test (6MWT), and Berg Balance Scale (BBS) after 6 months of home exercise, neither in the tele-management home exercise group nor in the routine home-based exercise group. DeBolt and McCubbin (2004) examined the effects of an 8-week home-based resistance exercise program on balance, power, and mobility in adults with multiple sclerosis using a force platform, TUG test, and the Leg Extensor Power Rig. They concluded that the home-based resistance program was well tolerated by participants and significantly improved their leg extensor power in a short period, but balance and mobility did not change. Aydın et al. (2014) evaluated the effects of calisthenic exercises performed by hospital-based and home-based exercise groups on balance, walking speed, fatigue, quality of life, and psychological status in patients with Multiple Sclerosis (MS). They suggested that in patients with MS, calisthenic exercises performed at home or the hospital might improve the balance, quality of life, and functional and psychological status, while no significant effect has been observed on fatigue.

Ghahfarrokhi et al. (2021). published a systematic review of home exercise in multiple sclerosis and concluded that home-based exercise training (HBET), performed 2-7 times a week, could improve health/performance-related physical fitness outcomes (namely, balance, gait ability, muscle strength, and aerobic capacity), fatigue, and quality of life outcomes in individuals with MS. They also suggest that there is a difficulty in comparing the results obtained by different authors due to the significant variability of the methods used for the assessment and the different exercise protocols used, with different recommendations for the physical activity (type, frequency, duration of use). Therefore, it is necessary to determine basic recommendations for outcomes in homebased exercise training interventions in the future (Ghahfarrokhi et al., 2021).

Conclusion

Patients are motivated to train at home, provided a guidance given by a specialist. Regular home exercise can positively impact the functional performance of MS patients and certain aspects of quality of life. Exercise can improve patients' balance and gait.

Limitation:

Only 6 out of 20 patients were examined twice before outbreak of global Covid-19 pandemic. The rest of the assessments of this clinical trial were postponed from March - May to September - October 2020. Not-examined participants were asked to continue rehabilitation trainings and invited for the second appointment at the last quarter of the year. Due to anxiety associated with the Covid-19 pandemic, 4 patients left the trial, 1 patient did not continue the program because of the surgery, and finally, 15 of the 20 MS patients were tested twice.

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