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Review

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The Effects of Aquatic Therapy on Depression, Fatigue, and Balance in Patients with Multiple Sclerosis (MS): a Systematic Review and Meta-Analysis

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ABSTRACT

Background: *Fatigue, depression, and balance impairment are common in patients with multiple sclerosis (MS). Aquatic therapy is an exercise program which is effective in improving the well-being of patients with MS. So, we designed this systematic review to estimate the pooled effects of aquatic therapy on depression, fatigue and balance in subjects with MS.*

Methods: *Two independent researchers did a systematic and comprehensive search of PubMed, Scopus, EMBASE, Web of Science, Google Scholar as well as gray literature, including references of the included studies, and conference abstracts. The search was done on October 31st 2022. We extracted data regarding the total number of participants, first author, publication year, country of origin, mean age, EDSS, and results of fatigue, depression and balance.*

Results: *The first search identified 6403 studies. After deleting duplicates, 3347 studies remained, and 86 full texts were evaluated. Ten studies remained for meta-analysis. The pooled standardized mean difference (SMD) of BBS (after-before) was 0.67 (95% CI 0.19–1.16) (I^2=11.6%, P=0.3). The pooled SMD of MFIS (after-before) was -0.4 (95% CI -0.71 to -0.09) (I^2=21%, P=0.2). The pooled SMD of FSS (after-before) was -1.13 (95% CI -1.95 to -0.3) (I^2=82.5%, P=0.003). The pooled SMD of BDI (after-before) was -1.83 (95% CI -2.31 to -1.35) (I^2=30.1%, P=0.2).*

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Conclusions: *The results of the present systematic review and meta-analysis show that aquatic therapy is effective for depression, fatigue, and balance improvement in subjects with MS.*

Keywords: multiple sclerosis, fatigue, depression, balance.

INTRODUCTION

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system (CNS), with a wide range of consequences such as physical, psychological, social, and financial problems (1, 2). It is the main cause of disability in youth, which affects women more than men (mostly in reproductive age) (3). Most patients lose their jobs and have marital problems due to MS.

Depression is the most common psychological complication, while fatigue is another disabling symptom that interferes with daily activities and quality of life (4, 5). On the other hand, gait imbalance is one of the main disabling physical complications in patients with MS, which affects nearly half of patients (6). Gait and balance problems are associated with mobility difficulties, limited community participation, social withdrawal, and impaired quality of life (7-9). So, rehabilitation plays an importantrole.

Exercise is one of the most important topics in the rehabilitation of subjects with MS; it helps muscle strength, mobility improvement, psychological wellness, and finally, quality of life improvement (10, 11). Several studies demonstrated that exercise therapy was effective in postponing and slowing down the progression of MS (10, 12, 13).

An exercise in the water (aquatic therapy) is one of the programs recommended by the American Physical Therapy Association (14). The environment of water makes exercise beneficial for subjects living with MS (turbulence, hydrostatic pressure and resistance) (15). Aquatic therapy could be a valuable adjunct to traditional treatment in subjects with MS (16, 17). Previous studies showed that aquatic therapy was effective in improving strength, fatigue, cardiovascular condition, psychological well-being and quality of life (17-20).

A recent systematic review and meta-analysis showed that aquatic therapy was effective for fatigue and balance. We designed the present systematic review to estimate the pooled effects of aquatic therapy on depression, fatigue and balance in subjects with MS. ❑

METHODS

We followed Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 for reporting our systematic review and meta-analysis (21).

Eligibility criteria

Before-after studies reporting scores of walking tests, fatigue and depression were used as inclusion criteria, while letters to the editor, case-control, case reports and cross-sectional studies were all excluded.

Information sources

Two independent researchers did a systematic comprehensive search of PubMed, Scopus, EMBASE, Web of Science, Google Scholar, and also gray literature including references of the included studies and conference abstracts. The search was done on October 31st 2022.

Search strategy

The following MeSH terms were used: ((((((((((((((((((((((((((Hydrotherapy[MeSH Terms]) OR (aquatic therapy[MeSH Terms])) OR (Hydrotherapy[Text Word])) OR (aquatic exercise*[Text Word])) OR (aquatic therap*[Text Word])) OR (water exercise*[Text Word])) OR (water-based exercise*[Text Word])) OR (water therap*[Text Word])) OR (pool exercise*[Text Word])) OR (pool therap*[Text Word])) OR (underwater exercise*[Text Word])) OR (underwater therap*[Text Word])) OR (Therapy, Aquatic[Text Word])) OR (Aquatic Exercise Therap*[Text Word])) OR (Exercise Therapy, Aquatic[Text Word])) OR (Therapy, Aquatic Exercise*[Text Word])) OR (Water Exercise Therap*[Text Word])) OR (Exercise Therapy, Water[Text Word])) OR (Therapy, Water Exercise[Text

Word])) OR (Therapy, Pool[Text Word])) OR (Aquatic training[Text Word])) OR (Water training[Text Word])) OR (Water-based training[Text Word])) OR (Water-based therap*[Text Word])) OR (water[Text Word])) OR (aquatic[Text Word])) AND (((((((Multiple Sclerosis[MeSH Terms]) OR (Multiple Sclerosis[Text Word])) OR (Sclerosis, Multiple[Text Word])) OR (Sclerosis, Disseminated[Text Word])) OR (Disseminated Sclerosis[Text Word])) OR (Acute Fulminating Multiple Sclerosis[Text Word])) OR (Multiple Sclerosis, Acute Fulminating[Text Word])).

Screening the studies and data extraction

After obtaining all retrieved studies, duplicates were deleted, and two researchers independently screened titles and abstracts. Full texts of eligible studies were evaluated and extracted data were entered the Excel sheet. In the case of discrepancy, the third one solved the problem.

We extracted data regarding the total number of participants, first author, publication year, country of origin, mean age, EDSS, and the results of fatigue, depression and balance.

Risk of bias assessment

The Cochrane Collaboration's tool was used for assessing the risk of bias of clinical trials (ROB2) and ROBINSON RISK OF BIAS for non-randomized studies (22, 23).

Statistical analysis

All statistical analyses were performed using STATA (Version 14.0; Stata Corp LP, College Station, TX, USA).

To determine heterogeneity, inconsistency (I2) was calculated.

We used the fixed or random-effects model for meta-analysis if heterogeneity between study results (I2) was either less or more than 50%. The standardized mean difference (SMD) was calculated as the effect size. ❑

RESULTS

Our first search identified 6403 studies. After deleting duplicates, 3347 studies remained, and 86 full texts were evaluated. Ten studies remained for meta-analysis (Figure 1).

Data extracted from studies showed that Iran was the country of origin for the majority of au-

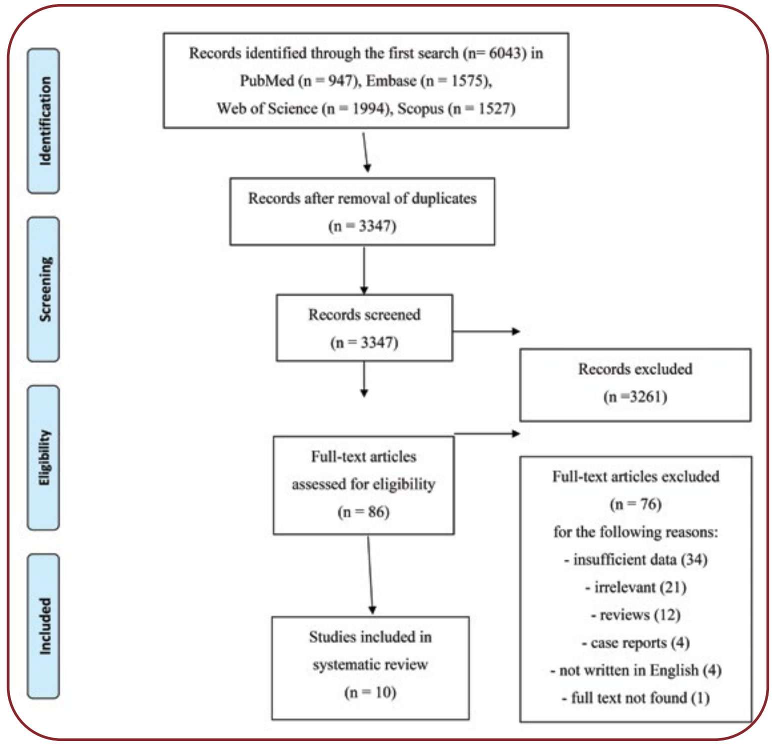

FIGURE 1. Flow chart of study inclusion

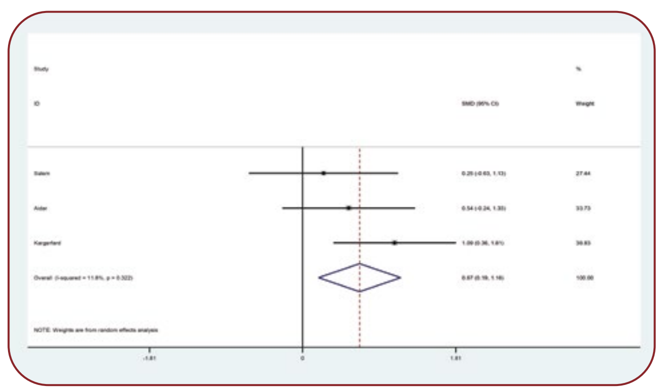

FIGURE 2. The pooled SMD of BBS

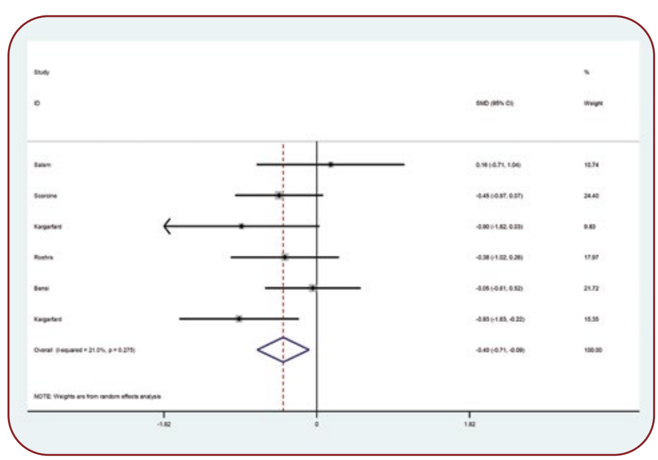

FIGURE 3. The pooled SMD of MFIS

TABLE 1. Data extracted from studies

Author	Country	Year	Particip.	Age	Gender	Disease duration	Type of aquatic intervention	BBS		Total MFIS		FSS		BDI	
								Pre	Post	Pre	Post	Pre	Post	Pre	Post
Salem *et al* (24)	USA	2011	10	55.90±9.12	8 f, 2 m	13.70 ± 8.64	60-min session of group aquatic training twice weekly	24+15	27+14	27.7+4.1	28.5+ 5.5				
Scorcine *et al* (25)	Brazil	2021	29	N/A	22 f, 7 m	N/A	Aquatic strength training			47.7 ±19.6	38.4 ±21.8	39.2 ±18.3	32.1 ±16.8		
Kargarfard *et al* (26)	Iran	2012	21 (10 exp, 11 ctr)	Exp: 33.7±8.6 /Ctr: 31.6±7.7	21 f	Exp: 4.9±2.3 / Ctr: 4.6±1.9	Three 60-min sessions/week, each including 10 min of warm-up, 40 min of exercise, 10 min of cool-down)			Exp: 42.1 ±14.1 / Ctr: 45.6 ±8.9	Exp: 32.3±6.4 /Ctr: 60.8±9.0				
Roehrs *et al* (17)	USA	2004	19	N/A	12 f, 7 m	N/A	Aquatic exercise 1-hour session 2 times *per* week			48.7± 12.1	43.5± 15.0				
Bansi *et al* (27)	Switzerland	2013	52 (24 exp, 28 ctr)	Exp: mean 50 95% CI (44.6–55.1) / Ctr: 52 (46.7-56.3)	Exp: 18 f, 10 m / Ctr: 17 f, 8 m	N/A	Cycling on an aquatic bike			Exp: mean 34.6 95% CI (26.6-42.6) / Ctr: 43.9 (37.5-50.4)	Exp: mean 33.6 95% CI (25.9-41.4) / Ctr: 42.9 (36.0-49.9)				
Razazian *et al* (28)	Iran	2015	36 (18 exp, 18 ctr)	Exp: 35.39±6.59 / Ctr: 33.11±6.60	36 females	Exp: 7.11±0.90 / Ctr: 6.78±0.65	The exercise program for the aquatic training group included a series of water activities for 8 weeks with 3 1-hour sessions *per* week (water: 28°C-30°C)					Exp: 48.72 ±11.46 / Ctr: 39.56 ±14.68	Exp: 25.25±1 1.71 / Ctr: 41.22 ±13.52	Exp: 19.17 ±7.83 / Ctr: 20.78 ±6.22	Exp: 4.78 ±3.42 / Ctr: 21.33 ±6.88
Castro-Sanchez *et al* (29)	Spain	2011	73 (36 exp, 35 ctr)	Exp: 46±9.97 / Ctr: 50±12.31	Exp: 26 f, 10 m / Ctr: 24 f, 13 m	Exp: 10.7±9.1/ Ctr: 11.9±8.7	The Ai-Chi exercise program was conducted in a swimming pool with a water temperature of 36◦C					Exp: median 6 (SD 3.1) / Ctr: 5 (5.1)	Exp: median 3 (SD 2.2) / Ctr: 4 (3.9)	Exp: median 14 (SD 7.72) / Ctr: 15 (8.68)	Exp: median 5 (SD 3.2) / Ctr: 13 (5.91)

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Hejazi *et al* (30)	Iran	2012	40 (20 exp/ 20 ctr)	Exp: 35.45/ Ctr: 30.4	40 f	Exp: 7/ Ctr: 5.45	Aquatic exercise training for 8 weeks as 3 sessions *per* week at 28 ° C							Exp: 16.45 ± 2.327 /Ctr: 15.55± 2.394	Exp: 12.35± 2.183 / Ctr: 16.1± 2.552
Aidar *et al* (31)	Brazil	2018	26 (13 exp, 13 ctr)	Exp: 41.3±7.3 / Ctr: 43.6±7.6	Exp: 9 f, 4 m / Ctr: 8 f, 5 m)	N/A	Aquatic exercise, three times per week and 45-60 min *per* session	Exp.: 41.83 ±5.19 / Ctr: 41.58 ±6.18	Exp: 44.61 ±5.22 / Ctr: 41.44 ±6.13						
Kargarfard *et al* (32)	Iran	2017	32 (17 exp, 15 ctr)	Exp: 36.5±9.0/ Ctr: 36.2±7.4	35 f	Exp: 6.4±2.3/ Ctr: 6.1±2.0	Aquatic training program (3 supervised training 45-60 min sessions *per* week; 50-75% estimated maximum heart rate)	Exp: 53.6±1.7 /Ctr: 52.3±3.3	Exp: 55.2 ±1.2 / Ctr: 50.2 ±4.6	Exp: 43.1 ±14.6 / Ctr: 44.5±9.3	Exp: 32.8 ±5.9 / Ctr: 61.0±8.2				

BBS=Berg Balance Scale; MFIS=Modified Fatigue Impact Scale; FSS=Fatigue Severity Scale; BDI=Beck's Depression Inventory; Exper=experiment; Ctr=control; Particip.=participants

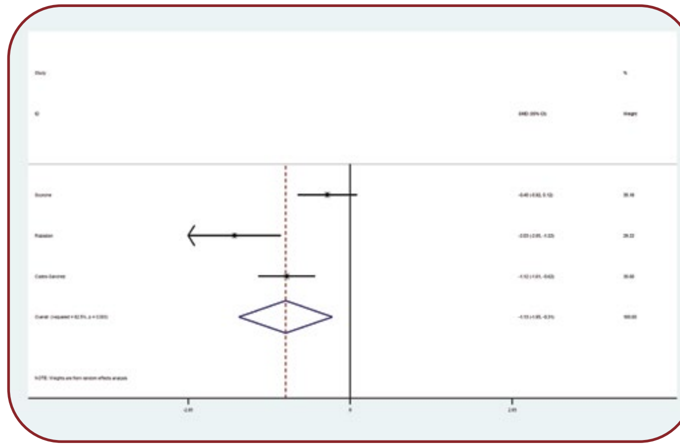

FIGURE 4. The pooled SMD of FSS

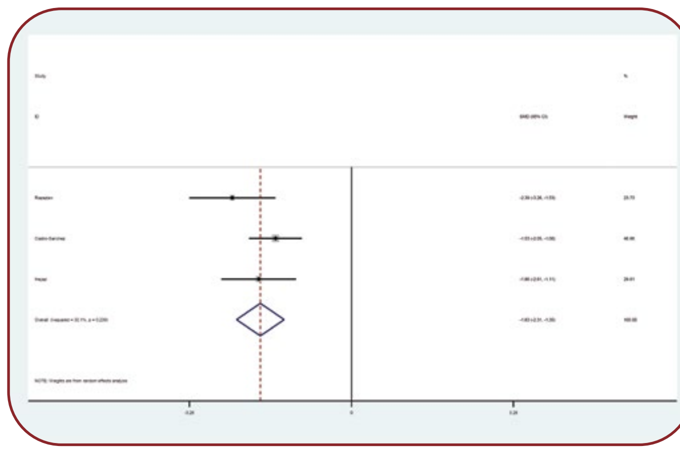

FIGURE 5. The pooled SMD of BDI

thors, study participants' mean age ranged between 33.7 and 55.9, EDSS between 2.1 and 6.3, and study duration varied between three and 20 weeks (Table 1).

The pooled SMD of BBS (after-before) was 0.67 (95% CI 0.19–1.16) (I^2=11.6%, P=0.3) (Figure 2).

The pooled SMD of MFIS (after-before) was -0.4 (95% CI -0.71 to -0.09) (I^2=21%, P=0.2) (Figure 3).

The pooled SMD of FSS (after-before) was -1.13 (95% CI -1.95 to -0.3) (I^2=82.5%, P=0.003) (Figure 4).

The pooled SMD of BDI (after-before) was -1.83 (95% CI -2.31 to -1.35) (I^2=30.1%, P=0.2) (Figure 5).

The quality assessment of non-randomized studies is summarized in Table 2.

The quality assessment of randomized studies is summarized in Table 3. ❑

TABLE 2. Quality assessment of non-randomized studies (ROBINS-I)

Study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall bias
Salem *et al*	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Scorcine *et al*	Low	Moderate	Low	Low	Low	Low	Low	Moderate
Roehrs *et al*	Low	Low	Low	Low	Moderate	Low	Low	Moderate
Hejazi *et al*	Low	Low	Low	Low	Moderate	Low	Low	Moderate

TABLE 3. Quality assessment of randomized trials (ROB2)

Study	Randomization process	Deviations from the intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall bias
Kargarfard *et al*	Some concerns	Low	Low	Low	Low	Some concerns
Bansi *et al*	Low	Low	Low	Low	Low	Low
Razazian *et al*	Low	Low	Low	Low	Low	Low
Castro-Sanchez *et al*	Low	Low	Low	Low	Low	Low
Aidar *et al*	Low	Low	Low	Low	Low	Low
Kargarfard *et al*	Low	Low	Some concerns	Low	Low	Some concerns

DISCUSSION

In this systematci review and meta-analysis we focused on the effects of aquatic rehabilittaion on fatigue, depression and balance in patients living with MS. The results showed that aquatic therpay led to a significant decrease of Modified Fatigue Impact Scale (MFIS), Fatigue Severity Scale (FSS), and Beck's Depression Inventory (BDI) scores as well as an improvement of Berg Balance Scale (BBS) scores.

The BBS is an objective assessment of balance, including 14 questions (each scored between 0-4). Higher scores indicate higher levels of balance. In our study, the pooled SMD of BBS was 0.67, which was significant, indicating that aquatic therapy was useful for improving balance in patients with MS.

In a study conducted by Salem *et al*, 10 patients with MS participated in a five-week aquatic exercise programme (twice weekly for an hour). Their results showed that the mean BBS improved from 24 to 27, while MFIS change was not significant (24).

Aidar *et al* evluated 13 cases in the aquatic group and 13 in the control group. The aquatic group attended three times per week and 45-60 minutes *per* session. Their results revealed a significant improvement of BBS in the intervention group, but no significant change in the control group (31).

The MFIS consists of 21 questions (each scored between 0 and 4), with higher scores indicating more fatigue experience.

Scorcine *et al* recruited 29 patients with MS who underwent 12-week aquatic therapy. The reported MFIS score was 47.7 before therapy and 38.4 after therapy. Also, Roehrs *et al* enrolled 18 subjects with MS who underwent a 12-week aquatic program; the mean MFIS score reported by them was 48.7 before the intervention and 43.5 after the intervention (17). We found that the pooled SMD of MFIS was -0.4 (significant difference), showing that aquatic therapy was effective in improving fatigue in subjects with MS.

The FSS is another questionaire used to evaluate the severity of fatigue, which consits of nine questions (each could be scored between 1 and 7). Like FSS, higher scores are indicative of higher fatigue experience.

Castro-Sanchez *et al* randomly assigned 73 patients into an intervention group and a control group. The intervention group received 20 week aquatic program. Their results showed that median FSS score decreased from 6 to 3 in the intervention group and from 5 to 4 in the control group. They also found that the BDI score decreased from 14 to 5 in the intervention group and from 15 to 13 in the control group (29).

In our meta-analysis, the pooled SMD for FSS was -1.13 (significant decrease), showing that aquatic therapy would help subjects with MS to improve their fatigue experience.

The pooled SMD of BDI was -1.83 (significant), which was indicative of positive effects of aquatic therapy on depression in people suffering from MS.

Depression is the most frequent psychological consequence in patients with MS, which is positively correlated with fatigue in these patients (5). Fatigue is related with physical disability in subjects with MS, and treatment of fatigue is a challenging issue (33). Nowadays, medications such as amantadine, modafinile, L-carnitin are used for treating fatigue in subjects with MS, while their efficacy is not satisfactory (34). The aquatic therapy program may help patients with MS to improve their mood status as well as their fatigue experience.

The present systematic review has two main strengths. Firstly, we evaluated the effects of aquatic therapy on depression, ftaigue, and balance. Secondly, we included more studies than previous systematic reviews.

Our study has also some limittaions. Firstly, the duration of follow-up is not similar for all studies. Secondly, all studies did not evaluate our outcomes.

CONCLUSIONS

The results of this systematci review and meta-analysis show that aquatic therapy is effective for depression, fatigue and balance improvement in subjects with MS. ❑

Conflicts of interest: none declared.

Financial support: none declared.

Ethical approval: This prospective study was approved by the Institutional Review Board of Istanbul Medeniyet University, Istanbul, Turkey, in accordance with the Declaration of Helsinki. Informed consent was obtained from all patients. This study conforms to all CONSORT guidelines and reports the required information accordingly.

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