INFLUENCE OF CORE STABILITY EXERCISE AND VITAMIN D ON PHYSICAL SELF-CONCEPT AND PHYSICAL FITNESS STATUS IN YOUNG WOMEN WITH MULTIPLE SCLEROSIS

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ABSTRACT:

Background: Multiple sclerosis (MS) is an emerging *neurological disease for which vitamin D deficiency can be a risk factor. Considering the reduction of physical fitness and self-concept in MS patients, the present study was conducted to determine the effect of core stability exercises and vitamin D consumption on physical self-concept and fitness status in young women with MS.*

***Methods**: In a prospective randomized clinical trial, 36 young women with MS (aged 32.72 ± 6.57 years old) were randomly divided into four groups: supplementation alone (SUP; n = 9), exercise alone (EXE; n = 8), both supplementation and exercise (SUP + EXE; n = 9), and control (CON; n = 10). All four groups completed the physical self-description questionnaire (PSDQ) before and after the interventions. The SUP group received 1500 IU of vitamin D every two weeks, and the exercise groups performed core stability exercises three sessions per week for eight weeks. For estimating the physical fitness, muscular power, flexibility, physical coordination, and balance were measured before and after the intervention.*

***Results**: There was a significant difference in physical self-concept between the four groups. The SUP + EXE group had the highest physical self-concept after treatment (203.44 ± 14.55) and the SUP group showed the lowest physical self-concept (164.44 ± 28.33). Total physical fitness Z scores of SUP + EXE and EXE groups were the highest scores between the four groups (4.95 ± 2.18 and 1.12 ± 2.28, respectively). Moreover, scores of the SUP + EXE group increased significantly compared to the control group in terms of physical self-concept, muscular power, muscular perseverance, flexibility, physical coordination, and physical balance (P = 0.003, P = 0.002, P = 0.001, P = 0.001, P = 0.001, and P = 0.001, respectively). Furthermore, physical fitness indicated a significant positive correlation with physical self-concept (P = 0.002, r = 0.498).*

***Conclusion**: The findings demonstrated that core stability exercise, preferably along with vitamin D supplementation, can be prescribed to improve the physical fitness and self-concept of MS patients.*

***Keywords:** Core stability exercise, Vitamin D, Physical self-concept, Physical fitness, Multiple sclerosis*

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INTRODUCTION:

Multiple sclerosis (MS) is one of the most prevalent neurologic diseases. The number of patients suffering from MS has increased throughout Iran in recent years. Its prevalence is reported to be 29.3 per 100,000 people in Iran, which has been identified as a country with a high prevalence of MS among Middle Eastern countries (1). This disease affects women much more than men, particularly women in their second to fourth decades of life. A considerable number of risk factors contribute to the development of MS, such as vitamin D deficiency (2), increased levels of stress, and nutrient deficiencies in antioxidant agents, as well as hormonal, neurological, and immunological factors; increased levels of oxidative stress and production of nitric oxide and active oxygen species in the central nervous system can be other inducing factors (3,4). Moreover, MS is associated with complications such as neurological damage (5), sensory and concentration disorders (6,7), mild paralysis, muscular dystrophy, muscle weakness, fatigue (8–10), balance and coordination disorders (11), walking impairment, and mobility limitation and impairment (7,10).

Physical self-concept is an essential factor in evaluating the psychological function, including self-thinking and an individual's evaluations and perceptions of their characteristics (12), which is affected by physical status, interactions with the social environment, accidents, and physical injuries (13). Physical self-concept or physical self-description, as a non-academic aspect of self-concept, indicates an individual's attitude towards their body (e.g. body appearance and fat mass) and physical skills and abilities (e.g. flexibility, coordination, endurance, and strength). A decline in self-concept can cause both psychological and physical complications in patients suffering from various diseases (14).

Exercise leads to an increase in circulating glucocorticoids, and endogenous corticosteroids are assumed to decrease MS progression caused by cytokines (3). However, the vast majority of studies that have shown different results regarding the effects of exercise on physical fitness indices among MS patients have mostly considered aerobic (15), resistant (16), or concurrent training (8) and no special attention has been paid to core stability exercises. Core stability exercises require less exercise equipment, making them more convenient. Moreover, they do not induce a significant increase in body temperature, which might induce negative consequences in MS patients. Core stability exercises are specific exercises for abdominal and pelvic lumbar regions designed to strengthen balance and postural control (17); since these muscles can play an important role in balance control, strength, endurance, coordination, and neural power (18,19), strengthening them would be very beneficial for MS patients, whose muscles tend to be weaker in these areas.

On the other hand, growing evidence indicates that the intake of vitamin D supplements in MS patients tends to be less than the daily requirements (20). Vitamin D is a hormone with different functions, and its deficiency can contribute to the impairment of muscle function, sarcopenia, and consequently, lead to reduced muscle strength (21). Some available studies have suggested the indirect effect of vitamin D on muscle growth and function, which can be related to physical fitness (22). Two potential pathways could describe the effects of vitamin D on self-concept: first, the association between physical status and self-concept (23), and second, the effects of vitamin D consumption on the reduction of depression (24), and the association between depression and self-concept (14).

Considering these controversies in limited findings and due to the possible synergistic effect of vitamin D and exercise, we aimed to determine the effect of core stability exercise and vitamin D consumption on physical self-concept and physical fitness status measures in young women with MS.

METHODS AND MATERIALS:

Patients:

This randomized controlled clinical trial study was conducted on female MS patients who were referred to Shiraz MS Center, Shiraz, Iran. Initially, 120 female MS patients volunteered to participate in the study from January to July 2019. The inclusion criteria were as follows: patients aged 20 to 45 years old, having the capability to perform exercise activities approved by a physician, having the non-recurrent type of MS, scoring three or less on the Expanded Disability Status Scale (EDSS) which confirms the disease, its type, and severity specification by both an expert physician and diagnostic test results such as an MRI, passing of at least one year since the diagnosis of the disease, not having a previous history of cardiovascular diseases, diabetes, thyroid disorders, and gout, taking antispasmodic drugs and prednisone, and 20–35 ng/mL serum vitamin D. The exclusion criteria were absence from exercise training for more than three sessions, having an illness affecting exercise or the measured parameters, using certain medications or supplementation (vitamins and minerals) outside of the routine treatment and research that could affect the research results, experiencing severe psychological stress based on the participants' statements on the condition and recurrence of the disease. Also, the patients who did not use vitamin D supplements in the supplement groups, those who participated in sports activities in the control and supplementation groups or the ones who used vitamin D supplements in the exercise and control groups were excluded from the study.

Finally, 36 women who had been randomly assigned to four groups by using a computer-based program with block randomization protocol were considered as the study samples. The study groups included three experimental groups of vitamin D supplementation (SUP; n = 9), exercise (EXE; n = 8), and supplementation + exercise (SUP + EXE; n = 9) as well as one control (CON; n = 10) group. The consort flowchart is shown in Fig. 1.

All the participants signed an informed consent form. This study conforms to the *Declaration of Helsinki* regarding research involving human subjects and has been approved by the internal ethics and graduate committee of Shiraz University, Shiraz, Iran and was registered by the code number 2245442. One week before the initiation of the intervention, the participants completed the physical self-description questionnaire (PSDQ) to evaluate their physical self-concept. The performed physical fitness tests were as follows:

1. Upper extensor muscles strength test using dynamometry
2. Endurance measurement by testing trunk flexor core muscles at a 60-degree angle
3. Flexibility assessment using the Wells test
4. Coordination measurement using the tennis ball test
5. Balance measurement using single-leg stand test

INTERVENTIONS

The participants executed progressive training protocol of core stability exercises, which included flexibility and strength training exercises, three times per week for eight consecutive weeks. The exercise duration started from 20 minutes per session and incrementally increased to one hour per day. Resting time was limited to changing body posture and getting into the next positions (25). Overload principles were observed during the study by increasing the number of repetitions in each set and incorporating more multi-joint exercises. The supplementation group consumed 1500 IU of vitamin D in form of a capsule every two weeks; meanwhile, the control group continued their daily routine while avoiding any exercise.

Finally, by the end of the intervention, the questionnaire was filled out again and the physical fitness test was repeated similar to the baseline. We used the PSDQ to measure physical self-concept. This questionnaire consists of 56 questions to measure eight subscales: health (i.e. an individual's perception of their health and illness; eight subscales), body fat (i.e. an individual's perception of their fat and obesity status; six subscales), coordination (i.e. an individual's perception of their ability to do coordinated movements; six subscales), flexibility (i.e. an individual's perception of their ability to smoothly perform movements in a full range of motion; six subscales), exercise competence (i.e. an individual's perception of their competence in performing exercise movements; six subscales), physical activity (i.e. an individual's perception of their physical activity level; six subscales), self-esteem (i.e. one's thought of the value they put on their characteristics, features, and limitations; six subscales), and body appearance (six subscales). This scoring was based on the 6-point Likert scale. In a study by Marsh et al., the validity of the questionnaire to diagnose physical self-concept factors was approved. They reported the reliability coefficient for this questionnaire to be between 0.78 and 0.89 (26). Moreover, the validity and reliability of this questionnaire among the Iranian population were previously confirmed by Abdolmaleki et al. (27).

STATISTICAL ANALYSIS

The SPSS software version 16.0 for Windows (SPSS Inc., Chicago, IL) was used for statistical analyses. The Kolmogorov-Smirnov test was used to evaluate the distribution of data. Regarding the normality of distribution, the analysis of covariance (ANCOVA) test was used to compare the variables between the groups by adjusting for pre-intervention differences as covariates. In case of significant differences between the findings of the groups, the Bonferroni post hoc test was performed to compare pairs of groups. To investigate the association between changes in physical fitness status and physical self-concept, we initially converted the physical fitness indices to Z scores, and then assessed the sum of all the scores for physical fitness. Pearson correlation test was used to evaluate the association between total scores of physical fitness and physical self-concept. P-values <0.05 were regarded as significant.

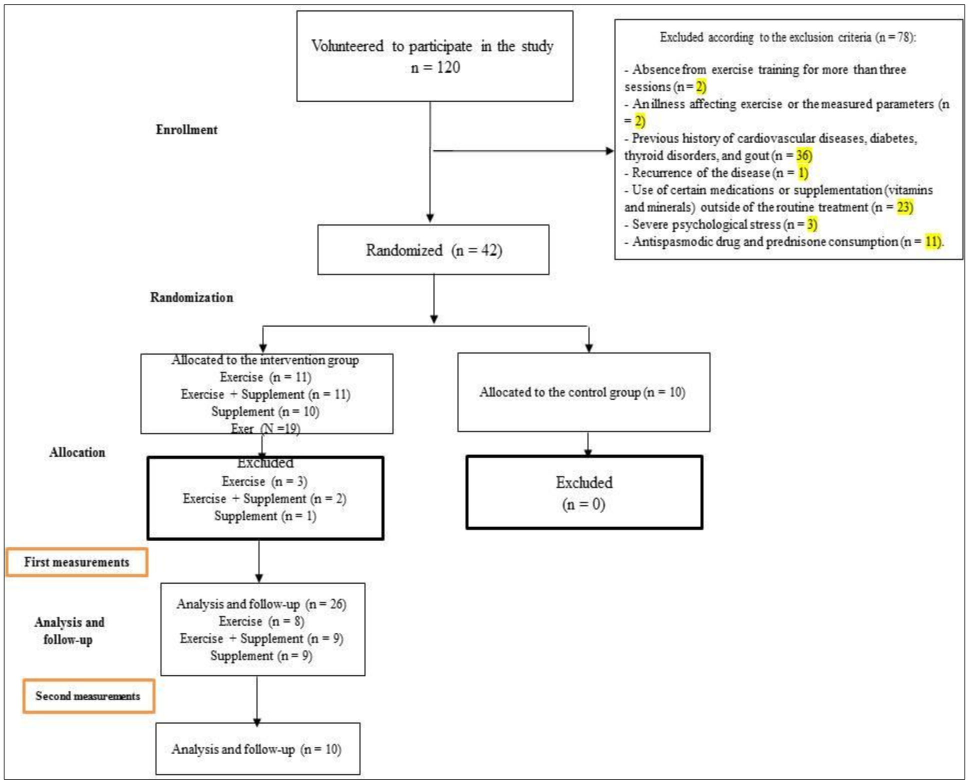

Fig. 1. The consort flowchart of the study procedures evaluating the influence of core stability exercise and vitamin D on physical self-concept and physical fitness status in young women with MS.

RESULTS:

The present study was conducted on 36 patients, including 9 patients in the SUP group, 9 patients in the SUP + EXE group, 8 patients in the EXE group, and 10 participants as controls. The mean age of all the participants was 32.72 ± 6.57 years. Table 1 shows the baseline characteristics of all the groups, indicating no significant difference in the descriptive data of the patients between the four groups (P > 0.05 for all the comparisons).

In Table 2, pre-intervention and post-intervention scores of physical fitness and physical self-concept in all the study groups are shown.

Table No. 1
Comparison of the subjects' descriptive characteristics among the studied groups

Training groups	EXE (Mean ± SD)	SUP (Mean ± SD)	SUP + EXE (Mean ± SD)	CON (Mean ± SD)	P-value
Age (years)	31.50 ± 7.80	36.22 ± 7.47	28.77 ± 3.59	34.10 ± 5.30	0.083
Weight (kg)	67.05 ± 12.34	66.70 ± 11.48	59.03 ± 8.77	67.59 ± 12.32	0.340
Height (cm)	164.06 ± 3.60	162.78 ± 5.82	164.72 ± 3.03	164.50 ± 4.35	0.780

EXE: Exercise group, SUP: Vitamin D supplement group, SUP + EXE: Vitamin D supplement + Exercise group, CON: Control group.

Table No. 2.
Descriptive characteristics of physical fitness and physical self-concept scores in all the groups.

Variable	Groups	Number	Pre-treatment (Mean ± SD)	Post-treatment (Mean ± SD)
Total physical fitness Z score	CON	10	-0.83 ± 2.32	-2.98 ± 2.01
	EXE	8	-0.50 ± 2.14	1.12 ± 2.28
	SUP+EXE	9	1.98 ± 2.28	4.95 ± 2.18
	SUP	9	-0.61 ± 3.85	-2.63 ± 2.49
Physical self-concept	CON	10	165.6 ± 27.56	172 ± 27.66
	EXE	8	162.37 ± 22.71	201.25 ± 20.08
	SUP+EXE	9	179 ± 28.71	203.44 ± 14.55
	SUP	9	159.11 ± 29.65	164.44 ± 28.33

CON: Control group, EXE: Exercise group, SUP + EXE: Vitamin D supplement + Exercise group, SUP: Vitamin D supplement group.

Figure No. 2
Comparison of physical fitness z scores. CON: Control group, EXE: Exercise group, SUP + EXE: Vitamin D supplement + Exercise group, SUP: Vitamin D supplement group.

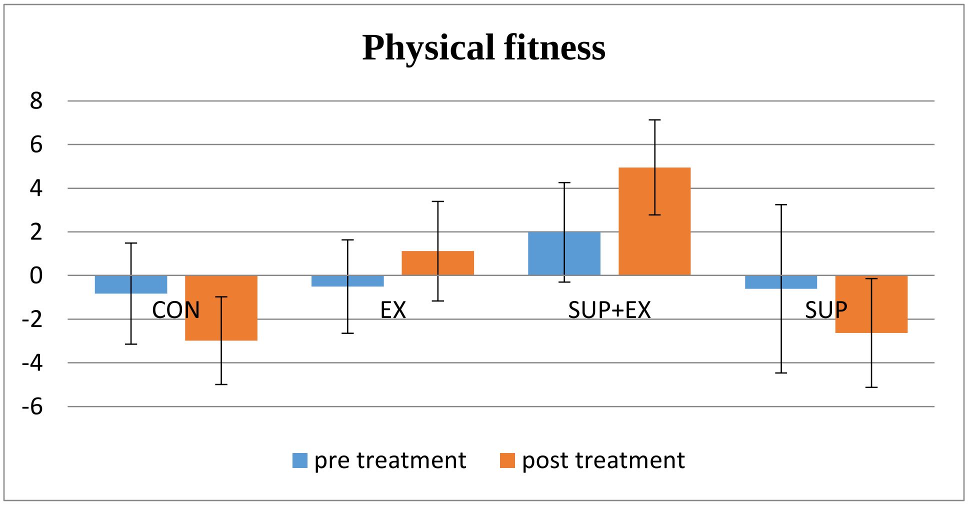

Figure No. 2 and 3 show the comparison of physical fitness z scores and physical self-concept among all the study groups before and after the intervention, respectively.

Figure No. 3
Comparison of physical self-concept. CON: Control group, EXE: Exercise group, SUP + EXE: Vitamin D supplement + Exercise group, SUP: Vitamin D supplement group.

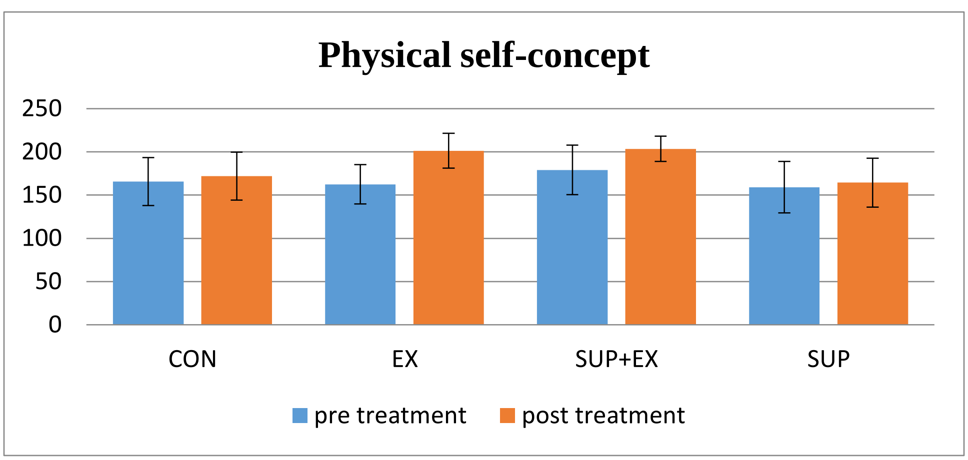

Table No. 3
Comparison of total physical fitness and physical self-concept among the groups using ANCOVA

	Source	Type III sums of squares	df	Mean square	F	P-value
Physical fitness	Physical fitness (before the intervention)	97.66	1	97.66	48.21	<0.001
	group	214.47	3	71.49	35.29	<0.001
Physical self-concept	Physical self-concept (before the intervention)	13569.94	1	13569.94	98.79	<0.001
	group	7180.56	3	2393.52	17.43	<0.001

Table 3 demonstrates the comparison of total physical fitness and physical self-concept among all the groups using ANCOVA. Covariance analysis was used to compare physical fitness and physical self-concept in the learner by controlling for differences in the pre-test. The results showed that the scores of physical fitness ($F = 35.29$, $p < 0.001$) and physical self-concept ($F = 17.43$, $p < 0.001$) differed significantly between the groups. Regarding physical fitness, a comparison of pairs of groups using the Bonferroni post hoc test showed that there was a significant difference between the CON and EXE groups ($p = 0.001$) as well as the CON and SUP + EXE groups ($p = 0.001$). Therefore, EXE alone and SUP + EXE increased the fitness score compared to the control group. There was also a significant difference between the EXE and SUP groups ($p = 0.001$) as well as SUP + EXE and SUP groups ($p = 0.001$). Also, physical fitness in the SUP + EXE group was significantly higher than the exercise group alone ($p = 0.026$).

On the other hand, regarding physical self-concept, there was a significant difference between the CON and EXE groups ($p = 0.001$) and the CON and SUP + EXE groups ($p = 0.003$). Moreover, there was a significant difference between EXE and SUP groups (p = 0.001) as well as SUP + EXE and SUP groups (p = 0.001). There was no significant difference in the physical self-concept of women with MS between the CON and SUP groups as well as the EXE and SUP + EXE groups.

Table No. 4.
Comparing the effect of supplementation and exercise on physical fitness and physical self-concept in all the study groups using the Bonferroni test

	Groups	Mean difference	Std. Error	P-value
Physical fitness	CON *vs.* EXE	3.895	0.67	0.001
	CON *vs.* SUP + EXE	6.141	0.70	0.001
	CON *vs.* SUP	0.215	0.65	> 0.999
	EXE *vs.* SUP + EXE	2.247	0.73	0.026
	EXE *vs.* SUP	3.680	0.69	0.001
	SUP *vs.* SUP + EXE	5.927	0.71	0.001
Physical self-concept	CON *vs.* EXE	31.671	5.56	0.001
	CON *vs.* SUP + EXE	21.384	5.47	0.003
	CON *vs.* SUP	2.684	5.40	> 0.999
	EXE *vs.* SUP + EXE	10.287	5.83	0.526
	EXE *vs.* SUP	34.355	5.70	0.001
	SUP *vs.* SUP + EXE	24.068	5.72	0.001

CON: Control group, EXE: Exercise group, SUP + EXE: Vitamin D supplement + Exercise group, SUP: Vitamin D supplement group.

As shown in Table 5, the correlation coefficient between the changes in physical fitness and physical self-concept is equal to 0.498. Considering that the significance level is obtained less than 0.01, a significant relationship between the changes in physical fitness and physical self-concept of young women with MS at the significance level of 0.01 was found. According to this correlation, there was a significant positive association between the changes (pretreatment-posttreatment) in total physical fitness scores and physical self-concept (P = 0.002).

Table No. 5
The correlation coefficient between the changes in physical fitness and physical self-concept

	Difference in physical self-concept	
	n = 36	
	Pearson correlation	P-value
Difference in physical fitness	0.498	0.002

Figure No. 4
Demonstrates the distribution of physical fitness scores and physical self-concept as a diagram.

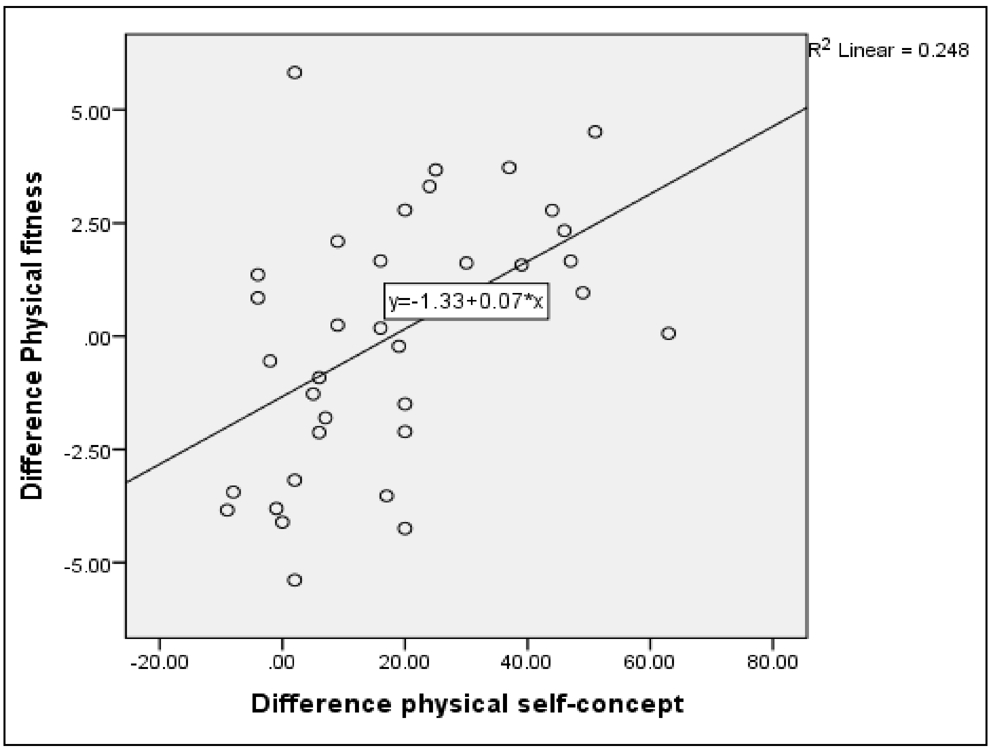

Figure No. 4. The distribution chart of changes in physical fitness and physical self-concept

DISCUSSION:

The results of the present study showed that the combination of core stability exercise and vitamin D supplementation as well as core stability exercise alone have significantly increased physical self-concept and physical fitness scores. Also, there was a significant positive correlation between the changes (pre-treatment and post-treatment) in total physical fitness scores and physical self-concept.

The results of the present study, regarding the positive effect of exercise on self-concept were consistent with those of previous studies (25,28,29). Fernández-Bustos JG et al. found that physical activity has a positive effect on self-concept in adolescents through the improvement of body satisfaction and physical perception (28). Liu et al. performed a meta-analysis on the association of physical activity intervention and self-concept in children and adolescents and found that school-based and gymnasium-based interventions have a strong relationship with increased self-concept and self-worth (29). Similarly, Aşçı et al. (25) showed that physical fitness training had a positive effect on physical self-concept in female university students. In contrast, Ghadiri et al. (30) investigated the effect of a resistance training period on the physical self-concept of boys aged 13 to 18 years old with cerebral palsy in Tehran and did not find any significant correlation. This discrepancy may be due to the training characteristics, subjects' attitudes, and their health status. Behavioral scientists believe that self-concept is affected by environmental factors related to exercise, training, and physical activity (31).

Based on the findings of recent studies and our results, which indicate the efficacy of exercise together with supplementation and exercise alone on the study indicators, it can be concluded that because of the disruption of the nicotinamide adenine dinucleotide phosphate system in these patients, the production of free radicals, including nitric oxide, tends to increase. These factors exacerbate inflammatory reactions and consequently, exacerbate brain damage; hence, the hypothesis that vitamin D3 may prevent the disease progression by inhibiting nitric oxide production was introduced (20). Vitamin D3 reduces myostatin expression (a negative regulator of skeletal muscle growth) and increases myogenic cell differentiation. Type I insulin-like growth factor (IGF-1) is a positive regulator of skeletal muscle growth and plays a crucial role in maintaining and increasing skeletal muscle mass in interaction with myostatin and myogenic agents (32). Studies have indicated that there is probably a vitamin D receptor in the skeletal muscle, and the metabolites of this vitamin affect muscle metabolism through the stimulation of protein synthesis, increase of type 2 muscle fibers, and improvement of muscle function (30,31). In addition, physical activity has an anti-inflammatory modifying role; therefore, it is likely to have the potential to reduce disease processes (32). Thus, it could be concluded that exercise and vitamin D had a synergistic effect on strengthening muscles and total physical fitness.

Meanwhile, endurance exercise causes the constant use of muscle fibers and is a stimulant for muscles' structural and functional changes. This type of capillary training increases capillary availability, myoglobin storage, mitochondrial function, and oxidative enzyme activity. Since individuals with MS usually experience gait disorders, they can provide more blood flow to their muscles by exercising (36). By offering more blood flow to the muscles, muscle endurance may be increased (37). Thus, exercise combined with vitamin D consumption may have a complementary effect on strength, endurance, flexibility, and coordination, which are components of physical fitness. During muscle contraction and body movement, afferent nerves are continually responding to their origin in the receptors in the skeletal muscle. The muscle spindle is the principal receptor of skeletal muscle, which continuously sends neural information about muscle tension, muscle length, and changes in the muscle length to the central nervous system (37). Furthermore, exercise improves the function of atrial and visual systems, increases the sense of depth, reorganizes the central nervous system, integrates the sensory depth, and changes motor responses (38).

Based on other findings of this study, changes in the physical fitness score had a significant positive association with physical self-concept in women with MS, which is consistent with the results of the studies by Perry and Marsh (39) and Marsh et al. (40). A positive and significant association between self-concept and athletic performance was demonstrated by Perry and Marsh in the swimming sport and by Marsh et al. in the gymnastics sport.

In general, physical activity may increase an individual's ability and physical fitness, which consequently changes the individual's evaluation and assessment of their skills. This positive association leads to a more positive attitude towards one's body. Moreover, based on the EXSEM model, we suggested that physical exercise may improve the objective evaluation of physical performance (which forms the basis of this model), and consequently, lead to an increase in self-acceptance or self-value and self-esteem regardless of perceived competency levels (41). Furthermore, as the results of this study demonstrate, it seems that the use of supplements alone is not sufficient to increase physical self-concept, and it is necessary to participate in sports activities.

Marsh et al. showed that physical self-concept is a combination of factors related to physical fitness, health, sports competence, body composition, and appearance. In addition, there is a high correlation between multiple dimensions of physical self-concept and fitness components (42). Meanwhile, several studies have indicated the association between physical self-concept and physical fitness, as well as the positive effect of physical activity and exercise on physical self-concept (43,44). Several of the physical self-concept questions are related to physical abilities that we trained and improved in the present study's program, and it seems that the improvement of these abilities has led to a positive evaluation of physical self-concept. Indeed, the patients reflected their real views on their physical abilities.

CONCLUSION:

It seems that exercise plus vitamin D supplementation and exercise alone, respectively, have the most significant effect on improving the physical symptoms of women with MS. The results also showed that improving physical fitness correlates significantly with physical self-concept. Therefore, core stability exercise, preferably with vitamin D supplementation according to the recommended amount in the study, or alone can be prescribed to improve the physical fitness of these patients.

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