New Approaches in Exercise Physiology (NAEP), Vol 4, No 8, 43-75, December 2022

Effects of Different Exercise Trainings on Patients with Multiple Sclerosis: A Review Study

Shirin Asadi
M.Sc. Student, Department of Exercise Physiology, Faculty of Physical Education and Sport Sciences, Allameh Tabataba'i University, Tehran, Iran.

Rasoul Eslami*
Associated Professor of Exercise Physiology, Faculty of Physical Education and Sports Sciences, Allameh Tabataba'i University, Tehran, Iran.

Received: September 20, 2022; **Accepted:** March 03, 2023

doi: 10.22054/NASS.2023.70239.1121

Abstract

Purpose: Multiple Sclerosis (MS) is an autoimmune disease which is on the rise in recent years especially in Iran. Although there has been much progress in MS treatment, there is no definitive cure for it. Considering high prices of prescription drugs and their serious side effects as well as, impact of this illness on function efficiency of individuals, it seems that exercise training is one of the effective, cheap, and without side effects methods, in improvement of the performance of MS patients. In this regard, the present study aimed to provide comprehensive information on the background and the latest studies conducted to evaluate the effect of various exercise trainings (resistance, aerobic, core stability, Pilates, and combined) on this disease. **Methods:** An electronic search from 1994 to 2022 was performed in the Magiran, SID, PubMed, Google Scholar, and Scopus databases to find published articles. The keywords were multiple sclerosis, physical activity, exercise, training, aerobics, resistance, combined, core stability and Pilates. Different articles were selected and reviewed according to relation with subject. **Results:** The results indicated that various exercise training with different duration, intensity, and frequency cause different adaptations in people. Furthermore, regular continuous combined exercise training can be more effective than one type of exercise training in improvement and reduction of the symptoms of MS disease. The mechanism of improvement in combined exercise training can be justified due to the benefits of concurrent use of two or more types of training protocols. **Conclusions:** It can be said that the combined use of exercise trainings is the most useful and effective method for these patients. However, more studies on the best combination of exercise trainings for MS patients should be done in the future.

Keywords: Multiple Sclerosis, Aerobic Training, Resistance Training, Combine Training, Core Stability, Pilates

Author's e-mail: shirin_asadi@atu.ac.ir; eslami.rasul@gmail.com **(Corresponding Author)**

INTRODUCTION

MS is the most common inflammatory disease of the central nervous system (CNS) (Inglese, 2006). This disease usually occurs at a young age, and women are more at risk than men, so that women in some countries are four times more likely to be affected by this disease (Debouverie et al., 2007). Although, the etiology of MS remains unknown, a combination of factors including genetic background, autoimmune mechanism and environmental factors especially viral infections are effective (Etemadifar & Ashtari, 2002). It is a multifactorial disease which for its occurrence, the factors must be in a specific course and sequence. The loss of myelinated nerve fibers leads to the formation of plaques that their size change from 1-2 mm to several centimeters and are spatially and temporally dispersed (Casper, 2005). Recurrent inflammation of the myelin sheath destroys and creates damaged areas in nerve fibers (Nakahara et al., 2012). When the myelin is slightly damaged, the transmission of nerve messages is less disturbed, while in severe damage, scar tissue replaces the myelin tissue and the transmission of nerve messages may be completely interrupted (Foley, 2000).

This disease causes problems such as disability, low quality of life, and death. For example, 50% of patients require assistance to move and 10% use a wheelchair (15 years after diagnosis disease) (Weinshenker et al., 1989). Clinical manifestations include limb weakness, muscle cramps, optic neuritis, visual impairment, diplopia, ataxia, bladder dysfunction (or urinary incontinence), constipation, cognitive impairment, depression, muscle weakness, fatigue, sexual dysfunction, numbness, vibration, dizziness, mild paralysis, pain, difficulty walking, difficulty concentrating and the loss of bladder control (Casper, 2005). MS has progressive and unpredictable conditions that be able to occurs at any time and result in producing widespread neurological disability (Karpatkin, 2005). There is still no definitive cure for MS. Therefore, MS treatment focuses on the immune response to interferon-β (IFN-β), symptoms control, and non-pharmacological interventions (NPI), including behavioral therapy, self-

care, and exercise training (Mada'inaval, 2005). Currently, exercise prescription is presented as a useful method to reduce functional ability problems in chronic diseases. Considering that over the past decade, therapeutic exercise has been beneficial for patients with MS, it can be considered as one of the effective complementary techniques for the rehabilitation of patients (Shiri et al., 2017). Many studies showed that exercise training in patients with mild-to-moderate MS has physical health and psychological benefits similar to healthy control group (Maghsoudi et al., 2012). Also, exercise training has different impacts such as improvement of the cardiorespiratory system (Mostert & Kesselring, 2002), muscular function (Dalgas et al., 2009) and patients' quality of life (Maghsoudi et al., 2012) and reducing depression (Rampello et al., 2007) and fatigue (Mostert & Kesselring, 2002). Since patients with MS have different neurological disorders, there is no an optimal types of exercise training for them (Mohamadzadeh et al., 2017). Therefore, in the present study, the effects of various types of exercise training on this disease have been investigated. For this purpose, a review of findings of others on the effects of resistance, aerobics, core stability, combined and Pilates exercise training has been conducted.

METHOD

This review focused on published studies examining the effect of different exercise trainings on persons with MS. To investigation of studied conducted on MS patients, key words were checked in Magiran, SID, PubMed, Google Scholar, Scopus databases. Search algorithm was based on all possible combinations of the terms of the following two groups: (1) "multiple sclerosis", "physical activity", "exercise" or "training"; And (2) "aerobics", "resistance", "combined", "core stability" and "Pilates". Searches were limited to articles published from 1994 to 2022. An initial screening at the title/abstract level was conducted using the following inclusion criteria to identify studies involving: (1) people with a diagnosis of MS; and (2) exercise training. Following the initial screening, full-text articles were evaluated and excluded using the following criterion: (1) no

exercise intervention (resistance, aerobic, core stability, Pilates, or combined exercise training). Finally, all eligible articles were included for the purpose of the investigation of effect of mentioned exercise trainings and their mechanisms of action on MS patients.

RESULTS AND DISCUSSION

The application and mechanism of the effect of various exercises trainings on MS patients:

1- Resistance Training:

Today, resistance training is one of the most common forms of exercise training which ordinary people and patients use it a lot to improve physical fitness, prevent injuries, increase muscle size, and rehabilitation programs. Various studies have investigated the effect of resistance training on different aspects of MS disease (Pahlevanzade et al., 2016). In Table 1 a summary of the researches conducted in related to resistance training in patients with MS is presented.

Table 1: Application of Resistance Training in Patients with MS

Sources	Purpose	Results
Mohamadzadeh et al (2017)	The effect of eight weeks of resistance, balance and combined (resistance-balance) training program on balance, gait and quality of life of women with MS	Both balance and resistance trainings improved balance as well as, resistance and combined trainings improved gait but did not have a significant effect on patients' quality of life.
Amiri et al (2020)	Effect of eight weeks of resistance training on balance, fatigue and muscle strength in women with MS	Resistance training significantly increased balance, upper and lower body muscular strength and significantly reduced fatigue.
Tofighi et al (2013)	Effect of 12-week progressive resistance training on balance, fatigue and disability in women with MS	Progressive resistance training increased balance and reduced fatigue in patients but had no effect on their physical fitness.
Dodd et al (2011)	Determining the effectiveness of progressive resistance	Progressive resistance training had short-term effects on reducing fatigue

	training on improving gait, muscle function, quality of life and fatigue in adults with MS	and increasing muscle endurance, leading to a slight improvement in muscle strength and quality of life in people with MS, but did not improve gait.
Eslami et al (2019)	Effect of six weeks of lower body resistance training on nerve conduction velocity, strength, balance and walking speed in MS patients	Controlled resistance training was able to improve the speed of nerve conduction in patients with MS, which ultimately led to improve functional capabilities such as strength, balance and walking speed.
Taul-Madsen et al (2021)	Systematic review and meta-analysis of aerobic or resistance training on improving lower body function and fatigue in patients with MS	Aerobic and resistance trainings were effective in improving lower body function (walking performance in particular) and fatigue.

Improving balance is important in people with multiple sclerosis due to their impaired balance and fall risk. Maintaining balance depends on information received by the cerebellum as the main center of balance, but the eyes, ears, nerves, arms and legs are also effective in balance and posture, hence, reinforcement interventions and compensatory mechanisms impact on the improving balance in MS patients (Etemadifar & Chitsaz, 2005). The strength training has a great effect on lower and upper body muscular strength, and as a result their balance (Korkmaz et al., 2011). Another possible mechanism provides evidence that resistance-based trainings are effective on sensory receptors. The activation of these receptors after resistance training leads to new balance control and better use of balance receptors (Arian et al., 2010). According to the obtained results, resistance training increases the balance of patients with MS (Cakit, et al., 2010; Grazioli, et al., 2019) but in some studies, the results are contradictory (Dodd et al., 2011). The reasons for the discrepancy between results can be because of duration of exercise training, number of subjects, different training methods, functional testing and conditions of each subject (e.g. age, sex) (Amiri et al., 2020). Since fatigue is one of the most common

symptoms of MS, hence, reducing fatigue in these patients is important. In addition to improving activation of core muscles (Dalgas et al., 2008), resistance training increase in nerve current towards Alpha motor neurons during maximum contraction which leads to the production of absolute peak power in the muscle fiber or motor unit (Schulz et al., 2004). On the other hand, metabolism increases during and after training, which increases blood flow, oxygen and better nutrition for the organs and ultimately reduces muscle weakness and improves the function of the nervous system (Tofighi et al., 2013). Totally, it can be said which all these changes decrease fatigue. According to results of some studies, resistance training improves the fatigue symptoms and reducing it in patients with MS (Akbar et al., 2020) but in some cases there is some contradictions (Hayes et al., 2011) probably due to the type of training protocol and the high intensity of the training (White et al., 2004). Considering that force production starts as a result of events in the motor cortex of the brain and ends with cross-bridge rotation between myofilaments, a disturbance at any point of this path may lead to a decrease in strength. Nerve demyelination in these patients may prolong conduction time of motor cortex neurons (Ayan Perez et al., 2007). Thus, reduction in the cross-sectional area of muscle fibers and changes in neuromuscular processes impact on strength. Therefore, strength training by increasing strength in these patients prevent muscle atrophy and lead to increasing daily activities (White et al., 2004).

2- Aerobic Training:

Aerobics exercise training is an appropriate non-pharmacological complementary method that reduces muscle spasms and increases the flexibility of muscles and joints, the movement of bones, and personal power (Petajan et al., 1996). Many studies have shown the positive effects of regular aerobic exercise training in reducing the symptoms of mental disorders and increasing the quality of life and improving mood (Brown, 1998). In Table 2 a summary of the researches conducted in related to aerobic exercise training in patients with MS is provided.

Table 2: Application of Aerobic Training in MS Patients

Sources	Purpose	Results
Dehestani Ardakani (2020)	Effect of 3, 6 and 9 weeks aerobic training program on quality of life (physical and mental dimension) in male patients with MS	Three weeks of aerobic training did not significantly change the quality of life of patients, but after 6 and 9 weeks, the effects on the quality of life of these patients became apparent.
Oken et al (2004)	The effect of 6 months of yoga and aerobic training on cognitive function, fatigue, mood and quality of life of MS patients	Yoga and aerobic training significantly increased the quality of life of patients. Also, there was a significant improvement in fatigue, but there was no relative improvement in cognitive function and mood of the intervention groups.
Fayazi et al (2017)	The effect of 8 weeks of aerobic training on physiological cost index, balance, and maximum oxygen consumption (VO_{2max}) in patients with MS	Aerobic training significantly reduced the physiological cost index in the experimental group. Also, it significantly increased maximal oxygen consumption and walking endurance in the experimental group.
Khajei et al (2011)	The effect of 8 weeks of aquatic aerobic training on cardiovascular risk factors in women with MS	Aquatic aerobic training had no significant effect on patients' high-density lipoprotein, but was significantly reduced low-density lipoprotein, cholesterol and triglyceride levels. In general, these trainings can increase the physical strength of patients, which lead to a modulation of cardiovascular risk factors and reduce them
Andreu-Caravaca et al (2021)	Systematic review and meta-analysis of the effectiveness of aerobic training on cardiorespiratory fitness, functional capacity, balance, and fatigue in people with MS	Aerobic training improves gait speed, walking endurance and balance. Cardiorespiratory fitness and fatigue perception also improved after aerobic training, but there were no significant differences with the control group

Since people with MS consume more energy to do things compared to normal people, this leads to increase fatigue and reduce quality of life in MS patients. Studies have shown that aerobic exercise training increases the quality of life and reduces fatigue of patients, which is probably due to

the effect of aerobic training on the motor system and neuropsychological system of patients (Motl et al., 2009; Kargarfard et al., 2010). Also, the improvement in the physiological cost index (PCI) of the patients is related to the improvement in the two parameters of walking speed and heart rate of these people, so that the heart rate during walking has decreased significantly, as well as the average walking speed has increased significantly. These changes in patients indicated the effect of aerobic exercise training on the body systems, including the cardiovascular and motor systems (Fayazi et al., 2017). Therefore, aerobic exercise training reduces the risk of cardiovascular disease by modulating the effective risk factors (Khajeh et al., 2011). Regarding that oxygen consumption (VO_2), the researchers concluded that in people with MS, the amount of oxygen consumed during activity spend more energy than healthy people, exercise training reduces energy expenditures and increases aerobic capacity of people, which leads to increasing endurance and walking speed and as a result preventing the consequences of the disease in MS patients (Motl & Goldman, 2011). On the other hand, aerobic training leads to a significant increase in the maximum oxygen consumption of patients, which researchers found its reason in improving the respiratory muscle function in these patients (Foglio, 1994).

Regarding the benefits of aerobic exercise training in water, it can be said that one of the main problems of these patients during activity is an increase in body temperature, which disrupts the nervous messages and increases the patient's disability. Water prevents the increase body temperature of patients. Also, it increases muscle strength, provides and increases oxygen level of brain, maintains and increases range of motion, develops muscle control, reduces muscle stiffness, increases the quality of life, balance and energy (Woods, 1992).

3- Core Stability Exercise Training:

Core stability exercise training is one of the types of trainings that requires less facilities and is easier to perform. This training is a specific description

of lumbopelvic and abdominal training which does not cause a significant increase in core body temperature (Hägglund et al., 2006). These muscles can play a role in balance, strength, endurance, coordination, and nerve control which are important problems of MS patients (McCaskey, 2011). In Table 3 a summary of the researches conducted in related to core stability training in patients with MS is provided.

Table 3: Application of core Stability Training in MS Patients

Sources	Purpose	Results
Rezaee et al (2017)	The effect of vitamin D and core stability trainings on improving the indicators of balance, muscle strength, muscle endurance, coordination and flexibility within eight weeks in patients with MS	Exercise training without vitamin D significantly increased muscle strength compared to the control group and improved endurance, coordination, flexibility and balance.
Mirzaei et al (2017)	Comparing the effectiveness of tai chi trainings and core stabilization trainings on static and dynamic balance within 8 weeks in women with MS	Both types of trainings improved the balance of patients (static and dynamic). However, the effectiveness of Tai Chi trainings and central region stability on improving the balance of patients with a moderate degree was much better than patients with a mild degree.
Keshtiaray et al (2020)	The effect of eight weeks of Traband training on core stability muscles in the movement speed of men with MS	Exercise training with Traband specifically on the core stability area had an effect on the movement speed of men with MS and improved the physical function of these patients.

Shahrokhi et al (2017)	The effect of core stability trainings on functional capacity and fatigue within eight weeks in patients with MS	core stability training can reduce the severity of fatigue and increase performance in patients with MS.
Farid et al (2016)	The effect of more than eight weeks of core stability training on the balance of patients with MS	Core stability trainings improved significantly the static and dynamic balance of patients with MS.

Due to the involvement of the main parts in the central nervous system and the decrease speed of nerve impulses due to demyelination of both sensory and motor axons, muscle weakness occurs in various areas, including the core stability area, where the balance of the human body is highly dependent on muscle function of this area (Shahnazari et al., 2013). Following a decrease in balance, the slow movement is inevitable (Asadizaker et al., 2010). Thus, trainings that aim to increase the efficiency of core stability muscles can increase the balance in these patients, which ultimately leads to an increase in their speed of movement (Moradi et al., 2016). As a result, the positive effect of the Traband training on the speed of movement of these patients is probably due to the improving performance of various muscles of core stability area, increasing balance and nerve impulses rate and improvement of biomechanical properties of joints and the range of motion (ROM) (Keshtiaray et al., 2020). Regarding the possible reasons for the increase in balance during core stability trainings, it can be said that the change in mechanoreceptor feedback leads to the reorganization of the central nervous system, proprioceptive sense integration, and changes in motor response (Young & Metzl, 2010). Also, it can be mentioned the activation of proprioceptive sense receptors, preparation of motor neurons in a group of muscles and joints to move, increasing coordination and integration of motor units, co-contraction of cooperating muscles, and increasing inhibition of opposing muscles (Kileff

& Ashburn, 2005). In addition, the anatomical position of the center of gravity is located in central area of body where the body's movements originate from there. Therefore, it seems that strengthening the muscles in this area improves the neuromuscular system and reduces the displacement of the center of gravity (COG) and its fluctuations, which leads to an increase in balance (Key, 2013). It should be noted that repeated active and passive stretching trainings, as well as focusing on the core muscles, increase the number of muscle cells and consequently increase flexibility (Seraj et al., 2013). Moreover, core stability trainings reduce fatigue by affecting neuromuscular mechanisms, risks of physical inactivity, excessive increase of muscular strength, and heat sensitivity (Heesen et al., 2006; Pariser et al., 2006).

4- Combined Exercise Training:

Considering the lack of definitive treatment and the high costs of prescription drugs for MS patients as well as, the high performance of combined exercise training, this type of training can be effective as a modulating and non-pharmacological interventional method along with pharmacotherapy (Abaspour et al., 2020). In Table 4 a summary of the researches conducted in related to combined training in patients with MS is provided

Table 4: Application of Combined Training in Patients with MS

Sources	Purpose	Results
Mohamadzadeh et al (2017)	The effect of eight weeks of resistance, balance and combined (resistance-balance) training program on balance, gait and quality of life of women with MS	Both balance and resistance trainings improved balance and resistance and combined trainings improved gait but did not have a significant effect on patients' quality of life.
Moradi et al (2016)	Comparison of core stability, resistance and combined trainings on functional endurance and control standing in men with MS	Core stability, resistance and combined trainings improved gait and control standing in men with MS. The combined training program was more effective than the others.

Ozkul et al (2020)	The effect of combined training (aerobic-Pilates) on different cognitive functions in patients with MS	Combined training had beneficial effects on different cognitive functions in patients with mild. Moreover, there was a correlation among cognitive functions, mood, and quality of life after training.
Grazioli et al (2019)	The effect of 12 weeks of concurrent resistance and aerobic training on balance, gait, fatigue, quality of life and disease severity	Combined training improved patients' quality of life, as well as improved balance and gait and reduced depression, fatigue, and disease severity.
Abaspour et al (2020)	The effect aerobic and bodyweight resistance trainings and resistance training with Traband and TRX on muscle strength, endurance and walking speed and psychological indices in women with MS	Combined exercise training significantly increased endurance, walking speed and muscles strength of the quadriceps and right and left arm, and significantly reduced depression and anxiety
Kordi et al (2014)	Comparison of effect of three methods of (resistance-aerobic) combined training within 8 weeks on serum levels of ghrelin, pro and anti-inflammatory cytokines (TNF-α and IL-10) in patients with MS	Combined training with an emphasis on strength training increased the levels of anti-inflammatory cytokines and reciprocally decreased the pro-inflammatory ones, but there was no significant difference in the serum ghrelin levels after a training period in the study groups.

Past studies have demonstrated that regular and continuous combined exercise training can improve and reduce MS disease progression. For example, combined training (core stability along with resistance with Traband) involve upper and lower body muscles, and as a result, strengthen the muscles of these two areas of the body, which lead to the improvement and efficiency of the organs and their effect on gait and posture control during standing in patients (Moradi et al., 2016). Other studies have

indicated that aerobic and stretching exercise training reduces fatigue in MS patients, but a combination of both is more effective (Pazokian et al., 2013). Regarding combined trainings (aerobic-resistance), it seems that the combination of resistance and aerobic trainings and various training methods increase neuromuscular adaptation and lower body muscular strength. On the other hand, aerobic training improves cardiorespiratory fitness and decreases energy expenditure (EE) during walking**.** Specificity of the training method and programs with appropriate intensity and duration improves walking speed and endurance in MS patients with mild to moderate disability (Abaspour et al., 2020). Also, studies have shown that in healthy individuals, there is a balance between Th1 inflammatory cytokines and Th2 anti-inflammatory cytokines, while in MS patients this balance is disrupted by increasing the ratio of TH1 cytokines (e.g. IL-1, IL-6, TNF-α) to TH2 (e.g. IL-10, IL-4) (Turner et al., 2009). Thus, TH2 anti-inflammatory cytokines improve MS disease. In contrast, TH1 cytokines are pro-inflammatory and play a key role in the pathogenesis of MS (Zeis et al., 2008). Given that IL-10 anti-inflammatory cytokine is an important factor in the treatment of MS and these patients are facing its deficiency, hence, it can be said that combined training with emphasis on strength training increases anti-inflammatory cytokines and reduces of pro-inflammatory cytokines which is important in improving MS disease (Kurdi et al., 2014).

5- Pilates:

Pilates is one of the most popular trainings in recent years, which includes a series of specialized trainings in related to encouraging the use of mind to control muscles. This training helps to maintain balance and improve spinal condition (Longworth, 1982). In Table 5 a summary of the researches conducted in related to Pilates training in patients with MS is provided

Table 5: Application of Pilates Training in MS Patients

Sources	Purpose	Results

Ghorbanian & Mahmoud Pour (2018)	The effect of eight weeks of Pilates training along with massage therapy on BDNF levels and fatigue index in women with MS	In response to training and massage, BDNF levels are significantly elevated, and fatigue index reduced.
Ghorbanian & Mahmoud Pour (2020)	The effect of eight weeks of Pilates training and massage therapy on serum levels of IL-17 and IFN-β cytokines in women with MS	The IL-17 had a significant decrease in the groups of Pilates, the massage, and the Pilates along with massage, and the IFN-β had an significant increase in the groups of massage and the Pilates along with the massage.
Asvar & Taghian (2020)	The effect of eight weeks of Pilates training on interleukine-18 level, fatigue, and balance in women with MS	Pilates trainings mitigated fatigue and IL-18 levels and improved balance in women with MS
Salehzadeh et al (2018)	The effect of eight weeks of Pilates training on balance, body composition, and vital signs including blood pressure and resting heart rate in women with MS	Pilates training could improve balance, body composition (fat percentage, body mass index, and waist to pelvis ratio), systolic blood pressure and resting heart rate, but was not observed significant difference in body weight and diastolic blood pressure.
Gheitasi et al (2021)	The effect of twelve weeks of Pilates training on balance of men with MS	Pilates training increased functional balance and largely avoided high impact, high power output, and heavy muscular and skeletal loading body parts.

Some studies have shown that brain-derived neurotrophic factor (BDNF) levels in MS patients were significantly lower than in healthy individuals (Frota et al., 2009). BDNF is a member of the neurotrophins family, which play role in all aspects of development of the central nervous system, including the survival and nerve cells proliferation and synapses formation. It seems that Low levels of BDNF effect on myelin degradation and

progression of axonal damage (Patanella et al., 2010). Exercise trainings like Pilates enhances hippocampal function and this mechanism largely occurs due to increase BDNF. Also, physical activity activates the mitogen-activated protein kinase (MAPK) pathway in the hippocampus and the cAMP-response element binding protein (CREB), which plays an important role in the formation of nervous system, memory, and BDNF (Finkbeiner, 2000). The results showed that Pilates trainings along with massage had a significant and positive effect in improving patients. In fact, frictions applied during the massage improve relaxation in muscle fibers and connective tissue. This relaxation allows the fibers to develop their relationship with the adjacent fibers and achieve ideal conditions. This condition reduces the activation time of pain receptors and increases local blood flow. Another theory is that a light touch massage in MS patients causes more release of painkillers such as Beta-endorphins in the body, which suppresses pain and facilitates movement in these patients (Fleck & Kraemer, 2014). Moreover, relaxation caused by massage therapy reduces cortisol secretion by increasing parasympathetic signals which can have a profound effect on management of MS symptoms and the quality of life in individual. Also, improvement in the mental and emotional condition of MS patients has been observed after massage therapy (Rousseaux & Pérennou, 2004). Given that physical activity activates some immune and hormonal responses, evidence shows that exercise trainings (e.g. Pilates) can improve chronic neuroinflammation and associated damage by affecting inflammatory and anti-inflammatory cytokines (Florindo, 2014) and move cytokine profiles in chronic diseases towards anti-inflammatory effect, which results in positive effects on health and protection of the body against chronic diseases associated with low levels of inflammation (Walsh et al., 2011). As mentioned before, one of the major problems for MS patients is imbalance and fatigue. In this regard, Pilates exercise training is effective in protecting the nervous system by improving neurotrophic factors. Therefore, it has the potential to create a positive effect on the motor function of MS patients. Since Pilates is a suitable method for

practicing of the mind, body and control of postural movements, hence, this method can be used for improvement of balance and mental and physical diseases and as an auxiliary method for treatment of patients. Strength training has a special place in Pilates and increases the strength of patients (Marandi et al., 2013). Considering that maintaining balance based on sensory information and is affected by coordination, the range of motion of joint, and muscular strength, hence, improvement of balance in patients may be due to the increase in the muscle's strength (Blum & Korner-Bitensky, 2008). According to studies conducted, patients with MS usually choose a sedentary lifestyle, which leads to an increase in the body fat percentage and increase level of leptin in their blood, which has direct relationship with increasing coronary artery disease in these people (Ronti et al., 2006). The increase in body fat percentage reduces vessel compliance. Considering that leptin plays a key role in body weight regulating, the results showed that physical exercises led to a significant decrease in leptin level and, as a result, a decrease in body fat percentage of MS patients. (Paul et al., 2014).

On the other hand, further reduction in resting heart rate using Pilates exercise training indicates a possible improvement in the autonomic nervous system of patients. This effect is probably due to the effect of Pilates on the balance of the sympathetic and parasympathetic nervous systems, and a more decrease in resting heart rate which is one of the effective factors in the mortality of MS patients (Leon et al., 2005). In general, the changes in systolic blood pressure, resting heart rate and body fat percentage can be caused by the adaptation of cardiovascular, muscular and metabolic systems to exercise training (Salehzadeh et al., 2018).

CONCLUSION

Although the positive effects of exercise trainings (combined, aerobics, core stability, resistance and Pilates) on different factors including balance, strength and muscular endurance, cardiorespiratory function, patient safety issues, ability to walk, flexibility, fatigue, and quality of life in MS patients have been recognized, researchers are still seeking to achieve the

appropriate pattern of exercise training to help MS patients. The result of this review study indicated that regular moderate-intensity training in most cases leads to improvement and control of the disease without exacerbation of inflammation, but heavy training leads to fatigue and stress in patients. Also, the best type of exercise training for these patients is the combined exercise training. However, more studies are needed to determine which type of combined exercise training is more beneficial for MS patients. Moreover, more longer and varied exercise training period along with diet control should be investigate in patients with MS in the future studies.

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