Journal of Sport and Health Research 2024, 16(1):67-82

Karageorgou, A.; Kokaridas, D.; Theodorakis, Y.; Goudas, M.; Krommidas, C.; Mousiolis, S. (2024). The effect of exercise and goal setting strategies on improving quality of life of multiple sclerosis patients. *Journal of Sport and Health Research.* 16(1):67-82. https://doi.org/10.58727/jshr.95321

Original

EL EFECTO DEL EJERCICIO Y LAS ESTRATEGIAS DE ESTABLECIMIENTO DE OBJETIVOS EN LA MEJORA DE LA CALIDAD DE VIDA DE LOS PACIENTES CON ESCLEROSIS MÚLTIPLE

THE EFFECT OF EXERCISE AND GOAL SETTING STRATEGIES ON IMPROVING QUALITY OF LIFE OF MULTIPLE SCLEROSIS PATIENTS

Karageorgou, A.[1]; Kokaridas, D.[1]; Theodorakis, Y.[1]; Goudas, M.[1]; Krommidas, C.[1]; Mousiolis, S.[1].

[1]*Department of Physical Education and Sport Science, University of Thessaly*

Correspondence to:
Anastasia Karageorgou
Department of Physical Education and Sport Science, University of Thessaly
Trikala 42100, Greece
Email: ankarageorgou@yahoo.gr

Edited by: D.A.A. Scientific Section Martos (Spain)

editor@journalshr.com

Received: 04/07/2022
Accepted: 21/04/2023

Journal of Sport and Health Research 2024, 16(1):67-82

RESUMEN

El objetivo del presente estudio fue examinar el efecto de un programa combinado de ejercicio y establecimiento de metas en pacientes con esclerosis múltiple (EM) para mejorar su calidad de vida y reducir los síntomas de ansiedad y depresión. La muestra ha consistido en 30 pacientes con EM (15 hombres y 15 mujeres), de 23 a 65 años, sometidos aleatoriamente a un experimento y a un grupo de control. El grupo experimental (N = 15) participó en un programa de ejercicio de 8 semanas combinado con estrategias de establecimiento de metas autoseleccionadas y los principios de la Teoría de la Autodeterminación (SDT; por ejemplo, Ryan & Deci, 2000) para aumentar su participación en el ejercicio. El grupo de control (N = 15) no participó en ningún procedimiento interventivo. En el momento pre- y posinterventivo, ambos grupos emplearon instrumentos para medir su nivel de calidad de vida (SF-36), ansiedad y depresión (HADS)**.** Se utilizaron ANOVA de medidas repetidas de dos vías y las pruebas no paramétricas de la U de Mann-Whitney y de Wilcoxon para examinar las posibles diferencias en las variables dependientes entre el tiempo (pre y post-intervención) y los grupos (experimental, control). Los resultados mostraron una mejora en las características de calidad de vida (funcionamiento físico, vitalidad, rol emocional, salud mental, salud mental general) y una reducción de los niveles de depresión y ansiedad solo para los participantes del grupo experimental en comparación con los individuos del grupo de control (p < .05). Con base en los hallazgos, se han hecho más observaciones relativas al efecto de un programa combinado de actividad física y fijación de objetivos sobre la mejora en la calidad de vida de los pacientes con EM.

Palabras clave: actividad física, estrategias de cambio comportamental, desorden autoinmune, bienestar.

ABSTRACT

The aim of the present study was to examine the effect of a combined exercise and goal-setting program in patients with multiple sclerosis (MS) on improving their quality of life and reducing symptoms of anxiety and depression. The sample consisted of 30 patients with MS (15 men & 15 women), aged 23 to 65 years, randomly assigned into an experimental and a control group. The experimental group (N = 15) participated in an 8-week exercise program combined with self-selected goal-setting strategies and the principles of Self-Determination Theory (SDT; e.g., Ryan & Deci, 2000) to increase their exercise participation. The control group (N = 15) did not participate in any intervention procedure. Pre and post intervention, both groups completed instruments measuring their quality of life (SF-36), anxiety and depression (HADS). Two-way repeated measures ANOVA and the non-parametric tests of Mann-Whitney U and Wilcoxon were used to examine possible differences on the dependent variables between time (pre and post-intervention) and groups (experimental, control). Results showed a significant improvement on quality of life features (physical functioning, vitality, emotional role, mental health, general mental health) and a reduction of depression and anxiety levels only for the experimental group participants compared to control group individuals (p < .05). Based on these findings, further recommendations were made concerning the effect of a combined physical activity (PA) and goal-setting program on improving quality of life of patients with MS.

Keywords: physical activity; behavioral change strategies; autoimmune disorder; well-being.

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INTRODUCTION

Multiple sclerosis (MS), is one of the most representative inflammatory demyelinating chronic diseases that affects both motor and sensory nerve conduction and causes varying degrees of disability (Kutzelnigg & Lassmann, 2014). Some of its symptoms include muscle weakness and fatigue, instability, loss of joint function movement, blurred vision, speech problems and unpredictable changes of remission and exacerbation periods that may lead to partial or complete paralysis for the more severe cases, making MS a purely individual situation that each patient experiences differently (Compston & Coles, 2008).

The variety of symptoms that affect the mental and physical condition of MS patients (Buhse et al., 2014) result in patients becoming dependent on family environment with a continuous decline in their quality of life (Kargarfard, 2012; Fruewald et al., 2008). According to World Health Organization (1995; p. 1403), quality of life is defined as "*an individual's perception of his/her position in life in the context of the culture and value systems in which he/she lives and in relation to his/her goals, expectations, standards and concerns*".

Depression is also frequent due to the disease itself as well as psychosocial factors (Rickards, 2005) that cause lack of interest, sleeping problems, eating disorders and suicidal ideation (Siegert & Abernethy, 2005). In the research of Hunter et al. (2021) in patients with MS observed that 73% of participants had severe depressive symptoms that can significantly reduce quality of life and employment status in persons with MS (Ploughman et al., 2020). MS patients experience intense anxiety caused either by a lack of social support or by the fear of the disease, creating negative emotions that affect and aggravate the whole situation (Makri, 2013).

Dalgas et al. (2015) showed that increased physical activity (PA) reduces and/or prevents depression in MS patients, with the intensity of exercise influencing findings. Furthermore, Marck et al. (2014) and Dalgas and Stenager (2010) noted that participation in exercise programs, especially in organized and individualized ones, improves the quality of life of MS patients as a form of treatment that helps patients reduce the incidence of MS flares (Mostert & Kesselring, 2002), and improve their functionality level compared to patients who do not exercise (Motl & Snook, 2008; Romberg et al., 2005). Overall, relative evidence indicates that exercise yields a statistically significant and reliable reduction in depressive symptoms for people with MS (Ensari et al., 2014). Thus, future research is absolutely necessary to conduct (Dalgas et al., 2015) to further highlight the importance of exercise as an integral part of the daily life of MS patients (Vozikis & Sotiropoulou, 2012).

Goal-setting helps to adopt health behaviors and more specifically is an effective behavioral change strategy towards exercise (Grover et al, 2016; McEwan et al., 2016; Pearson, 2012; Shilts et al., 2004; Swann et al., 2021), that needs an action plan and commitment so as to succeed (Bailey, 2017; Locke & Latham, 2002). Based on goal-setting theory, effective goals must be personal, achievable, specific, challenging, time-limited, and measurable (Brown et al., 2016; Lawlor & Hornyak, 2012; Locke & Latham, 2006; MacLeod, 2012). Especially when goals are defined by the participants themselves, goal-setting interventions can be even more effective (Williams & French, 2011) creating a more positive effect in relation to PA behavior (McEwan et al., 2016).

Marks et al. (2005) showed that MS treatment measures improve as the effectiveness of self-management improves, whereas Bloom et al. (2006) noted that MS patients gave higher scores on the likelihood of success in achieving self-selected goals. Geurts et al. (2019), in their study of a mobile application that supported participants with MS in achieving personal goals in walking, revealed positive trends in walking ability and habits. Overall, findings suggest that goal-setting is positively related to the increase in exercise levels of MS patients (Casey et al., 2017).

In relation to Self-Determination theory (SDT; Ryan & Deci, 2000), SDT is a theoretical framework that attempts to explain the reasons behind one's participation in exercise. Research has shown that satisfaction of competence (e.g., to feel confident in a task) and intrinsic motives (e.g., to do something that I like) are significant predictors of exercise participation across a range of different research contexts (e.g., healthy or patients, young or adults individuals) (Teixeira et al., 2012). Similarly, Ng et al. (2012, p. 325) proposed that "*SDT is a viable conceptual framework to study antecedents and outcomes of motivation for health-related behaviors*".

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Furthermore, Fortier et al. (2012) tested three SDT theory-based randomised control trials targeting to promote PA in different frames and populations. They found significant intervention effects on participants' PA levels and motivation to engage in exercise. Consequently, the principles of SDT (Ryan & Deci, 2000) were also adopted in the present intervention study, as later described in procedure section.

Research so far has focused mainly on the factors that constitute the overall health profile of MS patients (Karageorgou et al., 2019), who generally feel exhausted to carry out their daily activities (Kastanias & Tokmakidis, 2008) and exhibit mood swings, emotional instability, irritability or even mental illness (Koutsouraki et al., 1998). As a result, MS patients face difficulties to set personal goals in their lives (Polykandriotis & Kyritsi, 2006). Samartzis et al. (2014) also found that reduced cognitive function and retrospective memory affect the quality of life of MS patients regardless of depression and disease severity (Hadgkiss et al., 2015), whereas Makri (2013) noted that stress, physical health and overall perceived quality of life of MS patients affect cognitive function. As for PA, only the study of Garopoulou (2012) showed that the implementation of a hydrotherapy program can improve the motor skills and quality of life of adults with MS.

Furthermore, reviewing the literature it seems that no research has yet been conducted that examines the potential benefits of participating in exercise programs that include goal-setting interventions in an attempt to improve quality of life parameters of MS participants. Thus, the main purpose of the present study was to examine the effect of an exercise program combined with self-selected goal-setting strategies and the principles of SDT (e.g., Ryan & Deci, 2000) on improving MS patients' quality of life consisted of physical health features (physical functioning, role physical, bodily pain, general health) and mental health features (social functioning, role emotional, vitality, and mental health). A secondary goal of the combined exercise program was to reduce MS patients' anxiety and depressive symptoms.

METHODS

Participants

Thirty (30) MS patients (15 males and 15 females), all adults 23 to 65 years old (M = 38.70 ± 9.53 years) and members of the Hellenic Multiple Sclerosis Society in central Greece, constituted the sample of this study. After an initial meeting, all MS individuals expressed their interest to participate in the study. Next, they signed a consent form ensuring confidentiality of voluntary participation and responses and they were randomly assigned in an experiment and a control group. The experiment group (N = 15) participated in a combined exercise and goal-setting program, whereas control group individuals (N = 15) did not take part in any of the research procedures.

It should be noted that preliminary findings of this intervention that showed exercise group participants with MS reporting higher rates of leisure-time PA compared to the non-exercisers MS patients, are presented in the study of Karageorgou et al. (2022). Thus, this study focuses solely on the psychological outcomes of this intervention.

Instruments

Health-related quality of life. The Greek version (Pappa et al., 2005) of the SF-36 survey (Ware & Sherbourne, 1992) was used to evaluate participants' health-related quality of life. SF-36 is a self-assessment tool designed to examine individual perceptions regarding quality of life in relation to eight different areas, that is, physical functioning (e.g., *Walking 100 meters*), role physical (e.g., *During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?*), bodily pain (e.g., *How much bodily pain have you had during the past 4 weeks?*), general health (e.g., *I am as health as anybody I know*), social functioning (e.g., *During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with your normal social activities with family, friends, neighbors or groups?*), vitality (e.g., *Did you feel full of life?*), role emotional (e.g., *During the past 4 weeks, have you had any of the following problems*

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with your work or other regular activities as a result of any emotional problems?) and mental health (e.g., *Have you been a very nervous person?*). These eight domains are grouped into two main areas of physical and mental component scores, with higher values indicating a higher quality of life. The SF-36 health survey was previously used and validated not only in MS patients but in other chronic diseases as well, with good psychometric properties (Krokavcova et al., 2009).

Depression and anxiety. The Greek version (Michopoulos et al., 2008) of the Hospital Anxiety and Depression Scale - HADS (Zigmond & Snaith, 1983) was used for detecting states of depression and anxiety and measuring severity of emotional disorder in patients who may need additional psychological evaluation and support. The usefulness of HADS has been previously reported as a reliable indicator of major depression and generalized anxiety disorders in MS patients (Honarmand & Feinstein, 2009).

Procedure

The study protocol and its procedures were approved by the University of Thessaly bioethics committee. Following the meeting that preceded the commencement of the program and the consent form signed by the participants, the sample was randomly assigned through a lottery process (1:1) in an experiment and a control group. In the first exercise session, the participants of the experiment group (N = 15) completed a commitment card as a "personal contract' that they would be able to abide by their decision. Furthermore, each participant of the experiment group was informed and familiarized with self-regulation and goal-setting strategies for PA by the researcher, with the purpose to provide each individual the opportunity to choose placement and type of exercise.

Next, the intervention program for the experiment group participants included an eight-week exercise combined with self-selected goal-setting strategies at a frequency of 2 to 3 sessions per week of 20 to 30 minutes per session that could be gradually increased to 60 to 90 minutes as the program progressed, based on patients' choice and goal-setting procedures and under the supervision of the primary researcher.

Prior implementing the intervention program, resting heart rate was measured. Heart rate was recorded at each exercise and exercise intensity was initially set at 55% of resting heart rate (Karvonen et al., 1957) and kept as an intensity goal throughout application of the exercise program.

The protocol was based on the principles of SDT (Ryan & Deci, 2000) as implemented on the THALES Project (Hatzigeorgiadis et al., 2016). According to SDT, to increase individual motivation, it is necessary to strengthen three basic psychological needs, that is, the need: a) to feel competent, b) to feel autonomous, and c) to develop essential relationships (Deci & Ryan, 2000; Ryan & Deci, 2000). To reinforce the need to feel competent, participants completed a daily goal list (e.g., duration of exercise time, times per week). In this way, each participant learned to set achievable, self-evaluated, realistic and short-term goals according to own abilities. As for autonomy, participants had the opportunity to choose the place and the type of exercise to increase their enjoyment and engagement. Finally, the need to develop meaningful relationships was reinforced through the relationship developed with the primary researcher and with the other participants.

At the beginning of each session, the researcher was informed by each participant and all information was recorded in the personal diary of each one so that there is detailed feedback progress and individual effort throughout the program.

Instruments used for all participants of both groups were administered for completion prior and after the intervention program. The control group (N = 15) did not participate in any intervention procedure. It is important to mention that the combined exercise program was also offered to the participants of the control group after the end of the intervention program.

Statistical analysis

Data analysis included the use of the Statistical Package for Social Sciences (IBM SPSS Statistics v26.0). Initially, normal distribution was verified using Kolmogorov-Smirnov test (K-S). A z score of SF-36 variables was also calculated and named Quality of Life Index (QoL Index). Then, separate independent samples t-tests were conducted in order to check for possible differences in the examined variables between groups (experimental and control) at the pre-intervention measurement. Following, a two-way repeated measures ANOVA (2x2) was used to detect possible differences in the examined variables between time (pre-post), group

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(experimental and control) and interaction between time and groups. In case normal distribution was violated, a Mann-Whitney *U* non-parametric test was conducted to assess probable differences in post-intervention results between the two groups, while a Wilcoxon non-parametric test was used to examine possible differences between pre and post-intervention measures within each group. Statistical significance was set at $p < .05$.

RESULTS

Descriptive statistics and normal distribution

Descriptive statistics (M ± SD) and normal distribution of the examined variables in pre and post measures are as follows (Table 1).

Table 1. Descriptive statistics and normal distribution of variables in pre and post- measures.

	Pre		Post	
Variables	**M ± SD**	**K-S**	**M ± SD**	**K-S**
Physical functioning	20,37 ± 5,90	0,519	21,57 ± 6,18	0,53
Role Physical	6,13 ± 1,76	1,402*	5,87 ± 1,76	1,402*
General Health	14,27 ± 4,11	0,753	14,87 ± 3,83	0,823
Vitality	13,87 ± 3,60	0,537	15,23 ± 3,48	0,515
Mental health	19,57 ± 4,52	0,742	21,00 ± 4,43	0,825
Role emotional	4,83 ± 1,29	1,738*	5,07 ± 1,11	1,640*
Bodily pain	7,00 ± 1,93	1,266	7,00 ± 1,86	0,757
Social functioning	4,70 ± 1,90	0,789	4,63 ± 1,75	0,816
General physical health	47,77 ± 10,92	0,461	49,30 ± 10,70	0,587
General mental health	42,97 ± 6,87	0,785	45,93 ± 6,52	0,961
Anxiety	7,50 ± 4,26	0,663	6,90 ± 4,19	0,67
Depression	7,37 ± 3,86	0,651	6,53 ± 3,48	0,657
QoL Index (z scores)	0,00 ± 0,87	0,155	0,00 ± 0,92	0,135

Notes. M = Mean; *SD* = Standard Deviation; K-S = Kolmogorov-Smirnov *Z* test; QoL = Quality of Life Index; * $p < .05$.

Differences between the two groups at the pre-intervention measurement

Separate independent samples t-tests revealed no statistically significant differences on physical functioning (t_{28} = -.152, p = .880), role physical (t_{28} = -.204, p = .839), bodily pain (t_{28} = -.944, p = .353), general physical health (t_{28} = -1.125, p = .270), vitality (t_{28} = -1.908, p = .067), role emotional (t_{28} = 1.289, p = .208), social functioning (t_{28} =.095, p = .925), anxiety (t_{28} = .896, p = .378), and depression (t_{28} = .895, p = .379), between the two groups (experimental and control) at the pre-intervention measurement. In contrast, there were statistically significant differences on general health (t_{28} = -2.396, $p < .05$), mental health (t_{28} = -2.609, $p < .05$), general mental health (t_{28} = -2.445, $p < .05$), and QoL Index (t_{28} = -2.040, $p \leq .05$) between the two groups at the initial measurement. More specifically, examining the mean scores of the above variables, results showed that the control group reported higher scores on general health, mental health, general mental health and QoL Index compared to the experimental group at the pre-intervention measurement.

Differences between the two groups on physical and mental health

Two-way ANOVAs with repeated measures showed significant interactions between time and group only on "physical functioning" (Wilks' λ = .855, $F_{1,28}$ = 4.767, $p < .05$, ηp^2 = .15). Additional analysis of these interactions revealed significant differences on "physical functioning" ($F_{1,28}$ = 7.051, $p < .05$, ηp^2 = .20) between pre- and post measures only for the participants of the experiment group, with significantly higher scores noted in post measures (Table 2; Figure 1). No significant interactions were noted between time and group on "general health" (Wilks' λ = .910, $F_{1,28}$ = 2.761, p = .108, ηp^2 = .09), "bodily pain" (Wilks' λ = .950, $F_{1,28}$ = 1.474, p = .235, ηp^2 = .05) and "general physical health" (Wilks' λ = .885, $F_{1,28}$ = 3.654, p = .07, ηp^2 = .12).

As for "role physical", Mann Whitney *U* test showed no statistically significant differences on post-intervention scores (U = 108.00, p = .845) between the two groups (Table 2). Similarly, Wilcoxon test showed no significant differences between pre and post measures both for the experiment (Z = -.683, p = .494) and control group (Z = -1.166, p = .244).

Table 2. General physical health differences between the two groups (experimental, control).

	Experimental group		Control group	
Variables	**Pre (M ± SD)**	**Post (M ± SD)**	**Pre (M ± SD)**	**Post (M ± SD)**
Physical functioning	20,20 ± 5,44 [a]	23,07 ± 5,74 [c]	20,53 ± 6,52	20,07 ± 6,43

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Role Physical	6,07 ± 1,94	5,93 ± 1,94	6,20 ± 1,61	5,80 ± 1,61
General Health	12,60 ± 3,58	14,13 ± 3,76	15,93 ± 4,03	15,60 ± 3,89
Bodily pain	6,67 ± 2,06	7,07 ± 2,12	7,33 ± 1,80	6,93 ± 1,62
General physical health	45,53 ± 11,84	50,20 ± 12,04	50,00 ± 9,80	48,40 ± 6,56

Notes. M = Mean; *SD* = Standard Deviation; [a] Significant difference on physical functioning between pre and post measures only for the experimental group.

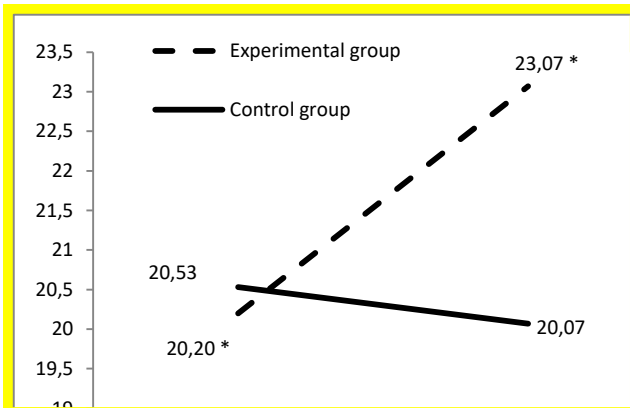

Figure 1. Time (pre, post) and group (experimental, control) differences on MS patients' physical functioning (* $p < .05$).

Furthermore, significant interactions were found between time and group on "vitality" (Wilks' λ = .818, $F_{1,28}$ = 6.223, $p < .05$, ηp^2 = .18), "mental health" (Wilks' λ = .657, $F_{1,28}$ = 14.638, $p < .001$, ηp^2 = .34), and "general mental health" (Wilks' λ = .633, $F_{1,28}$ = 16.250, $p < .001$, ηp^2 = .37; Figure 2) variables. Additional analysis between pre and post measures showed significant differences on "vitality" ($F_{1,28}$ = 11.873, $p < .01$, ηp^2 = .30), "mental health" ($F_{1,28}$ = 20.720, $p < .001$, ηp^2 = .43), and "general mental health" ($F_{1,28}$ = 28.233, $p < .001$, ηp^2 = .50) only for the experiment group participants following the intervention program, with significantly higher scores achieved in all dependent variables in post measurements (Table 3). No significant interactions were noted between time and group on "social functioning" (Wilks' λ = .920, $F_{1,28}$ = 2.422, p = .131, ηp^2 = .08).

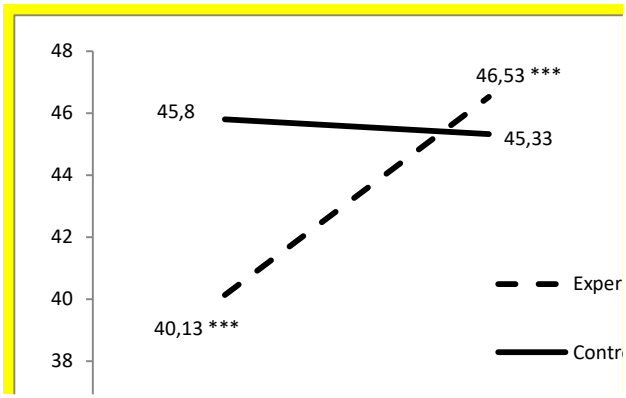

Figure 2. Time (pre, post) and group (experimental, control) differences on MS patients' general mental health (*** $p < .001$).

As for "role emotional", Mann Whitney *U* test revealed statistically significant differences on post-intervention scores (U = 52.00, $p < .01$, η^2 = .21) between the two groups, with experiment group participants exhibiting higher scores compared to those in the control group (Table 3). Wilcoxon test showed no significant differences between pre and post measures both for the experiment group (Z = -1.594, p = .111) and the control group (Z = .00, p = 1.00).

Table 3. Mental health differences between the two groups (experimental, control).

	Experimental group	
Variables	**Pre (M ± SD)**	**Post (M ± SD)**
Vitality	12,67 ± 3,22 [a]	15,47 ± 3,78 [a]
Mental Health	17,60 ± 4,40 [b]	21,13 ± 5,01 [b]
Role emotional	5,13 ± 1,30	5,60 ± 0,83 [c]
Social functioning	4,73 ± 2,09	4,33 ± 1,80
General mental health	40,13 ± 6,46 [d]	46,53 ± 6,64 [d]
	Control group	
Variables	**Pre (M ± SD)**	**Post (M ± SD)**
Vitality	15,07 ± 3,65	15,00 ± 3,27
Mental Health	21,53 ± 3,83	20,87 ± 3,94
Role emotional	4,53 ± 1,25 [e]	4,53 ± 1,13 [c, e]
Social functioning	4,67 ± 1,76	4,93 ± 1,71
General mental health	45,80 ± 6,24	45,33 ± 6,56

Notes. M = Mean; *SD* = Standard Deviation; [a, b, d] Significant differences on vitality, mental health and general mental health between pre and post measures only for the experimental group; [c] Significant differences on role emotional between experimental and control groups; [e] Significant differences on role emotional between pre and post measures only for the control group.

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Differences between the two groups on anxiety and depression

Two-way ANOVAs with repeated measures revealed significant interactions between time and groups on anxiety (Wilks' λ = .690, $F_{1,28}$ = 12.554, p < .01, ηp^2 = .31; Figure 3) and depression (Wilks' λ = .631, $F_{1,28}$ = 16.371, p < .001, ηp^2 = .37; Figure 4). In particular, significant differences were noted between pre and post measures on anxiety ($F_{1,28}$ = 11.610, p < .01, ηp^2 = .29) and depression ($F_{1,28}$ = 16.270, p < .001, ηp^2 = .37) only for the participants of the experiment group following the intervention program, with significantly lower scores achieved in all dependent variables in post measurements (Table 4).

Table 4. Anxiety and depression differences between the two groups (experimental, control).

	Experimental group	
Variables	**Pre (M ± SD)**	**Post (M ± SD)**
Anxiety	8,20 ± 4,75 [a]	5,93 ± 4,13 [a]
Depression	8,00 ± 3,76 [b]	5,13 ± 3,20 [b, c]
	Control group	
Variables	**Pre (M ± SD)**	**Post (M ± SD)**
Anxiety	6,80 ± 3,75	7,87 ± 4,16
Depression	6,73 ± 3,99	7,93 ± 3,26 [c]

Notes. *M* = Mean; *SD* = Standard Deviation; [a, b] Significant differences on anxiety and depression between pre and post measures only for the experimental group; [c] Significant differences on depression between experimental and control groups only for the post measures.

No significant differences emerged between pre and post measures concerning the control group ($F_{1,28}$ = 2.851, p = .102). Significant differences were also noted on depression between the two groups in post measurements ($F_{1,28}$ = 5.626, p < .05, ηp^2 = .17), with experiment group participants exhibiting lower scores on depression compared to those of the control group (Table 4; Figure 4).

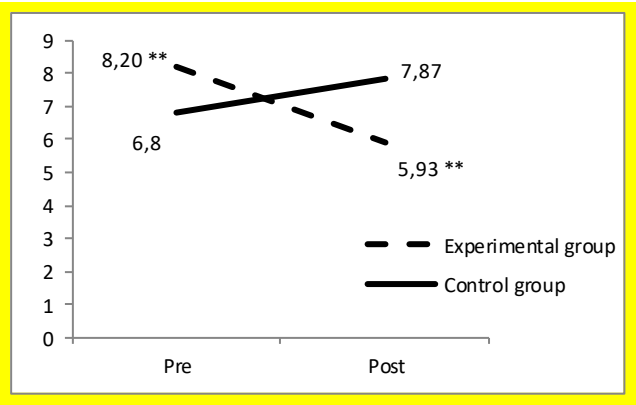

Figure 3. Time (pre, post) and group (experimental, control) differences on MS patients' anxiety (** p < .01).

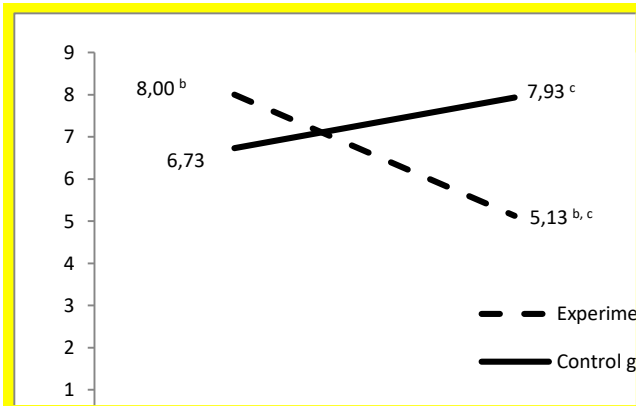

Figure 4. Time (pre, post) and group (experimental, control) differences on MS patients' depression ([b, c] p < .001).

Differences between the two groups on QoL Index

Two-way ANOVA with repeated measures revealed significant interactions between time and groups on QoL Index *z* scores (Wilks' λ = .691, $F_{1,28}$ = 12.532, $p \leq .001$, ηp^2 = .31). Analyzing this interaction, results showed significant differences between experimental and control group at the pre-intervention measurement ($F_{1,28}$ = 4.162, $p \leq .05$, ηp^2 = .13). More specifically, control group reported higher *z* scores in QoL index (M = .31 ± .83) compared to experimental group (M = -.31 ± .83) at the initial measurement. No significant differences emerged on *z* scores of QoL Index between the two groups in post-intervention measurements ($F_{1,28}$ = 269, p = .608; Experimental group: M = .09 ± .99; Control group: M = .09 ± .86).

DISCUSSION

The purpose of this study was to examine the effect of an 8-week exercise program combined with self-selected goal-setting strategies and the principles of SDT (Ryan & Deci, 2000) on improving quality of life and reducing anxiety and depression of MS patients. Overall, a comparison between pre and post-intervention measures revealed an improvement on quality of life features (physical functioning, vitality, emotional role, mental health, general mental health) and a reduction of depression and anxiety levels only for the experimental group participants compared to control group individuals.

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Increase of physical functioning level of the experiment group participants following intervention is in agreement with Stroud and Minahan (2009) who noted a physical functioning improvement of patients with multiple sclerosis engaged in regular PA. Similar findings of improved physical functioning ratings were recorded in the study of Huisinga et al. (2011) in 26 MS patients completing 15 elliptical exercise training sessions. In the same study of Huisinga et al. (2011) a significant improvement in the emotional role factor was also illustrated, indicating a positive perception development of dealing with the emotional problems caused by MS limitations. Similar results were also reported by the Hammer et al. (2005) study of 11 patients with MS participating in a single-subject experimental design of therapeutic riding sessions. Likewise, an improved emotional role of MS participants found in this study, demonstrates the positive effect of the combined exercise program on the perceptions of MS individuals who felt more physically and emotionally active to participate in their daily activities following the completion of the protocol.

Improved vitality in post-measures noted only for the experiment group participants is in line with the findings of Bjarnadottir et al. (2007) research which showed that short, moderate aerobic exercise can improve the perceived quality of life of MS patients in terms of vitality and physical functioning in daily physical activities, without necessarily reducing physical limitations created by the disability. Tallner et al. (2015) in their study of 265 MS patients reported significantly important differences in vitality in favor of those who were physically active. Kerling et al. (2015) recorded similar vitality increase findings in MS patients involved in a three months' exercise program, whereas Mostert and Kesselring (2002) showed that vitality can significantly improve for MS individuals and provide a positive effect on their vitality level even with exercise protocols of shorter duration that the eight weeks of this study.

In the Ysrraelit et al. (2018) study of 700 MS patients and 300 neurologists completing the SF-36 quality of life questionnaire, physicians considered physical functioning (75%) and emotional role (52%) as the most important factors in the quality of life of MS patients whereas patients with MS reported physical functioning (58%) and vitality (52%) as the most significant factors. These findings suggest the importance of these factors in quality of life research.

Indeed, post-measures in mental health and general mental health factors in this study shows the valuable effect of the exercise program on improving these quality of life features, that in turn, enhanced mood and mental health of experiment group participants leading to an improved general mental component score. Similar mental health benefits were reported in Tallner et al. (2015) and Kerling et al. (2015) studies, emphasizing the positive effect of exercise as a mean to improve general mental health of physically active individuals with MS (Stuifbergen & Becker, 2001). On the other hand, these results are not in line with Langeskov-Christensen et al. (2022) findings that showed no significant effects on MS patients' quality of life following the implementation of an aerobic exercise program, probably due to the high-intensity of their program that focused mainly on physical functioning improvements.

Furthermore, lower post-scores reported for experiment group participants on depression and anxiety features compared to those in the control group, further highlight the promising outcome of the exercise program in reducing perceived levels of depression and anxiety experienced by MS patients following intervention. The findings are consistent with the studies of Farmani et al. (2015) and Stroud and Minahan (2009) comparing quality of life features between exercisers and non-exercisers with MS and the study of Molt et al. (2009) showing that MS patients who were more physically active exhibited lower levels of depression.

As Jones et al. (2012) pointed out in the largest known study of its kind with 4178 respondents with MS, anxiety and depression are highly prevalent in people with MS, thus, further support service planning and research is needed to provide the best care for MS individuals to help alleviate these debilitating conditions. In this regard, Dalgas et al. (2015) in their meta-analysis concluded that overall research findings suggest that PA reduces depression symptoms in MS patients, with further researches needed to draw final conclusions. Nevertheless, the sum of research evidence reveals small but reliable and statistically significant reductions in depression levels in exercise participants with MS (Ensari et al., 2014).

According to Schüler et al. (2019) therapists of MS patients should also use psychology tools to change health behavior and be more aware of psychological theories that they should implement to optimize

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treatment approaches. Motl et al. (2018) call attention to the obvious disconnect that exists between the evidence of exercise benefits and the participation rates in PA among people with MS. Thus, they propose that the lack of broad participation by individuals with MS despite existing evidence of meaningful exercise benefits can be improved only through the inclusion of behavior change theories in the design of the exercise programs that will implement these behavior theory interventions such as goal setting to increase PA behavior (Motl et al., 2018).

Sufficient evidence shows that exercise is effective for improving physical and psychological components that greatly influence health-related quality of life (Latimer-Cheung et. al., 2013). In addition, recent research findings point out the usefulness of implementing behavior approaches such as the goal-setting used in this study, to increase exercise levels of MS patients and optimize physical and psychological outcomes (Casey et al., 2017).

Since MS treatment measures improve as the effectiveness of self-management improves (Marks et al., 2005), the findings of this study agree with Geurts et al. (2019) study revealing positive trends toward PA when participants with MS set personal goals, as well as the conclusion of Casey et al. (2017) meta-analysis that future PA interventions should continue to focus on psychosocial constructs such as goal-setting. Quite clearly, goal-setting is positively related to the increase in exercise levels of MS patients who are more likely to succeed when achieving self-selected goals (Bloom et al., 2006; Consolvo et al., 2009).

As for the role of SDT (Ryan & Deci, 2000) in this study, findings suggest its importance as a theoretical framework to improve MS patients' quality of life, since it satisfies the three basic psychological needs (autonomy, competence, relatedness) that lead to the adoption of a more physically active lifestyle. This hypothesis is also supported by the preliminary findings of the present intervention as presented in Karageorgou et al. (2022), which showed that exercise group participants with MS reported higher rates of leisure-time PA compared to non-exercisers. Finally, the present findings concerning quality of life of MS participants are in line with previous studies in the broader fields of exercise and health psychology that previously used SDT (Ryan & Deci, 2000) as a "*vehicle*" to help healthy individuals or patients to improve their PA levels and well-being (e.g., Fortier et al., 2012; Ng et al., 2012; Ntoumanis et al., 2021; Teixeira et al., 2012).

CONCLUSIONS

In conclusion, the results of this study showed that the application of an exercise program combined with goal-setting strategies and the principles of SDT (Ryan & Deci, 2000) improved a number of significant features including physical functioning, vitality, emotional role, mental health, general mental health, depression and anxiety for the experiment group participants with MS, which are considered as the most important factors that determine the quality of life of MS individuals (Ysrraelit et al., 2018). According to Homayuni et al. (2021), to improve quality of life of MS patients, it is important to pay attention to factors such as leisure-time, positive thinking, and exercise.

Limitations of the present study include the small number of participants with MS and the use of self-report measurements. Therefore, future research with larger samples and different methodological procedures (e.g., semi-structured interviews) is needed to further investigate the effect of exercise on the MS patients' quality of life in combination with behavior change strategies (e.g., goal-setting) and theoretical frameworks (e.g., SDT; Ryan & Deci, 2000).

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