RESUMO
A prática de exercícios resistidos é uma das formas mais comuns de exercitar-se na sociedade contemporânea. Nesse estudo, buscamos sistematizar, propor e aplicar um programa de exercícios resistidos adaptados para um grupo de pessoas com esclerose múltipla (EM).

Foram convidadas 80 pessoas com a doença e cadastradas em uma entidade de pessoas com EM da cidade de Campinas e Região. Deficiência e incapacidade neurológica foram determinadas pela Expanded Disability Status Scale (EDSS). Para avaliar a capacidade funcional utilizou-se a Medida de Independência Funcional (MIF), a caminhada cronometrada de 7,62 metros, o Timed “Up and Go” test, Box and Block test, e o teste de alcance funcional. O programa com exercícios resistidos teve duração de 10 semanas consecutivas, com duas sessões semanais. Nove sujeitos apresentaram-se para o estudo, sendo seus resultados divididos em grupo 1 (4 pessoas sedentárias) e grupo 2 (5 pessoas que participavam ou haviam participado regularmente de outros programas com exercícios físicos).

Um sujeito do grupo 1 completou o programa com alta taxa de adesão, tendo sua avaliação não apontado alteração nos valores do EDSS e do MIF. Observou-se redução no tempo para execução da caminhada cronometrada de 7,62 metros (-21%) e no Timed “Up and Go” test (-12,8%). Houve melhora na execução do teste Box and Block: membro direito (2,1%) e membro esquerdo (6,7%) e piora no teste de alcance funcional (-7,5%). Os resultados desse estudo estão de acordo com os dados publicados na literatura, destacando a adequação e segurança de um programa com exercícios resistidos para melhora de aspectos funcionais de pessoas com esclerose múltipla.

PALAVRAS-CHAVE
esclerose múltipla, exercício resistido, exercício físico

ABSTRACT
Resistance exercise practice has become one of the most common forms of physical activity. In this study we sought to standardize, propose and apply an adapted resistance exercise program for a group of people with multiple sclerosis (MS). An invitation was made to 80 people attending an institution for people with MS in the city of Campinas, state of Sao Paulo, Brazil. Neurological disability and impairment were determined by the Expanded Disability Status Scale (EDSS). To evaluate the functional capacity we used the Functional Independence Measure (FIM), walking time (10 feet), the Timed “Up and Go” test, the Box and Block test and the Functional Reach test. The resistance exercise program lasted 10 weeks with two weekly sessions. The nine participants were divided in Group 1 (4 sedentary people) and Group 2 (5 people that regularly participated in other physical exercise programs). One individual from Group 1 completed the program with high compliance, showing no alterations at the EDSS and FIM scores. There was a reduction in the 10 feet walking time (-21%) and at the Timed “Up and Go” test time (-12.8%). The Box and Block test showed improvement: dominant limb (2.1%) and non-dominant limb (6.7%), but the Functional reach test deteriorated (-7.5%). The results of this study are in agreement with the international literature, indicating the adequacy and safety of a resistance exercise program in the improvement of functional aspects for people with MS.

KEYWORDS
multiple sclerosis, resistance exercise, exercise
INTRODUCTION

The observation of the impact caused by physical exercise programs has progressively become an object of study among researchers involved with multiple sclerosis (MS). In the 80’s and 90’s, the emphasis was given to aerobic exercise programs and those performed in the water, which showed to be safe and effective for improving the cardiovascular conditioning, fatigue and quality of life. In the recent years, interventions that involved resistance exercise programs have become more prominent. These studies prioritized the participants’ muscular strength increase based on proposals conducted in at-home environments, with elastic tapes and special garments with additional weights or in controlled environments with specific devices. As a result, there was increased muscular strength and resistance, fatigue reduction and improved ambulation.

The practice of physical exercises by individuals with MS tends to be aimed exclusively at therapeutic aims. Consequently, spaces such as workout gyms, clubs and squares tend to be less sought by people with MS, which can mean a restriction in the opportunities for social integration and experiences in varied physical exercise practices.

The present study aimed at systematizing, proposing and applying an adapted resistance exercise program to a group of people with MS, observing the level of adherence and the impact of this program on the functional aspects of this population.

METHODS

According to Thomas e Nelson, the present study was characterized as being a descriptive research, classified as an assessment case study, as it “involves description and interpretation, but the main objective is to use the data to evaluate the merit of some practice, program, movement or event”. The study was approved by Ethics Committee in Research of the Faculdade de Ciências Médicas da Unicamp, under # 020/2004 and all the participants signed the Free and Informed Consent Form.

SUBJECTS

Subject recruiting was carried out by inviting the individuals registered at the Multiple Sclerosis Group of Campinas and Region (GEMC), totaling 80 subjects associated with the disease. The selection period occurred during the months of July and August, 2004, and aimed at forming a group with 10 to 15 participants. The inclusion criteria included having a confirmed diagnosis of MS, neurological follow-up, no disease outbreak in the thirty days before the start of the study and being capable of going to the facilities of the Physical Education School of the Universidade Estadual de Campinas (Unicamp), where the adapted resistance exercise program would be carried out.

PROCEDURES

The subjects who volunteered to participate in the study were initially submitted to an interview aimed at the identification and guaranteeing their eligibility for the study. Subsequently, the program was explained, the Free and Informed Consent Form was signed and vital signs were measured. The subjects considered eligible for the study were then submitted to the assessment at the start and at the end of the program, which consisted of:

EDSS ASSESSMENT

The deficiency and motor impairment were established by the Functional Systems scale and the Expanded Disability Status Scale (EDSS) proposed by Kurtzke. The EDSS is a tool to measure the neurological impairment that consist of 20 intervals of 0.5 points, where 0 indicates a normal neurological assessment, 5.5 indicates the capacity of walking at least 100 meters without help or the need for resting and 10 indicates death due to MS. For an EDSS < 8, the classification is based on ambulation and neurological assessment focused on eight Functional Systems: visual, pyramidal, sensory, cerebellar, sphincter, cerebral, encephalic trunk and others. In this scale, the score 8.5-9.5 is based on self-care functions. Although it emphasizes ambulation and despite its problems in standardization, sensitivity, reliability and inter-examiner variability, this measure is still the most frequently used in clinical assays with individuals presenting MS.

FUNCTIONAL CAPACITY

The Functional Independence Measure (FIM) was used to measure the individuals’ impairment. The main objective of this tool is to quantitatively assess the load of care required by an individual to perform the 18 common daily motor and cognitive tasks, which totaled a maximum of 126 points. The Brazilian version of the FIM showed to be sensitive to alterations and clinically useful to evaluate rehabilitation results.

LOWER LIMB FUNCTION MEASURE

Timed “Up and Go” test:

The timed “Up and Go” test evaluates the lower limb function and includes agility and balance maneuvers. In this test, the examiner measures the time spent by an individual to get up from an armchair, walk three meters, turn around and sit back on the armchair. Due to the fact that this measurement does not require special equipment or the examiner’s training to apply it, it has become a practical tool to evaluate lower limb function.

10-feet Walking Time

It is a measure of the lower limb function present in the Multiple Sclerosis Functional Composite (MSFC). This tool was developed in 1994 by the American Society of Multiple Sclerosis and currently, it has been progressively used in clinical studies of individuals.
with MS. It consist in requesting the patient to walk, as fast as possible, a previously demarcated distance of 10 feet on an anti-sliding floor. The durations of two attempts are recorded and the patient is allowed to use gait support.

**UPPER LIMB FUNCTION MEASURE**

**Box and Block test**

The Box and Block test consists in the transportation of small wooden cubes measuring 2.5 x 2.5 x 2.5 cm, for one minute. These blocks must be taken from one side to the other side of a wooden box with divisions. The number of blocks must be recorded for the right and the left upper limb, for two attempts. The Box and Block test, which is a fast, simple and easy-to-apply test, has shown to be more sensitive in detecting alterations in the functional capacity of upper limbs of individuals with MS than the EDSS.

**BALANCE MEASURE**

**Functional Reach Test**

The functional reach test is an easy-to-apply scale, developed to evaluate the balance capacity of the elderly. The functional reach is the maximum distance that an individual can reach when bending forward with the arms extended at the shoulder level while maintaining a fixed standup base.

**TRAINING PROGRAM**

The proposed resistance exercise program consisted of two weekly sessions, for ten consecutive weeks. The duration of each session was related to the learning of the exercises and their sequence. As the participants became more used to the proposed exercises, the duration of each session decreased, varying from 80 to 50 minutes.

At the beginning of the session stretching activities, which lasted 5 to 7 minutes, were conducted. The muscular strengthening program included the practice of resistance exercises for the main muscular groups, with free weights (dumbbells and ankle weights) and the participants’ own weight against the gravity force. Auxiliary material such as sports mats, exercise steps and batons were also used. When this proposal was created, we selected simple and low-cost exercises. Thus, we chose the following exercises: 1- squatting; 2- horizontal adduction flexion of the shouldes (crucifix); knee flexion; 4- lateral upper limb elevation with the trunk bent forward in the sitting position (inverted crucifix); 5- advance; 6- lateral upper limb elevation; 7- plantar flexion; 8- elbow flexion; 9- sit-ups and 10- elbow extension.

As a result, we organized the sequence of exercises aiming at alternating the effort of the lower and the upper limbs, thus helping the physical rehabilitation.

We followed the minimum exercise recommendations for the development of muscular strength proposed by the American College of Sports Medicine (ACSM) and we took into account the fatigue experienced by individuals with MS. The ACSM recommends a program with a low volume of exercises for the elderly or fragile individuals, which contains a series of 10 to 15 dynamic repetitions with 8 to 10 exercises for the large muscle groups. In the present study, the load control was determined by the volume/intensity ratio, i.e., when an exercise with 15 repetitions was completed, the load was increased and the volume was reduced to 10 repetitions. The participant was instructed to complete a series of exercises with sub-maximum effort, equivalent to one or two repetitions before the concentric fatigue.

**RESULTS**

After the end of the two-month recruiting period, 9 subjects who were interested in participating in the study were evaluated. Given the fact that there were some individuals who were participating or had previously participated in physical exercise programs on a regular basis in the three-month period prior to the study, it was considered pertinent to divide the participants in Group 1 (G1) and Group 2 (G2).

G1 consisted of 4 female participants, aged 23 to 51 years and EDSS between 1 and 2.5. These participants declared they had not participated in regular exercise programs in the three-month period prior to the study.

- Subject 1, 23 years and EDSS of 1.5, left the group after the evaluation, justifying that she needed to help in the care of her nephews, as one of the parents had started working and thus could not take care of the children any longer.
- Subject 2, 47 years and EDSS of 1.5, had an accident at home and had a lower limb fracture, thus becoming unable to complete the program. This individual safely performed three consecutive sessions of resistance exercises and emphatically stated that the program was adequate for her physical condition.
- Subject 3, 42 years and EDSS of 1.0, had received a positive diagnosis of the disease four months before the start of the program and gave up participating in the study after 4 sessions. According to her report, she decided to quit participating in the study because she could not cope with imagining herself as the other people in the group, who were at a more advanced stage of the disease evolution and were impaired.
- Subject 4, 51 years and EDSS of 2.5, had been diagnosed four years before her participation in the study and did not use medication for MS. She completed 19 of the 20 sessions of the proposed resistance exercise program.

The result of her evaluation before and after the program was as follows:

There was no alteration in the EDSS and FIM scores before and after the intervention.

The evaluation of the lower-limb function showed a decrease of 21% in the time spent during the 10-feet walking test and a decrease in 12.8% in the Timed “Up and Go” test. The evaluation of the upper-limb function, represented by the Box and Block test,
indicated an improvement of 2.1% for the right limb (dominant) and 6.7% for the left limb (non-dominant). The Functional Reaching Test, which evaluates the balance skill, indicated a worsening of 7.5% when performing the task.

Group 2 consisted of 5 individuals, being 3 female and 2 male individuals, aged 31 to 56 years and EDSS between 2 and 6.5. This group was characterized by individuals who had been practicing physical exercises or had participated in another exercise program in the three months prior to the study.

- Subject 1, a 39-year-old male and EDSS of 5.5 quit the program after one session. He had personal problems at home and had difficulty getting to the research facility, given the distance from his house to the place where the sessions were conducted as well as his ambulation difficulties.

- Subject 2, a 31-year-old male and EDSS of 6.5 quit the program after participating in two sessions, in order to undergo physical therapy sessions and alternative therapies for the treatment of the disease, made available by the local hospital center.

- Subject 3, a 48-year-old female and EDSS of 6.0, practiced yoga, self-healing and Global Postural Reeducation (GPR) and participated in six non-consecutive sessions (one weekly session) as complement to other activities.

- Subject 4, a 56-year-old female and EDSS of 2, practiced yoga, hydrotherapy and acupuncture and participated in seven consecutive sessions (one weekly session); her participation during the program duration was a complement to other activities.

- Subject 5, 48-year-old female and EDSS of 2, practiced yoga and had dancing lessons. She participated in 20 sessions (2 weekly sessions) and decided to take up weight lifting at home about one year ago, after participating in the pilot-project of the present study.

**DISCUSSION**

The practice of resistance exercises, popularly known as body-building or “pumping iron”, an activity that is historically related to high-intensity physical exertion and the aim of attaining an esthetically sculpted body, was often valued and practiced by male teenagers and male adults. This perspective might have limited the interest and the participation of a larger number of individuals in the study, as well as the classical indication of reducing physical exertion as a means to decrease fatigue and possible outbreaks of the disease.

Additionally, the simultaneous offer of Yoga and Lian Gong activities to the same group of people with MS, can also have influenced the adherence to the study and showed the preference of this population for the aforementioned practices, as observed by Orlando. Another hypothesis refers to the access to the research facility, as the difficulties in transportation, ambulation and frequent fatigue complaints by people with MS can have a crucial role in the adherence to activities outside the home.

When analyzing the scientific literature regarding the practice of physical exercises by individuals with MS, it can be observed that the programs have been developed basically in two distinct environments. The first set of studies comprehends activities in a controlled laboratory environment. Petajan et al. reported that this type of program can favor social interaction and lead to positive psychological changes, possibly related to the improved physical conditioning. Another group of studies has proposed activities to be carried out at home, which can make it easier for a larger number of people to practice exercises; however, the studies indicate lower adherence to the proposed sessions when compared to the group activities. Factors related to motivation seem to influence this practice, as it lacks the constant presence of a professional and guide as well as the stimulus of belonging to and participating in a group.

Therefore, the choice of the environment for the practice of the physical exercises by people with MS requires consideration. The complexity of the disease leads to a variety of signs and symptoms and to different degrees of impairment, which especially interfere with the lifestyle. In this context, the practice of physical exercises must be considered in the light of individual possibilities, without disregarding preferences and aptitude. We believe that options to facilitate the involvement and adherence to the practice of physical exercises must include the participation in programs of associations of individuals with the same disease, public spaces, clubs, gyms, or even with personalized training.

In the present study, the activities were carried out in the morning, in a room that had electric wall fans, as well as large doors that favored the air circulation and maintained the room temperature at comfortable levels. The literature has shown that the increase in body temperature is undesirable for individuals with MS, as it increases fatigue symptoms, making it difficult to maintain the physical effort, and, in some cases, it may result in ophthalmologic symptoms. The restrooms were close to the physical exercise practice room, as the increase in urinary frequency and urgency is
common in people with MS\textsuperscript{21}. These questions deserve special attention and all the more when associated to ambulation impairment and symptoms of fatigue, characteristic of people with MS, as they are crucial for their presence in an environment and participation in activities frequently directed to people without the disease.

The results of the present study confirm literature data regarding the adequacy and safety of a resistance exercise program for people with MS. Throughout the study, there was no outbreak of the disease or injuries. According to the participants’ reports, the place where the exercises were performed and study design were adequate for individuals with MS. The analysis of the results of the evaluation of subject 4, Group 1, before and after the program, showed improvement in lower-limb function and at the manual dexterity test. The intervention did not result in positive alteration at the balance test. The EDSS and FIM of subject 4 remained unaltered, showing that the program had no negative effect on the course of MS.

After 10 weeks of program participation, the subject showed improvement at the Timed “Up and Go” test of 12.8%, a similar result to that previously reported by DeBolt and McCubbin\textsuperscript{4}, who observed a mean improvement of 12.7% at the test. Such program consisted of eight weeks of an at-home program with resistance exercises for people with MS. In this study, the weights were added progressively to special garments in order to control the load.

The improvement of 21% in the performance time at the 10-feet Walking Test demonstrated by the study is in agreement with the results obtained by Romberg et al\textsuperscript{5}. The authors proposed a program that consisted of elastic bands with different tensions in an at-home environment for six months, finding an improvement of 12% in the time spent to fulfill the task. Dissimilarly, the results of the study by White et al\textsuperscript{6}, with resistance exercises for the lower limb, carried out in specific equipment for 8 weeks, do not corroborate such results, demonstrating an absence of significant alteration regarding the test result. According to these authors, a longer walking test might be more sensitive to alterations in the mobilization velocity.

The result of the manual dexterity test, the Box and Block Test, showed an improvement of 2.1% or 1.5 blocks for the dominant limb and 6.7% or 4 blocks for the non-dominant one. The results of the study by Romberg et al\textsuperscript{5} are similar to those obtained at the present study, presenting an improvement of 2.4 blocks in the dominant limb and 1.3 blocks in the non-dominant one. This test and the other two used for the evaluation of lower-limb function, given their simple design, can be used in a variety of places, representing an important means of assessment of functional alterations in people with MS that are participating in physical exercise programs.

The balance assessment data showed a reduction of 7.5% in the Functional Reaching Test. The study by DeBolt and McCubbin\textsuperscript{4}, based on more accurate methods of balance assessment, showed an improvement regarding the levels of this capacity; however, the results did not reach statistical significance. It is important that further studies evaluate activities that can promote balance improvement, as this is a common problem for people with MS and is related to a higher probability of falls and injuries\textsuperscript{21}. The present study paid special attention to this problem, which was observed in some of the participants and thus, some exercises were adapted so they could be performed either in the sitting position or lying down. For the activities that had to be performed standing up, the participants had the support of a lateral bar.

We consider it important to prioritize the use of low-cost materials, which could be easily found in gyms or acquired by groups of people with MS. The proposed program consisted of a low volume of exercises, represented by a series of 10-15 repetitions of 10 different exercises for the main muscular groups\textsuperscript{20,25}. The increase in the physical exertion intensity occurred progressively during the training period, according to a volume-intensity ratio. The loads were increased after performing 15 repetitions of the exercise, followed by the reduction of the volume to 10 repetitions. When the participant reported augmented fatigue symptoms before the beginning of the session, the load was reduced and a longer interval was allowed between the exercises.

The concern regarding the fatigue led us to alternate upper-limb exercises with lower-limb ones and to determine a minimal interval of one-minute between the exercises. We observed that the participants’ degree of impairment usually determined the recovery time. The participants who were less severely affected showed to be promptly willing to move on to the next exercise, whereas those more severely affected needed a longer recovery time. In this sense, we prioritized the contact with the participants, seeking to respect their recovery needs, which could influence the sessions due to several factors such as the activities carried out on the previous day, significant psychological factors or even the increase in the room temperature. The subjective perception of the physical exertion, measured at the end of each session using the Borg scale, made the comparison easier as well as the recognition of the physical exertion between the sessions, leading to possible adjustments in the program in order to prevent excessive physical effort, which are responsible for the augmented fatigue symptoms\textsuperscript{26}.

We propose that the meaning of resistance exercise practice for these individuals must be supported by the perspective of the search for the maintenance or development of muscular strength, leading to an active and independent lifestyle, as a means to minimize the consequent losses of physical capacity due to MS as well as aging. It is also noteworthy the relevance of the participation in these physical activities to recognize new movements and sensations, which are potentially significant for the individual’s development.

Finally, based on the present study and other studies on resistance exercises for people with MS, we believe that the main question to be asked is not whether these individuals can or cannot practice physical exercises, but what the best place for this practice is and what type of qualification the professional must have in order to apply such program.

Hence, the issue of the responsibility must be stressed and it is the responsibility of the physicians in charge to inform their patients on the benefits brought on by this practice and the criteria of the professional’s choice to conduct it; the individuals with MS must choose the most adequate place, taking into account their physical, emotional and financial condition; the Physical Education courses, at Graduation and Post-Graduation levels, must be responsible for preparing the professional, who, in several environments such as...
clubs, gyms and associations, is in charge of designing and conducting resistance exercise programs adapted to the special needs of each individual.

REFERENCES