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The effects of a 24-week exercise intervention and detraining on individuals with Intellectual and Developmental Disabilities

Wirkungen einer 24-wöchigen Bewegungsintervention und nachfolgenden Detrainings bei Menschen mit Intelligenzminderung und Entwicklungsstörungen

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ABSTRACT

Objective Regular physical exercise can promote physical fitness, reduce the risk of chronic diseases, increase independence and success in daily activities, and promote quality of life for individuals with intellectual and developmental disabilities (IDD). On the one hand, if this exercise practice is discontinued or interrupted, the associated beneficial effects can be lost. The aim of this study was to examine possible changes in body com-

position and physical and functional fitness variables after regular practice of a physical exercise program, as well as after the same period of detraining.

Materials and Methods This study followed a quasi-experimental methodology of 6 months of physical exercise, followed by 6 months of interruption. The sample consisted of 10 individuals with IDD, with an average age of 43.2 years (SD = 9.47). Weight, body mass index, handgrip, Timed Up and Go and Sit to Stand were assessed at initial intervention, post-intervention, and follow-up.

Results Participants improved in all variables after the intervention program, but only significantly in the handgrip test (Bonferroni corrected: $t = 1.05$; $p = 0.019$; $W = 0.21$). After 6 months without regular exercise, the participants showed a decline in physical and functional fitness variables, but only in handgrip significantly ($p = 0.044$).

Conclusions Although there are some gains from physical exercise program, there seems to be a loss of these gains after the end of the program. It is therefore recommended to avoid the period of detraining, which is fundamental to promoting the benefits of exercise, healthy ageing, independence, success in carrying out activities of daily living and quality of life.

ZUSAMMENFASSUNG

Fragestellung und Hintergrund Bei Menschen mit Intelligenzminderung und Entwicklungsstörungen (Intellectual and Developmental Disabilities, IDD) kann körperliche Bewegung die körperliche Fitness fördern, das Risiko der Entwicklung chronischer Krankheiten verringern, die Unabhängigkeit sowie den Erfolg bei täglichen Aktivitäten steigern und die Lebensqualität verbessern. Allerdings können die mit dem Training einhergehenden positiven Effekte verloren gehen, wenn die Bewegungsübungen vorübergehend oder dauerhaft eingestellt werden („Detraining“). Ziel der vorliegenden Studie war es, mögliche Veränderungen der Körperzusammensetzung und von Variablen der körperlichen und funktionellen Fitness nach regelmäßiger Durchführung eines körperlichen Trainingsprogramms sowie nach dem gleichen Zeitraum ohne Training zu untersuchen.

Material und Methoden Die Studie verwendete ein quasi-experimentelles Design, bei dem eine sechsmonatige Phase mit körperlichem Trainingsprogramm von einer sechsmonatigen Phase ohne Training gefolgt wurde. Die Stichprobe bestand aus 10 Personen mit IDD; das mittlere Alter betrug 43,2 Jahre (SD 9,47). Gewicht, Body-Mass-Index, Handgriffstärke, Zeitdauer für Aufstehen und Gehen (TUG-Test) und vom Sitzen zum Stehen wurden zu Beginn der Intervention, nach der Intervention und bei der Nachuntersuchung bestimmt.

Ergebnisse Die Teilnehmenden verbesserten sich nach dem Interventionsprogramm in allen Variablen, wobei aber nur die Veränderung im Handgriff-Test statistisch signifikant war (Bonferroni-korrigiert: $t = 1,05$; $p = 0,019$; $W = 0,21$). Nach 6 Monat-

en ohne regelmäßiges Training zeigten die Teilnehmenden Verschlechterungen bei den körperlichen und funktionellen Fitnessvariablen, aber nur die Abnahme im Handgriffstest war signifikant ($p = 0,044$).

Schlussfolgerung Obwohl mit einem körperlichen Trainingsprogramm einige Verbesserungen erzielt werden, scheinen diese nach Beendigung des Programms wieder verloren zu gehen. Es empfiehlt sich daher, die Phase des Detrainings zu vermeiden. Dies ist für die Verbreitung der positiven Wirkungen körperlicher Betätigung, für ein gesundes Altern, für Unabhängigkeit, für den Erfolg bei den Aktivitäten des täglichen Lebens und für die Lebensqualität von grundlegender Bedeutung.

Introduction

The population with IDD is characterized by a deficit in intellectual and adaptive functioning in the conceptual, social and practical domains and is based on three criteria: (1) a deficit in intellectual functioning (reasoning, problem solving, planning, summarizing, thinking, judging, school learning and learning from experiences), supported by a clinical and standardized assessment, namely an individual intelligence test; (2) a deficit in one or more adaptive behaviors, affecting activities of daily living (communication, social participation, living independently, namely at home, at work or in the community); (3) identified with mild, moderate, severe or profound degrees, developing before the age of 22 years [1].

As a result of many barriers to practice [2, 3], individuals with IDD are mostly sedentary and inactive [4, 5], making them more vulnerable to the comorbidities that result, particularly high health costs [6–8]. In the study by Dairo et al. [4], only 9% of the sample with IDD met the minimum recommendations of 150 minutes of moderate to vigorous physical activity per week.

Regular physical exercise, which consists of systematic planning of physical activity and involves structure and repetition, can develop, or maintain physical capacities such as strength, endurance, balance, and flexibility [9]. In addition to improved physical fitness, regular physical exercise practice is associated a lower risk of developing metabolic and cardiovascular diseases (e. g. diabetes, hypertension, high cholesterol) and other age-related comorbidities, and with an increase in average life expectancy [10, 11]. These diseases are being neglected in this population and there is an urgent need for strategies/tools to address these diseases [12–16].

For this reason, strategies for maintaining/increasing physical fitness should include exercise [17]. A systematic review that aimed to critically identify the evidence on the efficacy of exercise interventions in individuals with IDD, showed moderate to strong evidence of benefits in physical fitness [17]. Similarly to the population without disabilities, a meta-analysis also showed that regular exercise by individuals with IDD has an impact on body composition variables, making them less susceptible to a diagnosis of metabolic or cardiovascular diseases [12, 18]. In sum, implementing physical exercise in individuals with IDD is a useful strategy for improving well-being, promoting healthy ageing [19–21] and success

in performing daily activities [22–26], positively influencing their independence [27, 28] and quality of life [29–33].

However, most interventions in this population are short-term, given the current constraints [34, 35]. Likewise, studies of longitudinal effects are unknown, as the impact of detraining. Several studies, in different populations (e. g., elderly people), have reported that detraining caused a partial loss of exercise-induced benefits and even a further decline to a level below pre-exercise values [36–38]. In a sample of elderly people who participated in a 7-month combined cardiorespiratory and strength training exercise program implemented twice a week, Teixeira-Salmela et al. [39] found a decline to baseline values after interruption of the program. Rodrigues and colleagues [40] also found that the benefits gained from an intervention program, namely a reduction in body fat and an increase in muscle mass, were lost after completing the multicompetent exercise program (one that consists of strength, endurance, and balance training) to values below baseline.

Therefore, the aims of our study are to examine the effects of a physical exercise program on body composition and physical and functional variables, and to find out whether these effects are maintained after a period of interruption.

Materials and Methods

Research design

This research follows a quasi-experimental design in accordance with the Declaration of Helsinki [41]. Approval of the Ethical Standards for Research in Sports and Exercise Sciences was granted by the Ethics Committee of the Faculty of Sports Sciences and Physical Education of the University of Coimbra (with the approval code CE/FCDEF-UC/00872021). Previously of study, all participants and their families received comprehensive information about the purpose and procedures of the experimental methodology (in-person) and provided their informed consent by signing a consent form. Participation was voluntary and without monetary reward. The study was carried out during the calendar year 2023. The sessions were conducted by two exercise technicians with specific training in intervention with the IDD population. The assessments were car-

ried out by the laboratory technicians and the research team. Data processing was the responsibility of the research team.

Participants

Adult volunteers from an institution supporting people with disabilities, located in Leiria, took part in this study. Inclusion criteria were: 1) adult individuals with Intellectual and Developmental Disabilities; 2) absence of medical contraindications that make it impossible to exercise at the prescribed intensities and exercise; 3) ability to perform movements such as pulling/pushing; 6) ability to perform the planned assessments. Exclusion criteria were: 1) inability to engage in 24 weeks of physical exercise; 2) inability to walk without support; 3) profound IDD; 4) communication difficulties; 5) missing written consent; inability to commit to the assessments at week 0, 24 and 48.

Materials/Instruments/Procedures

Anthropometry

A portable stadiometer scale, specifically SECA model 870, was utilized to measure both body weight and height. Participants were instructed to stand barefoot on the platform of the stadiometer, leaning against the pole of the device, maintaining a conventional positioning their arms alongside their body. The body mass index (BMI) was subsequently calculated using the formula weight (in kilograms) divided by height (in meters squared). These measurement techniques were found to be feasible, reliable, and accurate for individuals with IDD, as supported by prior studies [29, 42–44].

Neuromuscular capacity

A manual dynamometer, specifically CAMRY EH101, was employed for conducting a handgrip test aimed at evaluating upper limb strength. The test was carried out with the dominant hand. The reliability and validity of the test were confirmed by Cabeza-Ruiz [45] and Oppewal and Hilgenkamp [46], with the protocol adhering to recommendations outlined in the Brockport Fitness Test Manual [47].

Functional capacity

To answer the aims of the study, specific tests from the Fullerton functional test battery [48, 49] were used to assess physical fitness, namely:

- i) The 30-second “sit to stand” test, validated for the IDD population [43, 45], assessed lower limb strength and endurance (number of executions in 30 seconds without using the upper limbs). The test starts with the participant sitting in the middle of the chair, with their back straight and their feet shoulder-width apart and fully flat on the floor. At the “start” signal, the participant stands up to maximum extension (vertical position) and returns to the initial sitting position. The participant is encouraged to complete as many repetitions as possible in a time interval of 30 seconds.
- ii) The “Timed up and Go” test, validated for the IDD population [45] aimed to assess physical mobility, namely speed, agility and dynamic balance. The participant must be sitting on a chair, with their hands on their legs and their feet flat on the floor. At the start signal, they get up from the chair and walk as fast as possible (without running) around a cone (located 2.44m away) and return to the chair. The participant should

be informed that the test is judged by the time taken to perform the exercise.

Intervention

The intervention was prescribed and carried out in accordance with the American College of Sport Medicine guidelines [50] and recommendations of various previous studies [51–53]. The training sessions were carried out twice a week, implemented by an exercise technician (professional who assessed and prescribed physical exercise) experienced in assessing and prescribing exercise for individuals with IDD. The training sessions were never held on two consecutive days. Due to institutional and logistical constraints, the training session was a group session, but the prescription was individualized and took place in a local gym.

The sessions included a short warm-up, lasting between 5 and 10 minutes, which consisted of a slow walk, games and play (like the game of catch, caterpillar or imitation). It was also during this phase that the exercise technician would take the opportunity to strengthen interpersonal relationships with the participants, asking them about issues in their lives, while also contributing to creating a comfortable atmosphere with the participants. This was followed by a cardiorespiratory training phase of 10 minutes of walking or running where the participants began the training program at an intensity of 40% Heart Rate Reserve (between 12 and 17 according to the Borg RPE Scale [54]), which progressed to 80% (the intensity was adjusted every 2 weeks). All the participants utilized a heart rate monitor. After cardiorespiratory training, a strength training phase followed in which participants performed 6 exercises (10–15 repetitions; 2–3 sets) recruiting the main muscle groups (dorsal, chest, hamstrings, shoulders and 2 quadriceps exercises), using weight training equipment such as ankle weights or there bands. Progression was made by increasing the load or volume. The session finished with 4 static stretches, each lasting between 30 and 60 seconds. During the stretching exercises, the muscle was extended along the joint and held in a position of low to slight discomfort before being released. The flexibility exercises were centered on low intensity stretching of the muscles recruited during the previous exercises. The exercise technician used verbal instructions, kinesthetic feedback and demonstrated the stretches that were required. The exercises were the same for all participants, but the loads were adjusted to the abilities and characteristics of each participant.

Statistics analysis

Descriptive statistics were calculated, including mean and standard deviation for the variables under study. The normality of the data was verified using the Shapiro-Wilk test (for sample sizes of less than 50), and homoscedasticity was analyzed using the Levene test. Friedman’s test was used to compare and identify possible differences between groups. To mitigate type I errors, the multiple comparison test incorporated the Bonferroni correction, calculated as the alpha level divided by the number of tests [55]. Kendal’s W effect size (appropriate for the Friedman test, which allows two paired groups to be compared) was calculated using the reference values specified as follows: “small” effect ≥ 0.01 , “medium” effect ≥ 0.3 and “large” effect ≥ 0.5 [56, 57].

The significance level for rejecting the null hypothesis was set at 5% and the analyses were carried out in IBM SPSS, version 29.

Results

Attendance at the sessions was checked using a record sheet and participants who did not attend 75% of the sessions were excluded. A total of 10 individuals with IDD participated in this study (5 women), with a mean age of 43.20 years (standard deviation = 11.00), weight of 70.46 kilograms (standard deviation = 14.83) and height of 156.28 cm (standard deviation = 9.47). There were no dropout rates. The descriptive analyses of the data collected at the 3 moments (pre-intervention, post-intervention, and detraining) are presented in ► **Table 1**.

As we can see on ► **Table 1**, the Weight and BMI values decreased over the 3 moments. Weight decreased from the first moment (70.46 ± 14.83 kilograms) to the second (69.92 ± 13.65 kilograms) and decreased again at moment 3 (68.11 ± 13.62 kilograms). The same can be verified with the BMI variable (moment 1: 29.07 ± 7.32; moment 2: 28.98 ± 6.99; moment 3: 28.91 ± 6.54).

► **Table 1** Mean and standard deviation of the 3 moments.

	Moment 1 (pre-intervention)	Moment 2 (post-intervention)	Moment 3 (detraining)
	M ± SD	M ± SD	M ± SD
Weight	70.46 ± 14.83	69.92 ± 13.65	68.11 ± 13.62
BMI	29.07 ± 7.32	28.98 ± 6.99	28.91 ± 6.54
Hand grip test	18.08 ± 7.74	21.16 ± 9.9	19.68 ± 9.07
TUG	8.75 ± 4.61	8.19 ± 5.15	9.16 ± 3.91
Sit to stand	12.2 ± 4.39	14.4 ± 5.23	13.2 ± 5.63

Notes: BMI, body mass index; TUG, Timed Up and Go test; M, mean; SD, standard deviation.

On the other hand, handgrip strength increased from moment 1 (18.08 ± 7.74 kilograms) to 2 (21.16 ± 9.9 kilograms) and decreased again between moments 2 (21.16 ± 9.9 kilograms) and 3 (19.68 ± 9.07 kilograms). Even so, the descriptive statistics for moment 3 (19.68 ± 9.07 kilograms) are higher than those for moment 1 (18.08 ± 7.74 kilograms).

There seems to be an improvement in the TUG test from moment 1 (8.75 ± 4.61 seconds) to 2 (8.19 ± 5.15 seconds) and a decline from moment 2 (8.19 ± 5.15 seconds) to 3 (9.16 ± 3.91 seconds), with higher values than at moment 1 (8.75 ± 4.61 seconds). Regarding the Sit to Stand test, we can see the same as with the handgrip strength test, i. e. the values increased from moment 1 (12.2 ± 4.39 repetitions) to 2 (14.4 ± 5.23 repetitions) and decreased again between moments 2 (14.4 ± 5.23 repetitions) and 3 (13.2 ± 5.63 repetitions). However, the descriptive statistics for moment 3 (13.2 ± 5.63 repetitions) are higher than those for moment 1 (12.2 ± 4.39 repetitions).

► **Table 2** shows the results of the mean comparisons between the measurements.

Despite the results of the descriptive statistics, significant improvements were only found in the handgrip test (moment 1 ≠ moment 2; Bonferroni corrected: $t = 1.05$; $p = 0.019$; $W = 0.21$). Likewise, after 6 months without regular exercise, the participants showed a significantly decline in handgrip values ($p = 0.044$).

Discussion

The main aim of this study was to examine the effects of an exercise program on body composition and physical and functional variables (measured by reliable and cost-effective methods) and whether these effects can be maintained after finishing the exercise program.

Looking at the descriptive statistics, the participants improved all variables after the intervention program, but only significantly in the handgrip test. The lack of significant values may be related to limitations in the physical exercise prescription itself, particularly regarding the principles of Frequency, Intensity, Type and Time (FITT), namely lower weekly frequency.

The effects of physical exercise have been studied in the IDD population. For example, Curado et al. [58], implementing an intervention program with sports, found improvements in functionality vari-

► **Table 2** Mean comparisons between measurements.

	Median (interquartile range)			Pairwise comparisons (moments) ^{a,b}
	Moment 1 (pre-intervention)	Moment 2 (post-intervention)	Moment 3 (detraining)	
Weight	75.5 (27.83)	75.15 (27.22)	65.8 (26.2)	c
BMI	29.75 (14.67)	29.55 (12.58)	28 (11.48)	c
Hand Grip test	19.15 (13.23)	21.95 (17.10)	21 (11.92)	M1 ≠ M2 ≠ M3
TUG	6.87 (4.52)	6.09 (4.94)	8.68 (6.55)	c
Sit to Stand	12.5 (6)	15.5 (7.5)	15 (10.5)	c

Notes: BMI, body mass index; TUG, Timed Up and Go test; a, Friedmann; b, Bonferroni correction; c, No differences detected.

ables, assessed through a questionnaire (self-reports: $t = -2.19$; $p = 0.03$; $\eta^2 = 0.282$ and proxy reports: $t = -2.64$; $p = 0.01$; $\eta^2 = 0.410$) and body composition (BMI: $t = -2.08$; $p = 0.05$; $\eta^2 = 0.254$ and muscle mass; $t = -1.94$; $p = 0.05$; $\eta^2 = 0.221$), but not physical fitness. The author justifies the lack of results by the low weekly frequency and duration of the program and problems with the prescription itself. In the same sense, Jacinto et al. [59] found significant differences in fat mass (initial \neq final; Bonferroni corrected: $t = 2.405$; $p = 0.048$; $W = 0.08$) when analyzing the exercise intervention group, as well as some neuromuscular capacity variables.

After the program intervention finished, none of the 10 participants in this study continued to practice structured physical exercise. After 6 months without regular exercise, the participants showed a decline in physical and functional fitness variables, but only in handgrip significantly ($p = 0.044$). The detraining of this sample with IDD seems to be a negative effect on the variables that have been promoted through physical exercise and, significantly, on handgrip strength.

Handgrip strength is a simple measure of overall muscle strength and is related to independence in activities of daily living in individuals with IDD [60]. Individuals with IDD have reduced voluntary muscle activation values when compared to people without disabilities, associated with a reduction in muscle strength [61]. Associated with this data it should be emphasized that the functional decline of these individuals begins at school age [62]. This fact emphasizes the importance of regular physical exercise in order to maintain/increase physical fitness values. The significant decline in the muscle grip strength of the participants in this study (moment 2 to moment 3) may indicate a decrease in the capacity to produce strength and in the connections between motor units, leading to impaired neuromuscular capacity, muscle loss and weakness [63, 64].

The impact of detraining on individuals with IDD is still scarce and could be explained by low adherence to physical exercise due to sedentary and inactive lifestyles [4]. However, Rosety-Rodriguez et al. [65], despite recruiting 20 women with Down syndrome, concluded that a 3-month period of detraining significantly impaired the participants' chronic inflammation. Before the interruption of intervention, the participants carried-out a 10-week aerobic training program, implemented 3 times a week, of treadmill walking at an intensity of 55 to 65% of peak heart rate. More recently and also with the Down Syndrome population, Boer et al. [66], after 3 months of detraining, reported a decline in parameters associated with aerobic and functional capacity in participants who completed 12 weeks of interval or continuous aerobic training.

Regarding the Sit to Stand test, our results are in accordance with Boer's study [66]. The author found no significant differences between moments (detraining), although there was a decline. Although both studies show a decline in lower limb strength, this does not seem to be significant at 3 and 6 months. On the other hand, in the opposite direction to that shown by the author [66], we found no significant differences in the TUG test, although there was a decline. It seems that agility, coordination, and balance can also be affected by detraining. Interrupting the regular practice of properly structured and adapted physical exercise can reverse the positive adaptations of exercise programs on the functional capacity of individuals with IDD.

Boer [66] found no significant differences in weight and BMI. The values of both variables decreased with the intervention program and increased with its discontinuation to the same or closely to the pre-intervention values. Rosety-Rodriguez et al. [65] also evaluated other body composition variables, namely waist circumference and fat mass, and reported a decrease in values with the exercise program, but that these values increased again 1, 3 and 6 months after interruption the exercise program. Contrary to these previous studies, our results for weight and BMI decreased with the intervention program and decreased 6 months after it was stopped. The fact that our study recruited a sample of older people, and the early ageing of this population may explain our results.

Although regular physical activity and exercise is essential for all populations, including those with IDD, guidelines were only created for this group in 2020 [9]. Based on these recommendations and the Convention for the Rights of People with Disabilities [67], several countries are adapting processes and strategies for this population to adopt healthier and more active lifestyles.

Recognizing that there are barriers to the practice of physical exercise (personal – 6 topics, family – 4 topics, social – 13 topics, financial – 1 topic and environmental – 1 topic), the investigation of its facilitators is essential, in order to ensure that this practice is carried out in the most effective way possible [3]. The adoption of a physically active lifestyle in individuals with IDD is crucial to increasing or maintaining physical and functional fitness, reducing the risk of metabolic and cardiovascular diseases. Often, the family members, caregivers or institution technician of these individuals are also sedentary and inactive, making it difficult to mobilize them towards healthy lifestyles [68, 69]. Previous studies have shown that the level of practice of carers, family members or caregivers can be an indicator of their attitude towards active lifestyles and suggest that the more active they are, the more likely they are to introduce these lifestyles in individuals with IDD [70].

There is a need to raise awareness among people with IDD themselves, families, guardians, professionals who work with them and institutions/organizations that support this population, educating and empowering them with knowledge and healthy, active practices that will contribute to a healthy life and full social participation. Through awareness-raising campaigns (e. g. media, lectures, among other ways) based on the assumption that physical exercise for people with disabilities adds value to life, giving them better relational skills, more competence, more independence, and better physical fitness, as well as a more self-determined attitude and, consequently, quality of life, helping to prevent typical diseases in this population. It should be noted that parents, families, guardians should promote the adoption of more active lifestyles as early as childhood, if the clinical condition allows, so that the love and practice of physical activity is maintained throughout life, promoting quality of life, and avoiding sedentary behavior in this population [13].

It is necessary to promote training courses for professionals, not only in initial formation, but also continuing, with the integration of program content covering the dimensions of physical exercise for people with IDD, as well as the characterization of the physical, physiological, psychological, social and emotional aspects inherent in IDD, with the aim of updating technical skills relating to physical exercise, as well as the professional development of physical

exercise and a more holistic and detailed view of the person and, consequently, an adjusted programming and execution of the various sessions of physical exercise programs, taking into account the concern for their well-being and quality of life [13]. In the same sense, physical exercise should be prescribed in a playful, fun way, with friends and based on their daily routines [71, 72].

As far as we know, this is one of the first studies to provide information on the effects of a 24-week detraining period after an exercise program on anthropometry, body composition and some physical and functional fitness variables. Although there have been gains from physical exercise, there seems to be a loss after the end of the program. It is therefore recommended to avoid the period of detraining, which is fundamental to promoting the benefits of exercise, healthy ageing and quality of life. Creating active tools and strategies can help avoid detraining, maintaining fitness and health even during periods when the regular training routine cannot be strictly followed, such as the holiday period. Despite the originality of our study and the promising results, some limitations and potential sources of bias are methodological weaknesses that should be considered when interpreting the results. Firstly, study participants were selected for convenience. Secondly, it was not possible to recruit a control group. Thirdly, there are more body composition, physical and functional fitness variables than those assessed. Finally, some important variables were not controlled for, namely diet and the amount of physical activity practiced over the periods. The constraints found in the process of assessment, prescription, and implementation of exercise in this population did not allow us to respond to the limitations, so future studies should attempt.

This study is one of the first to analyze the effect of detraining on individuals with IDD. It is useful for individuals with IDD themselves, parents, families, guardians, professionals working with them and institutions, organizations supporting this population, highlighting the importance of regular physical exercise adapted to the individuals to maintain, increase the benefits of the practice. This implies a long-term commitment and adherence to a regular exercise routine.

Conclusions

The participants in this study showed improvements in the variables assessed after the intervention program, highlighting the importance of regular physical exercise to promote anthropometric, body composition, physical and functional fitness variables. After interruption of the exercise program, there was a decline in several of the components, with a significant impact on handgrip strength. To maintain these benefits induced by regular exercise, participants must remain physically active throughout their lives.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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