Effects of different strength training intensities on health-related parameters towards engaging in physical activity in elderly

Efectos de diferentes intensidades del entrenamiento de la fuerza sobre los parámetros relacionados con la salud en la atracción hacia la actividad física de las personas mayores

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Abstract

To assess the effects of a progressive resistance training program at different intensities on health-related quality of life, anxiety, and motivation towards engaging in physical activity among older people. Prospective, municipal multi-centers, non-randomized controlled trial. 76 older adults were assigned to: vigorous intensity (n = 19), vigorous-moderate intensity (n = 21), moderate intensity (n = 19), or control group (n = 17). The exercise groups performed six exercises with elastic bands per session, twice a week, for 8 months. Vigorous intensity, vigorous-moderate intensity and moderate intensity group performed 6, 10 and 15 repetitions, respectively. Health-related quality of life was assessed using the 36-Item Short Form Health Survey, trait and state anxiety using the State-Trait Anxiety Inventory, and motivation towards engaging in physical activity using the Behavioural Regulation in Exercise Questionnaire. The moderate intensity group showed a significant increase in the summary of the physical components of health-related quality of life ($p = 0.001$; $\eta p^2 = 0.158$) and a significant decrease in external regulation ($p = 0.002$; $\eta p^2 = 0.145$) and amotivation ($p = 0.013$; $\eta p^2 = 0.97$). In contrast, the vigorous intensity group showed a significant increase in state anxiety ($p = 0.004$; $\eta p^2 = 0.076$) and a significant decrease in introjected regulation ($p = 0.018$; $\eta p^2 = 0.097$). Moderate intensity strength training programs are best suited for older adults because they improve health-related quality of life and decrease less self-determined forms of regulation, all without increasing anxiety states.

Keywords: motivation, quality of life, well-being.

Resumen

Evaluar los efectos de un programa de entrenamiento progresivo de la fuerza a diferentes intensidades sobre la calidad de vida relacionada con la salud, la ansiedad y la motivación para atraer hacia la realización de actividad física entre las personas mayores. Ensayo controlado prospectivo, multicéntrico municipal, no aleatorizado. 76 adultos mayores fueron asignados a: grupo de intensidad vigorosa (n = 19), vigorosa-moderada (n = 21), moderada (n = 19), o grupo de control (n = 17). Los grupos de ejercicio realizaron seis ejercicios con bandas elásticas por sesión, dos veces por semana, durante 8 meses. Los grupos de intensidad vigorosa, vigorosa-moderada y moderada realizaron 6, 10 y 15 repeticiones, respectivamente. La calidad de vida relacionada con la salud se evaluó mediante la Encuesta de Salud de formulario corto de 36 elementos, el rasgo y el estado de ansiedad mediante el Inventario de Ansiedad Estado-Rasgo, y la motivación para realizar actividad física mediante el Cuestionario de Regulación del Comportamiento en el Ejercicio. El grupo de intensidad moderada mostró un aumento significativo en el resumen de los componentes físicos de la calidad de vida relacionada con la salud ($p = 0.001$; $\eta p^2 = 0.158$) y una disminución significativa en la regulación externa ($p = 0.002$; $\eta p^2 = 0.145$) y desmotivación ($p = 0.013$; $\eta p^2 = 0.97$). En contraste, el grupo de intensidad vigorosa mostró un aumento significativo en el estado de ansiedad ($p = 0.004$; $\eta p^2 = 0.076$) y una disminución significativa en la regulación introyectada ($p = 0.018$; $\eta p^2 = 0.097$). Los programas de entrenamiento de la fuerza de intensidad moderada son más adecuados para los adultos mayores porque mejoran la calidad de vida relacionada con la salud y disminuyen las formas de regulación menos autodeterminadas, todo sin aumentar los estados de ansiedad.

Palabras clave: motivación, calidad de vida, bienestar.

Introduction

Older people constitute a substantial proportion of the total population, and their numbers are projected to increase. In 2019, more than one billion people were aged over 60 years and this number will increase to 1.4 billion by 2030 and 2.1 billion by 2050. This increase is occurring at an unprecedented rate and will accelerate in the coming decades, especially in developing countries (WHO, 2020). In the European Union, 20.3% of the population was aged over 65 years in 2019, some 2.9 percentage points more than in the previous decade (Eurostat, 2020). Specifically in Spain, according to data from National Institute of Statistics, 19.58% of the total population was aged over 65 years old in 2019 (INE, 2020).

'Healthy ageing' is defined as the process of promoting and maintaining the functional capacity that permits wellbeing in old age, with functional capacity being understood as the attributes related to health that allow people to be and do what is important to them (Beard et al., 2016; Who, 2015). Although healthy ageing has traditionally focused on indicators such as physical impairments, cognitive disabilities, and social restrictions (Rowe & Kahn, 1997), psychological indicators have also more recently been highlighted (Fox et al., 2007).

Among the modifiable factors, data published in the academic literature suggests that engaging in physical activity (PA) could improve the well-being and quality of life of elderly individuals and consequently, contribute to increasing the probability of healthy aging among this population (Daskalopoulou et al., 2017; Makino et al., 2015; WHO, 2015). Thus, it is very important to understand the best type of physical activity to encourage and at what intensity in order to maximize its possible benefits.

Numerous studies have shown the relationship between PA and quality of life (Bize et al., 2007; Calatayud et al., 2015; Gómez-Morales et al., 2019; Pucci et al., 2012) and have demonstrated improvements both in physical dimensions (e.g., pain, physical function, and physical role; Espejo et al., 2016; Wanderley et al., 2011) as well as in mental health dimensions (Olsson et al., 2015; Prieto et al., 2015). However, there is disparity in the results in this population, especially in terms of the type and intensity of physical activity that these older adults should engage in order to obtain the greatest improvements (Van Malderen et al., 2013).

Similarly, engaging in PA has been associated with an increase in general psychological well-being and decreased stress and anxiety levels (Conn, 2010; Kadariya et al., 2019). Most studies that have found a reduction in anxiety have done so after the completion of aerobic exercise (Ekkekakis et al., 2008; Hale et al., 2002; Pan et al., 2018) practiced at moderate to low intensities (Guszkowska, 2004). While, on the contrary, other studies have found that high-intensity PA is associated with increased anxiety (Arent, 2004; Katula et al., 1999). However, a recent review (Mochcovitch et al., 2016) concluded that more work would be needed to identify the ideal PA modality, frequency, duration, and intensity to optimize the positive effects of exercise on anxiety in this population.

Moreover, motivation plays a key role in the initiation and continued engagement in PA. In this regard, the self-determination theory (SDT; Ryan & Deci, 2002) provides an excellent framework for examining PA motivation in older adults (Frederick-Recascino, 2002). SDT suggests that PA regulation is supported by different levels of motivation, from intrinsic motivation to extrinsic motivation (which, in order from lowest to highest extrinsic motivation, includes the following dimensions: identified regulation, introjected regulation, and external regulation) and amotivation. Forms of more self-determined regulation towards PA (intrinsic motivation) are related to greater adherence to PA (Duncan et al., 2010; Teixeira et al., 2012; Vanroy et al., 2019).

In general, most of the interventions and programs for adults include aerobic exercise activities, while interventions aimed at increasing strength are less frequent (Pan et al., 2018; Weisser et al., 2009). However, physical strength training programs aimed at older people are now becoming increasingly common because they are easy to apply, and are low cost, durable, accessible, and effective (Colado & García-Massó, 2009; Martins et al., 2013).

To the best of our knowledge, no studies have yet evaluated the impact of PA on quality of life, emotional well-being, or motivation in this population by implementing the same strength training program at different intensities. Thus, the main objective of this study was to compare the effect of strength training programs that differed only in intensity (vigorous, vigorous–moderate, or moderate) on quality of life, anxiety, and motivation towards engagement in PA among older individuals.

Methods

Study design

This prospective, multi-center, non-randomized controlled trial (trial registration: ClinicalTrials.gov NCT03952104) was approved by the Universidad Cardenal Herrera-CEU Human Ethics Committee and followed the ethical guidelines set out in the Declaration of Helsinki. All participants signed a written informed-consent statement and were allocated, according to their center, to the different strength training intensity study groups (vigorous, vigorous–moderate, moderate, or control).

Eligibility Criteria

To be eligible for inclusion, participants had to be aged 65 or older, able to ambulate independently, able to communicate, and willing to stay in the same municipal activity center for the elderly for the subsequent eight months. The exclusion criteria were the presence of unstable cardiovascular disease or a neurological disorder that could prevent or compromise engagement in PA or the previous completion of a strength training program in the six months prior to the start of the study.

Procedure

Upon enrollment in the study and after completing the primary and secondary outcome measures (baseline), the four municipal activities centers (and therefore, their respective participants) were randomly assigned either to the eight-month vigorous strength training intensity group (n = 19), the vigorous–moderate group (n = 21), the moderate group (n = 19), or the control group (n = 17). All the outcome measurements (baseline and postintervention) were recorded by the same two trained psychologists who were blinded to the group allocation.

All the intervention groups underwent two familiarization sessions in the first week before starting the definitive training program. The participants had an instructor and an assistant to learn the assimilation of the technique (ergonomics, amplitude, breathing, etc.), the adequate control of the intensity in each of the exercises and their possible progression throughout the eight-months. Participants were asked to maintain their eating

habits and regular physical activity from the beginning until the end of the study, and were told not to participate in any alternative exercise programs for the duration of the study. Likewise, during the training sessions the participants were instructed to wear comfortable and suitable clothing and footwear, not to drink stimulating drinks, and to bring a bottle of water to avoid dehydration. Adherence was controlled by keeping session attendance records, and we recommended that the participants attend at least 80% of the total planned sessions. All the sessions were carried out in groups in each of the centers and were always directed by the same instructor. Before completing the training program, the instructors demonstrated the exercises and their proposed implementation techniques to ensure that all the exercises were completely executable by the target population, and to ensure that the total duration of each session did not exceed 60 minutes.

Before and after the intervention, each participant completed three questionnaires. The first to assess the level of physical activity before starting the interventions, the second to determine quality of life, and the third to diagnose anxiety and distinguish it from depressive syndromes. Interviewers were psychologists, each of whom received extensive training and supervision in conducting this interview.

Intervention

The physical intervention program consisted of two weekly strength training sessions for eight consecutive months. In each session, the three intervention groups performed identical exercises in terms of movement execution and pace (Figure 1), order, number of exercises (six exercises), and number of sets per exercise (four sets), but with different intensities (i.e., resistances), using elastic bands (TheraBand®, Akron, OH, USA). These elastic bands have different levels of stiffness against elongation that allowed to modified the employed resistance across the training program. To achieve an adequate use of the training resistance, and also an equivalent progression in the training of each one the three groups over the eight-month period, the handgrip length of the elastic bands was modified according to an equivalent prescribed rating of perceived exertion (RPE). This RPE was obtained of the OMNI-Resistance Exercise Scale of perceived exertion with elastic bands (Colado et al., 2012). All groups trained with a RPE of six or seven, at the end of each set of each exercise, during the first fourth weeks, and of eight or nine until the end of the study. The vigorous intensity group performed six submaximal repetitions (equivalent to 85% of the one-repetition maximum [1RM]) of each exercise; the intermediate intensity group (vigorous–moderate) performed 10 submaximal repetitions (equivalent to 75% of 1RM) of each exercise; finally, the moderate intensity group performed 15 submaximal repetitions (equivalent to 70% of 1RM) of each exercise.

Figure 1. Initial and final position of the 6 strength training exercises performed with TheraBand elastic bands

Outcome measures

a) Sociodemographic data

An ad-hoc questionnaire was designed to collect information regarding age, sex, and level of education. We used the short form of the International Physical Activity Questionnaire (IPAQ-SF; Booth, 2000) to assess the participants' level of physical activity before starting the interventions (baseline). This self-report questionnaire uses seven items to collect data on PA performed in the past seven days (Craig et al., 2003; Lee et al., 2011). This questionnaire has been validated in 12 countries (Craig et al., 2003) and shows adequate psychometric properties. Moreover, the short version (IPAQ-SF) has shown acceptable validity in the adult Spanish population (Román et al., 2013).

The total number of days and minutes of PA were calculated by adding the scores from all the PA categories from the seven days prior. The data from the IPAQ-SF were then converted to Metabolic Equivalent minutes per week (MET-min/week), using the formula published by Ainsworth et al., (2011). We used this measure as an indicator of PA. Specifically, the IPAQ-SF questionnaire records activity at four intensity levels: (1) vigorous activity such as aerobics; (2) moderate activity such as leisure cycling; (3) walking; and (4) sitting. This makes it possible to classify participants according to their PA level: high (> 1.500 METs), moderate (600–1.500 METs) and low (< 600 METs).

b) Primary outcome

The 36-Item Short Form Health Survey (SF-36), is a generic health-related quality of life questionnaire comprises 36 questions that correspond to two domains, the physical component summary (PCS) and mental component summary (MCS; Ware & Sherbourne, 1992), and eight dimensions, the PCS comprises four dimensions (physical functioning, role physical, bodily pain and general health), and the MCS includes vitality, social functioning, emotional role, and mental health. The score for both the PCS and the MCS domains ranged from 0 to 100, with 100 representing the best state of health and 0 representing the worst. PCS and MCS were used as primary outcomes to indicate physical domain and mental domain scores, respectively,

in order to generalize the overall effect of physical and mental health status. Studies published on the metric characteristics of the Spanish version of the SF-36 have provided sufficient evidence for its reliability, validity, and sensitivity in similar contexts (Alonso et al., 1995).

c) Secondary outcomes

The State-Trait Anxiety Inventory (STAI) is a commonly used measure of trait and state anxiety (Spielberger et al., 1982; Spielberger, 1983) that can be used in clinical settings to diagnose anxiety and distinguish it from depressive syndromes. The STAI is used to assess trait anxiety and state anxiety, and we used the state anxiety scale to assess anxiety in this study. State anxiety refers to a transitory period characterized by a feeling of tension, apprehension, and an increase in the activity of the autonomic nervous system, which can vary both in time and in intensity. This scale comprises 20 items scored on a Likert-type response scale from 0 ('Not at all') to three ('A lot'). The total score is obtained by adding the values of the items (after inverting the scores of the negative items), and ranges from 0 to 60 with higher scores corresponding to higher levels of detected anxiety (Kvaal et al., 2005). The published reliability coefficient for the state anxiety scale is 0.94. In addition, the STAI generally maintains adequate metric properties and is sensitive to increases in environmental stimuli that produce stress (Guillén-Riquelme & Buela-Casal, 2011).

Motivation towards engaging in PA was assessed through the Behavioural Regulation in Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004) which consists of 19 items measuring stages on the continuum of self-determination. It measures external regulation (four items), introjected regulation (three items), identified regulation (four items), intrinsic regulation (four items), and amotivation (four items) on a scale from one ('Not at all true for me') to five ('Absolutely true for me'). Each of the subscales has a maximum score, with a maximum of 20 for external regulation, identified regulation, intrinsic regulation, and amotivation, and 15 for introjected regulation. The BREQ-2 showed an acceptable internal consistency (α ranging from 0.81 to 0.89) in previous work (Moreno Murcia et al., 2007).

Data analysis

The desired sample size was calculated after undertaking a pilot study of 20 participants, which indicated an effect size of 0.22 for the primary outcome; considering this, as well as an α value of 0.05 and a desired power of 80%, we used G*Power (v.3.1.9.2) software (Faul et al., 2009) to estimate that a sample size of 64 participants would be required. Accounting for potential losses of 20%, we established the final total sample size at 76 participants. No participants suffered adverse effects due to the intervention, and withdrawals from the study were due to family issues.

We analyzed our data using an intention-to-treat approach. First, we determined the baseline differences between the groups by using one-way analysis of variance (ANOVA) for continuous variables (age and adherence) or the χ. test for categorical variables (sex and physical activity level). Two-way mixed ANOVA tests were used to compare the effects of the interventions on the outcome measures between the groups, with time (baseline versus the eight-month follow-up) serving as the within-group factor and the intervention type as the between-group factor (vigorous, vigorous–moderate, moderate, and control). The effect sizes were estimated using the ηp. and were interpreted following Cohen's guidelines for small, moderate, and large effect sizes (ηp. = 0.01, 0.06, or 0.14, respectively; Cohen, 1988). We performed the statistical analyses using version 19.0 of the SPSS statistical package (IBM Corp., Armonk, NY, USA). Probabilities exceeding 95% (alpha .-values less than 0.05) were used as the threshold cut-off for statistical significance.

Results

We screened 139 participants in this non-randomized controlled trial and a total of 76 were recruited to this study; 63 were not allocated to the different groups because they declined to participate (n = 52) or did not meet the inclusion criteria: unable to ambulate independently (4 participants), presence of unstable cardiovascular disease or a neurological disorder that could compromise the exercise (4 participants), or completion of a previous strength training program in the six months prior to the start of the study (3 participants). Finally, 76 Spanish older adults (76.30 % females; 70.10± 5.71 years) were allocated to the different groups (vigorous, vigorous–moderate, moderate, or control). Figure 2 shows the progression of the participants through the trial.

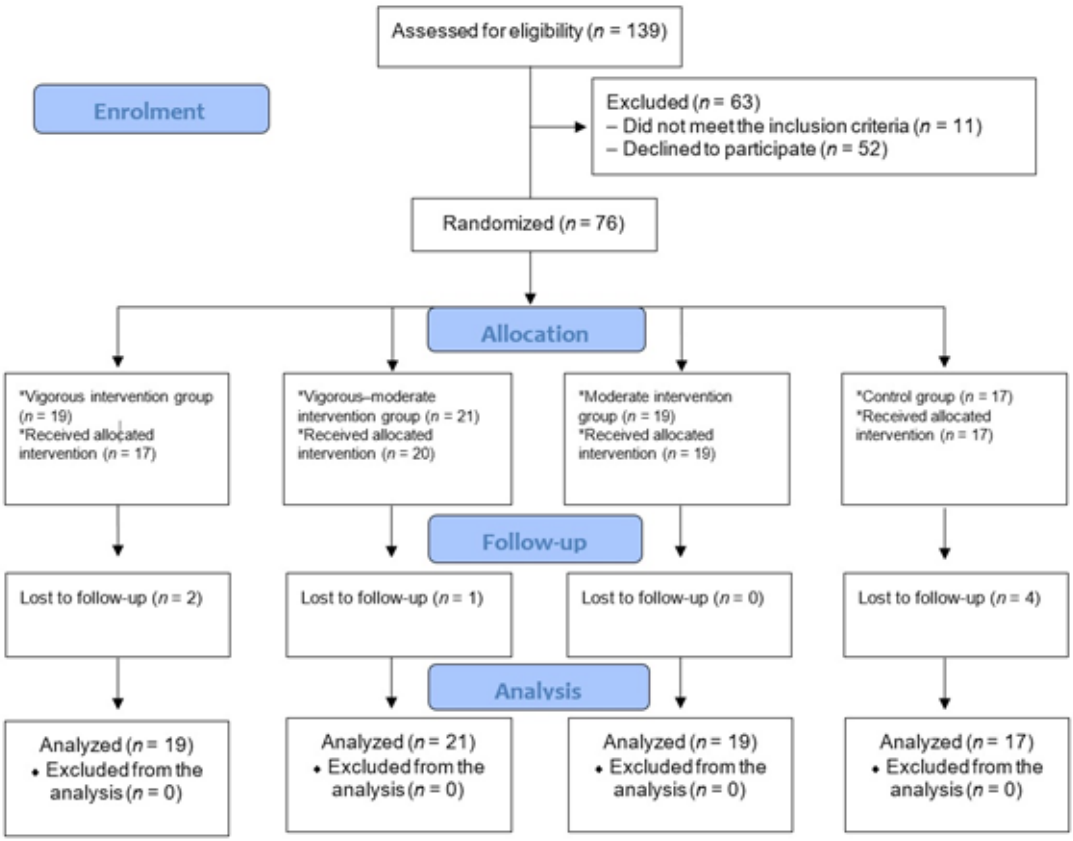

Figure 2. Progression of the participants through the trial

The χ^2 tests showed no baseline differences between groups in the gender distribution (p = .145) or in terms of the physical activity level (p = .122). Similarly, the one-way ANOVA did not show any significant differences between groups in the percentage of adherence to the strength training sessions (vigorous [79 %]; vigorous–moderate [88 %]; and moderate [84 %], p = .181). Regarding age, the pair comparison only showed significant differences at baseline between vigorous and moderate groups (vigorous [73.31 ± 6.12 years]; vigorous–moderate [70.11 ± 5.02 years]; moderate [67.02 ± 4.21 years]; control [70.06 ± 6.13 years]).

The results of the 2-way mixed ANOVA showed a significant increase in the physical component summary (p = .001; large effect size), and a significant decrease in external regulation (p = .002; large effect size) and amotivation (p = .013; moderate effect size) after eight months in the moderate intervention group (table 1). In contrast, we observed a significant increase in the STAI score (p = .004; moderate effect size) and a significant decrease in introjected regulation (p = .018; moderate effect size) in the vigorous intervention group.

Table 1. Intragroup comparisons: baseline vs. postintervention (at 8 months)

VARIABLES	GROUP	Baseline	Post-intervention	Diff. (95 % *CI*)	*Partial eta²*	*P*
Physical Component Summary (PCS)	CONTROL	75 ± 18	70 ± 24	5 (-3 to 12)	.027	.188
	VIGOROUS	73 ± 11	76 ± 16	-3 (-9 to 2)	.027	.192
	MODERATE-VIGOROUS	82 ± 12	83 ± 14	-2 (-6 to 3)	.006	.541
	MODERATE	65 ± 19	74 ± 15	-9 (-14 to -4)	.158	.001**
Mental Component Summary (MCS)	CONTROL	84 ± 9	77 ± 15	8 (-2 to 18)	.036	.127
	VIGOROUS	74 ± 15	80 ± 12	-6 (-13 to 1)	.051	.069
	MODERATE-VIGOROUS	75 ± 19	85 ± 13	-10 (-17 to -4)	.128	.003**
	MODERATE	67 ± 20	73 ± 16	-6 (-13 to 1)	.047	.080
State-Trait Anxiety Inventory (STAI)	CONTROL	12.5 ± 6.1	13.3 ± 7.0	-0.8 (-4.7 to 3.1)	.003	.688
	VIGOROUS	13.1 ± 6.5	16.7 ± 7.2	-3.6 (-7.1 to -0.2)	.076	.004**
	MODERATE-VIGOROUS	10.8 ± 5.5	18.2 ± 7.9	-7.5 (-11.5 to -3.4)	.201	.001**
	MODERATE	18.0 ± 9.2	18.2 ± 9.9	-0.2 (-4.2 to 3.9)	.000	.940
Intrinsic regulation (BREQ-2)	CONTROL	4.5 ± 0.8	4.5 ± 0.8	0 (-0.2 to 0.2)	.001	.814
	VIGOROUS	4.7 ± 0.4	4.7 ± 0.3	0 (-0.3 to 0.2)	.001	.791
	MODERATE-VIGOROUS	4.5 ± 0.4	4.4 ± 0.5	0.1 (-0.2 to 0.3)	.002	.738
	MODERATE	4.6 ± 0.4	4.7 ± 0.6	-0,1 (-0.4 to 0.2)	.004	.622
Identified regulation (BREQ-2)	CONTROL	3.8 ± 0.4	3.9 ± 0.5	-0.1 (-0.5 to 0.3)	.003	.681
	VIGOROUS	4.4 ± 0.5	4.2 ± 0.5	0.2 (-0.1 to 0.5)	.023	.258
	MODERATE-VIGOROUS	4.1 ± 0.6	4.0 ± 0.5	0.1 (-0.2 to 0.5)	.012	.405
	MODERATE	4.5 ± 0.5	4.2 ± 0.4	0.3 (0 to 0.7)	.058	.068
Introjected regulation (BREQ-2)	CONTROL	2.3 ± 0.9	3.0 ± 1.1	-0.7 (-1.5 to 0)	.064	.055
	VIGOROUS	3.7 ± 1.1	2.9 ± 1.4	0.8 (0.1 to 1.4)	.097	.018*
	MODERATE-VIGOROUS	3.2 ± 1.2	2.9 ± 1.6	0.3 (-0.3 to 1.1)	.021	.276
	MODERATE	3.4 ± 0.7	3.5 ± 1.3	-0.1 (-0.9 to 0.7)	.001	.800
External regulation (BREQ-2)	CONTROL	1.6 ± 0.9	1.2 ± 0.6	0.4 (-0.1 to 0.8)	.045	.102
	VIGOROUS	1.4 ± 0.7	1.1 ± 0.2	0.3 (0 to 0.7)	.048	.090
	MODERATE-VIGOROUS	1.2 ± 0.3	1.2 ± 0.6	0 (-0.4 to 0.3)	.002	.704
	MODERATE	1.8 ± 0.9	1.1 ± 0.6	0.7 (0.2 to 1.1)	.145	.002**
Amotivation (BREQ-2)	CONTROL	1.3 ± 0.4	1.4 ± 0.6	-0.1 (-0.3 to 0.1)	.008	.487
	VIGOROUS	1.1 ± 0.3	1.0 ± 0.2	0.1 (-0.1 to 0.3)	.010	.446
	MODERATE-VIGOROUS	1.0 ± 0.1	1.0 ± 0.1	0 (-0.2 to 0.3)	.001	.793
	MODERATE	1.4 ± 0.5	1.1 ± 0.3	0.3 (0.1 to 0.6)	.097	.013*

BREQ-2 = Behavioural Regulation in Exercise Questionnaire *p<.01 **p<.05

Discussion

As far as we are aware, this is the first study that has compared the effect of strength training programs that only differ in intensity (vigorous, vigorous–moderate, or moderate) on quality of life, anxiety, and motivation towards engaging in PA among older people. Our main finding was that, in general terms, engaging in a moderate intensity PA program generated greater benefits in the variables we studied compared to the vigorous or vigorous–moderate intensity programs.

Specifically, our results showed that the group of older people who performed the resistance training program at moderate intensity for 32 weeks significantly improved their quality of life, especially that related to physical health, with a large effect size. Therefore, it seems that the participants in this group obtained greater benefits in the physical dimensions (physical functioning, physical role, bodily pain, and general health) and thus, this intervention positively contributed to healthy aging. These results are congruent with other studies that showed the positive benefits of engaging in physical exercise by performing strength training programs to improve the quality of life among elderly populations (Cakar et al., 2010; Krist et al., 2013; Lobo et al., 2010; Park et al., 2015; Paterson & Warburton, 2010) as well as with those that observed functional improvements by practicing this type of PA at a moderate intensity (Capodaglio et al., 2007; Cavani et al., 2002; Lobo et al., 2010; Skelton & McLaughlin, 1996; Taaffe et al., 1999; Vincent et al., 2002).

Regarding motivation, the results of the intragroup analysis showed that, unlike the other two groups, the moderate intensity group scored significantly less in external regulation and demotivation at the end of the training program, with large and moderate effect sizes respectively. We interpreted this result as a positive finding because it implies that extrinsic motivation decreased after exercising at this intensity. In this sense, reasons for engaging in PA that focus on pressure from other people, or to obtain external rewards, can have a negative impact on maintaining this behavior. In this line, some studies have shown that demotivation is negatively related to the continuity of practicing sports (García-Calvo et al., 2011; Thogersen-Ntoumani et al., 2007). In summary, the results of this study suggest that participation in moderate PA programs could modify, in the desired direction, the degree of internalization of the goals and values that participants associate with exercise; that is, it can reduce their extrinsic motivation.

With regard to anxiety levels, our results showed that, unlike the moderate intensity group, individuals who performed PA at a higher intensity (vigorous or moderate–vigorous) suffered a significant increase in state anxiety scores. Interestingly, previous studies have found similar results (Arent, 2004; Katula et al., 1999; Raglin et al., 1993) although without differentiating between PA intensities. In fact, some authors have argued that exercise can cause various types of stress, specifically distress, which could induce negative effects (Li & He, 2009), such as tension or anxiety. If we consider anxiety as the level of activation or arousal experienced by an individual, participants in the vigorous or moderate–vigorous PA groups may have experienced greater muscle tension and greater activation of the nervous system as a consequence of performing these PAs at a higher intensity and thus, would have scored higher in questionnaire items referring to states of tension. Furthermore, subjectively perceiving greater tension and/or activation may not be experienced as a positive experience by older adults. In this sense, this would be an undesired consequence of engaging in PA which, together with the decrease in introjected regulation (vigorous PA group), could mean these individuals would be less motivated to continue PA practice once the program finishes.

Although it is desirable that older adults should be intrinsically motivated to engage in PA, introjected regulation includes reasons such as avoiding feelings of guilt or achieving feelings of pride. However, although this latter form of regulation supposes minimal internalization of the value of PA by participants, there is no benefit to achieving decreased levels of this regulation unless it is to increase other more self-determined forms of regulation. Considering this fact, and the results related to anxiety, it seems that vigorous PA would not be the most recommended option to achieve sustained engagement in PA over time in older adults. We were unable to find any academic literature that compared the variables we studied in this type of PA program at different intensities, thus making it very difficult to contrast our results with previous publications.

Finally, we would like to note the limitations of this study. The main limitation was its lack of participant randomization, presumably introducing bias. Although participants were recruited and alternately randomized by center (due to limited resources), a randomized allocation would be required to control the influence of other extraneous variables. Nonetheless, no baseline differences between groups were found in terms of gender distribution, PA level, or percentage of adherence to the strength training sessions, and baseline comparisons only showed statistical differences in age between the vigorous and moderate exercise groups. Furthermore, the participants we enrolled had demonstrated an initial level of motivation to engage in a strength training program. Therefore, our findings may only be generalizable to individuals who are similarly interested in such interventions. In addition, our participants were recruited from municipal activity centers for the elderly, which may have further influenced our results because of the sociodemographic status of these individuals. Finally, the time limitations of our study did not allow us to determine whether any increase in PA would be maintained in the long term. Nevertheless, our results related to motivation towards PA and state anxiety suggest that the greater the intensity of the resistance training, the harder it was to maintain engagement in the PA over time.

Despite these limitations, this study is the first to compare how different intensities of strength training programs (vigorous, vigorous-moderate, moderate) effect health-related quality of life (physical and mental components), state anxiety, and motivation towards PA in an elderly population. In addition, the design of the strength training programs used (total number of sessions and identical exercises in terms of execution of the movements, order, number, and number of series per exercise), allowed us to isolate and specifically determine the effect of intensity on the variables studied. In summary, our findings support the implementation of moderate intensity programs because these improve health-related quality of life (physical component summary) and decrease external regulation and amotivation, without increasing state anxiety.

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