Original Article

Body composition, bone status and quality of life in older people involved in a municipal program of physical activity and health

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Abstract:

The objective of this study is to analyze the effectiveness of a physical activity program addressed to older people. 48 people were involved in the performance of calcaneus bone ultrasonography and anthropometry tests. Afterwards, over six months, all physical activity was registered. At the end of this period, ultrasonography and anthropometry tests were again performed. Quality of life was also measured. Collected data show great incidence of overweight and osteoporosis. However, the training program does not significantly reduce fat mass but it does not increase the muscle mass either. Furthermore, bone mass loss reached 2.2% ($p=0.003$). These results show the inefficiency of a training program with the usual features of physical activities offered to older people. If the results of our study are confirmed, this kind of programs would not be contributing to achieve a healthy aging process, at least from a physical point of view.

Key words: Aging, Physical Exercise, Bone Mineral Density, Body fat, Overweight.

Introduction

Aging process is inherent to life; it entails a progressive deterioration of the functional capacity of the different body organs and systems, as a consequence of the biological changes that inexorably take place. Functional systems involution related to age is aggravated with inactivity or sedentary lifestyles (Daley & Spinks, 2000). In fact, a sedentary lifestyle increases the risk of developing chronic conditions (Booth, Laye, & Roberts, 2011). However, dependency or bad health should not be the unavoidable consequence of aging (Cadore, Pinto, Bottaro, & Izquierdo, 2014).

Accordingly, several papers showed that physical exercise can stop such deterioration (Gremenaux et al 2012) and, in some cases, even revert the aging process (Daley & Spinks, 2000), attaining positive effects on health and quality of life of older people. Benefits of physical exercise on the aging process have been proved at different levels. In this sense, training can improve the bone status, maintain it, or at least, reduce bone mass loss (Bocalini, Serra, & dos Santos, 2010; Rhodes et al, 2000; Stolzenberg et al, 2013). However, positive effects are not fulfilled in every anatomic zone. Likewise, increasing of strength and muscle mass in elder people has been confirmed (Cadore et al, 2010; Mayer et al, 2011; Romero-Arenas, 2013), as well as equilibrium improvement (Madureira et al, 2007). Moreover, among several other positive effects (Vincent et al, 2012), an increase in cardiovascular performance (Vigorito & Giallauria, 2014) or a decrease in bodyweight in obese people (Bocalini et al, 2012) has been achieved. Nevertheless, prescription of physical exercise needs to be pinpointed (Gremenaux et al, 2012), especially concerning bone density (Ashe et al, 2013; Gómez-Cabello, Ara, González-Agüero, Casajus, & Vicente-Rodríguez, 2012; Kohrt et al, 2013).

Anyway, sufficient scientific evidence exists in order to design quite successfully interventions promoting an acceptable aging process. In relation to this, health and physical exercise local programs acquire a preventive approach, on account of their accessibility to a great amount of older people. These programs must respond to the achievement of several goals to ensure a healthy aging process. Thus, from a physical point of view, they should fulfill bone and muscle mass increasing, fat mass decreasing, as well as equilibrium and coordination improvement, besides improving cardiovascular parameters. Furthermore, they must foster psychological well-being and social interaction. Thereby, older people could carry out their daily activities independently, ensuring a fair quality of life.

Linking with the above mentioned, the objective of this study is to analyze the effectiveness of a physical exercise program for older people, in relation to body composition, bone density and quality of life. That is, to check if improvements in this aspects are being obtained or, at least they are kept between healthy margins.

These objectives are developed analyzing a program that matches typical features of most health and physical activity programs offered to older people. More precisely, 60 minutes sessions, twice a week. Exercises

involved are the most commonly chosen in this kind of activities, commonly known as “gymnastics for older people”. During these sessions, exercises without overloads or with small weights are carried out. They are therefore, low intensity activities, at muscle level. Besides, the progression of loads (in terms of volume and intensity) throughout the months is scarce or null.

Material & methods

In order to assess the effectiveness of the training program, an observational study was designed, with pre-post data analysis using groups created accordingly with their activity level. This study has the ethical institutional approval and it was carried out following the ethical principles of the Declaration of Helsinki (DoH) made by the World Medical Association in 2013, as well as the rules established in the good clinical practices recommended by the Spanish Agency of Medicines and Medical Devices.

Participants

99 participants of the local health and physical activity program voluntarily took part in this study. However, only 62 completed all tests. In addition, afterwards, people younger than 65 years old and those who had any kind of medical or hormonal prescription, especially if it somehow affected bone tissue or body composition, were excluded. Thus, the results of 48 people (9 men and 39 women), were analyzed.

Procedure

Participants were evaluated twice, at the beginning of the training program and after six months of activity. In both occasions bone status and body composition was measured. Besides, quality of life (OPTQoL) and lifestyle was assessed. Calcaneus bone quantitative ultrasonography test was used for bone measurement (Babatunde, & Forsyth, 2013; Ibáñez, 2003; Navas et al, 2006; Vidal, Cabello, Rueda, & Mormontoy, 2004). Measurements were taken on the non-dominant foot, with the Sonost 2000 (Harter et al, 2013), which has a precision error lower than 1.5. This equipment measures BUA (dB/MHz) and SOS (m/s), from which calculates T-Score. The estimation of BMD (Bone Mass Density) was performed with the following formula (Sosa et al, 2003):

$$BMD (g/cm^2) = 0.002592 \times (BUA + SOS) - 3.687$$

Bioimpedance was used for carrying out the body composition study, with the Tanita BC 418 MA weighing scale (precision: 0.1kg) and in fasting state. Ultrasonography and anthropometry tests were performed in the Laboratory of the Institute of Sciences of Physical Activity and Sport, thus, not needing equipment displacement and assuring similar moisture and temperature conditions. Along with these tests, data related to lifestyle were collected and Quality of Life related to Health was evaluated using the OPTQoL questionnaire (Ariza-Ariza, Hernández-Cruz, & Navarro-Sarabia, 2004). Questionnaires were filled collectively, in each of the sports facilities in which the program took place.

Finally, a detailed trace of the training program was made over 6 months. For that purpose, attendance to guided training sessions and all exercises performed (series and repetitions) were registered. A training diary where each participant wrote down extra physical activity performed apart from guided sessions as, for instance, walking or dancing, was also simultaneously implemented.

Statistical analysis

Once all tests were performed and training program features registered, a statistical treatment of collected data was initiated, using SPSS Statistics 22.0, fixing a level of significance of $p = 0.05$. Firstly, a descriptive study about bone status and body composition was performed (mean $\pm$ standard deviation). In addition, incidence of obesity and osteoporosis was analyzed. Concerning this last issue, the proposed cutoff for calcaneus bone ultrasonography test was established as criterion (Sosa et al, 2003). This fact implies considering the existence of osteoporosis from a T-Score lower than -1.8. Furthermore, the features of the training program (amount of exercises, series, repetitions, extra activities and total amount of time of activity) were analyzed.

Secondly, pre-post differences were analyzed for all participants, through the Wilcoxon test for related samples. In addition, according to the trace of the training program, per a quartile analysis was also performed, thus creating four groups depending on their activity level ($n = 12$ for each group). Group 1: little active (27.9%-68.3%), Group 2: moderately active (68.3%-80.7%), Group 3: active (80.7%-86.9%) and Group 4: very active (86.9%-100%). After that, pre-post differences were analyzed for each group, through the non-parametric Wilcoxon test for related samples, in relation to bodyweight, fat mass, muscle mass and bone mineral density (BMD).

To finish this statistic analysis, a lineal correlation study between bone status, body composition and quality of life related to health was performed. Concerning this last issue, it must be pointed out that the lower the punctuation in the OPTQoL questionnaire, the higher the quality of life.

Results

Before the training

Thirty-nine women and nine men, above 65 years old, completed 6 months of training, with a mean follow- of $77.1\% \pm 15\%$. This means a weekly frequency of 1.5 sessions. During this period there were no injuries or bone fractures. In table 1 anthropometric characteristics and initial bone status of all 48 participants are shown.

Table 1. Initial descriptive study results (mean $\pm$ standard deviation).

	Men (n =9)	Women (n = 39)	All (n = 48)
Age (years)	71.1 $\pm$ 3.5	71.9 $\pm$ 3.8	71.8 $\pm$ 3.8
Weight (Kg)	78.9 $\pm$ 8	68.1 $\pm$ 10.8	70.1 $\pm$ 11.1
Size (cm)	169.3 $\pm$ 5.2	155.3 $\pm$ 5.7	158 $\pm$ 7.8
BMI	27.5 $\pm$ 2.3	28.3 $\pm$ 4.8	28.1 $\pm$ 4.5
Fat mass (%)	28.2 $\pm$ 2.5	38.9 $\pm$ 5.5	37 $\pm$ 6.6
Fat mass (Kg)	22.3 $\pm$ 3,7	27 $\pm$ 7.8	26.2 $\pm$ 7.5
Muscle mass* (Kg)	8.8 $\pm$ 0.7	6.5 $\pm$ 0.8	6.9 $\pm$ 1.2
BUA (dB/MHz)	105.2 $\pm$ 14.4	84.7 $\pm$ 15.4	88.6 $\pm$ 17.1
SOS (m/s)	1524.1 $\pm$ 20.7	1500.6 $\pm$ 13.5	1505 $\pm$ 17.5
BMD (g/cm ²)	0.536 $\pm$ 0.09	0.422 $\pm$ 0.07	0,440 $\pm$ 0.08
T-Score	-0.48 $\pm$ 0.96	-1.81 $\pm$ 0.75	-1.56 $\pm$ 0.94

*Data corresponding to left leg.

Body Mass Index (BMI) data show the existence of a certain overweight, in fact, 52.1% of the participants has a BMI ≥ 25 , and 25.2% a BMI ≥ 30 . That implies that 77.3% needs to reduce, up to some point, his bodyweight. The prevalence of overweight is similar to that found by Mavrovounioti, Mavrovouniotis, Argiriadou & Zaggelidis (2009), in women over 60 years. This situation is confirmed when fat mass values are analyzed. According to these values, both men and women would have overweight (Gallagher et al, 2000).

Concerning data obtained from the ultrasonography test, mean T-Score is placed amidst normal values (Sosa et al, 2003). However, there is great individual variability. As a matter of fact, 45.8% would have osteoporosis if a cutoff lower than -1.8 is established, as it is suggested for the calcaneus bone ultrasonography test. Regarding women, 53.8% would be suffering of osteoporosis. In addition, if BMI and T-Score are analyzed together, only 14.6% lays inside the values considered as normal. These data evidence that most of the people under study need to reach one or more of the following objectives: lowering their BMI, diminishing their fat mass or increasing their bone density.

Training program

The physical exercise program took place throughout two non-consecutive weekly sessions, each one lasting 60 minutes, structured in three parts: warming, main part and return to calm. During the main part, exercises focusing on strength-resistance, equilibrium and coordination were performed. More precisely, 7 to 15 leg exercises per session were performed, with a total of 20 to 90 repetitions per exercise, grouped generally in 2 or 3 series. The most common exercises were $\frac{1}{2}$ squat and splits or strides. Besides guided training program sessions, participants performed extra activities. The most common one was walking, with a duration of 379 ± 298 monthly minutes. These activities, along with the two 60 minutes weekly sessions, generated a total amount of 798 ± 362 minutes of physical exercise per month. This means 200 minutes of exercise per week.

After the training

Pre-post differences analysis for all the participants (table 2) shows a slight increase, statistically significant, of bodyweight ($p < 0.05$). However, this change does not imply modifications of fat mass or leg muscle mass. Conversely, bone status did actually experience changes. More precisely, a statistically significant decrease was obtained in SOS ($p < 0.01$) and in BMD ($p < 0.01$). Bone density loss was 2.2%.

Regarding pre-post differences by groups, only the “active” subjects (group 3) show a significant decline ($p = 0.023$) of bodyweight. Bodyweight of the rest of the groups remained stable. Results related to bone density line up with them. Only the “active” group experienced a significant decline ($p < 0.01$) of BMD. This loss reached 2.5%. However, in this group, no relationship between bodyweight decline and bone density loss was found. In the rest of the groups, although significant changes are not found, there is an evident decreasing

tendency of BMD, at a 2.8% rate for “little active”, 1.3% for “moderately active” and 1.9% for “very active”. Regarding the rest of the variables under study, no significant changes have been observed in any group.

Table 2. Initial versus final differences for all participants (n = 48).

	Initial	Final
Weight	70.1 ± 11.2	70.4 ± 10.7*
Fat mass (%)	37 ± 6.6	36.9 ± 6.8
Fat mass (Kg)	26.2 ± 7.5	26.1 ± 7.4
Leg muscle mass (Kg)	6.9 ± 1.2	6.8 ± 1.2
BUA (dB/MHz)	88.6 ± 17.1	90.9 ± 15.7
SOS (m/s)	1505 ± 17.5	1498.8 ± 14.4**
BMD (g/cm ²)	0.444 ± 0.08	0.434 ± 0.07**

*p<0,05 **p <0,01

Body composition, bone density and quality of life

Finally, a lineal correlation analysis between body composition, bone status and quality of life completed the study. The results obtained show a relationship of $r = -0.56$ ($p < 0.01$) between the total score in OPTQoL and SOS. This means that the lower the SOS, the lower quality of life subjects perceive, despite not suffering any bone fracture or being in a rehabilitation period. Nonetheless, the most closely related component to quality of life is relative fat mass ($r = 0.79$; $p < 0.01$). Thus, subjects with a lower fat percentage get lowest scores, which implies a better quality of life.

Discussion

Results obtained show that most of the population under study needs to improve body composition, bone status or both of them. However, the training program in which they participated did not improve these aspects. In fact, the observed bone mineral density loss of 2.2% is amongst levels of sedentary population (Borer, 2005; Bocalini et al, 2010; Daly et al, 2013). Nevertheless, establishing comparisons is complicated, owing to the fact that bone loss rhythm is not the same in every anatomic zone (Mitchell & Yerges-Armstrong, 2011). In that sense, although prescription of physical exercise in order to increase bone density is not clear in older population, several papers prove the benefits of training (Ilona, Taina, Mirela, Eugenia, & Mihaela, 2010; Villareal et al, 2011; Kohrt et al, 1997; Iwamoto et al, 2001; Verschueren et al, 2004), either increasing bone status or diminishing the rhythm of loss.

These Results confirm that strength training with many repetitions and light load does not improve bone mass (Howe et al, 2011). However, subjects did not perform exclusively this kind of exercise, they also walked for a considerable amount of time. Nonetheless, this kind of exercise does not seem to be either a specific load that induces changes in BMD (Gómez-Cabello et al, 2012). Regarding the type of exercise, programs based on activities without overloads (Korpelainen et al, 2006) do not attenuate bone density loss in older people, at the calcaneus bone level. On the contrary, high intensity strength level (60-80%) does provide significant bone density increase (Marques et al, 2011), or at least, its preservation (Bocalini et al, 2010).

In regard to body composition, fat and muscle masses remained constant, which implies stopping aging related changes (Gómez-Cabello, Rodríguez, Vila-Maldonado, Casajús, & Ara, 2012; Tabernero et al, 2001). However, several interventions evidence that reducing fat mass and increasing muscle mass in older people is possible (Villareal et al, 2011; Solverg et al, 2013). Actually, in our study, the “activity level” does not seem to influence nor body composition neither bone status, showing the inefficiency of the program when trying to fulfill these objectives.

On the other hand, the results of our study line up with those obtained by other researches (De Hollander et al., 2013; Pan, Cole, & Geliebter, 2011; Villareal, Banks, Siener, Sinacore, & Klein, 2004), showing that obesity worsens quality of life, particularly its physical dimension. However, it would be necessary to analyze if body composition modifications imply improvement in the perceived level of quality of life.

Conclusions

The program of physical activity being analyzed does not attenuate the bone mass loss related to age. Besides, it is proven to be little effective regarding older people body composition. This could be mainly attributed to its low intensity. In this kind of programs, exercises are performed one after the other, barely pausing and with a high amount of repetitions, preventing working at high intensities. For these reasons, we propose to modify the strength training, working at higher speed, with heavier loads and lesser repetitions, thus trying to stimulate the bone and muscle mass increase. However, training with high intensities must be faced progressively, to ensure a proper adaptation. In addition, the program under analysis presents too many holiday

periods which, along with a low weekly frequency prevents in many cases from achieving improvements in body composition or bone density.

Regarding aerobic workout, we consider convenient increasing the load, both in duration and intensity, because “walking” turned in many occasions into “strolling”, thus enabling bodyweight maintenance, but not fulfilling decrease of fat mass.

Anyway, we believe that health and physical exercise programs for elder people should have tools in order to periodically control changes yielded in the organism. This feedback would enable training readjustment and fulfill better results. Besides, they should have a multidisciplinary team offering healthy lifestyle habits advice, especially regarding nutrition. Moreover, it is important to have mechanisms that foster participation of a higher amount of people in this kind of programs.

Nevertheless, new studies must analyze the efficacy of other programs addressed to older people. If our results are confirmed, this kind of health and physical activity programs would not be contributing to a healthy aging process, at least from a physical point of view.

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