Original Article

The effects of daily physical activity on functional fitness, isokinetic strength and body composition in elderly community-dwelling women

ANTÓNIO M. MONTEIRO[1,2] ✉ , PEDRO SILVA[3], PEDRO FORTE[4,2], JOANA CARVALHO[3]

[1]*Department of Sports Sciences, Polytechnic Institute of Bragança. Bragança, Portugal*

[2]*Research Centre in Sports, Health and Human Development, Portugal*

[3]*Research Centre in Physical Activity Health and Leisure, Faculty of Sport, University of Porto. Porto, Portugal*

[4]*Department of Sports, Higher Institute of Educational Sciences of the Douro, Penafiel, Portugal*

ABSTRACT

Physical inactivity has been classified as a public health problem. The excess fat with muscle loss along with the general decline of physical and functional capacity. The aim of this study was to evaluate the relative contribution of objectively estimated daily physical activity (PA) in functional fitness, isokinetic strength and body composition in community-dwelling elderly women. Sixty elderly female volunteered for this research, with 67.69 ± 5.30 years old. Daily PA was assessed using accelerometers for 7 days. The evaluation and quantification of body composition, total lean body mass, fat mass, total body fat mass and bone mineral density, were made with the DXA equipment. Body Mass Index (BMI) was also calculated. The functional fitness (FF) assessment was performed using Functional Fitness Test. The knee extensor and flexor isokinetic strength was evaluated in both lower limbs, using a dynamometer at two different angular velocities: 60°/sec. and 180°/sec. Body Composition, Bone Mineral Density (p = 0.014) and Fat Mass (p = 0.029) were statistically lowers in the 3rd tertile compared to the 2nd one. The knee flexion peak torque at 180°/sec on the dominant leg (p = 0.051) and non-dominant leg (p = 0.020) was statistically different between the less active group and the most active group. For the FF, no significant differences between groups were found. Our results suggest that daily PA seems to induce benefits on BMI and % Fat Mass as well as on isokinetic

✉ **Corresponding author.** *Polytechnic Institute of Bragança, Campus Santa Apolónia, 5301-856 Bragança, Portugal.*
E-mail: mmonteiro@ipb.pt
Submitted for publication June 2018
Accepted for publication October 2018
Published June 2019 *(in press October 2018)*
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2019.142.11

knee flexion strength of independent and community dwelling-resident's older women. **Keywords:** Daily physical activity; Functional fitness; Isokinetic strength; Body composition.

Cite this article as:
Monteiro, A.M., Silva, P., Forte, P., & Carvalho, J. (2019). The effects of daily physical activity on functional fitness, isokinetic strength and body composition in elderly community-dwelling women. *Journal of Human Sport and Exercise*, *14*(2), 385-398. doi:https://doi.org/10.14198/jhse.2019.142.11

INTRODUCTION

Physical inactivity has been classified as a public health problem (Leitzmann et al., 2007) comparable to high cholesterol, smoking, hypertension and type 2 diabetes (Stewart, 2005). Furthermore, as a result of decreased physical activity (PA) with age, older people tend to gain more body fat and lose muscle mass (Kyle et al., 2001). This combination of excess fat with muscle loss along with the general decline of physical and functional capacity has been associated with increased risk of disability, morbidity and development of several chronic diseases in the elderly (Zamboni et al., 2005).

Aging and/or disuse, has been associated with several alterations that induce declines in physiological systems and consequently in physical abilities, such as muscle strength, balance, flexibility and, aerobic capacity (Singh, 2002). Among others, the loss of muscular strength, in particular of the lower limbs, seems to be of particular importance since it can drastically affect the mobility (Daley & Spinks, 2000) and increase the risk of falls and injuries (Portegijs et al., 2006). Similarly, aerobic capacity is also considered as determinant for autonomy, health and quality of life of older people (Pedersen & Saltin, 2006). In fact, for the daily routine of the elderly a minimum threshold in terms of cardiovascular ability is necessary (Daley & Spinks, 2000).

Finally, the declines observed with aging in other components of functional fitness (FF), such as balance, flexibility and agility have also negative effects on mobility and autonomy, limiting the ability of older people to perform many different tasks of daily life (Carvalho, Marques, & Mota, 2009; Takeshima et al., 2007). Activities such as shopping, getting out of bed, dressing, tie your shoes, take care of your personal hygiene and domestic tasks require a combination of several components of the FF as muscle strength, aerobic capacity, balance, flexibility and agility.

Despite the potential association between PA and the positive outcomes for health and functional capacity of older adults (Haskell et al., 2007; Vogel et al., 2009), most studies are based on specific protocols of physical exercise (PE), being more scarce those who relate unstructured daily PA and its influence on different components of FF and body composition (BC).

In addition, most studies did not assess PA objectively, commonly using questionnaires. Although this is a fairly validated method (Bauman, Phongsavan, Schoeppe, & Owen, 2006) it presents a main gap of precise information about the intensity of activity, since the perception of an activity as "difficult" or "easy" will depend on the level of tolerance and fitness of the individual, both of which are affected by age (Shephard, 2003).

Concerning BC, the use of less sensitive evaluation methods to estimate BMI and body fat may underestimate, in the case of the elderly, the amount of fat (Bemben, 1998) and masking the ratio of physical activity, body composition and functional fitness.

Finally, there is a conflicting data in the limited studies concerning the effects of daily PA on muscular skeletal system, particularly on muscle strength. According to our knowledge, earlier studies have shown no change (Westhoff, Stemmerik, & Boshuizen, 2000), and didn´t found a direct causal relationship between PA and daily muscle strength (Carvalho, Marques, Soares, & Mota, 2010; Malliou et al., 2003).

These results may be due to the methodology used to assess muscle strength in the elderly. The isokinetic is considered one of the most accurate methods to evaluate muscle strength (Carvalho et al., 2009; Carvalho et al., 2010; Malliou et al., 2003), but studies that have used this methodology in combination with objectively monitored PA are scarce (Carvalho et al., 2010; Malliou et al., 2003). Therefore, the aim of this study was to evaluate the relative contribution of daily PA in body composition, functional fitness and isokinetic strength in elderly community residents.

MATERIALS AND METHODS

Subjects and experimental design

Eighty Caucasian elderly women, aged between 60 and 85 years (67.69 ± 5.30) volunteered to participate in this study.

At baseline, participants completed a questionnaire reporting overall health in order to observe the present and past medical conditions, as well as medication. Inclusion criteria to participate in the study included: (i) having 65 or more years, (ii) be functionally independent in their daily tasks, (iii) no clinical manifestations of severe chronic diseases or medication that could compromise the experimental protocol, including severe cardiovascular, muscular, metabolic and joints complications.

Participants were also excluded from the study if they did not provide enough PA data: if the accelerometers did not have at least 3 complete week days, with a minimum of 8 hours of monitoring. Thus, based on these criteria, of the 80 starting participants, 20 were excluded.

Before starting the study, all participants received a complete explanation of the purpose, risks and procedures of the investigation, and provided written informed consent. The investigation was in full compliance with the Helsinki declaration, and the Institutional Review Board approved all methods and procedures.

Measurements

The same evaluator performed all measurements. All test stations were organized in a circuit, and the same conditions were maintained for each test at all testing periods. On the test day, subjects first completed 8–10 min warm-up led by a physical education instructor and then completed all test items.

Anthropometry and body composition

Weight, was evaluated in light clothing and without shoes. It was used a digital scale with attached stadiometer (SECA ®) for evaluation of height, measured between the vertex and the reference plane of the ground. The BMI, expressed in kg/m2 was calculated by the standard formula [weight (kg) divided / height2 (m)]. The reference values for the World Health Organization (WHO, 2006) for BMI (normal weight between 18.50 and 24.99 kg/m2, pre-obese between 25 and 29.99 kg/m2; obese class I from 30 to 34.99 kg/m2 obese class II between 35 and 39.99 kg/m2) were used. For the evaluation and quantification of BC, a total body scan [total lean body mass - TLBM (kg), fat mass - FM (%) and total body fat mass - TBFM (kg) and Bone Mineral Density – BMD (DP)] by DXA equipment (Hologic QDR - 4500 ®; software for windows XP, version 12.4) was performed. The BMD was expressed in relative values in T-score (<-1 SD) according to the WHO criteria (WHO, 2006). All subjects were placed in supine position and all procedures were applied by the same trained technician according to standardized assessment (Afghani & Johnson, 2006). The calibration was performed before testing according to the manufacturer's instructions (Kohrt, 1995).

Physical activity

Habitual PA levels were assessed using accelerometers model GT1M (Actigraph, FL,USA) during 7 consecutive days (5 week days and 2 weekend days) as an objective measure of daily PA. Participants were instructed to wear the accelerometer over their right hip. Exceptions included time spent sleeping, showering, and participating in water-based activities. Participants were asked to maintain their usual activities and record them in a diary. Epochs of 1 minute were selected to record the PA. Participants had to provide at least 3 complete week days, with a minimum of 8 hours of monitoring. Data from each monitor were downloaded by the investigators and compared with data from the diary before the average counts per minute were calculated. Periods with 60 minutes consecutive of zeros were exclude from the analyses (Freedson, Melanson, & Sirard, 1998).

Activity levels were expressed in counts.min-¹ (number of records for one minute). The cut point was set at counts per minute ≥1041 (moderate to vigorous PA [MVPA]) which corresponded to a mean VO2 of 13 mL kg 283−1 min−1, based on the counts associated with a reference activity, which was walking at 3.2 km/h (Copeland & Esliger, 2009). The 60 records obtained were divided in tertiles: 1st tertile, low active; 2nd tertile, fairly active; 3rd tertile, very active. To calculate tertiles (1st tertile, counts ≤ 507.75, 2nd tertile, 507.75 to 752.08 counts; 3rd tertile, ≥ 752.08 counts) of PA the cut-off points for the elderly by Copeland and Esliger (2009) were used.

Functional Fitness Test

The Functional Fitness Test (FFT) was used to assess functional fitness (Rikli & Jones, 1999). This battery was developed to evaluate the main physical parameters associated with functional mobility and consists of 6 items: lower body strength (30-Second Chair Stand), upper body strength (Arm Curl), lower body flexibility (Chair Sit-and-Reach), upper body (shoulder) flexibility (Back Scratch), agility/dynamic balance (8-Foot Up-and-Go) and aerobic endurance test (2-Minute Step Test). The tests were conducted in a circuit in order to minimize the effects of fatigue. On the testing days, subjects first completed an 8 to 10 minutes' warm-up, performed in the morning and in one session. Before the test, participants received instructions and a demonstration of each item.

Isokinetic strength

The dynamic concentric muscle strength of both knees (flexion and extension muscle groups) was measured (peak torque - Newton meters) on a custom-made isokinetic (Biodex System 2, NY, USA) at two different angular velocities: 60°/sec. (1.05 rads-1) and 180°/sec (3.14 rad s-1). Strength measurements were carried out in accordance with the manufacturer's instructions for knee extension/ flexion (Wilk, 1991).

Subjects were comfortably seated with the trunk and thigh restrained by chest, waist and thigh straps. The rotational axis of the dynamometer was aligned with the lateral femoral epicondyle and the resistance positioned at a distance of two finger-widths above the lateral malleolus of the ankle joint. The Biodex angle reading was calibrated to the anatomic joint angle measured by a goniometer. Gravity corrections to torque were based on leg weight at 0º and calculated later by the software of the equipment. Before testing, participants performed a standardized warm on a bicycle ergometer (Monark, Sweden) for 5 minutes at 60 rpm, using a load of 2 % of their body weight.

After familiarization with the machine, participants performed five maximal efforts at 180º/s and three at 60º/s, with a 2-minute rest between tests. To evaluate maximal isokinetic strength, the totality of the leg movement was required from 90º position flexion to maximal extension during the test, all participants were verbally encouraged to develop their maximum strength, not having any "visual feedback. The following parameters were considered: peak torque (Nm); hamstrings / quadriceps ratio (%).

Statistical analysis
Descriptive data are expressed as means and standard deviations (SD). Normality of distribution was determined for all continuous variables by a Kolmogorov–Smirnov test. A one-way repeated ANOVA was performed on each dependent variable, to detect differences between the three tertiles. When F ratios were significant, post hoc mean comparisons were analyzed with the Bonferroni test to compare differences between groups. The level of statistical significance was maintained at $p < 0.05$ and all analyzes were performed using the Statistical Package for the Social Sciences ® (SPSS ®) version 19.0.

RESULTS

Based on the inclusion/exclusion criteria, 20 individuals out of the 80 recruited were not eligible to be in the study. Thus, results presented are from the 60 women who met all research inclusion criteria. Table 1 shows the main characteristics of the sample.

Table 1. General characteristics of the sample according to PA levels

Variable	N	PA	Mean±DP	Min	Max
Age	20	1º Tertil	69.50±6.11	60	85
	20	2º Tertil	65.20±3.09	60	73
	20	3º Tertil	66.75±5.41	60	86
Height	20	1º Tertil	1.51±0.75	1.43	1.76
	20	2º Tertil	1.56±0.71	1.45	1.75
	20	3º Tertil	1.57±0.09	1.44	1.70
Weight	20	1º Tertil	69.77±10.64	52.20	90.50
	20	2º Tertil	77.95±13.72	57.90	116.40
	20	3º Tertil	67.85±12.48	42.70	103.20

Mean values and their standard deviations (mean ± SD); Age (years), height (m), weight (kg); Differences between tertiles of Daily Physical Activity (Esliger & Copeland, 2009).

The table 2 shows the values of BC in the 3 PA tertiles.

There were statistically significant differences between the 2nd and 3rd tertile in BMI and FM ($p = 0.029$). No significant differences were observed in TLM, TFM and BMD.

Considering the mean baseline BMI (27.7 ± 2.9Kg/cm²) of the women of the 1st tertile BMI (30.45 kg/m2) and 2nd tertile (32.37 kg/m2), they are classified as obese grade 1 presenting the 3rd tertile (27.59 kg/m2), a moderate risk, corresponding to the cut-off of overweight (pre-obesity).

The older women of the 1st tertile (less active group) present lower values (SD = -1.26) than the normal cut-off points, (WHO, 1994) and those of the 2nd tertile (SD = -0.47) and 3rd tertile (SD = -0.87) present values above the normal cut-off points. No significant differences were observed between the tree different tertiles of PA.

Table 2, Body Composition according to PA levels

Variable	N	PA	Mean±D	*p*	Min	Max
BMI (kg/m²)	20	1º Tertil	30.47±4.68	0.014*	23.73	41.88
	20	2º Tertil	32.37±6.11**		24.07	47.59
	20	3º Tertil	27.59±4.02**		20.59	40.82
TLM (Kg)	20	1º Tertil	40.61±6.04	0.361	33.43	57.46
	20	2º Tertil	43.91±7.29		31.25	59.62
	20	3º Tertil	41.85±8.38		27.65	55.73
TFM (Kg)	20	1º Tertil	26.82±10.03	0.127	12.77	56.21
	20	2º Tertil	29.65±7.74		18.03	40.57
	20	3º Tertil	23.94±8.27		12.77	51.64
FM (%)	20	1º Tertil	38.69±4.82	0.029*	28.80	44.50
	20	2º Tertil	40.35±6.32**		24.50	47.50
	20	3º Tertil	35.10±7.17**		18.20	48.50
BMD (DP)	20	1º Tertil	-1.26±1.02		-3.00	2.10
	20	2º Tertil	-0.47±1.08	0.074	-2.40	2.50
	20	3º Tertil	-0.86±1.13		-3.20	2.10

*Mean values and their standard deviations (mean ± SD), BMI = body mass index; TLM = Total Lean Mass; TFM = Total fat mass; FM =% Fat Mass; BMD = Bone Mineral Density. P values: One-Way ANOVA, post hoc ** Values with significant differences; Significance level, p <0.05; Differences between tertiles of Daily Physical Activity (Esliger & Copeland, 2009).*

The table 3 illustrate the values of Functional Fitness in the 3 PA tertiles.

Table 3. Functional Fitness according to PA levels

Variable	N	PA	Mean±SD	*p*	Min	Max
AM (nºrep)	20	1º Tertil	25.80±9.75	0.058	11.00	43.00
	20	2º Tertil	30.50±8.88		14.00	53.00
	20	3º Tertil	32.60±8.36		18.00	49.00
SCS (nºrep**)**	20	1º Tertil	20.55±5.73	0.073	8.00	31.00
	20	2º Tertil	21.75±7.33		12.00	36.00
	20	3º Tertil	25.10±5.93		15.00	33.00
BS (cm)	20	1º Tertil	-11.55±9.04	0.744	-27.00	8.00
	20	2º Tertil	-10.65±10.69		-33.00	2.50
	20	3º Tertil	-13.15±11.30		-40.00	8.50
CSR (cm)	20	1º Tertil	4.43±6.70	0.201	-10.00	16.00
	20	2º Tertil	6.70±8.00		-14.00	20.50
	20	3º Tertil	9.32±10.44		-5.00	30.00
2-ST (min.)	20	1º Tertil	132.35±56.35	0.149	56.00	227.00
	20	2º Tertil	124.50±42.18		53.00	196.00
	20	3º Tertil	158.30±67.81		61.00	287.00
TUG (seg.)	20	1º Tertil	4.81±0.86	0.143	3.66	7.40
	20	2º Tertil	5.01±1.13		3.75	8.00
	20	3º Tertil	4.44±0.64		3.40	5.72

*Mean values and their standard deviations (Mean ± SD); 30-Second Chair Stand (SCS), Arm Curl (AM), Chair Sit-and-Reach (CSR), Back Scratch (BS), 8-Foot Up-and-Go (TUG) and 2-Minute Step Test (2-ST); P values: One-Way ANOVA, post hoc ** Values with significant differences; Significance level, p <0.05; Differences between tertiles of Daily Physical Activity (Esliger & Copeland, 2009).*

Differences in muscle strength in the 3 PA tertiles groups are listed in Table 4.

Table 4. Isokinetic muscle strength of both lower limbs at two angular velocities (120º/sec and 60º/sec) according to PA levels (Peak Torque, Nm; hamstrings/quadriceps ratio, %)

Variable	N	PA	Mean±SD	*p*	Min	Max
KE180ºDL (N.m)	20	1º Tertil	57.65±15.36	0.060	26.40	104.30
	20	2º Tertil	65.10±15.24		41.50	96.50
	20	3º Tertil	69.93±17.51		41.90	112.30
KE 180ºNDL (N.m)	20	1º Tertil	56.70±14.54	0.208	34.60	98.30
	20	2º Tertil	63.11±12.64		41.80	86.90
	20	3º Tertil	64.39±16.11		34.70	94.80
KF180ºDL (N.m)	20	1º Tertil	33.39±11.38**	0.051*	14.50	58.40
	20	2º Tertil	36.54±12.24		20.80	60.50
	20	3º Tertil	42.02±9.23**		23.70	59.00
KF180ºNDL (N.m)	20	1º Tertil	35.08±9.88	0.363	18.00	52.80
	20	2º Tertil	36.68±9.83		21.40	59.30
	20	3º Tertil	39.68±11.08		22.60	66.00
KF/EJ180ºDL (%)	20	1º Tertil	58.03±14.24	0.290	29.00	86.00
	20	2º Tertil	54.85±11.76		36.20	77.80
	20	3º Tertil	61.20±11.73		43.80	88.60
KF/EJ180ºNDL (%)	20	1º Tertil	62.48±12.25	0.426	46.00	87.60
	20	2º Tertil	58.03±9.24		39.20	73.20
	20	3º Tertil	62.45±14.78		43.00	93.70
KE60ºDL (N.m)	20	1º Tertil	92.42±18.40	0.055	66.60	152.20
	20	2º Tertil	103.32±21.40		57.30	144.90
	20	3º Tertil	110.49±28.79		55.40	182.60
KE 60ºNDL (N.m)	20	1º Tertil	93.09±19.17	0.443	58.00	145.40
	20	2º Tertil	99.89±18.09		64.10	134.80
	20	3º Tertil	100.94±24.96		49.40	148.60
KF60ºDL (N.m)	20	1º Tertil	45.37±9.75**	0.020*	26.80	66.30
	20	2º Tertil	50.07±12.15		26.40	69.90
	20	3º Tertil	56.99±15.58**		31.00	81.40
KF60ºNDL (N.m)	20	1º Tertil	49.36±12.77	0.301	33.70	92.90
	20	2º Tertil	52.21±10.47		34.30	69.40
	20	3º Tertil	55.67±14.66		29.30	83.40
KF/EJ60ºDL (%)	20	1º Tertil	49.38±7.84	0.332	31.70	64.40
	20	2º Tertil	48.66±5.99		37.90	60.20
	20	3º Tertil	51.84±7.23		40.10	68.10
KF/EJ60ºNDL (%)	20	1º Tertil	53.25±7.78	0.450	40.50	66.60
	20	2º Tertil	52.50±6.87		40.20	66.70
	20	3º Tertil	55.74±10.27		36.20	80.00

*Mean values and their standard deviations (Mean ± SD); Knee Extension (KE); Knee Flexion (FJ); hamstrings/quadriceps ratio (KF/E); Dominant Leg (DL); Not Dominant Leg (NDL); Minimum (Min); Maximum (Max); p values: One-Way ANOVA; **post hoc Values with significant differences; Significance level, p <0.05; differences between tertiles of Daily Physical Activity (Esliger & Copeland, 2009).*

Only KJ180ºDL and KFJ60ºDL presented statistically significant differences between the 1st and 3rd tertile.

DISCUSSION

The purpose of the present study was to evaluate the relative contribution of daily PA in body composition, functional fitness and isokinetic strength in community-dwelling older women. Concerning BC, the subjects of the 3rd tertile (group of the most active) present lower significant values of BMI and FM compared to the ones of the 2nd tertile. Furthermore, our data didn´t found any significant differences on FF among the 3 tertiles of PA, suggesting the no effect of PA on daily overall functionality of these community-dwelling elderly women. Regarding the isokinetic strength only statistically significant differences were found in knee flexion of the dominant limb at both angular velocities (60°/sec, 180°/sec) between the most active (3rd tertile) and less active women (1st tertile).

Considering the mean baseline BMI (27.7 ± 2.9Kg/cm²) of the women of the 1st tertile BMI (30.45 kg/m2) and 2nd tertile (32.37 kg/m2), they are classified as obese grade 1 presenting the 3rd tertile (27.59 kg/m2), a moderate risk, corresponding to the cut-off of overweight (pre-obesity). Our data showed significant differences ($p < 0.05$) between the 2nd and 3rd tertile ($p = 0.011$), suggesting that a certain amount of MVPA seems necessary to observe potential benefits in BMI. However, despite these differences, taking into account that BMI a less accurate anthropometric variable to assess fatness, underestimating specially in older subjects body fat content (Heiat, Vaccarino, & Krumholz, 2001), literature has pointed the use of other indicators with a more accurate assessment of BC. In this study, beyond the BMI, a total body scan for the evaluation of BC in DXA was carried out, and the same statistically significant differences were found in FM between the 2nd and the 3rd percentile. This result is of special importance, since in addition to its relationship with a more favorable profile of health, particularly with regard to cardiovascular and metabolic diseases such as type 2 diabetes (Maggi et al., 2006), excess of body fat is also seen as a major factor for functional decline (Sternfeld, Bhat, Wang, Sharp, & Quesenberry, 2005). This is also, to some extent, confirmed in our study since the more active women with a lower BMI are also those with highest values, although not statistically significant, in terms of FF.

Despite the no significant differences between the PA tertiles on BMD, it seems relevant to show while the older women of the 1st tertile (less active group) present lower values (SD = -1.26) than the normal cut-off points, (WHO, 2006). Those of the 2nd tertile (SD = -0.47) and 3rd tertile (SD = -0.87) present values above the normal cut-off points. Thus, it appears that, although no significant differences between the groups, there is an important trend for increases on BMD according to PA levels. This is of special importance since aging is linked to a reduced amount of bone tissue, especially in women as a consequence of estrogen insufficiency, which consequently motivates bones to become weaker, commonly leading to osteoporosis (Cooper et al., 1995).

Accordingly, strategies, as PA, targeting the prevention of bone fractures in the elderly women should focus on reducing the risk of falls, namely lower limbs muscle strength and balance, and maintaining or improving bone health. However, despite these differences in FM, there were no significant differences in TLM among the different PA tertiles, neither in lower strength. Thus, in general, our results suggest that daily PA is not sufficient to induce favorable changes in terms of muscle function and mass at least among these community-dwelling elderly women.

It is important to note that to succeed in increasing muscle mass, the training needs to be monitored not only with adequate nutrition, particularly regarding protein intake (Rydwik, Lammes, Frandin, & Akner, 2008) but also, depending on the baseline conditions, with a specific training muscle strengthening (ACSM, 2009; Pedersen & Saltin, 2006) to which none of the elderly in our sample was submitted. Moreover, although controlled for several covariates, the confounding influence of other variables such as genetic variation, diet composition and socio-cultural factors may, at least in part, also explain our results.

As stated earlier, despite the potential relationship between BC and functionality and the trend in favour of the most active elderly, there were no statistically significant differences among the 3 PA tertiles in any of the components of the FF (Rikli & Jones, 1999). Probably, the differences in the daily PA performed by the reasonably healthy and active elderly women of our sample have not been sufficiently evident in regards to noticing differences in FF Overload and specificity of training seems to be determinant for inducing relevant functional physiological adaptations. It is possible that, given the characteristics of the sample that includes older women living in rural areas and as such with reasonable levels of PA and FF, the appropriate overload likely to induce improvements in FF was not achieved with non-formal MVPA. We can speculate that for our older women the manipulation of the frequency, intensity, duration and type of exercise is pertinent (McArdle, Katch, & Katch, 2004).

The characteristics of the sample in terms of functionality, may at least partly explain the lack of differences in some of the assessed parameters. Taking into account that our sample is comprised by women with a mean age of 67.69 ± 5.30 years, we can consider the Scoreboard of FF in FFT (Rikli & Jones, 1999). So, matching with normative values we can state that all of our items FF are higher. For example, the values of lower flexibility are within the recommended values or even better than the normative scores described by Rikli & Jones (1999) (-0.5 cm to +4.5 cm). Similarly, with regard to the normative values of aerobic endurance test (73 -107 rep), all the women among the 3 PA tertiles, and specially those in the 3rd tertile (158.30 rep) present higher values. Also, comparing the upper limb strength values we found that in all tertiles, our elderly have higher values than the normative upper limit value (12-18 rep). In the same way, the lower strength values of our sample are within or above the normative values (11 -16 reps.). Finally, also the TUG, the values of our elderly are within the recommended scores (6.4 s - 4.8 s), presenting those of the 3rd tertile better performances compared to the normative value. We can speculate that although there are no significant differences between the 3 tertiles of PA, the elderly women in this study appear to have a low risk of falls. That may be due they present an overall average to perform the TUG less than 14 s (Shumway-Cook, Brauer, & Woollacott, 2000) and have higher values than the normal values in terms of lower strength, particularly those considered more active.

There is a trend to increase, specialty in TUG, SCS and AM, among the PA tertiles, presenting the 3rd tertile the best scores, followed by the second and first tertile, suggesting a tendency to increase functional tests performances by increasing non-formal PA. Although, with no significant differences, this trend seems to us worthy of highlighting. The decrease in muscle strength, particularly the lower limbs, and the ability to control balance are, among others, main risk factors for limited mobility and occurrence of falls (Sihvonen, Sipila, & Era, 2004).

Concluding, although our data contradicts some of the studies that indicate that the maintenance or even increase in the functionality of the elderly subjects can be achieved by the adoption of a physically active lifestyle (McAuley et al., 2007; Visser et al., 2005), it is possible that the characteristics of our sample, as well as the small number, justify the absence of differences between the PA tertiles. In this sense, our data reinforces the idea that, depending on the characteristics of the elderly, there is probably a need of a systematic, specific overload by means of exercise training in order to induce significant increases in the community-dwelling older FF.

Regarding the possible influence of PA daily levels on isokinetic strength, we only found statistically significant differences in knee flexion at both angular velocities (60º/sec and 180 °/sec) between the 1st and 3rd tertile. This may be related to the fact that normally the flexor muscles that the less required in the day-to-day, and as it is possible that differences in MVPA between the 1st and 3rd tertile are sufficient for evidencing the differences in knee flexion strength. This result is important in the evaluation of the strength in the lower limbs in the sense that it may be an important predictor of the functional capacity of the elderly (Westhoff et al., 2000). It is important to note that isokinetic dynamometers provide a more accurate profile of muscle contraction properties and also better isolation of the assessed neuromuscular function of the muscle groups than functional tasks such as 30-s chair stand test (Carvalho et al., 2010; Lohne-Seiler, Torstveit, & Anderssen, 2013).

Both the knee extensor and flexor muscles groups play an important role on functional capacity of the elderly (Westhoff et al., 2000) and on their body stability and locomotion. Its use in slow and fast gait (Carvalho et al., 2010), in step climbing (McFadyen & Winter, 1988) and in the lifting of the chair (Millington, Myklebust, & Shambes, 1992) has been well documented in kinematic, electromyography and kinetic. Probably greater significant differences in muscle strength may have been observed if this study comprised a frail and/or sarcopenic elderly sample. Once again, the limited significant differences observed in our study among the isokinetic evaluation reinforces the concept that exercise prescriptions should include specific strength training to provide a more accurate and intense training stimulus for muscle strength improvements (Carvalho et al., 2010). On the other hand, taking into account the absence of differences between groups on hamstrings/quadriceps ratio, we can speculate that the different daily tasks performed by our elderly mobilize equally both muscle groups (Carvalho, Mota, & Soares, 2003).

Our results reveal that the daily activity hasn't significant results in the functionality of elderly women living in the community, suggesting that PA daily, by itself, is not sufficient to fulfill the principles of overload and specificity of these community-dwelling older women who have reasonable levels of FF. Thus, we assume that improving the overall functionality of independent elderly women will only be achieved with the implementation of an exercise program that respects the basic principles of training.

Several limitations of this study are worthy of comment. Subjects were well-functioning community-dwelling volunteers and were therefore not representative of all older adults. It is important to take into account that in general, study participants performed the selected fitness tests above the norms and they did not have severe diseases. Care should thus be taken in extrapolating our findings to unfit, very old and frail populations. In addition, considering that this is a cross-sectional study, it is not possible to provide evidences for causality from our results. Finally, the lack of concurrent measures of dietary habits and food consumption can also be considered a limitation specially in relation to body composition data (Rydwik et al., 2008). In spite of these limitations, this study has several strengths, including the use of accelerometers to objectively assess PA and the use of performance-based tests to objectively evaluate fitness.

CONCLUSION

Considering the above-mentioned limitations and the strengths, this research demonstrated through objective measurements of PA, BC and fitness that among relatively healthy community-dwelling older women. Higher PA levels seems to influence lower values of BMI and FM, as well as better knee flexor isokinetic strength levels. However, for this community-dwelling older women, the differences among the daily PA patterns were not sufficient to observe differences in TLM, TFM, BMD and FF, reinforcing the concept that a more appropriate training stimulus is required for reasonably healthy, fit and active community-dwelling older women.

Although these findings provide some clue to the influence of PA patterns on BC, FF and muscle strength of the older adults, additional evidence is needed to validate and build upon our findings.

ACKNOWLEDGEMENTS

This study was developed in the Research Centre on Physical Activity Health and Leisure (CIAFEL) that is supported by Pest-OE/SAU/UI0617/2011.

REFERENCES

ACSM. (2009). American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc, 41(3), 687-708. https://doi.org/10.1249/MSS.0b013e3181915670

Afghani, A., & Johnson, C. A. (2006). Resting blood pressure and bone mineral content are inversely related in overweight and obese Hispanic women. Am J Hypertens, 19(3), 286-292. https://doi.org/10.1016/j.amjhyper.2005.10.024

Bauman, A., Phongsavan, P., Schoeppe, S., & Owen, N. (2006). Physical activity measurement-a primer for health promotion. Promot Educ, 13(2), 92-103. https://doi.org/10.1177/10253823060130020103

Bemben, M. G. (1998). Age-related alterations in muscular endurance. Sports Med, 25(4), 259-269. https://doi.org/10.2165/00007256-199825040-00004

Carvalho, J., Marques, E., & Mota, J. (2009). Training and detraining effects on functional fitness after a multicomponent training in older women. Gerontology, 55(1), 41-48. https://doi.org/10.1159/000140681

Carvalho, J., Marques, E., Soares, J. M., & Mota, J. (2010). Isokinetic strength benefits after 24 weeks of multicomponent exercise training and a combined exercise training in older adults. Aging Clin Exp Res. https://doi.org/10.1007/BF03324817

Carvalho, J., Mota, J., & Soares, J. M. (2003). Strength training vs. aerobic training: cardiovascular tolerance in elderly adults. Rev Port Cardiol, 22(11), 1315-1330.

Cooper, C., Cawley, M., Bhalla, A., Egger, P., Ring, F., Morton, L., & Barker, D. (1995). Childhood growth, physical activity, and peak bone mass in women. J Bone Miner Res, 10(6), 940-947. https://doi.org/10.1002/jbmr.5650100615

Copeland, J. L., & Esliger, D. W. (2009). Accelerometer assessment of physical activity in active, healthy older adults. J Aging Phys Act, 17(1), 17-30. https://doi.org/10.1123/japa.17.1.17

Daley, M. J., & Spinks, W. L. (2000). Exercise, mobility and aging. Sports Med, 29(1), 1-12. https://doi.org/10.2165/00007256-200029010-00001

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. Med Sci Sports Exerc, 30(5), 777-781. https://doi.org/10.1097/00005768-199805000-00021

Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., . . . Bauman, A. (2007). Physical Activity and Public Health: Updated Recommendation for Adults From the American College of Sports Medicine and the American Heart Association. ACSM/AHA Circulation, 116(9), 1081-1093. https://doi.org/10.1161/CIRCULATIONAHA.107.185649

Heiat, A., Vaccarino, V., & Krumholz, H. M. (2001). An evidence-based assessment of federal guidelines for overweight and obesity as they apply to elderly persons. Arch Intern Med, 161(9), 1194-1203. https://doi.org/10.1001/archinte.161.9.1194

Kohrt, W. M. (1995). Body composition by DXA: tried and true? Med Sci Sports Exerc, 27(10), 1349-1353. https://doi.org/10.1249/00005768-199510000-00001

Kyle, U. G., Genton, L., Hans, D., Karsegard, V. L., Michel, J. P., Slosman, D. O., & Pichard, C. (2001). Total body mass, fat mass, fat-free mass, and skeletal muscle in older people: cross-sectional differences in 60-year-old persons. J Am Geriatr Soc, 49(12), 1633-1640. https://doi.org/10.1111/j.1532-5415.2001.49272.x

Leitzmann, M. F., Park, Y., Blair, A., Ballard-Barbash, R., Mouw, T., Hollenbeck, A. R., & Schatzkin, A. (2007). Physical activity recommendations and decreased risk of mortality. Arch Intern Med, 167(22), 2453-2460. https://doi.org/10.1001/archinte.167.22.2453

Lohne-Seiler, H., Torstveit, M. K., & Anderssen, S. A. (2013). Traditional versus functional strength training: effects on muscle strength and power in the elderly. J Aging Phys Act, 21(1), 51-70. https://doi.org/10.1123/japa.21.1.51

Maggi, S., Noale, M., Gallina, P., Bianchi, D., Marzari, C., Limongi, F., & Crepaldi, G. (2006). Metabolic syndrome, diabetes, and cardiovascular disease in an elderly Caucasian cohort: the Italian Longitudinal Study on Aging. J Gerontol A Biol Sci Med Sci, 61(5), 505-510. https://doi.org/10.1093/gerona/61.5.505

Malliou, P., Fatouros, I., Beneka, A., Gioftsidou, A., Zissi, V., Godolias, G., & Fotinakis, P. (2003). Different training programs for improving muscular performance in healthy inactive elderly. Isokinet Exerc Sci, 11(4), 189-195.

McArdle, W. D., Katch, F. I., & Katch, V. L. (2004). Exercise physiology: energy, nutrition and human performance. 5. ed. Baltimore: Lippincot Williams & Wilkins, 162, 202, 235.

McAuley, E., Morris, K. S., Doerksen, S. E., Motl, R. W., Liang, H., White, S. M., . . . Rosengren, K. (2007). Effects of change in physical activity on physical function limitations in older women: mediating roles of physical function performance and self-efficacy. J Am Geriatr Soc, 55(12), 1967-1973. https://doi.org/10.1111/j.1532-5415.2007.01469.x

McFadyen, B. J., & Winter, D. A. (1988). An integrated biomechanical analysis of normal stair ascent and descent. J Biomech, 21(9), 733-744. https://doi.org/10.1016/0021-9290(88)90282-5

Millington, P. J., Myklebust, B. M., & Shambes, G. M. (1992). Biomechanical analysis of the sit-to-stand motion in elderly persons. Arch Phys Med Rehabil, 73(7), 609-617. doi:0003-9993(92)90124-F [pii]

Pedersen, B. K., & Saltin, B. (2006). Evidence for prescribing exercise as therapy in chronic disease. Scand J Med Sci Sports, 16 Suppl 1, 3-63. https://doi.org/10.1111/j.1600-0838.2006.00520.x

Portegijs, E., Sipila, S., Pajala, S., Lamb, S. E., Alen, M., Kaprio, J., . . . Rantanen, T. (2006). Asymmetrical lower extremity power deficit as a risk factor for injurious falls in healthy older women. J Am Geriatr Soc, 54(3), 551-553. https://doi.org/10.1111/j.1532-5415.2006.00643_6.x

Rikli, R. E., & Jones, C. J. (1999). Development and validation of a functional fitness test for community-residing older adults. J Aging Phys Act, 7(2), 129-161. https://doi.org/10.1123/japa.7.2.129

Rydwik, E., Lammes, E., Frandin, K., & Akner, G. (2008). Effects of a physical and nutritional intervention program for frail elderly people over age 75. A randomized controlled pilot treatment trial. Aging Clin Exp Res, 20(2), 159-170. https://doi.org/10.1007/BF03324763

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. Br J Sports Med, 37(3), 197-206; discussion 206. https://doi.org/10.1136/bjsm.37.3.197

Shumway-Cook, A., Brauer, S., & Woollacott, M. (2000). Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther, 80(9), 896-903.

Sihvonen, S. E., Sipila, S., & Era, P. A. (2004). Changes in postural balance in frail elderly women during a 4-week visual feedback training: a randomized controlled trial. Gerontology, 50(2), 87-95. https://doi.org/10.1159/000075559

Singh, M. A. (2002). Exercise comes of age: rationale and recommendations for a geriatric exercise prescription. J Gerontol A Biol Sci Med Sci, 57(5), M262-282. https://doi.org/10.1093/gerona/57.5.M262

Sternfeld, B., Bhat, A. K., Wang, H., Sharp, T., & Quesenberry, C. P., Jr. (2005). Menopause, physical activity, and body composition/fat distribution in midlife women. Med Sci Sports Exerc, 37(7), 1195-1202. https://doi.org/10.1249/01.mss.0000170083.41186.b1

Stewart, K. J. (2005). Physical activity and aging. Ann N Y Acad Sci, 1055, 193-206. https://doi.org/10.1196/annals.1323.029

Takeshima, N., Rogers, N. L., Rogers, M. E., Islam, M. M., Koizumi, D., & Lee, S. (2007). Functional fitness gain varies in older adults depending on exercise mode. Med Sci Sports Exerc, 39(11), 2036-2043. https://doi.org/10.1249/mss.0b013e31814844b7

Visser, M., Simonsick, E. M., Colbert, L. H., Brach, J., Rubin, S. M., Kritchevsky, S. B., . . . Harris, T. B. (2005). Type and intensity of activity and risk of mobility limitation: the mediating role of muscle parameters. J Am Geriatr Soc, 53(5), 762-770. https://doi.org/10.1111/j.1532-5415.2005.53257.x

Vogel, T., Brechat, P. H., Lepretre, P. M., Kaltenbach, G., Berthel, M., & Lonsdorfer, J. (2009). Health benefits of physical activity in older patients: a review. Int J Clin Pract, 63(2), 303-320. https://doi.org/10.1111/j.1742-1241.2008.01957.x

Westhoff, M., Stemmerik, L., & Boshuizen, H. (2000). Effects of a low-intensity strength training program on knee-extensor strength and functional ability of frail older people. JAPA(8), 325-342.

WHO. (2006). World Health Organisation "BMI Classifications" http://www.who.int/bmi/index.jsp?introPage=intro_3.htm

Wilk, K. (1991). Isokinetic Testing – Setup and Positioning. In Biodex System II Manual, Applications/Operations Biodex Medical System, Inc, New York, USA.

Zamboni, M., Mazzali, G., Zoico, E., Harris, T. B., Meigs, J. B., Di Francesco, V., . . . Bosello, O. (2005). Health consequences of obesity in the elderly: a review of four unresolved questions. Int J Obes (Lond), 29(9), 1011-1029. https://doi.org/10.1038/sj.ijo.0803005

