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Evaluation of Some Physical and Health Parameters in a Local Physical Activity Program for Seniors

Paulo Infante[a] Gonçalo Jacinto[a] Anabela Afonso[a] José Conde[b] Teresa Engana[b] Jorge Vicente[b] Pedro Silva[b] Ana Carla Coelho[c] Paula Costa[c]

[a]Departamento de Matemática/ECT e Centro de Investigação em Matemática e Aplicações /IIFA, Universidade de Évora, Évora, Portugal; [b]Divisão da Juventude e Desporto, Câmara Municipal de Évora, Évora, Portugal; [c]Administração Regional de Saúde do Alentejo, Évora, Portugal

Keywords
Active ageing · Physical activity · Physical exercise · Physical fitness

Abstract
Background: About 1/5 of the population of Évora Municipality in Portugal is aged 65 and over, and there has been a continued deterioration in the ageing index (159 in 2016). Évora City Hall offers the Active Seniors program which aims to promote physical activity and healthy lifestyles among older adults (at least 55 years). This study aims to evaluate the effect on some physical and medical parameters of the participants in this program within a period of 6–12 months, showing why it is worthwhile for the municipalities to elect this type of programs. ***Methods:*** A 1-year follow-up of three groups of seniors was conducted that covered participants enrolled for the first time in the Active Seniors program and individuals who had participated in the Active Seniors program in previous years and who would maintain or increase the number of sessions per week. Participants self-reported sociodemographic and past health information and were submitted to medical tests, and anthropometric and physical evaluations. Differences in medical and physical parameters were evaluated using analysis of covariance and mixed models. ***Results:*** In just 6 months, seniors who participated in the Active Seniors program for the first time improved several medical tests results and improved their performance in physical fitness tests (all $p < 0.05$). The increase in the number of sessions per week decreased the systolic blood pressure values after only 6 months ($p < 0.001$) and improved the physical fitness tests over 12 months ($p < 0.05$). ***Conclusions:*** The Active Seniors program is an effective way to improve the health and physical fitness of older adults. The continuation of the program, with or without the increase in the number of weekly sessions, allows controlling the medical parameters and increasing the functional fitness of the participants.

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Paulo Infante
Departamento de Matemática/ECT e Centro de Investigação em Matemática e Aplicações/IIFA da Universidade de Évora, Colégio Luís Verney
Rua Romão Ramalho, 59
PT–7000-671 Évora (Portugal)
E-Mail pinfante@uevora.pt

Avaliação de alguns parâmetros físicos e de saúde num programa autárquico de atividade física para seniores

Palavras chave
Aptidão física · Atividade física · Envelhecimento ativo · Exercício físico

Resumo
Contexto: No concelho de Évora cerca de 1/5 da população tem 65 ou mais anos e tem-se assistido a um agravamento continuado no índice de envelhecimento (159 em 2016). A Câmara Municipal de Évora oferece o programa Seniores Ativos que visa promover a atividade física e estilos de vida saudáveis junto dos adultos com pelo menos 55 anos. Este estudo visa avaliar o efeito em alguns parâmetros físicos e médicos com a participação neste programa ao longo de 6 e 12 meses, procurando também mostrar que vale a pena que os municípios apostem nesse tipo de programas. ***Métodos:*** Durante 12 meses foram seguidos três grupos de adultos, com 55 ou mais anos, que abrangiam indivíduos que participavam pela primeira vez neste programa e indivíduos que já participavam no programa Seniores Ativos em anos anteriores e que iriam manter ou aumentar o número de sessões por semana. Os participantes forneceram informações sociodemográficas e do seu estado de saúde, e foram submetidos a exames médicos e a avaliações antropométricas e físicas. As diferenças nos parâmetros médicos e físicos foram avaliadas usando testes paramétricos e não paramétricos, análise de covariância e modelos mistos. ***Resultados:*** Em apenas 6 meses, os seniores que participaram pela primeira vez no programa Seniores Ativos melhoraram os resultados dos seus testes médicos e melhoraram o seu desempenho em todos os testes de aptidão física (todos $p < 0.05$). O aumento do número de sessões por semana originou uma diminuição do valor da pressão sanguínea sistólica em apenas 6 meses ($p < 0.001$) e uma melhoria nos resultados dos testes de aptidão física ao longo dos 12 meses ($p < 0.05$). ***Conclusões:*** O programa Seniores Ativos é um meio eficaz para melhorar a saúde e a aptidão física dos idosos. A permanência no programa, com ou sem aumento no número de sessões semanais, permite controlar os parâmetros médicos e melhorar a aptidão funcional dos participantes.

Introduction

The World Health Organization (WHO) recognizes the importance of physical activity (PA) in physical, mental, and social health and states that intervention policies are necessary to promote the practice of PA in all age and social groups [1]. The regular practice of PA is effective in preventing various coronary diseases, like type 2 diabetes, cancer, hypertension, obesity, depression, osteoporosis, and premature death [2]. Recent evidence suggests that physically active people have a reduced risk of dementia [3] and cognitive decline [4]. PA promotes well-being, increases social interaction and quality of life for individuals who practice it, contributes to environmental sustainability and provides benefits to society [5, 6]. The promotion of PA programs would not only contribute to reduce population morbidity and the costs associated with chronic diseases health care. It is therefore not surprising that the WHO states that PA is one of the main factors to consider for an active and life quality ageing.

In today's society, the increase in the number of elderly people is a positive sign of development. However, it entails a significant increase in the costs for health and social services [7]. PA is important for the elderly increasing and maintaining the quality of life and independence, improving strength, balance, coordination, flexibility, endurance, mental health, motor control and cognitive function. It also helps to prevent falls [8] (the greatest cause of disability among the elderly population). In the social context, walking and organized physical exercise sessions allow social interaction and reduce loneliness and social exclusion [9].

In Portugal, there are several PA programs developed by the local government for elderly people; however, none measures the efficiency of those programs in the health and life quality of the participants [10]. We must point out that it is not our intention to measure the dose-response obtained with a certain physical load. It is a case study of a municipal initiative, not individualized training and/or laboratory testing, where the results could be different given greater control over experimental units and conditions. The Active Seniors (AS) program is developed by Évora City Hall, being a free program, whose main objectives are to improve, develop, meliorate, acquire and maintain active lifestyles in the elderly. According to 2011 Portugal Census, about 1/5 of the population of the municipality of Évora is aged 65 and over; for every 100 young people under the age of 15 there are 138 elderly people aged 65 and over (ageing index). For every 100 elderly people aged 75 and over there are 108 elderly

people aged 65 to 74 (longevity index). In 2016, a deterioration was observed in all these indicators. The total population decreased 5%, the population of elderly aged 65 and over increased to 22%, the ageing index increased to 159, and the longevity index decreased to 103.

During the European Year of Active Ageing and Solidarity between Generations, in 2012, the Évora City Hall, in partnership with the Évora University (through the Research Centre for Mathematics and Applications – CIMA), carried out a study about the physical, psychological and social aspects of the AS program. In this paper, we present the results of this study regarding some medical and physical parameters, at the beginning of the study and after 6 and 12 months of follow-up, in adults with 55 or more years. The study was carried out between December of 2012 and February 2014.

We analyze some health and physical parameters of the participants in AS program over a 1-year follow-up. The specific goals are to analyze which changes on several medical (weight, body mass index [BMI], abdominal perimeter, HDL, LDL, non-HDL, diastolic BP, systolic BP, triglycerides) and physical (strength of the upper and lower body, aerobic fitness, agility/dynamic balance, and flexibility of the upper and lower body) parameters are obtained: (1) just after 6 months of participation; (2) after 12 months of participation; (3) with the increase in the frequency of participation per week. This study aimed to understand the impact of the AS program on some aspects of the quality of life of the participants and to serve as a tool to draw some conclusions for the future of these programs.

Methods

The AS Program

The AS program was created in 2005 by Évora City Hall with the partnership of some local Social Institutions. The main objectives of the AS program are to promote PA and healthy lifestyles, mobilize the sedentary population by integrating the PA into daily routines and increase awareness about health, social and economic benefits of PA practice.

It is a 1-year program of one weekly PA session of 1 h for the population over 55 years old. The AS sessions are of low to moderate intensity and in some cases very low. The activities are developed by physical education teachers and take place in the green spaces of the city (maintenance circuits, nature trail, public garden), in the facilities of the partners and in the municipal pool. Some sessions are held at home, with elderly people institutionalized in both urban and rural areas.

The classes are varied and suitable both to the mobility of each one, and to particular conditions of diseases and limitations. The resources available to SA are limited and consider their limitations on sessions. The exercises aim to improve/maintain the physical condition, slow down typical losses of aging, maintaining the safety of the elderly.

During 2013 and 2014, 21 institutions and a total of 442 participants were enrolled in the program.

Participants

For this study, the target population aged 55 years or over lived in the municipality of Évora at the time of the study. Two types of requests for participation were disclosed:

1 One application was addressed to individuals, not participating in the AS program, and who wanted to join the AS program.
2 The second request was addressed to the group of current AS program participants who desired to maintain or increase the current weekly frequency of PA. Since there was some prior knowledge about the health status of this group of participants and their availability, the request to increase the frequency of the practice was directed at individuals who were known to be able to do so.

To integrate this study, all volunteers agreed to test their physical and medical parameters at the beginning of the study and 6 and 12 months later. Due to budget restrictions, 12 months after the beginning of the study only physical parameters were evaluated. All of them signed a free consent term and were required to attend at least 75% of classes. It was an observational study.

The final sample of 80 participants compromises a non-probabilistic convenience sample and was divided into 3 groups:

1 Beginners: 15 adults who will participate in the AS program for the first time at the beginning of the study, with a weekly frequency equal to that of the default group;
2 1× Active: 37 members of the AS program who maintained the current frequency of once a week;
3 3× Active: 28 members of the AS program who volunteered to increase the frequency of PA to three times a week.

Measures

At the beginning of the study (December 2012), the participants answered a questionnaire about several demographic, social, and health status characteristics, such as sex, age, occupation, presence of some diseases, and consumption of medicines. Participants were submitted to anthropometric evaluation, and blood tests to measure systolic and diastolic blood pressure, cholesterol (HDL, LHL, non-HDL), and triglycerides. For all participants, the blood samples were obtained before the physical tests. The blood tests and the anthropometric evaluation were carried out by the nursing team from Regional Health Administration of Alentejo. To assess the functional fitness performance, the participants underwent the battery Senior Fitness Tests (SFT) [11] at the beginning of the study and 6 months later (June 2013).

The SFT includes measures of strength (upper and lower body), aerobic fitness, agility/dynamic balance, and flexibility (upper and lower body). Four of the six tests in the SFT involve body movement measurements, which include arm-curl test (to do as many arm curls as possible in 30 s) and 30-s chair-stand test (stand up and sit on a chair for 30 s) to measure strength, 6-min walk test (distance walked for 6 min) for aerobic fitness, and 8-ft up-and-go test (time necessary to get up from a chair, walk 2.44 meters and return to the initial position) to measure agility/dynamic balance. The other two tests are the back scratch test (minimum distance reached with hands behind back) and the chair sit-and-reach test

Table 1. Summary statistics for age (mean ± standard deviation) and number of reported diseases (prevalence by category), per group, measured at baseline

Variable	Category	Beginners (n = 15)	1× Active (n = 37)	3× Active (n = 28)	p
Age		69.7±5.8	70.8±7.2	68.8±6.1	0.480[a]
Number of reported diseases	0–1	20.0%	21.6%	25.0%	0.696[b]
	2–3	26.7%	32.4%	42.9%	
	4 and more	53.3%	45.9%	32.1%	

[a] ANOVA. [b] χ^2 test.

(distance from the hands to the tips of the feet) to measure flexibility. The normative standards of the SFT for senior age groups of American men and women ranging from 60 to 94 years of age are described in Rikli and Jones [11]. Similar normative values have been reported for a Portuguese sample of healthy elderly people ranging from 65 to 103 years age [12].

The AS sessions are of low to moderate intensity. The classes are varied and suitable both to the mobility of each participant, and to particular conditions of diseases and limitations. They are composed of dances and games, with balance, strength, flexibility, aerobic work, coordination, skills, and concentration exercises. The sessions have an initial warming-up, followed by the main exercises, and ending in relaxing and stretching exercises.

About 1 year after the beginning of this study (February 2014) only some participants repeated the SFT, since some participants were unable to be present on the day the physical evaluation tests were performed. Therefore, the sample size was 80 participants at the beginning of the study and 6 months later, but only 23 a year later (6 from the Beginners group, 11 from 1× Active group and 6 from 3× Active group).

Statistical Analysis

Analysis of variance (ANOVA), followed by Tukey-Kramer multiple comparisons test, was used to test for differences in age and BMI% between groups. The χ^2 test was used to evaluate differences between groups for the number of reported diseases.

A longitudinal study was carried out to understand the benefits for participating in the AS program for 6 months. For each group, paired Student t tests were used to examine differences of means in medical and physical fitness results between the beginning of the study (baseline) and 6 months after. Under the violation of the assumption of normal distribution in the sample differences, instead of the Student t tests Wilcoxon's paired tests were used, if it was possible to assume the symmetry of the distribution, or the signal tests otherwise. An analysis of covariance (ANCOVA) was applied to all medical and physical fitness variables to compare those groups that actually performed PA in the study period (Beginners, 1× Active and 3× Active), adjusting for the values obtained at baseline (first measurement). With this approach, it is possible to compare differences between groups after 6 months in the medical parameters and in the level of performance of the SFT. ANCOVA is the best statistical model to analyze the data and compare the groups with each other, when we have two measurement points with groups that cannot be considered completely randomized [13]. The assumptions of ANCOVA were verified, i.e. the homogeneity of regression slopes, the non-dependence between the group and the result of the first measurement, the normality of the errors, the homogeneity of the variances in the different groups and the linearity between the response and covariate variables. When the assumption of normality was not validated and a suitable transformation could not be found, a non-parametric ANCOVA was performed [14]. For tests where the group factor was found to be significant, multiple comparisons were performed to compare each level with the previous one, that is, the Beginners group was compared with the 1× Active group, and this last group was also compared with the 3× Active group.

For the analysis of the physical fitness after 12 months of participation in this study, that is including the third measurement, we used the linear mixed-effect models (LMM) [15, 16]. At this last moment of measurement, the follow-up group of 80 participants were reduced to 23. The reduction of the number of observations was due to the fact that after 12 months some participants did not fulfil the requirements imposed to participate in the study, and others were unable to be present on the day the physical evaluation tests were performed. Therefore, for the 12-month analysis we have a much smaller sample than the one that was used in the 6-month analysis. This was one of the main reasons for using LMM, since they prevent listwise deletion due to missing data. In addition, the design is unbalanced, and the measurements were not equally spaced (although for the sake of simplifying in the description of the results, it was considered that the measurements were equally spaced). Finally, in this case study we have repeated measures and LMM allow to consider the dependence and correlation structure of the errors. The model used to estimate the effects of each physical variable had one fixed effect (group variable) with tree levels, individuals were used as random effects, and the first measurement was used as a covariate. Only the ordinate was considered for each individual (allowing to control for the performance difference of each individual), since only 3 observations were available at the time [17]. The assumptions underlying each model, namely the normality and homoscedasticity of the errors, the normality of the random effects and MCAR assumptions were validated for all parameters analyzed. It should be noted that the LMMs were not used with the 80 individuals of the initial sample because the underlying assumptions could not be verified. The estimation of fixed effects and components of variance was done by the maximum penalized

Table 2. Number of observations (*n*) and mean ± standard deviation of some medical and physical parameters, per group, measured at baseline and after 6 months

Characteristic	Beginners (*n* = 15)			1× Active (*n* = 37)			3× Active (*n* = 28)		
	baseline	6 months	*p*	baseline	6 months	*p*	baseline	6 months	*p*
Weight, kg	76.9±14.5	73.9±15.4	<0.001[c]	67.0±10.4	65.6±11.1	0.006[c]	69.0±10.2	69.0±10.7	0.092[c]
BMI, %	24.4±4.2	23.6±4.3	<0.001[c]	21.8±3.1	21.3±3.3	0.006[c]	21.9±2.8	21.9±3.0	0.092[c]
Abdominal perimeter, cm	103.4±10.9	98.5±12.1	0.015[b]	94.0±11.5	93.2±10.5	0.184[b]	96.2±11.1	94.9±10.2	0.228[a]
HDL, mg/dL	54.7±9.0	51.1±8.4	0.006[a]	52.5±12.3	48.4±12.3	0.011[b]	50.8±11.8	50.6±12.5	0.460[a]
LDL, mg/dL	101.5±23.0	102.9±30.6	0.151[c]	109.3±30.4	105.1±30.6	0.237[a]	99.2±23.8	91.7±27.0	0.086[a]
Non-HDL, mg/dL	124.0±33.0	123.0±31.1	0.001[c]	138.0±27.5	135.0±29.6	0.341[a]	130.0±26.7	125.0±25.3	0.147[a]
Diastolic BP, mmHg	71.2±13.5	72.1±8.2	0.377[a]	75.2±10.6	73.9±8.9	0.250[a]	72.9±8.3	74.4±12.0	0.727[a]
Systolic BP, mm Hg	137.7±21.6	128.3±12.3	0.005[c]	141.9±19.4	129.7±17.2	<0.001[a]	142.1±14.7	129.8±18.1	<0.001[a]
Triglycerides, mg/dL	127.0±33.3	132.0±41.4	0.018[c]	160.0±101.9	172.0±118.2	0.250[c]	150.0±75.5	157.0±70.3	0.679[a]
Arm curl, repetitions	17.4±3.9	19.9±3.5	<0.001[a]	19.6±4.7	22.9±4.4	<0.001[a]	19.5±3.8	25.3±4.2	<0.001[a]
30-s chair stand, stands	15.1±3.2	16.7±2.7	<0.001[a]	15.5±3.3	17.7±3.3	<0.001[a]	17.4±3.2	18.7±3.7	0.011[a]
6-min walk, m	535±70	611±78	<0.001[a]	546±66	584±100	<0.004[c]	589±58	678±84	<0.001[a]
8-ft up-and-go, s	6.4±1.3	6.0±1.4	0.001[c]	5.9±1.0	5.8±0.9	0.033[c]	5.1±0.9	5.0±0.9	0.092[c]
Back scratch, cm ±	−17.8±12.3	−10.0±10.0	<0.001[a]	−12.8±10.7	−8.2±9.2	<0.001[a]	−9.7±10.0	−8.5±9.2	0.004[c]
Chair sit-and-reach, cm ±	3.1±6.1	9.0±8.1	<0.006[a]	5.4±6.7	10.5±8.8	<0.001[a]	1.5±11.8	8.4±11.9	<0.001[a]

[a] Student *t* test. [b] Wilcoxon test. [c] Signs test.

likelihood method. When the fixed-effect factors were significant, Tukey's multiple comparison test was applied to find out the significant differences.

All statistical analyses were carried out using R software, and a statistical significance level was assumed at 5%.

Results

Group Characterization

The percentage of females was higher than that of males in all groups: Beginners (67%), 1× Active (86%), and 3× Active (68%) groups. The age of the participants varied between 55 and 90 years of age (Table 1). The Beginners group was the one with less variability in ages, while the 1× Active group has the highest variability. In the 1× Active group, 1 in 4 participants was over 75 years old. There was no significant difference between groups regarding mean age of the participants ($p = 0.48$). One in 3 participants in the Beginners and 3× Active groups indicated that they had practiced PA in the last 6 months outside the AS program. In the other group, the percentage was lower. More than 90% of the participants reported taking medications. More than half (53%) of the Beginners group were medicated for at least 4 different diseases (Table 1). There was no significant difference between groups regarding the number of reported diseases ($p = 0.70$).

From results presented in Table 2, we can observe that at baseline, participants from all groups had normal HDL values (40–59 mg/dL). Members of the 3× Active group had optimal mean levels of blood concentration of bad cholesterol (LDL <100 mg/dL), and the remaining groups had near optimal mean levels (101–130 mg/dL). All groups presented normal mean results of diastolic blood pressure (<85 mm Hg). Groups 1× Active and 3× Active started with a mean value of systolic blood pressure at the first stage of hypertension (140–159 mm Hg). Only the Beginners group had desirable mean results of triglycerides (<150 mg/dL), while the other groups had high mean values (>150 mg/dL).

Participants had a normal BMI (values in the range 18.5≤ BMI% <24.9); however, participants in the Beginners group presented values that were less similar to each other (Table 2). There was a significant difference in BMI% between groups ($p = 0.03$). The average BMI in the Beginners group was significantly higher than in the 1× Active group ($p = 0.03$). In the Beginners and 1× Active groups, there were participants with moderate obesity (30≤ BMI% <35), but in all groups around 90% of the participants presented an increased metabolic risk (abdominal perimeter >94 for men and >80 for women). About 5% of participants in the 1× Active and 11% in the 3× Active groups were underweight (BMI% <18.5). The reference values for BMI and abdominal perimeter can be found in WHO [18].

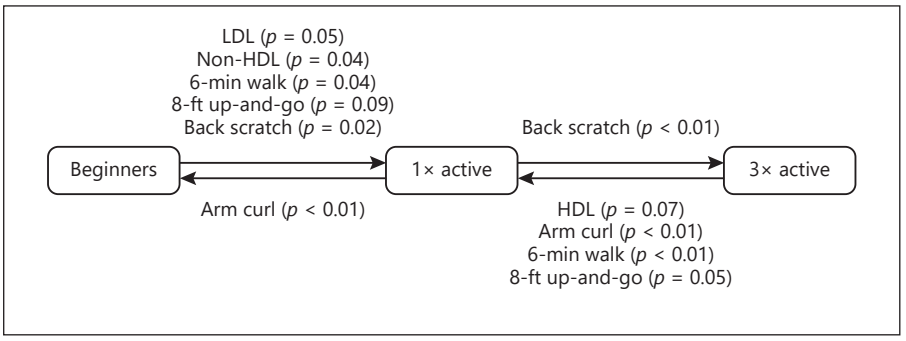

Fig. 1. Results of the multiple comparisons that were significant in medical and physical tests based on ANCOVA models (the group with the best result is associated with the origin of the arrow). Marginal significance differences ($p < 0.1$) were also reported.

The most regular scores in all SFT tests were achieved by the participants already engaged in the AS program, i.e. 1× Active and 3× Active groups (Table 2). The Beginners group presented a lower performance in the 6-min walk and back scratch tests.

Health and Physical Fitness Benefits after 6 Months of Participation in the AS Program

Differences within Groups

In the longitudinal analysis, we observed that some significant changes occurred in medical and physical fitness tests within the groups after 6 months of participation in the AS program (Table 2).

None of the groups significantly reduced the diastolic blood pressure, but all decreased their systolic blood pressure. The participants in the Beginners group significantly reduced the other medical parameters except the LDL and reduced significantly the weight, BMI and the abdominal perimeter. The 1× Active group decreased significantly their weight, BMI, HDL, and systolic BP. The 3× Active group had a marginal significant reduction in weight, BMI, and LDL values and a significant reduction in systolic BP.

The Beginners, 1× Active, and 3× Active groups got better scores in all SFT tests; however, the results in 8-ft up-and-go test for the 3× Active group were marginally significant.

Differences between Groups

With ANCOVA, significant differences were found between groups in some medical and physical fitness parameters after 6 months, adjusting to baseline values as covariates. Comparing participants with equal values at baseline, the mean values of non-HDL and LDL after 6 months were significantly lower in the Beginners group than in the 1× Active group. After 6 months, the values of LDL were (marginally significative) lower, in mean, in the 3× Active group in comparison to the 1× Active group, when comparing participants with the same LDL values at baseline (Fig. 1).

Regarding the physical variables, when comparing participants in equal circumstances at baseline, the group that increased the frequency of PA (3× Active) achieved better mean performance than the group that maintained the frequency of the PA (1× Active) in the aerobic fitness, upper body strength and agility/dynamic balance (Fig. 1). The Beginners group presented significantly better performances in the aerobic fitness and upper body (shoulder) flexibility than the 1× Active group, and also a marginal significant better performance in the agility/dynamic balance. It is interesting to note the strong effect of PA in only 6 months in the Beginners group. The 1× Active group had a better upper body flexibility after 6 months than the 3× Active group and a higher upper body strength than the Beginners group. In the lower body strength and flexibility tests, no differences were detected between any of the groups, while there were differences in the three groups regarding upper body flexibility.

Physical Fitness after 12 Months of Participation in the AS Program

Table 3 presents the summary statistics of the physical tests at baseline and after 6 and 12 months of participation in the AS program.

All sociodemographic characteristics of participants were not significant in all adjusted LMM models (all $p > 0.05$), and therefore none of these variables were included in the final model. The interaction between group and the measurements of the variables was not statistically significant (all $p > 0.05$, i.e. the effect of the measurement does not depend on the group; neither does the effect of the group depend on the moment when the measurement was obtained. Only for the arm curl test were the results adjusted for the individual's age, since it was the only model where age was significant ($p = 0.04$). The variation associated with the random effects (individuals) is re-

Table 3. Number of observations (*n*) and mean ± standard deviation of physical tests, per group, at baseline and after 6 and 12 months

Test	Time	Beginners (*n* = 6)	1× Active (*n* = 11)	3× Active (*n* = 6)
Arm curl, repetitions	Baseline	12.8±3.5	14.6±2.7	17.7±1.9
	6 months	15.3±2.8	18.2±3.4	19.7±3.9
	12 months	16.2±5.8	15.7±5.0	21.2±4.6
30-s chair stand, stands	Baseline	7.0±2.0	6.0±1.0	4.9±0.7
	6 months	5.5±1.3	5.1±0.8	3.8±0.4
	12 months	5.6±1.7	4.7±0.8	3.8±0.6
6-min walk, m	Baseline	505.0±46.2	537.3±45.5	600.8±45.1
	6 months	586.7±52.0	567.7±140.3	705.8±79.5
	12 months	496.0±76.7	468.5±156.9	581.7±140.3
8-ft up-and-go, s	Baseline	14.3±3.3	17.9±3.6	19.0±1.3
	6 months	17.0±2.4	23.4±5.2	26.3±2.8
	12 months	17.8±6.4	20.6±3.3	22.3±2.9
Back scratch, cm ±	Baseline	–18.3±15.7	–11.8±11.8	–7.0±3.6
	6 months	–10.3±12.0	–7.1±10.0	–5.3±3.7
	12 months	–19.0±19.9	–8.3±7.1	–6.9±3.9
Chair sit-and-reach, cm ±	Baseline	–0.3±5.7	3.4±5.9	1.2±5.0
	6 months	5.2±6.8	8.8±8.4	10.0±6.0
	12 months	–0.8±10.3	10.3±12.1	3.2±13.7

sponsible for 15% (arm-curl test), 13% (30-s chair stand test), 53% (6-min walk test), 81% (8-ft up-and-go test), 82% (back scratch test), and 66% (chair sit-and-reach test) of the total variation.

No significant differences were found between groups in the performance of the tests that measure flexibility (back scratch and chair sit-and-reach). The 3× Active group had better scores than the Beginners and 1× Active groups in the tests 30-s chair stand ($p = 0.03$ and $p < 0.01$, respectively), 6-min walk ($p = 0.05$ and $p = 0.02$, respectively), and 8-ft up-and-go ($p < 0.01$ and $p = 0.04$, respectively). No differences were found between the groups 3× Active and 1× Active in the arm-curl test, but both performed better in this test than the Beginners group ($p < 0.01$ and $p < 0.01$, respectively).

The performance of the groups at 6 months was better in all tests than at baseline, but the same was not observed at the end of 12 months. After 12 months, the performance was no better than at 6 months but was better than at baseline in the tests: arm curl ($p < 0.01$), 30-s chair stand ($p = 0.05$), 8-ft up-and-go test ($p < 0.01$), and chair sit-and-reach ($p < 0.01$). After 12 months, the performance decreased when compared with 6 months in the tests: 6-min walk ($p < 0.01$) and back scratch ($p = 0.02$). In this last test, no differences were found in the scores of the groups at baseline and after 12 months.

Discussion

This study aimed to examine for the first time the effects of the AS program on the health and physical fitness of its participants. This is a PA program for elderly people offered in Évora, Portugal, whose main objectives are to promote health and improve physical function. PA promotion is one of the most difficult and important tasks in lifestyle change, as society is becoming increasingly successful in reducing our need to move [19].

In an 8-year follow-up, it was demonstrated that participants who became active during the follow-up period had significant health benefits even if they started relatively late in life [20]. For older people, adequate aerobic exercise is associated with a 1- to 2-year increase in life expectancy, as well as improved functional independence, even in people who became physically active as late as age 60 years [21]. We have observed the same as reported by these authors, since only 6 months after initiating regular PA in the AS program several improvements were observed, both in medical parameters and in the fitness tests.

Participants who started their regular participation in the AS program improved all scores on physical fitness tests only 6 months after PA introduction. In the medical tests, there were no significant improvements in HDL

and diastolic blood pressure, two values that showed no improvement in either group. When we compare the performance of this group with the participants that had already been practicing regular PA, considering equal values at baseline, it was concluded that there was a significant reduction of bad cholesterol and an increase in the flexibility of the upper body. The participants already engaged in the AS program did not change most of the medical parameters, which contributed to the fact that their health status did not continue to deteriorate (active ageing). Increasing the frequency per week of PA (i.e., number of sessions per week) leads to the control of good cholesterol and improves the flexibility and strength of the upper body as well aerobic fitness and agility. PA can be seen as a therapeutic complement, for hypertension, for glycaemia and for psychological diseases (depression, anxiety).

In previous studies, it was shown that participants who became physically active were more likely to be healthy than those who remain inactive [20]. It was also seen in other studies that the effect of PA on HDL levels varies among exercise intervention studies [22]. It seems that there exists a minimum exercise volume to obtain a significant increase in HDL level. Considering the short reduction in blood pressure with endurance and strength training, it is noteworthy that exercise is a great therapeutic complement, even having an impact on the natural history of hypertension [22]. Our results go exactly in this direction. Just after 6 months of PA in the AS program, we observed that the group that regularly initiated PA (Beginners group) improved the medical results in terms of LDL and non-HDL values when compared to their baseline values, but also when compared to the group that maintained their regular participation in the AS program (1× Active group).

Regarding the physical parameters, existing studies observed a reduction in performance with increasing age [12]. Lower levels of aerobic resistance, flexibility, and strength increase the risk of fall, increase the severity of injury, and limit the functional ability of this age group [23]. In our study, we observed a marked improvement in endurance and agility in those who started or increased the frequency of participation in the AS program for 6 months. The results indicate that the introduction of regular PA in the participants' lives allows them to have the values of the physical tests identical or superior to those relatively younger (active ageing), which allows them to achieve the same or greater functionality and autonomy. The participants that have initiated regular PA in the AS program, saw their performance after 12 months become significantly better than at baseline in the arm curl, 30-s chair stand, 8-ft up-and-go, and chair sit-and-reach physical tests. However, this group had no difference in performance when comparing the results at 12 and 6 months. This result may be related to one of the following situations: (1) after 6 months, they reach their best performance; if they stopped PA after 6 months, maybe they would not be able to maintain their performance after 12 months; or (2) the AS program is interrupted in July and August; however, despite this 2-month interruption, the participants were able to maintain their performance if they remained engaged in the AS program, i.e. with the practice of PA. Their state of health stabilized avoiding the deterioration of their quality of life.

These results should not be seen only in a perspective of differences, or not, in performances between groups or longitudinally. Due to the advanced age of individuals, often the nonexistence of differences translates into a slowing down of the loss of functions (active ageing).

This study has some limitations that should be considered. It is a case study of a municipal initiative, not individualized training and/or laboratory testing, where the results could be different given greater control over experimental units and conditions. The results cannot be generalized to all population. Some systematic errors may be present due to observers, individuals and instruments. Lastly, the design was unbalanced, sample units selected for convenience, and the first and second measurements were done by different evaluators.

Conclusion

There were improvements in the strength and flexibility of the upper body and aerobic fitness associated with the increasing frequency of PA in a 6-month period of participation in the AS program. After just 6 months of participation, the seniors who started regular participation improved most of the medical parameters, except HDL and diastolic blood pressure; the seniors who maintained the participation with the same frequency of participation reduced their body fat, HDL and systolic blood pressure and stabilized the other medical parameters, while the seniors who increased the frequency of PA controlled their good cholesterol.

These findings should carefully consider a scenario of active ageing. With the practice of PA, health and physical fitness of the participants improved or stabilized, which avoids the deterioration of their quality of life.

The inclusion in this program has increased with the years, and further studies are needed to better understand its effects on health and physical fitness. Albeit the limitations, this study found that the participation in the AS program allows to improve or control the medical parameters and increase the functional fitness of the participants.

On the other hand, we believe that this study stimulates local debate, which is otherwise nonexistent or scarce, and increases the knowledge of the local reality. The efficiency of this program was evaluated by the results obtained. Without this program, everything would be different for these people. This program helps to keep these people active, non-dependent, non-lonely, and motivated for something that gives them a better quality of life (both physically and psychically). Therefore, even with so many limitations, it is worthwhile the municipalities elect this type of programs.

Further studies should assess the effectiveness of these programs in reducing health costs.

Statement of Ethics

This research had the concordance of CME (Câmara Municipal de Évora) and ACES (Agrupameto de Centros de Saúde do Alentejo Central). Informed consent of each participant was obtained. All the participants participated in our study voluntarily and after their consent. We respected the confidentiality and anonymity of our participants. All clinical investigations were conducted according to the principles expressed in the Declaration of Helsinki.

Disclosure Statement

The authors declare that they have no competing interests.

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