FINAL REPORT

"PHYSICAL FITNESS AND COGNITIVE PERFORMANCE OF THE ELDERLY - COMPETITION AS AN ADDITIONAL MOTIVATION FOR PROMOTING AN ACTIVE LIFESTYLE"

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1. Introduction

Physical inactivity, as a behavior risk factor, is regarded as the greatest public health problem of the 21st century, because of its high prevalence in the world population and associated problems [1]. The negative effect of a sedentary lifestyle has been associated with an increased risk of morbidity, cardiovascular disease, congestive heart failure (CHF), stroke, osteoporosis, obesity, type 2 diabetes, some types of cancer and hypertension [2]. Such context led the World Health Organization (WHO) [3] in 2014 to set, within the 9 global non-communicable diseases, targets for the year 2025, from which two were related to physical activity - the reduction of 25% in premature mortality from cardiovascular diseases, cancers, and diabetes by 2025; a 10% relative reduction in the prevalence of insufficient physical activity.

Frailty syndrome is an age-associated condition that is characterized by decreases in the functional reserve and resistance to stressors, related to different physiological systems. This syndrome is strongly associated with sarcopenia and puts older individuals at special risk for disability, hospitalization, and death induced by falls [4-6]. Along with sarcopenia, skeletal muscle fat infiltration, which is assessed through muscle tissue attenuation, it is associated with an increased risk of reduced mobility, in both older men and women [7]. Frailty also increases with age and is associated with disease and disability and can be identified by the presence of three or more of the following criteria: unintentional weight loss, weakness, slow walking speed, low physical activity, and exhaustion [8].

Another issue is the body composition changes overtime, which is an important hallmark of the ageing process, namely the consequences of the central obesity incidence and body fat accumulation [9, 10]. This subject has transverse effects in functional capacity, muscle mass, muscle strength, disabilities in activities of daily living and impaired quality of life in elderly population [11 - 14]. Furthermore, the excess of weight has been associated to increased mortality [13, 15, 16]. However, among older adults, higher BMI levels appear to have no association with higher mortality or even to provide some survival advantage, when compared to low Body Mass Index (BMI) levels [17]. Using BMI as a risk factor to health, evidence showed some mortality protection among the BMI range of 25–30 kg/m^2 (overweight), in elderly population [13, 15]. This trend of some protection of the

"weight" in later life is part of the complex 'obesity paradox' characterization [17]. Further data is needed among this populations to clarify this kind of associations, namely regarding the body composition, strength and mortality rates, in elderly populations.

In line to the previously described, consistent scientific data described the significant role of muscle strength on functional activities, of the elderly daily routines, having a huge impact on another health determinants [13]. Muscle strength, estimated via the handgrip test, is an independent determinant of mortality, highlighting the strength exercise exposure, in addition to the cardiorespiratory activities [18, 19].

In another field of study, exercising and performance are associated with inflammatory biomarkers [20]. The data from these authors suggest that reduced inflammation is associated with an increased physical fitness performance and may be also associated with lesser degree of central obesity. Consistent associations were found between physical activity and performance, lower erythrocyte sedimentation rate, and lower plasma levels of fibrinogen, C-reactive protein, and interleukin [20].

Scientific literature has reported the benefits of adapted physical exercise in patients with poor health condition, demonstrating that a single session of aerobic exercise at an intensity of 50-100% of VO2 max. produces a lowering of 18-20 mm Hg in systolic and7-9 mm Hg in diastolic blood pressure [21]. Literature has also reported that physical activity intervention programs, aiming to develop physical capacities in aged people, have positive effects on function and autonomy [1, 21].

A vast array of randomized training studies has been performed to examine the increase in physical fitness in older adults and many others can be found in systematic reviews [22]. For example, resistance training has been shown to delay or reverse the negative effects of ageing on neuromuscular function. There have been studies that demonstrate an increased muscle strength in response to intensive strength exercise [23], combined strength and power exercise [24], functional exercises and Tai Chi [25]. A recent intervention mode, multicomponent training, has been investigated in aged people with evident benefits in muscular function [26, 27].

Since 1950, the physical activity epidemiology field showed an increased importance regarding scientific data that support the role of exercise as an independent determinant of health. As so, we have seen an evolution of the physical activity guidelines with

constant update recommendations regarding the different dimensions: frequency, intensity, time and type. This last one, the type of exercise, showed some variability on health positive effects, increasing the variability of options to meet the guidelines. As so, different strategies were needed to fit the large spectrum of recommendations to the daily routine of the individuals, contributing to a healthy aging [28].

In line to the previously described, sports practice is a simple way to population exercise, in recreation mode. Sport practice may promote variable exercise intensity, friendship, motivation and competition, in fair-play mode. However, little is known about intervention plans by using sport modalities in elders. Whether or not exercising on multi-sport base provide additional improvement on elders' health and life quality is not deeply investigated. Therefore, the project aimed to evaluate the health-related physical fitness, self-perception of health, and biological markers, in aged population. Also, by creating a dynamic database in a mixed design study (split-plot design) with a randomized assignment of participants, two experimental groups.

Specific objectives were defined, among the elderly participants, in five European countries:

- To assess the impact of an intervention plan base on sport competition in physical fitness and fitness and cognitive performance, and to analyze the association between variable, on the elderly;

- To investigate the impact of additional events such as "intergenerational games" on physical fitness status and healthy lifestyle, on aged population;

- Understand the motivation for systematic physical activity on aged population;

- To create intergenerational links for social inclusion;

- To drive and contribute to the development of more effective health promotion policies and strategies.

2. Methods

The research was developed in five European countries – Portugal, Italy, Spain, Bulgaria and Hungary- throughout 3 years (follow-up). A short-term course aiming to explain the main goals of the study and to standardize procedures to implement the assessment battery was performed prior the implementation of the project.

Four moments of assessment were designed: March/April 2018, September/October 2018, March/April 2019, September/October 2019. A multidisciplinary team was engaged in order to develop the participant's recruitment.

The timeline assessments were specific illustrated in figure 1.

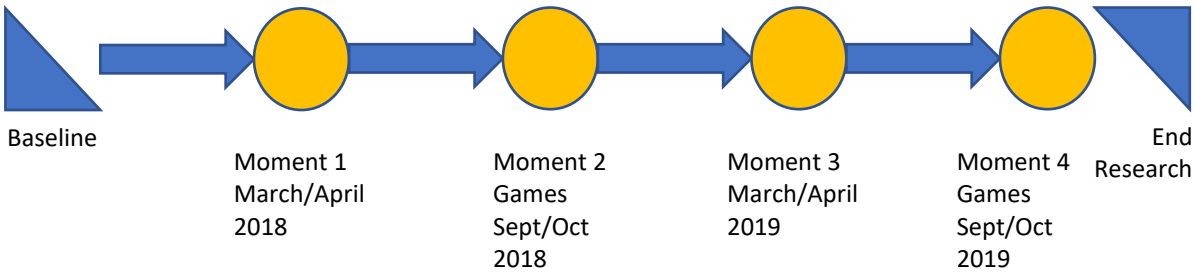


Figure 1 – Timeline of the four participants assessments

Participants

Elders from the 5 countries were recruited to participated on the project. Recruitment was performed on invitation base at social centers spread information on local health authorities. The cohort have 418 elders, being 305 females (72.9%), with a mean age of 70.63±6.75 years, height of 160.0±8.48 cm, weight of 73.49±12.50 Kg, BMI of 28.68±4.56 kg/m2). Sample sociodemographic and anthropometric characteristics are presented on Table 1 and Table 2.

As an experimental design, two groups were defined – Experimental Group (EG), a Control Group (CG). The EG undertake training prescription, twice a week, looking at the competition, named in the results section as "games" group; the CG was asked to maintain the regular daily routines, not enrolled in formal competition, named in this report as "nGames", no games group. Participants volunteered to participate on the

study and freely sign informed consent, according to national rules for human research and in line with Helsinki Declaration's ethical recommendations for studies in humans.

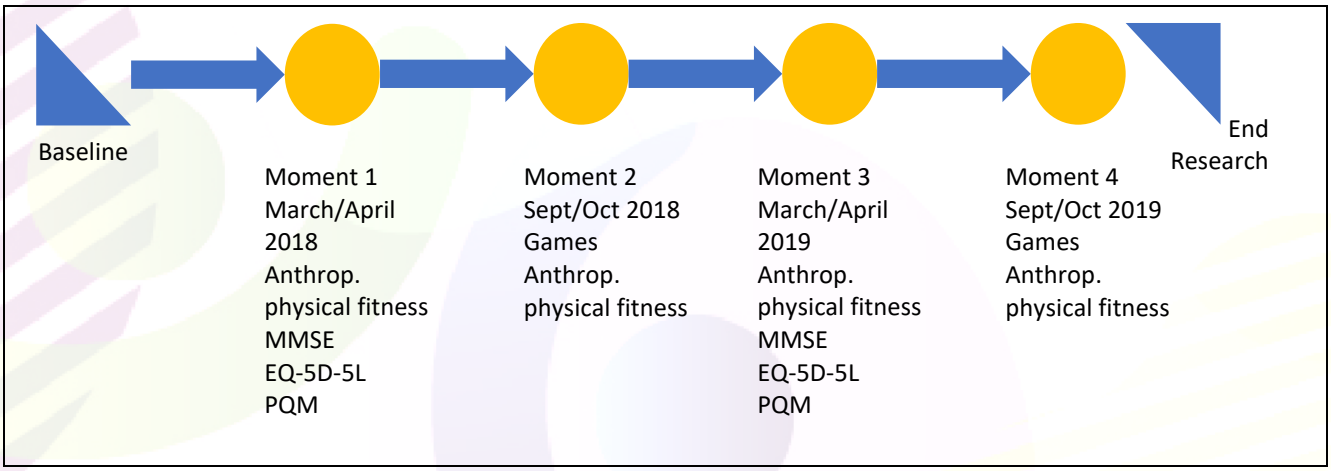
As inclusion criteria was defined: aged 65 years old and up; to present medical agreement for physical activity practice; availability to participate on Games event "Olympics4all"; and commitment with intervention plan.

2.1. Assessment

Prior the assessment sessions, the supervising team provide a short-term course to countries multidisciplinary teams (3 persons from Bulgaria, Hungary, Italy and Spain, each, and 18 from Portugal). The short-term course aimed to explain the main goals of the study and to standardize procedures to implement the assessment battery.

In this experimental study, assessment sessions were performed in an appropriate place available by the local the multidisciplinary team, under the supervision of researchers from the IPVC and Vigo University.

Participants were assessed on anthropometric measures, according to ISAK procedures 29 and physical fitness by the Rikli & Jones protocol 30, in all moments. The MiniMental State Examination [31], Participation Motivation Questionnaire [32, 33] and Questionnaire EQ-5D-5L [34] were assessed in moment 1 and 3 (for details, see Figure 2).



Note: Anthrop - anthropometric measures; physical fitness - Rikli & Jones protocol; MMSE - MiniMental State Examination; EQ-5D-5L - EQ-5D-5L questionnaire; PQM - Participation Motivation Questionnaire.

Figure 2 – Timeline of the four assessments and testing protocol

Data were collected by each country on appropriated excel file and organized in a single one for further analyzes.

2.2. Training Protocol

Subjects in the CG were asked to maintain their daily life routines. EG follow the prescribed intervention plan as training session took 90 minutes to complete, two sessions per week over 10 months (a total of 80 sessions, hours of training range from 232h to 304h), from March to July and September to March (2018 and 2019). Dimensions of exposure among EG were aerobic activities (40min), muscle strength (20min), body balance (10min), technical skill (10min) and stretching specific exercises (10 min).

The progression throughout the training program was monitored by the multidisciplinary team on appropriated excel file for further analyzes. Also, exercises training varied from single sport skill to dual tasks as reported in literature [26, 27].

As main target of the training plan, two competitions took place in the 5 countries involved in the project, on the following dates – September 2018 and September 2019. The competitions guidelines included selected sports (football, basketball, athletics and swimming) and country's traditional games (see Figure 2).

3. Results

The sample distribution by country and sex is presented on table 1.

Table 1- Distribution of the sample (N= 418) by country, gender and games participation, at baseline.

	N (%)	**Bulgaria**	**Hungary**	**Italy**	**Portugal**	**Spain***
	Female	64 (84.3)	43 (72.1)	94 (77.7)	53 (37.8)	51 (43.2)
	Male	12 (15.7)	12 (27.9)	27 (22.3)	33 (62.2)	29 (56.8%)
	Total	**76**	**55**	**121**	**86**	**80**
Games	Female	40	26	44	17	23
	Male	5	8	17	20	10
nGames	Female	24	17	50	36	28
	Male	7	4	10	13	19

Note: * Spain enrolled the study at moment 3

One hundred and forty-eight elders participate actively in the project. The prevalence of female was higher with exception of Portugal and Spain, and the dropout was 7.27%, with a range from 0% to 18.2%.

Sociodemographic and anthropometric characteristics of the participants, by country and sex, at baseline, are presented on Table 2.

Table 2- Sociodemographic and anthropometric characteristics of the sample by country and sex, at baseline.

		Age (yrs) mean±SD	Height (cm) mean±SD	Weight (Kg) mean±SD	BMI (kg/m^2) mean±SD	Academic Level		
						Primary School (%)	High School (%)	University (%)
Global	n = 418	70,63±6,75	160,00±8,48	73,49±12,50	28,68±4,56	-	-	-
	Female n= 305	70,20±6,78	157,27±6,71	71,59±12,52	28,93±4,85	-	-	-
	Male n=113	71,96±6,50	168,50±7,81	79,42±10,45	27,87±3,40	-	-	-
Bulgaria	Female n=64	70,83±5,55	157,43±5,81	75,54±10,66	30,58±4,79	-	62,5%	37,5%
	Male n=12	69,67±3,96	169,67±4,92	83,41±9,47	28,93±2,64	-	66,7%	33,3%
Hungary	Female n=43	66,58±5,44	160,91±7,39	75,19±12,88	29,05±4,61	-	58,1%	41,9%
	Male n=12	71,17±6,25	171,10±9,65	77,98±13,50	26,40±2,24	-	50,0%	50,0%
Italy	Female n=94	70,11±7,39	159,84±6,17	69,88±13,31	27,33±4,86	24,7%	29,6%	45,7%
	Male n=27	71,54±7,51	171,90±9,15	81,60±11,57	27,70±4,10	26,1%	34,8%	39,1%
Portugal	Female n=53	71,64±6,68	154,04±5,98	67,31±11,84	28,37±4,81	92,5%	7,5%	0,0%
	Male n=33	71,06±6,15	168,42±6,14	79,07±9,65	27,90±3,29	75,8%	18,2%	6,1%
Spain*	Female n=52	70,98±7,15	153,74±5,48	71,28±12,02	29,96±4,40	40,0%	50,0%	10,0%
	Male n=29	76,28±5,73	161,50±4,22	75,03±7,91	28,17±3,50	52,9%	35,3%	11,8%

Note: * Spain enrolled the study at moment 3

At baseline, the participants presented similar demographic and anthropometric characteristics, between countries. In the BMI, an excellent marker for health, female showed higher value than men. In relation to education, academic level, Portugal and Spain presented evident differences from the other countries. In fact, Bulgaria, Hungary and Italy showed high percent of participants with undergraduate level as education. Considering the age-group in study and the European economic-political context at their working-life time, the education, high education, may influence positively the approach to health-life style.

The intervention plan impact on participants was analyzed as the differences from moment 1, baseline, and moment 4, in the all group and by country. Also, to better understand the huge data information, results were presented as anthropometric variables, physical fitness variables and motivation for exercising. The intervention plan

related changes on anthropometric variables are presented on Table 3. Data analyzes was performed by experimental and control group.

Table 3- Participants' anthropometric assessment at baseline and after intervention plan, by group (Games group and non Games group).

	n = 418	Weight (Kg)	BMI (kg/m^2)	% FAT	Waist (W) circunf. (cm)	Hip (H) circunf (cm)	W:H ratio
Games	M1	74,13±12,91	28,71±4,61	33,68±8,28	93,72±11,46	106,20±11,58	,88±,09
	M4	72,83±11,82	27,90±4,12	31,08±8,48*	94,39±10,84	106,97±9,19	,93±,12*
nGames	M1	72,69±11,95	28,63±4,50	34,77±8,30	93,57±13,24	105,92±11,09	,88±,09
	M4	72,90±13,13	29,13±4,41	32,85±7,76	99,96±11,75*	105,28±18,24	1,18±1,45*

Note: Games – participants who enroll the training plan; nGames – participants who do not enroll the games; W:H ratio – waist to hip ratio; M1 – moment 1 as baseline; M4 – moment 4 as pos intervention assessment; * significance $p < 0.05$.

According to record values, participants who enroll the training plan significantly decrease the %fat (M1 =33,68±8,28, M4 31,08±8,48, $p < 0.05$) and increase the waist to hip ratio (M1 = ,88±,09, M4 =,93±,12, $p < 0.05$). Despite having a reduction in percent of fat, the distribution that may help indicate a person's overall health (waist to hip ratio) indicates significant increments, on Games group. However, the final score is still bellow the cut line as defined by World Health Organization [3]. Different situation can be found in nGames group. In fact, the group who not enroll the training plan increase significantly both the waist circumference (M1 = 93,57±13,24, M4 = 99,96±11,75, $p < 0.05$) and the Waist to Hip Ratio (M1 = ,88±,09, M4 = 1,18±1,45, $p < .05$), throughout the two years intervention plan. Both health markers reach important scores and may be at high risk on health condition.

The variations on anthropometric measures over the intervention time, by country, are presented on table 4.

Table 4 - Participants' anthropometric assessment at baseline and after intervention plan, by country and group (Games group and non Games group).

		n = 418	Weight (Kg)	BMI (kg/m^2)	% FAT	Waist (W) circunf. (cm)	Hip (H) circunf (cm)	W:H ratio
BU	Games	M1	76,05±12,08	30,07±4,96	38,84±6,20	96,95±10,51	112,52±11,28	,86±,06
		M4	74,45±11,21	29,31±4,52	35,93±6,03	94,44±10,21	111,53±10,47	,85±,06
	nGames	M1	77,86±8,80	28,63±4,50	37,43±7,31	98,35±11,29	114,35±7,73	,86±,07
		M4	76,12±12,20	29,13±4,41	38,20±7,57	97,56±16,25	114,00±12,25	,85±,08
HU	Games	M1	75,97±14,69	28,66±4,49	37,27±8,01	93,39±12,41	106,03±11,79	,88±,06
		M4	74,41±14,83	±	34,54±6,75	90,63±10,97	105,70±8,10	±
	nGames	M1	75,31±9,43	28,33±4,26	36,65±6,46	93,21±11,98	107,55±7,97	,87±,08
		M4	76,80±18,12	±	37,84±10,64	97,45±16,82	106,91±19,85	±
IT	Games	M1	75,29±14,15	27,88±4,80	29,24±7,98	91,82±12,22	107,39±13,82	,86±,09
		M4	70,76±11,73	26,39±3,76	27,30±8,06	93,00±11,82	106,36±9,18	,89±,10
	nGames	M1	69,51±12,86	26,90±4,54	29,64±7,06	88,59±13,29	104,48±10,20	,85±,08
		M4	71,47±10,75	26,37±3,11	27,89±5,39	99,22±9,30	108,83±7,65	,91±,06
PT	Games	M1	71,51±12,09	26,79±3,79	31,88±8,46	97,95±11,17	104,23±8,64	,94±,09
		M4	73,42±12,36	26,88±3,65	24,82±8,36	94,59±9,94	102,48±6,05	1,09±,08
	nGames	M1	72,05±12,76	29,24±4,35	38,51±8,57	99,18±10,35	105,39±8,66	,94±,08
		M4	55,30±!!!	21,30±!!!	25,70±!!!	73,00±!!!	99,00±!!!	1,36±!!!
SP	Games	M1	71,93±11,26	29,86±4,17	33,37±6,58	90,39±9,68	101,26±8,01	,89±,09
		M4	71,00±6,90	29,59±3,18	33,00±7,51	101,63±7,82	106,93±8,18	,95±,05
	nGames	M1	72,53±11,58	28,92±4,46	33,59±7,00	87,15±15,11	98,42±15,40	,89±,10
		M4	72,27±12,85	29,71±3,64	32,58±6,46	101,94±9,54	101,86±21,30	1,35±!!!

Note: BU – Bulgaria; Hu – Hungary; IT – Italy; PT – Portugal; SP – Spain. Games – participants who enroll the training plan; nGames – participants who do not enroll the games; W:H ratio – waist to hip ratio; M1 – moment 1 as baseline; M4 – moment 4 as pos intervention assessment.

As a consistent pattern, the group enrolled in the games, observed a decreased or a maintenance of the cardiovascular risk factors, as overall obesity and central obesity

determinants. On the other way, the participants not enrolled in the games, showed a slightly increase overtime.

The individual follow-up of the five countries shows a general trend in improving health markers, on Games group. In fact, the findings are particularly evident on Bulgaria, Hungary and Portugal, showing Spain a opposite trend. Furthermore, the nGames group presented a decrease-controlled variable. Together, decreases on nGames groups and stability or improvement on Games group, the final scores highlight the impact of the intervention plan of aged population life quality.

The intervention plan related changes on physical fitness variables are presented on table 5. Data analyzes was performed by experimental and control group.

Table 5- Participants' physical fitness assessment at baseline and after intervention plan, by group (Games group and non Games group).

	n = 418	Handgrip Right (Kg)	Handgrip Left (Kg)	Chair stand (reps)	6 min walking (m)	Chair sit & reach (cm)	Timed up & go (sec)	Back scratch (cm)
Games	M1	30,58±8,81	28,37±9,90	16,39±4,69	560,42±120,85	1,32±8,76	7,14±2,15	-9,69±12,91
	M4	31,24±8,91	29,21±8,96	18,44±4,98	612,86±79,57	3,13±9,13	6,09±1,39	-7,09±11,74
nGames	M1	26,01±7,18	23,71±10,07	14,91±4,93	490,08±101,45	-,40±10,06	8,11±2,92	-10,88±12,69
	M4	30,74±8,89	29,46±9,09	16,56±3,72	555,81±88,38	2,95±7,65	6,65±1,81	-13,60±15,24

Note: Games – participants who enroll the training plan; nGames – participants who do not enroll the games; M1 – moment 1 as baseline; M4 – moment 4 as pos intervention assessment.

The two years intervention plan as a whole seem to promote improvements on physical fitness. The findings showed important changes on lower limb muscle strength, assessed as *Chair to Stand test*, and on cardiorespiratory capacity, assessed as 6 Minutes Walking test. However, the nGames group also reported improvements. In fact, despite no being enrolled on Games plan, the nGames group follow both individual and community intervention plans with success. The evidences may indicate that regular physical activity, with or without games intervention plan, has benefits on fitness and life quality. In addition, the improvements observed in nGames group was due to the lowest fitness level at baseline - same exposure conducts to different adaptations. Further and holistic investigation is needed to better understand the best practices on age-related physical

activity. Whether or not games intervention plan is more efficient than others is not clear on the present study.

The variations on physical fitness measures over the intervention time, by country, are presented on Table 6.

Table 6 - Participants' physical fitness assessment at baseline and after intervention plan, by country and group (Games group and non Games group).

		n = 418	Handgrip Right (Kg)	Handgrip Left (Kg)	Chair stand (reps)	6 min walking	Chair sit & reach (cm)	Timed up & go (sec)	Back scratch (cm)
BU	Games	M1	26,36±3,43	20,57±4,47	13,55±3,68	594,73±108,98	-,48±5,32	9,91±1,87	-13,18±9,80
		M4	29,09±6,24	25,86±5,03	17,72±3,52	604,00±63,11	1,93±6,94	7,31±1,10	-10,02±9,62
	nGames	M1	25,81±2,61	19,79±3,49	14,84±3,08	541,55±83,20	-4,00±3,25	11,63±1,46	-7,26±5,96
		M4	27,33±5,17	24,22±3,63	17,11±2,32	585,33±56,30	3,11±7,80	8,27±1,69	-8,67±10,58
HU	Games	M1	27,66±8,34	27,06±9,65	14,58±2,61	692,09±132,59	6,58±8,75	5,88±1,66	-2,30±7,29
		M4	30,51±11,66	29,38±11,32	15,47±2,89	626,57±89,82	6,27±9,14	3,51±3,27	-2,15±7,92
	nGames	M1	27,89±6,40	25,80±4,86	14,21±4,43	567,05±93,69	7,84±11,18	5,54±1,16	-1,68±7,42
		M4	30,76±7,75	28,32±7,09	17,64±3,38	606,64±119,51	9,82±7,35	5,65±,86	-1,64±10,52
IT	Games	M1	33,37±9,99	32,26±10,42	19,48±5,02	482,12±74,95	3,79±8,39	7,08±1,47	-3,42±10,38
		M4	31,33±8,86	29,67±9,07	17,58±3,32	633,11±63,07	2,49±10,86	5,88±,73	-,2210,00±
	nGames	M1	26,39±9,87	24,87±16,17	16,59±6,97	440,00±100,15	1,55±9,71	7,66±2,59	-5,49±11,82
		M4	29,78±10,16	28,28±10,70	15,61±3,68	601,67±94,01	-1,28±8,90	6,53±1,84	-4,00±11,52
PT	Games	M1	34,78±10,82	33,05±11,10	17,65±3,77	579,32±97,58	1,16±7,33	5,93±1,52	-11,22±13,75
		M4	35,59±9,58	33,17±10,31	25,03±6,22	655,79±79,26	,28±8,03	4,47±,89	-9,30±11,05
	nGames	M1	23,31±5,35	22,53±6,17	14,12±3,15	461,88±83,47	-1,19±9,11	7,95±2,77	-14,24±11,64
		M4	26,00±!!!	26,00±!!!	19,00±!!!	642,00±!!!	7,00±!!!	3,86±!!!	1,00±!!!
SP	Games	M1	29,83±7,01	28,70±7,97	15,41±4,43	520,96±92,47	-3,51±9,92	6,50±1,54	-18,06±14,29
		M4	30,58±7,00	29,33±7,60	17,04±3,20	525,40±49,32	5,88±9,18	6,64±1,33	-17,88±12,48
	nGames	M1	29,23±6,29	27,23±7,00	13,35±3,83	519,57±94,36	-5,33±12,94	6,94±2,45	-15,57±17,45
		M4	31,76±9,25	31,10±9,31	16,51±4,02	521,08±68,07	2,85±6,20	6,67±1,80	-20,86±14,21

Note: BU – Bulgaria; Hu – Hungary; IT – Italy; PT – Portugal; SP – Spain. Games – participants who enroll the training plan; nGames – participants who do not enroll the games; W:H ratio – waist to hip ratio; M1 – moment 1 as baseline; M4 – moment 4 as pos intervention assessment.

It was found differences between the involved countries on the final output. Bulgaria findings show evident increases on muscle strength and agility but not on stretching test

(Chair sit & reach, back scratch). This may be the training effects as Bulgaria based the intervention plan on exercises requiring muscle strength, mobility and mental decision. The intervention plan on Hungary show an important maintenance of the physical fitness levels, for two years. Considering the baseline, the Hungarian participants presented an excellent level of physical fitness at that stage. Therefore, the maintenance of such level of physical fitness was the big issue. Italy shows important improvements cardiorespiratory capacity and agility. In fact, this group focus the exercise training on recreation games and challenging task. The sessions were running with good dynamic and interaction between participants. Apparently, for future intervention, exercising more the muscle strength is needed. The Portuguese group show similar behavior to Italian group. However, future intervention should provide more time and focus on stretching exercises as the agility and movement range seems to be compromised. The Spanish group enroll the project in the end of the first year. Also, the participants involved on intervention games have an exercising history for more than 4 years and they are the oldest group. Therefore, in terms of physical fitness little changes were expected on physical fitness. Like Italy, the big challenge for the Spanish group was the attendance and the increase in number of participants.

Considering the above reported, the games intervention is effective in promoting physical fitness but not different from other intervention plans. The exercising focus on motor capacities influence directly the more or less increment on physical fitness. The main finding seems to point that in intervention with aged population, a vast array of exercises is needed for a holistic wellbeing.

Another issue of the present project was to investigate the motivation for exercising or whether competition may promote additional motivation for exercising. The results of the PMQ are reported for all participants on table 7 and for all participants by country on table 8.

Table 7- Participants' motives for physical activity practice, by group (Games group and non-Games group).

	n = 418	Dim. Social	Dim. Fitness	Dim. Recognition	Dim. Challenge	Dim. Medical	Dim. Involvement	Total score
Games	M1	2,62±,47	2,52±,45	2,15±,64	2,47±,45	2,57±,49	2,46±,56	2,48±,43
	M3	2,49±,49	2,44±,34	2,06±,66	2,42±,35	2,60±,40	2,37±,68	3,80±,98
nGames	M1	2,59±,47	2,46±,48	2,10±,63	2,45±,45	2,49±,61	2,43±,57	2,44±,41
	M3	2,46±,54	2,50±,42	2,23±,68	2,42±,37	2,63±,41	2,56±,54	3,64±,80

Note: Dim. – dimensions of PMQ scale; ST – score total, the average of the six dimensions; Games – participants who enroll the training plan; nGames – participants who do not enroll the games; M3 – moment 3.

Rated from 1 to 3 points, the six questionnaire dimensions initial scores are quite similar among them. Nevertheless, the Dimension Social reach the highest value and Dimension Recognition show the lowest scores, on both participants enrolled on the Games and participants who not enroll the Games. The Games participants reports higher scores, on all dimensions.

At moment 3, about one year later, the dimension Medical assumed the highest value on both groups. However, like on Moment 1, the final scores are quite similar among groups. The Total score represents the global motivation for exercising and rates from 1 to 5. This variable was the only real increment found, on both groups. In fact, increment was more than 1 point, meaning an increase motivation for exercise and to get a healthy lifestyle.

According to the findings, it seems that competition, assessed as challenge dimension, was not the main motivation to enroll the games intervention plan, at least more than the other dimensions.

Table 8 - Participants' motives for physical activity practice, by country and group (Games group and non Games group).

		n = 418	Dim. Social	Dim. Fitness	Dim. Recognition	Dim. Challenge	Dim. Medical	Dim. Involvement	Dim. ST
BU	Games	M1	2,64±,43	2,57±,46	2,35±,52	2,54±,43	2,48,53±	2,41±,56	2,51±,42
	nGames	M1	2,48±,46	2,37±,53	2,21±,54	2,48±,43	2,25±,71	2,26±,70	2,38±,40
HU	Games	M1	2,59±,59	2,58±,59	2,21±,62	2,51±,55	2,56±,62	2,45±,62	2,49±,53
	nGames	M1	2,71±,36	2,53±,48	2,09±,62	2,44±,50	2,58±,52	2,56±,45	2,46±,45
IT	Games	M1	2,58±,47	2,38±,44	1,84±,58	2,35±,47	2,52±,43	2,47±,49	2,36±,38
	nGames	M1	2,53±,54	2,31±,48	1,81±,58	2,32±,50	2,38±,69	2,34±,58	2,30±,44
PT	Games	M1	2,84±,24	2,71±,33	2,47±,63	2,60±,43	2,76±,45	2,64±,44	2,72±,40
	nGames	M1	2,74±,35	2,67±,38	2,37±,59	2,61±,34	2,70±,45	2,57±,48	2,63±,31
SP	Games	M1	2,49±,49	2,45±,34	2,06±,67	2,43±,35	2,61±,41	2,37±,69	2,41±,38
	nGames	M1	2,45±,56	2,48±,42	2,19±,68	2,41±,37	2,62±,42	2,54±,55	2,46±,37

Note: BU – Bulgaria; Hu – Hungary; IT – Italy; PT – Portugal; SP – Spain. Games – participants who enroll the training plan; nGames – participants who do not enroll the games; ST - score total, the average of the six dimensions; W:H ratio – waist to hip ratio; M1 – moment 1 as baseline; M4 – moment 4 as pos intervention assessment; * significance $p < 0.05$.

Considering the motivation for exercising by country, the answer's profile does not change from one to another country. The highest and the lowest scores are still the Dimension Social and the Dimension Recognition, respectively, except Spain. Also, the participants of the nGames group recorded lower scores than their counterparts. Among the Games participants, the Spanish one's reported the lowest scores and the Dimension Medical as the most important factor for exercising. This finding may be due to Spain group represent the higher age-group on the project.

Because errors on data acquisition, the country' data was not considered for analysis on moment 3. Little confidence information was available by country and it did not allow a precise and detailed description.

The life quality, assessed as EQ-5D-5L TEST, follow 5 dimensions - mobility, self-care, usual activities, pain/discomfort and anxiety/depression – and measure the self-rated health. Each dimension is divided in 5 levels (1 to 5), indicating "no problems" (level 1) to "extreme problems" (level 5).

The scores obtained in the present study, as a whole and by country, are presented in Table 9 and Table 10.

Table 9- Participants' life quality assessment at baseline, moment 1, and moment 4 plan, by group (Games group and non Games group).

	n = 418	Mobility	Self-Care	Usual Activities	Pain, Discomfort	Anxiety, Depression	Health Today	EQ-5D-5L Index
Games	M1	1,45±,75	1,12±,46	1,25±,59	1,86±,85	1,57±,79	76,69±16,50	,86±,14
	M4	1,56±,88	1,00±,00	1,11±,33	1,56±,73	1,00±,00	78,89±16,16	,91±,07
nGames	M1	1,76±,93	1,31±,72	1,49±,83	1,97±,93	1,78±1,05	73,03±18,17	,78±,22
	M4	1,11±,32	1,05±,23	1,11±,32	1,58±,69	1,26±,56	85,17±13,10	,92±,08

Note: Games – participants who enroll the training plan; nGames – participants who do not enroll the games; M1 – moment 1; M4 – moment 4.

Considering the final scores on both moments, the health state of the participants seems to show no problems or slight problems in all dimensions. In fact, 33% of the Games group and 22% of the nGames group (information not available on Table 9) report no problems in any dimensions. The percent remained unchanged from M1 to M4 on Games group and increase to 47% on nGames group. No reports were found at level 5 (extreme problems) and 1,4% of the participants report severe problems on mobility (level 4). In relation to Index values which inform about the quality-adjusted life years (QALYs) and may be used to inform economic evaluations of health care interventions, the scores presented values above 0.78. Such values indicate good level of QALYs, meaning satisfactory health care intervention.

Table 10 - Participants' life quality assessment at baseline, moment 1, and moment 4 plan, by country and group (Games group and non Games group).

		n = 418	Mobility	Self-Care	Usual Activities	Pain, Discomfort	Anxiety, Depression	Health Today	EQ-5D-5L Index
BU	Games	M1	1,8±0,79	1,4±0,75	1,84±0,88	2,38±0,86	1,98±0,92	69,42±14,46	0,75±0,19
		M4	1,56±0,62	1,44±0,59	1,6±0,62	1,96±0,52	1,73±0,62	76,71±12,01	0,76±0,14
	nGames	M1	2,48±1,03	2,16±1,07	2,39±1,02	2,52±0,93	2,48±1,18	58,87±16,37	0,56±0,26
		M4	2,32±0,83	2,23±0,96	2,35±0,88	2,39±0,72	2,19±0,79	62,81±13,02	0,61±0,19
HU	Games	M1	1,29±0,63	1±0	1,06±0,24	1,35±0,54	1,18±0,39	82,5±12,75	0,94±0,1
		M4	1,56±0,88	1±0	1,11±0,33	1,56±0,73	1±0	78,89±16,16	0,91±0,07
	nGames	M1	1,67±0,91	1,14±0,65	1,24±0,7	1,67±0,97	1,29±0,72	80,62±11,02	0,86±0,22
		M4	1±0	1±0	1,2±0,4	1,8±1,1	1±0	83,6±17,39	0,94±0,08
IT	Games	M1	1,38±0,78	1,05±0,29	1,1±0,35	1,95±0,77	1,75±0,82	77,1±13,53	0,87±0,1
		M4	1,17±0,43	1,04±0,2	1,11±0,37	1,66±0,67	1,43±0,58	83,21±13,5	0,9±0,11
	nGames	M1	1,6±0,96	1,17±0,49	1,42±0,74	1,82±0,77	1,73±0,99	76,27±17,09	0,82±0,18
		M4	1,14±0,36	1,07±0,27	1,07±0,27	1,5±0,52	1,36±0,63	85,77±11,88	0,91±0,08
PT	Games	M1	1,08±0,28	1±0	1±0	1,3±0,57	1,27±0,56	85,32±14,62	0,96±0,06
		M4	1,13±0,34	1±0	1,1±0,38	1,28±0,6	1,1±0,38	88,33±12,27	0,95±0,09
	nGames	M1	1,57±0,68	1,08±0,28	1,18±0,49	2±1,04	1,61±0,98	73,57±18,26	0,82±0,17
		M4	1,68±0,96	1,17±0,67	1,24±0,58	1,73±0,9	1,54±0,78	69,76±17,1	0,83±0,2
SP	Games	M1	1,6±0,86	1,11±0,53	1,22±0,52	2,04±0,8	1,44±0,76	71,91±21,06	0,85±0,1
		M4							
	nGames	M1	1,65±0,81	1,15±0,49	1,35±0,59	1,85±0,75	1,8±1,01	75,95±19,85	0,81±0,16
		M4							

Note: BU – Bulgaria; Hu – Hungary; IT – Italy; PT – Portugal; SP – Spain. Games – participants who enroll the training plan; nGames – participants who do not enroll the games; M1 – moment 1; M4 – moment 4.

Considering the final scores by country, the health state of the participants showed similar behavior to whole sample. Bulgaria presented level 2 (slight problems) and level

3 (moderate problems) on all five dimensions, on nGames group. Furthermore, the nGames Bulgaria' index presented a score bellow 65, meaning a not so good QALYs. Spanish group reported level 2 on "Pain/discomfort" dimension. However, as they enrolled the study latter, the scores cannot be analyzed as intervention effects because of the cross-sectional design.

4. Limitations

Regardless of several meetings among the senior countries' leaders, some drawbacks conduct to limitations on the results interpretation:

- procedures uniformization cross countries;
- inter group information bias, within countries;
- as a behavioral intervention, difficulties to control and assess the main exposure;
- subjective assessment of some outcomes;
- dynamic cohort.

5. Scientific output

Both partial and the final results were presented and discussed at national and international meetings and submitted for publication published in national and international journals. Also, partial results, moment by moment, were presented and discussed at internal meeting with project partners.

Scientific production was developed in three different ways – 1) published or under submission paper; 2) participation on conferences; 3) presentation on project meetings.

1) published or under submission paper

L Dallolio, S Colaci, A Masini, S Marini, J M Cancela-Carral, P Bezerra (2020). Health impact of an intervention sport-competition-based in elderly: the "In-Common sport" project. *European Journal of Public Health*, Volume 30, Issue Supplement_5, September 2020, ckaa166.416, https://doi.org/10.1093/eurpub/ckaa166.416

Cancela, J. M., Sanchez-Lastra, J. M., Camões, M., Bezerra, P. (2020). Hematological detraining-related changes among elderly individuals with high blood pressure. Rev Assoc Med Bras; 66(8):1108-1115. http://dx.doi.org/10.1590/1806-9282.66.8.1108.

Cancela, J. M., Sanchez-lastra, M. A., Camões, M., & Bezerra, P. (2020). Hematological detraining-related changes among elderly individuals with high blood pressure. *Rev. Assoc. Med. Bras.*, *66*(8), 1108–1115.

Cancela, J. M., Bezerra, P., Rodrigues, LP., Camões, M. (2020). Intervention-related On Aging Health State Over European Countries. May The Context Frame The Difference? *Medicine & Science in Sports & Exercise*, Vol 52, Issue 7S, pp 444.

Bezerra, P., Clemente, F.M., Dvorak, M., Camões, M. (2019). Age-related Health State Over European Countries: The Context May Be The Difference. *Medicine & Science in Sports & Exercise.* 2019, v. 49, nº5, p. S429-430.

Colaci, S. (2020). Progetto In Common Sports: attività fisica e sport adattati per un gruppo di over 60. Indagine valutativa dei benefici sullo stato di salute dei partecipanti. Undergraduate thesis at Alma Mater Studiorum – University of Bologna.

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Bezerra, P., Rodrigues, LP, Cancela, J. M., (2018). The influence of winter and summer seasons on physical fitness in aged population. *Archives of Gerontology and Geriatrics*, V. 76, May-Jun, p. 80-84.

2) participation in conferences

Medicine & Science in Sports & Exercise, 2020, San Francisco, USA

Medicine & Science in Sports & Exercise, 2019, Orlando, USA

2º Forum REDESPP –Desporto 2018, Leiria, Portugal

3) presentation in project meetings

Online meeting, 2020

Cesena, Italy, 2019

Vila Nova de Cerveira, Portugal, 2019

SanXenxo, Spain, 2019

Zolpont, Budapest, Hungary 2019

Aksakovo, Bulgaria, 2018

6. Conclusions and evidences

The main finding of the present project is the commitment of the participants, cross country, on exercising for health. In fact, despite not exercising before the proposed activity, the enrolled participants showed a high systematic assistance (80% mean among countries) to training sessions and the absents/dropout was less than 15%, highlighting the relevance of structured practice, namely among elderly population. In addition, and even with limitations in the interpretation of some associations, the community enrolment among organized competitions validate the specific objectives of the project and gives prospective viability, regarding behavioral public health interventions.

In relation to the main objectives proposed, the findings showed:

Objective 1 - To assess the impact of an intervention plan base on sport competition in physical fitness and fitness and cognitive performance, and to analyze the association between variable, on the elderly;

The results are not clear about the impact of the competition on physical fitness of ages population. Participants report as main motivation for exercising the social issues. However, the scores of the Games group are higher than nGames group.

Objective 2 - To investigate the impact of additional events such as "intergenerational games" on physical fitness status and healthy lifestyle, on aged population;

The findings showed an evident increase on physical fitness and healthy lifestyle among aged population, independently of the country, educational status, sex or age.

Objective 3 - Understand the motivation for systematic physical activity on aged population;

The motivation for systematic physical activity exercising is the greatest finding of the project. In fact, one of the main difficulties in promoting active lifestyle among ages population is the dropout. In the present case, the percent of absent was low with a tendency to 0. Maybe the competition, the challenge and the important space for promotion of social interaction are the keys for a successful intervention plan.

Objective 4 - To create intergenerational links for social inclusion;

The variable was not well controlled. However, the finding of a successful social inclusion may be understood by indirect variables. In fact, considering the sociodemographic variables (the education level, marital status, gender, lower to higher income from retirement and ethnicity), the projected interaction and the created group's dynamics, the participants revealed a high percent of training sessions and events assistance, enjoy and enthusiasm on exercising and health competition.

Objective 5 - To drive and contribute to the development of more effective health promotion policies and strategies.

The scientific findings and the enthusiasm of the aged population in participating on project provide good evidences in developing intervention programs with important impact and low costs.

For future intervention it may be important to consider the increment of weekly session of exercising. We believe that the impact will be more efficient, and it will follow the recent ACSM' guidelines for health in aged population. Also, the intervention must be following the regional and local sport development in order to use the intrinsic motivation for exercising. In this aspect, the traditional games seem to be an excellent start point. Adapted facilities, in terms of accessibility and comfort, may be the difference in linkage for successful intervention plan.

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