Journal of Physical Activity Research, 2024, Vol. 9, No. 1, 1-7
Available online at http://pubs.sciepub.com/jpar/9/1/1
Published by Science and Education Publishing
DOI:10.12691/jpar-9-1-1

A Longitudinal Analysis of Physical Activity Levels in European Older Adults: The Survey on Health, Ageing and Retirement in Europe

Eleni Theodoropoulou*, Nektarios A. M. Stavrou, Konstantinos Karteroliotis, Maria Koskolou

School of Physical Education and Sport Science, National and Kapodistrian University of Athens, Greece
*Corresponding author: eltheodorop@phed.uoa.gr

Received January 12, 2024; Revised February 15, 2024; Accepted February 22, 2024

Abstract Background: The health benefits of physical activity (PA) are well established. The current study investigated the vigorous and moderate PA levels over time in older Europeans analyzing data of the Survey on Health, Ageing and Retirement in Europe, which is a cross-national database of the older population. Methods: Longitudinal analyses were conducted for twelve countries that participated in repeated measures in 2015, 2017 and 2020. In total, 9.011 individuals (63.04±22.96 years) answered the PA questions. Principal Findings: Analyses indicated decreases in vigorous PA over time, as adults that never participated in vigorous PA increased from 39% (2015) to 45.8% (2020). These findings were confirmed for moderate PA. Greater reductions in PA were found in southeast countries, such as Greece and Poland, whereas lower decreases in PA were observed in north countries, such as Switzerland and Denmark. Conclusion: The declining PA trends in several European countries indicate the importance of promoting an active and healthy lifestyle in aging populations. Future studies should be carried out to investigate the PA discrepancies among European countries.

Keywords: *exercise, SHARE project, repeated measures, Europeans, old age*

Cite This Article: Eleni Theodoropoulou, Nektarios A. M. Stavrou, Konstantinos Karteroliotis, and Maria Koskolou, "A Longitudinal Analysis of Physical Activity Levels in European Older Adults: The Survey on Health, Ageing and Retirement in Europe." *Journal of Physical Activity Research*, vol. 9, no. 1 (2024): 1-7. doi: 10.12691/jpar-9-1-1.

1. Introduction

Regular physical activity (PA) has been proven to be an effective strategy for the prevention and treatment of obesity, metabolic syndrome, cardiovascular diseases, as well as for the enhancement of physical health and the reduction of mortality rates [1,2,3,4,5]. In addition, PA promotes life expectancy, well-being and mental health, including prevention of cognitive decline, depression and anxiety in both adult and older individuals [1,2,3,4,5]. Despite the apparent benefits of PA, 31.1% of adult populations globally do not meet sufficient PA levels for enhancing health, with wide variations ranging from 17% in the southeast Asia to about 43% in the north states of America and the eastern Mediterranean countries [6]. In line with this, the Eurobarometer survey in European Union countries has indicated that 45% of individuals never exercise or participate in sports and PA [7]. The survey has also revealed that during the covid-19 pandemic, half of Europeans have reduced their PA levels or even stopped altogether [7]. The apparent findings have been confirmed by recent studies [8,9].

However, many studies examining PA levels are cross-sectional and thus longitudinal changes in the PA behaviour have not been extensively explored [6,7,8,9]. Such data are not optimal for observing the longitudinal PA trends and justifying a cause-and-effect relationship. In line with this, there is a need for comparisons in the PA trends over time among countries and world regions [6]. Moreover, few researchers have investigated vigorous PA levels. The health benefits of vigorous PA are well-established [4,10,11] and there is evidence that the self-report instruments assessing high intensity PA have been more valid and reliable compared to measures evaluating PA performed with medium or low intensity [12,13].

Therefore, the purpose of the current study was twofold. The first purpose was to investigate the vigorous and moderate PA levels over time in older European individuals, analyzing data from studies of the Survey on Health, Ageing and Retirement in Europe (SHARE) conducted in the years 2015, 2017 and 2020. The second purpose was to examine differences among various European countries in the longitudinal PA trends, including both vigorous and moderate PA assessments. No such research has been carried out until now.

2. Materials and Methods

2.1. Participants' Selection and Study Design

In the study, data have been analyzed from the SHARE, which was performed in various countries of the European Union and Israel [14,15]. Specifically, the SHARE is a multidisciplinary and cross-national panel database on ageing, health, socio-economic status and social and family networks of more than 140.000 non-institutionalized individuals, aged 50 years old and over [14,15]. The SHARE was conducted via computer assisted personal interviews in eight waves ranging from 2004 to 2020. The wave 8 of 2020 was completed before the covid-19 pandemic. Following that, a specific survey (wave 9) was carried out for the covid-19 pandemic in 2020.

For the selection of participants the following criteria were set: (a) answering the PA questions in several waves of the SHARE and (b) the sample size of each country should be at least 200 participants answering the PA questions in several waves of the SHARE. Based on the above criteria, three waves were conducted over a period of six years (i.e. 2015, 2017 and 2020, before the pandemic) and twelve European countries were investigated in the current study. In particular, the countries were the following: Austria, Belgium, Czech, Denmark, France, Germany, Greece, Italy, Poland, Spain, Sweden and Switzerland. Due to the poor PA data availability over time and the lack of countries' participation either in one of the above waves or in the previous waves (< 2015), a longer period of time and more countries were not examined. Specifically, Croatia, Estonia, Ireland, Luxemburg, Portugal and Slovenia were excluded due to incomplete PA data in several waves of the SHARE.

Therefore, to investigate the PA levels over time, a longitudinal study design with repeated measures was used among the same samples of the twelve European countries, which participated in the waves 6, 7 and 8 of the SHARE that were conducted in 2015, 2017 and 2020, respectively [16,17,18]. In total, 10.489 individuals answered the PA questions at the three waves, from which 1.478 participants were excluded due to missing values and outliers in the vigorous and moderate PA questions. Therefore, 9.011 individuals, 4.153 men and 4.858 women (M = 63.04, S = 22.96 years) were included in the statistical analyses. Table 1 depicts the descriptive statistics of the specific European countries' samples.

2.2. Measures

Country, age, gender, vigorous and moderate PA levels were recorded using the SHARE-questionnaire that is translated in the language of each country [14,15,16,17,18]. In particular, a specific code was assigned for each country recorded. To record age and gender the following items were used, respectively: "how old are you?" and "what is your gender?". To assess the vigorous PA levels, the question "how often do you engage in vigorous physical activity, such as sports, heavy housework, or a job that involves physical labour?" was used. To measure the moderate PA levels, the question "how often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or doing a walk?" was used. The response categories of the PA questions were "hardly ever or never", "one to three times a month", "once a week" and "more than once a week".

2.3. Statistical Analyses

Initial analysis indicated non-normal distributions for the values of the PA variables [19]. Listwise deletion of missing values and univariate and multivariate outliers was performed [19]. Means, medians, standard deviations, frequencies, sums and % rates were used.

To explore differences in PA among the 2015, 2017 and 2020 SHARE's studies, two Friedman nonparametric tests were conducted for the vigorous and moderate PA questions, respectively [19]. The Wilcoxon test was used for the post hoc comparisons. These analyses were used, because the PA variables had four-scale categorical responses. To identify significant differences among the PA repeated measures, the *chi*-square F value for the Friedman test and the z value for the Wilcoxon test were used. A p value of < .05 was considered statistically significant. The SPSS 25.0 statistical software (SPSS Inc., Chicago, IL, USA) was used.

Table 1. Descriptive Statistics of the Participants in the Physical Activity Measures in 2015, 2017 and 2020

Countries	Samples (*N*)	Men (*N*)	Women (*N*)	Men (*%*)	Women (*%*)	Age (*M*, years) [a]	Age (*SD*, years) [a]
Austria	501	218	283	43.5	56.5	64.25	23.06
Belgium	649	300	349	46.2	53.8	60.75	22.52
Czech	630	268	362	42.5	57.5	61.59	24.39
Denmark	845	405	440	47.9	52.1	62.74	21.50
France	738	330	408	44.7	55.3	63.51	22.55
Germany	715	343	372	48	52	63.83	20.68
Greece	1188	530	658	44.6	55.4	62.44	23.58
Italy	910	429	481	47.1	52.9	59.83	23.51
Poland	693	333	360	48.1	51.9	63.61	24.94
Spain	632	294	338	46.5	53.5	62.09	24.63
Sweden	725	340	385	46.9	53.1	66.91	22.58
Switzerland	785	363	422	46.2	53.8	64.92	21.57
Total	9.011	4.153	4.858	46.18	53.82	63.04	22.96

[a] Age at 2015.

3. Results

3.1. Physical Activity Descriptive Statistics

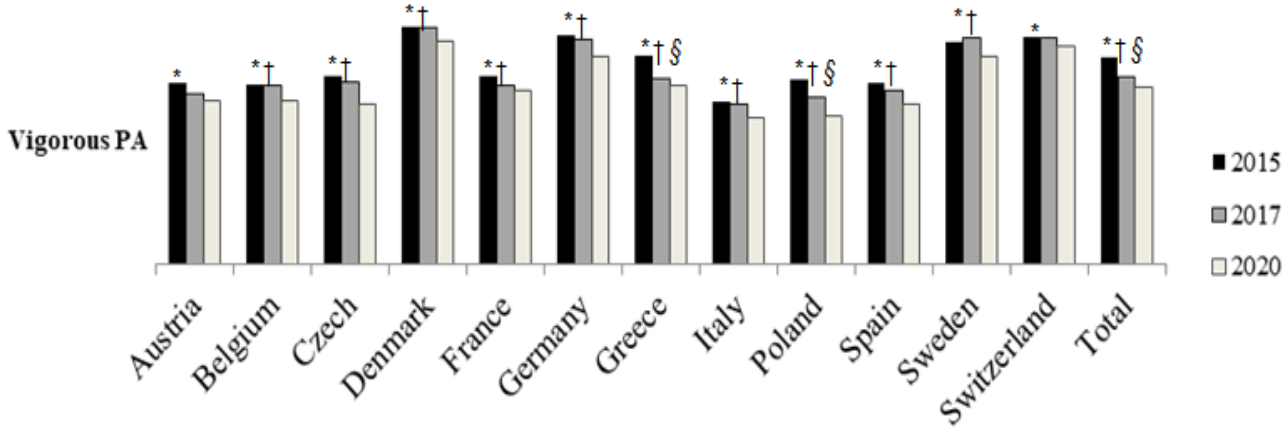
Tables 2 and 3 present the percentages of the individuals from each European country that participated in vigorous and moderate PA hardly ever or never, 1-3 times per month, once a week and more than once a week, respectively. Specifically, the percentage of older Europeans that hardly ever or never participated in vigorous PA increased from 39% in 2015 to 45.8% in 2020. In line with this, the percentage of older individuals that participated in vigorous PA more than once a week was reduced from 35.3% in 2015 to 29.8% in 2020 (Table 2). Regarding moderate PA, the percentage of older Europeans that hardly ever or never participated in moderate PA increased from 9% in 2015 to 13.7% in 2020 and those who participated in vigorous PA more than once a week decreased from 71.2% in 2015 to 65.5% in 2020 (Table 3). The highest percentages of individuals participating in vigorous and moderate PA more than once a week were detected in Denmark, whereas the lowest PA percentages were observed in Greece (Tables 2 and 3).

3.2. Vigorous Physical Activity Repeated Measures

Significant differences in vigorous PA were found among the repeated measures for Belgium ($F_{(2)} = 16.06$, $p < .01$), Czech ($F_{(2)} = 49.40$, $p < .01$), Denmark ($F_{(2)} = 15.20$, $p < .01$), France ($F_{(2)} = 10.97$, $p < .05$), Germany ($F_{(2)} = 20.40$, $p < .01$), Greece ($F_{(2)} = 175.84$, $p < .01$), Italy ($F_{(2)} = 25.67$, $p < .01$), Poland ($F_{(2)} = 45.50$, $p < .01$), Spain ($F_{(2)} = 26.01$, $p < .01$), Sweden ($F_{(2)} = 20.39$, $p < .01$) and all countries ($F_{(2)} = 253.79$, $p < .01$). These results were not confirmed for Austria and Switzerland. Figure 1 and Table 4 depict the differences for each country, according to the post-hoc comparisons. Despite the longitudinal decline of vigorous PA in all countries, greater reductions in vigorous PA were found in southeast countries, such as Greece, Poland and Spain, whereas lower decreases in vigorous PA were observed in north countries, such as Switzerland, Denmark and Sweden (Table 4).

3.3. Moderate Physical Activity Repeated Measures

Significant differences in moderate PA were detected among the repeated measures for Belgium ($F_{(2)} = 44.78$, $p < .01$), Czech ($F_{(2)} = 33.98$, $p < .01$), Denmark ($F_{(2)} = 22.20$, $p < .01$), France ($F_{(2)} = 38.46$, $p < .01$), Germany ($F_{(2)} = 25.88$, $p < .01$), Greece ($F_{(2)} = 56.27$, $p < .01$), Italy ($F_{(2)} = 14.33$, $p < .05$), Poland ($F_{(2)} = 17.36$, $p < .01$), Spain ($F_{(2)} = 20.10$, $p < .01$), Sweden ($F_{(2)} = 34.40$, $p < .01$), Switzerland ($F_{(2)} = 8.48$, $p < .05$) and all countries ($F_{(2)} = 269.10$, $p < .01$). These results were not confirmed for Austria. Figure 2 and Table 4 depict the differences for each country, according to the post-hoc comparisons. Despite the longitudinal reduction of moderate PA in all countries, greater decreases in moderate PA were found in southeast countries, such as Greece, Poland and Spain, whereas lower reductions in moderate PA were observed in north countries, such as Switzerland, Denmark and Sweden (Table 4).



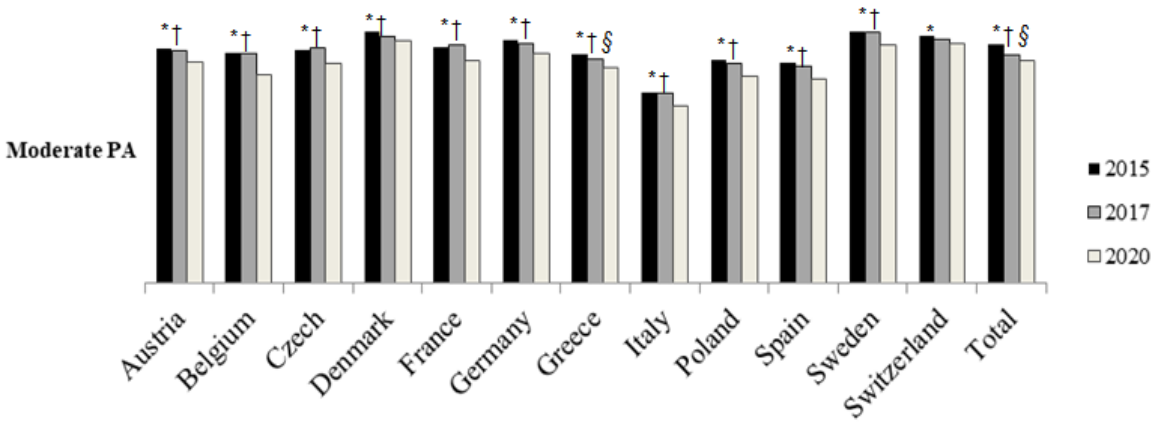
Notes. PA: physical activity; Vertical axes represent the vigorous PA means.

* Significant differences in the vigorous PA measures between 2015 and 2020 ($p < .05$)

† Significant differences in the vigorous PA measures between 2017 and 2020 ($p < .05$)

§ Significant differences in the vigorous PA measures between 2015 and 2017 ($p < .05$)

Figure 1. Differences in Vigorous PA Among the Repeated Measures in 2015, 2017 and 2020



Note. PA: physical activity; Vertical axes represent the moderate PA means.

* Significant differences in the moderate PA measures between 2015 and 2020 ($p < .05$)

† Significant differences in the moderate PA measures between 2017 and 2020 ($p < .05$)

§ Significant differences in the moderate PA measures between 2015 and 2017 ($p < .05$)

Figure 2. Differences in Moderate PA Among the Repeated Measures in 2015, 2017 and 2020

Table 2. Percentages of Individuals Participating in Vigorous Physical Activity in 12 Countries from the SHARE's Studies in 2015, 2017 and 2020

2015 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	35.5%	47.1%	45.7%	27.6%	51.1%	32.3%	26%	49.7%	46.2%	52.6%	30.8%	29.7%	39%
One to three times per month	7.9%	8.2%	13%	5.5%	6.7%	7.4%	26.9%	11.7%	11.5%	8.2%	9.6%	7.1%	10.1%
Once a week	14.1%	13.5%	14.6%	16.1%	13.1%	17.8%	24.1%	14.8%	7.5%	10.5%	14.9%	18.4%	15.6%
More than once a week	42.5%	31.2%	26.7%	50.8%	29.1%	42.5%	23%	23.8%	34.8%	28.7%	44.7%	44.8%	35.3%
2017 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	47.1	53.2%	46.3%	29.9%	52.4%	32.4%	29.6%	61.4%	57.8%	53.8%	31.3%	29.9%	41.8%
One to three times per month	6.7%	6.9%	11%	6.7%	7.9%	8.5%	32.6%	7.9%	8.1%	6.5%	9.9%	9.9%	12%
Once a week	13.1%	12.5%	14.6%	15.1%	14%	17.8%	24.7%	9.3%	11.8%	9.7%	16.6%	18.1%	15.7%
More than once a week	33.1%	27.4%	28.1%	48.3%	25.7%	41.3%	13.1%	21.4%	22.3%	30%	42.2%	42.1%	30.5%
2020 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	57%	53.7%	51.8%	31.8%	55.1%	39.8%	33.2%	60.3%	61%	63.4%	36.2%	32.4%	45.8%
One to three times per month	7%	7.5%	11.4%	6%	7.5%	7.8%	29.3%	7.8%	11.2%	7.5%	11.1%	9.7%	10.2%
Once a week	12%	12.8%	13.4%	12.4%	13.1%	15.8%	22.5%	11%	9.5%	9.3%	14.4%	18%	14.2%
More than once a week	24%	26%	23.4%	49.8%	24.3%	36.6%	15%	20.9%	18.3%	19.8%	38.3%	39.9%	29.8%

Table 3. Percentages of Individuals Participating in Moderate Physical Activity in 12 Countries from the SHARE's Studies in 2015, 2017 and 2020

2015 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	7.1%	8.7%	7%	3.5%	9.6%	5.7%	6.9%	23.7%	14.2%	14.7%	2.9%	3.9%	9%
One to three times per month	2.9%	5.8%	7.2%	2.9%	5.6%	4.3%	11.9%	9.8%	5.9%	5.4%	3.3%	4.1%	5.7%
Once a week	7.7%	16.1%	14.2%	7.7%	17.7%	13.4%	26.3%	18.1%	10.9%	12.3%	9.4%	10.7%	14.1%
More than once a week	82.3%	69.4%	71.6%	85.9%	67.1%	76.6%	54.9%	48.4%	69%	67.6%	84.4%	81.3%	71.2%
2017 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	11.2%	11.2%	8.7%	6.7%	8.9%	8.5%	6.9%	29.2%	16.7%	18.5%	3.4%	5.1%	10.6%
One to three times per month	3.6%	4.2%	5.7%	2.1%	3.7%	2.8%	10.5%	8.6%	5.2%	5.2%	4.6%	4.3%	5.5%
Once a week	10.4%	17.1%	11.6%	8.4%	11.8%	12.7%	28.5%	12.7%	10.8%	10.6%	7.6%	12.1%	14.1%
More than once a week	74.8%	67.5%	74%	82.8%	75.6%	76%	54.1%	49.5%	67.3%	65.7%	84.4%	78.5%	69.8%
2020 Physical Activity Categories	Austria	Belgium	Czech	Denmark	France	Germany	Greece	Italy	Poland	Spain	Sweden	Switzer-land	Total
Hardly ever or never	13.5%	15.7%	13.3%	6.5%	14.2%	10%	10.2%	29.2%	19.3%	23.7%	6%	5.9%	13.7%
One to three times per month	3%	6.6%	6.6%	3.6%	6.5%	4.4%	13.4%	11.8%	6.5%	3.9%	5.6%	3.3%	6.3%
Once a week	9%	16.8%	15.8%	8.4%	18%	14.3%	28.2%	15%	10.3%	9.2%	9.8%	11.5%	14.5%
More than once a week	74.5%	60.9%	64.3%	81.5%	61.3%	71.3%	48.2%	44%	63.9%	63.2%	78.6%	79.3%	65.5%

Table 4. Differences in the Physical Activity Measures Among 2015, 2017 and 2020 for each country, according to the post-hoc comparisons

Vigorous Physical Activity				Moderate Physical Activity			
Countries	2015-2020 (*z* value)	2017-2020 (*z* value)	2015-2017 (*z* value)	Countries	2015-2020 (*z* value)	2017-2020 (*z* value)	2015-2017 (*z* value)
Austria	-6.81**	-.96	-1.44	Austria	-5.73**	-2.28*	-.41
Belgium	-5.54**	-3.47*	-.14	Belgium	-6.43**	-4.31**	-.52
Czech	-4.71**	-6.30**	-1.71	Czech	-7.82**	-5.70**	-.76
Denmark	-3.09*	-3.28*	-.65	Denmark	-3.54**	-2.21*	-1.70
France	-4.60**	-1.00	-2.40*	France	-6.26**	-5.90*	-.69
Germany	-7.71**	-3.66**	-.89	Germany	-5.05**	-4.10**	-1.46
Greece	-9.43**	-3.80*	-9.96**	Greece	-7.10**	-4.88**	-2.87*
Italy	-6.39**	-3.32*	-.77	Italy	-5.74**	-3.63**	-.33
Poland	-8.11**	-4.33*	-3.47*	Poland	-6.41**	-4.04*	-.57
Spain	-7.97**	-4.21**	-1.30	Spain	-6.55**	-3.75**	-.78
Sweden	-4.73**	-4.15**	-.80	Sweden	-4.51**	-4.95**	-.64
Switzer-land	-3.69**	-1.74	-.22	Switzer-land	-2.09*	-1.83	-1.37
Total	-20.21**	-10.70**	-3.33*	Total	-21.01**	-13.56**	-2.72*

(*p < .05, ** p < .01)
Note. *Z* values were based on the Wilcoxon tests.

4. Discussion

The current study investigated the vigorous and moderate PA levels of older individuals over time, specifically at three time points over six years (i.e. in 2015, 2017 and 2020) in twelve European countries: Austria, Belgium, Czech, Denmark, France, Germany, Greece, Italy, Poland, Spain, Sweden and Switzerland. Such data are optimal for observing PA rates over time and pointing out differences in the PA trends among the European countries. Data were retrieved and analyzed from the multidisciplinary and representative database of the SHARE, strengthening the research purpose of identifying longitudinal changes in PA behaviour in European countries. Further, the vigorous PA assessment was a key feature of this study as participation in vigorous PA is a crucial indicator of PA levels due to its well-established health benefits, recognized by the WHO [4] and the American College of Sports Medicine [10,11].

The findings demonstrated that the older individuals of

northern Europe, compared to those living in southern Europe, are more physically active, which is in accordance with previous research data [7,20]. However, the longitudinal design of the current study indicated decreased vigorous and moderate PA levels over time in all countries, with greater PA reductions being observed in southeast countries, such as Greece, Poland and Spain, whereas lower PA decreases being detected in north countries, such as Switzerland, Denmark and Sweden. Recent studies have demonstrated that differences in urbanization, socio-economic development and availability of PA policies across European countries could explain the PA discrepancies among countries [7,20,21]. More specifically, low income and educational level, limited availability of national PA policies and guidelines in low-income countries, such as southeast European countries, could account for the low PA levels, highlighting the necessity of applying national policies and strategies promoting physically active aging in these countries [4,5,7,20]. According to the Eurobarometer (2022), high percentages of Europeans from the south and east countries are not members of health/ fitness/ sport clubs and centers due to financial difficulties and therefore, opportunities to engage in "free" PA programs, such as recreational activities in parks should be promoted [7]. Regarding education, despite its positive relationship with PA, it is not clear which differences in educational systems among north and southeast European countries contribute to the PA discrepancies among countries [7]. In line with this, although low availability of national PA policies in southeast European countries seems to be an important cause for the low PA levels, future research should be carried out to highlight differences in PA policies among European countries [7,20]. Further, policy options enhancing PA should be promoted, such as interventions in schools and workplaces, specific programs for older individuals, as well as accessibility to sports facilities and environment encouraging active transport and outdoor activities [7,20].

In addition, it is remarkable that the moderate PA levels were higher compared to the vigorous PA levels in all countries. This could be explained by the phrasing of the question about moderate PA levels, which includes both moderate and low PA types, such as gardening, cleaning the car and doing a walk without mentioning other PA types, such as sports or exercise performed with medium intensity. In line with this, a possible explanation for the high reported moderate PA levels may be the fact that medium or low intensity PA usually reflects activities of daily life, such as walking for transportation and household activities, which people do more and don't necessarily require high levels of functional fitness, compared to PA with high intensity, such as sports [20,22]. Further, with aging, some high intensity activities may be replaced by activities of lower intensity, as one's intention to participate in PA in later life may change [22]. This could be partly explained by the declining levels in several parameters of functional fitness, such as muscle strength, flexibility, agility and endurance [22]

Finally, this study has several limitations that should be considered. First, the fact that vigorous and moderate PA was assessed using only two questions is an important limitation [23,24]. Although objective measures of PA, such as accelerometers and calorimetry are more valid and reliable methods, self-reports measures are more appropriate for large-scale epidemiological studies [23,24]. Second, information about the duration of vigorous and moderate PA is not available. Third, measures were self-reported and problems associated with common method variance should be considered. Despite the apparent limitations, this study has some advantages that should be taken into account. In particular, key features of this study were the longitudinal study design with repeated measures in twelve European countries, as well as the PA assessments both at the vigorous and moderate level. In addition, the SHARE provides a European database of high quality and representativeness due to the high degree of standardization in data collection [14,15,16,17,18]. Finally, the sample size is sufficient to detect small effects and to minimize standard error and has high participation rates [14,15,16,17,18].

5. Conclusions

The current study demonstrated decreases in the vigorous and moderate PA levels of older European individuals over a time period of six years, indicating the importance of promoting an active and healthy lifestyle in aging populations. Prevalence of longitudinal differences in PA varied among the twelve European countries examined, with higher PA levels being observed in north European countries compared to southeast countries where lower PA levels are presented. This finding highlights the necessity of national policies promoting PA for older individuals in southeast European countries. Future studies should be carried out to further investigate PA levels over time in this population using objective measures of PA, such as accelerometers.

6. Availability of the SHARE Data

This research was conducted analyzing data from the SHARE's waves 6, 7 and 8 [16,17,18]. These data are available in the SHARE website without permission [14,15,16,17,18]. The SHARE has been funded by the European Commission, the German Ministry of Education and Research, the U.S. National Institute on Aging and various national funding sources.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

[1] Aggio, D., Papachristou, E., Papacosta, O., Lennon, L.T., Ash, S., Whincup, P., Wannamethee, S.G., and Jefferis, B.J., "Trajectories of physical activity from midlife to old age and associations with subsequent cardiovascular disease and all-cause mortality", *Journal of Epidemiology and Community Health*, 74(2), 130-136, January 2020.

[2] Cunningham, C., O'Sullivan, R., Caserotti, P., and Tully, M., "Consequences of physical inactivity in older adults: A systematic

review of reviews and meta-analyses", *Scandinavian Journal of Medicine & Science in Sports*, 30(5), 816-827, May 2020.

[3] Warburton, D.E.R., and Bredin, S.S.D, "Reflections on physical activity and health: What should we recommend?", *Canadian Journal of Cardiology*, 32(4), 495-504, April 2016.

[4] World Health Organization, "Global action plan on physical activity 2018-2030: More active people for a healthier world", 2018 [Online]. Available: https://apps.who.int/iris/handle/10665/272722.

[5] World Health Organization, "Global status report on physical activity 2022", 2022 [Online]. Available: https://apps.who.int/iris/handle/10665/363607.

[6] Hallal, P.C., Andersen, L.B., Bull, F., Guthold, R., Haskell, W., and Ekelund, U, "Global physical activity levels: Surveillance progress, pitfalls, and prospects", *The Lancet*, 380(9838), 247-257, July 2012.

[7] European Commission, "New Eurobarometer on sport and physical activity", September 2022 [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_5573.

[8] Clemente Remón, Á.L., Jiménez Díaz-Benito, V., Jiménez Beatty, J.E., and Santacruz Lozano, J.A., "Levels of physical activity among older adults in the European Union", *Journal of Aging and Physical Activity*, 29(2), 242-249, April 2021.

[9] Gomez, M., Figueiredo, D., Teixeira. L., Poveda, V., Paul, C., Santos-Silva, A., and Costa, E., "Physical inactivity among older adults across Europe based on the SHARE database", *Age and Aging*, 46(1), 71-77, January 2017.

[10] Haskel, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D., and Bauman, A., "Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association", *Medicine and Science in Sports and Exercise*, 39(8), 1423-1434, August 2007.

[11] Piercy, K.L., Troiano, R.P., Ballard, R.M, Carlson, S.A., Fulton, J.E., Galuska, D.A., George, S.M., and Olson, R.D., "The physical activity guidelines for Americans", *The Journal of the American Medical Association*, 320(19), 2020-2028, November 2018.

[12] Craig, C.L., Marshall, A.L., Sjostrom, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F., and Oja, P., "International physical activity questionnaire: 12-country reliability and validity", *Medicine and Science in Sports and Exercise*, 35(8), 1381-1395, August 2003.

[13] Sember, V., Meh, K., Sorić, M., Starc, G., Rocha, P., and Jurak, G., "Validity and reliability of International Physical Activity Questionnaires for adults across EU countries: Systematic review and meta-analysis", *International Journal of Environmental Research and Public Health*, 17(19), 7161, September 2020.

[14] Borsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., and Zuber, S., "Data resource profile: The Survey of Health, Ageing and Retirement in Europe (SHARE)", *International Journal of Epidemiology*, 42(4), 992-1001, August 2013.

[15] SHARE-ERIC - Survey of Health, Ageing and Retirement in Europe. Available: https://share-eric.eu/.

[16] Börsch-Supan, A., "Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 6. Release version: 8.0.0." SHARE-ERIC, Data set, 2022.

[17] Börsch-Supan, A., "Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 7. Release version: 8.0.0.", SHARE-ERIC, Data set, 2022.

[18] Börsch-Supan, A., "Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 8. Release version: 8.0.0.", SHARE-ERIC, Data set, 2022.

[19] Tabachnick, B.G., and Fidell, L.S., *Using multivariate statistics* (5th ed.), Allyn & Bacon, New York, 2007.

[20] Organization for Economic Co-operation and Development & World Health Organization, *Step up! Tackling the burden of insufficient physical activity in Europe*, OECD Publishing, 2023.

[21] Klepac Pogrmilovic, B., Ramirez Varela, A., Pratt, M., Milton, K., Bauman, A., Biddle, S.J.H., and Pedisic, Z., "National physical activity and sedentary behaviour policies in 76 countries: Availability, comprehensiveness, implementation, and effectiveness", *International Journal of Behavioral Nutrition and Physical Activity*, 17, 116, 2020.

[22] Smith, L., Gardner, B., Fisher, A., and Hamer, M., "Patterns and correlates of physical activity behaviour over 10 years in older adults: Prospective analyses from the English longitudinal study of ageing" *BMJ Open*, 5(4), April 2015.

[23] Skender, S., Ose, J., Chang-Claude, J., Paskow, M., Brühmann, B., Siegel, E.M., Steindorfe, K., and Ulrich, C.M., "Accelerometry and physical activity questionnaires - a systematic review", *BMC Public Health*, 16(515), June 2016.

[24] Warren, J.M., Ekelund, U., Besson, H., Mezzani, A., Geladas, N., and Vanhees, L., "Assessment of physical activity – a review of methodologies with reference to epidemiological research: A report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation", *European Journal of Cardiovascular Prevention and Rehabilitation*, 17(2), 127-139, April 2010.