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The European Journal of Public Health, Vol. 28, No. 5, 950–955

doi:10.1093/eurpub/cky086 Advance Access published on 14 May 2018

Associations between vigorous physical activity and chronic diseases in older adults: a study in 13 European countries

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Background: This study aimed to assess cross-sectional and prospective relationships between vigorous physical activity (VPA) and the risk of major chronic diseases among European older adults. **Methods:** Participants were 37 524 older adults who responded to the fourth (in 2011) and fifth (in 2013) wave of the SHARE project, from 13 European countries. Participants answered interview questions about the presence of chronic conditions and VPA. The cross-sectional and prospective association between PA and the number of chronic diseases was assessed using logistic regression models. **Results:** Among men and women, the prevalence of chronic diseases was significantly lower among those who reported VPA once a week or more than once a week. For men, VPA once a week was prospectively related with lower odds of heart attack, chronic lung disease, Parkinson's disease and Alzheimer's disease. VPA more than once a week was prospectively related with lower odds of having all chronic diseases. Women who engaged in VPA once a week presented lower odds of having chronic diseases, except for hypertension, high blood cholesterol and cancer. For VPA more than once a week, cancer was the only disease not associated with physical activity. **Conclusion:** VPA is associated with reduced risk of chronic diseases in men and women. Even the practice of VPA once a week seems to be sufficient to reduce risks of chronic diseases.

Introduction

The prevalence of chronic diseases has been growing around the world, mainly among older adults, including: heart diseases, hypertension, diabetes, cancer, obesity, and respiratory diseases.[1] As a result, chronic diseases are now the leading cause of morbidity and mortality worldwide.[2] The main factor identified as being, in part, responsible for the increasing prevalence of chronic diseases is the prevalence of physical inactivity.[3]

Physical activity can reduce chronic diseases and the risk of disease progression.[4,5] Thus, regular practice of physical activity has been recommended[6] because of its effectiveness for primary and secondary prevention of chronic diseases.[7] Even a minimum amount of physical activity has a protective health effect against chronic diseases, and it reduces mortality.[8–11]

Adults and older adults are recommended to practice at least 150 min per week of moderate to vigorous-intensity physical activity (VPA) or 75 min per week of VPA, furthermore older adults with poor mobility are suggested to perform physical activity to enhance balance and prevent falls on three or more days per week.[6] There is evidence that VPA is associated with a greater decrease in the risk of incidence of major chronic diseases than moderate-intensity physical activity.[10,12] Furthermore, VPA also improve static and dynamic daily motor tasks, which are very important for older adults.[13,14] As older adults are less likely to engage in VPA, it is important to better understand the cross-sectional and prospective relationship between VPA and the major chronic diseases among this population.

Several studies have analysed the relationship between physical activity and a particular chronic disease, not considering that a person can have several diseases.[15–17] The use of a more comprehensive approach that evaluates several diseases is needed. Furthermore, a study published recently using data from the Survey of Health, Aging and Retirement in Europe (SHARE) observed that VPA was cross-sectionally and prospectively associated with fewer reported chronic diseases.[18] This study provided general results and did not analyse the relationship between physical activity and particular chronic disease, adjusted for others diseases. Therefore, the purpose of this study was to assess the cross-sectional and prospective relationship between self-reported VPA and the risk of major chronic diseases among European older adults.

Methods

Participants and procedures

This study was based on the fourth and fifth wave of the SHARE. SHARE is an interdisciplinary and cross-national survey on aging that is run every 2 years and collects extensive information of individuals aged 50 and over in several European countries. All SHARE respondents who were interviewed in any previous wave are part of the longitudinal sample. It is fully described elsewhere.[19,20] The fourth wave data was collected in 2011 and the fifth wave in 2013; each included individuals aged 50 and over. From 58 489 participants who responded to the fourth wave in 2011, the 37 524 (64.2%) who also responded to the fifth wave were included in this study. The sample includes 16 204 (43.2%) men and 21 320 (56.8%) women from 13 countries from Scandinavia to the Mediterranean (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Netherlands, Slovenia, Spain, Sweden and Switzerland). Participants were between the ages of 50 and 102 years (66.2 ± 9.7) in 2011, and between the ages of 52 and 104 years (68.2 ± 9.7) in 2013.

Data were collected face to face by trained interviewers using a computer-assisted personal interviewing programme, supplemented by a self-completed paper-and-pencil questionnaire (available at http://www.share-project.org/methodological-research.html). Comparable questionnaires were applied in each country. Translation guidelines were applied and pilots were performed to enhance comparability. The study protocol was approved by the Ethics Committee of the University of Mannheim and by the Ethics Council of the Max-Planck-Society for the Advancement of Science.

Measures

Physical activity

Participants were asked to report their VPA practice frequency (e.g. sports, heavy housework, a job involving physical labour). The response options were: (i) more than once a week, (ii) once a week, (iii) up to three times a month and (iv) hardly ever or never. The last two response options were grouped into one category called 'less than once a week'.

Chronic diseases

Participants were asked to report whether their doctor has told them of the presence of the following conditions: heart attack or other heart problems, hypertension, high blood cholesterol, diabetes, chronic lung disease, cancer, stomach or duodenal ulcer, Parkinson's disease, hip fracture/femoral fracture, Alzheimer's disease/dementia.

Socio-demographic variables

The following elements were self-reported: age, marital status, education level, and place of residence. Marital status was classified into: married (e.g. married, partnership, co-habitating) or not married (e.g. widowed, divorced, separated or never married). Education was categorized according to the International Standard Classification of Education Degrees[21] and divided into three levels: low educational level (ISCED codes 0–2), middle educational level (ISCED codes 3 and 4) and high educational level (ISCED codes 5 and 6). Participants were asked to report whether they lived in a big city, a suburb or the outskirts of a big city, a large town, a small town, or in a rural area.

Statistical analysis

Descriptive statistics were calculated for all variables (means, standard deviation and percentages) for the entire sample, and stratified by gender. The men and women comparison at baseline (in 2011), according to participants' characteristics, was tested by Chi Square test and Independent sample *t*-test. Bivariate relationship between VPA and the presence of chronic diseases at baseline was tested by Chi-square test. The presence of chronic diseases in 2011 and VPA in 2011 entered in the cross-sectional analyses, while the presence of chronic diseases in 2013 and VPA in 2011 entered in the prospective analyses. The cross-sectional and prospective association between VPA and the presence of chronic diseases was assessed using binary logistic regression. For cross-sectional and prospective analysis, two different models were performed. Model 1 was adjusted for age, marital status, educational level, place of residence, smoking and country. Model 2 was further adjusted for the presence of all other chronic diseases. In all analysis VPA entered as categorical variable and the presence of chronic disease were tested against the practice of physical activity 'less than once a week' (reference category). All analyses were stratified by gender, because an interaction effect between gender and some chronic diseases was observed. Data analysis was performed using IBM SPSS Statistics version 24 (SPSS Inc., an IBM Company, Chicago, IL, USA). The significance level was set at $P < 0.05$.

Results

Table 1 presents the participants' characteristics at baseline. Most participants had a lower level of education (61.1%), were married (70.2%), and lived in a small town or rural areas (59.4%). The most prevalent chronic diseases were hypertension (39.2%), high blood cholesterol (23.3%), heart attack (13.2%) and diabetes (11.9%). More than half of participants reported no VPA (51%), 14.1% did once a week and 34.9% more than once a week.

The results of bivariate analysis between VPA and chronic diseases are presented in table 2. Among men and women, the prevalence of chronic diseases (heart attack, hypertension, high blood cholesterol, diabetes, chronic lung disease, cancer, stomach or duodenal ulcer, Parkinson's disease, hip fracture/femoral fracture and Alzheimer's disease) in 2011 and 2013 were significantly lower ($P < 0.001$) among those who reported the practice of VPA once a week or more than once a week.

Table 3 presents the results of the cross-sectional relationship between VPA and chronic diseases. For men, in the adjusted model for socio-demographic variables and smoking habits, engaging in VPA more than once a week was significantly associated with lower odds of having chronic diseases. When the model was further adjusted for the presence of other chronic diseases simultaneously, VPA more than once a week remained associated with lower odds of having chronic diseases when compared with those who reported VPA less than once a week. For women, the results were similar to men. However, in the adjusted model for socio-demographic variables and smoking habits, the relationship between VPA more than once a week and chronic diseases was not significantly related with cancer when compared to those who engaged in VPA less than once a week. In the further adjusted model for the presence of other chronic diseases, engaging in VPA more than once a week was not significantly associated with cancer, stomach or duodenal ulcer, and Parkinson's disease when compared with less active women.

Results of the prospective relationship between VPA and chronic diseases are presented in the table 4. In both models, compared with men who engaged in VPA less than once a week, those doing VPA more than once a week presented prospectively lower odds of having chronic diseases. For men, VPA seems to have a greater effect on Parkinson's disease (OR: 0.36, 95% CI: 0.19–0.67, $P < 0.01$) and Alzheimer's disease (OR: 0.47, 95% CI: 0.25–0.88, $P < 0.01$). Practicing VPA once a week, compared to those who do less than once a week, was prospectively related with lower odds of heart attack (OR: 0.73, 95% CI: 0.61–0.88), chronic lung disease (OR: 0.70, 95% CI: 0.55–0.90), Parkinson's disease (OR: 0.38, 95% CI: 0.17–0.84) and Alzheimer's disease (OR: 0.16, 95% CI: 0.05–0.51). In the model adjusted for socio-demographic variables and smoking habits, women who practice VPA at least once a week were prospectively less likely to have chronic diseases, except for cancer, when compared to those who do less VPA. In the fully adjusted model, women who engaged in VPA once a week, compared with those who do VPA less than once a week, presented lower odds of having chronic diseases, except for hypertension, high blood cholesterol, and cancer. As for VPA more than once a week, cancer was the only disease not associated with physical activity.

Table 1 Participants' characteristics at baseline (2011)

	% Unless otherwise stated			
	Total (n = 37 524)	Men (n = 16 204)	Women (n = 21 320)	P
Education				<0.001[a]
Low	61.1	62.7	58.9	
Middle	26.1	25.2	27.4	
High	12.8	12.1	13.8	
Age (M±SD)	66.2 ± 9.7	66.0 ± 9.4	66.3 ± 9.9	0.035[b]
Marital status				<0.001[a]
Not married	29.8	20.2	37.2	
Married	70.2	80.0	62.8	
Place of residence				<0.001[a]
Big city	13.7	12.5	14.6	
Suburbs of a big city	10.5	10.9	10.2	
Large town	16.4	15.3	17.1	
Small town	25.1	25.0	25.1	
Rural area	34.3	36.4	32.9	
Doctor said you had				
Heart attack	13.2	15.4	11.5	<0.001[a]
Hypertension	39.2	37.9	40.2	<0.001[a]
High blood cholesterol	23.3	22.4	24.1	<0.001[a]
Diabetes	11.9	13.1	11.0	<0.001[a]
Chronic lung disease	6.5	6.9	6.2	0.005[a]
Cancer	5.1	4.9	5.2	0.158[a]
Stomach or duodenal ulcer	5.6	5.8	5.4	0.123[a]
Parkinson's disease	0.6	0.8	0.5	0.002[a]
Hip fracture/femoral fracture	2.2	2.0	2.4	0.007[a]
Alzheimer's disease/dementia	1.1	1.0	1.1	0.140[a]
VPA				<0.001[a]
Less than once a week	51.0	45.4	55.2	
Once a week	14.1	14.0	14.2	
More than once a week	34.9	40.6	30.6	

Abbreviation: M, mean; SD, standard deviation; PA, physical activity.
a: Tested by Chi Square.
b: Tested by *t*-test.

Discussion

The purpose of this study was to investigate the cross-sectional and prospective associations between self-reported VPA and the risk of major chronic diseases in European older adults. It was found that VPA was associated with a reduced risk of chronic diseases. One of the most relevant findings was that even one session of VPA per week was cross-sectionally and prospectively associated with lower odds of having chronic diseases such as heart attack, chronic lung disease, Parkinson's disease and Alzheimer's disease among both men and women. Practicing VPA more than once per week further increased the number of chronic diseases that were negatively associated with VPA.

These results provide additional support for the documented inverse relationship between physical activity and cardiovascular, metabolic and mental chronic diseases.[4,10,11,22] The results also support that older people benefit from engaging in VPA, as observed previously,[22–24] regardless of adherence to prevailing physical activity guidelines.

The fact that the practice of VPA once a week was cross-sectionally and prospectively associated with lower odds of having some chronic diseases among men and women (e.g. heart attack, chronic lung disease, Parkinson's disease and Alzheimer's disease) reinforces the evidence that even a single weekly bout of exercise of high intensity may reduce the risk of chronic disease or cardiovascular death.[25–27] This fact is a message of hope for those who are unable to fulfil the recommendation for regular practice of physical activity, as being physically active, even below the recommended levels, still carries beneficial health effects. Moreover, if those who are physically inactive resolve to participate in VPA, at least once a week, they will collect its health benefits, regardless of their past sedentary behaviour.[18]

Although the analysis was stratified by gender, it was interesting to observe that cross-sectionally and prospectively VPA had the same effect on heart attack, chronic lung disease, Parkinson's disease and Alzheimer's disease among men and women. On the other hand, VPA once a week was cross-sectionally related to hypertension and high blood cholesterol in women, but not in men. This suggests that the gender has a moderating effect in some chronic diseases.[28,29]

In spite of the benefits of physical activity, its levels among older people are low.[14] Due to a multitude of health problems; older adults hardly achieved the recommended levels of physical activity. Therefore, the implementation of programmes that promote participation in MPA, but mainly VPA, may be considered as a strategy to reduce the number of chronic diseases in the older population.

Table 2 Relationship between VPA and chronic diseases, by gender and year (2011 and 2013)

	2011				2013			
Doctor said you had (yes)	**Less than once a week**	**Once a week**	**More than once a week**	***P***	**Less than once a week**	**Once a week**	**More than once a week**	***P***
	Men (%)							
Heart attack	20.9	11.1	10.7	<0.001	18.5	11.1	10.1	<0.001
Hypertension	42.3	38.5	32.9	<0.001	43.5	40.2	35.2	<0.001
High blood cholesterol	25.2	22.5	19.1	<0.001	22.2	21.7	19.0	<0.001
Diabetes	16.8	12.2	9.2	<0.001	17.8	14.0	10.5	<0.001
Chronic lung disease	9.7	5.5	4.4	<0.001	9.2	5.8	4.4	<0.001
Cancer	6.3	4.5	3.5	<0.001	6.1	4.3	3.4	<0.001
Stomach or duodenal ulcer	6.9	4.7	4.8	<0.001	4.2	2.7	2.5	<0.001
Parkinson's disease	1.3	0.3	0.3	<0.001	1.7	0.4	0.5	<0.001
Hip fracture/femoral fracture	2.8	1.2	1.3	<0.001	1.9	1.0	0.8	<0.001
Alzheimer's disease/dementia	1.7	0.3	0.3	<0.001	2.9	0.4	0.7	<0.001
	Women (%)							
Heart attack	15.1	7.7	6.7	<0.001	13.5	6.9	5.7	<0.001
Hypertension	45.3	37.7	32.2	<0.001	46.8	39.2	34.5	<0.001
High blood cholesterol	27.1	20.8	20.3	<0.001	26.6	21.5	20.3	<0.001
Diabetes	14.0	8.2	6.8	<0.001	15.1	9.1	7.8	<0.001
Chronic lung disease	7.6	4.5	4.6	<0.001	7.3	4.6	4.1	<0.001
Cancer	6.0	4.0	4.5	<0.001	4.8	3.3	3.4	<0.001
Stomach or duodenal ulcer	6.1	4.1	4.7	<0.001	4.5	2.7	3.0	<0.001
Parkinson's disease	0.8	0.1	0.1	<0.001	1.1	0.3	0.3	<0.001
Hip fracture/femoral fracture	3.2	1.2	1.2	<0.001	2.8	0.8	0.9	<0.001
Alzheimer's disease/dementia	1.6	0.4	0.3	<0.001	2.7	0.7	0.5	<0.001

Tested by Chi Square.

Table 3 Cross-sectional parameters estimates the association of VPA and chronic diseases

	Model 1. OR (95% CI)		Model 2. OR (95% CI)	
Doctor said you had (in 2011)	**Once a week**	**More than once a week**	**Once a week**	**More than once a week**
	Men			
Heart attack	0.62 (0.52–0.74)	0.55 (0.48–0.62)	0.65 (0.54–0.78)	0.61 (0.54–0.70)
Hypertension	0.94 (0.83–1.06)	0.74 (0.67–0.81)	0.99 (0.87–1.13)	0.82 (0.75–0.91)
High blood cholesterol	0.90 (0.78–1.03)	0.71 (0.64–0.79)	0.99 (0.85–1.14)	0.84 (0.75–0.94)
Diabetes	0.79 (0.66–0.94)	0.58 (0.51–0.66)	0.83 (0.69–0.99)	0.65 (0.57–0.74)
Chronic lung disease	0.61 (0.48–0.79)	0.49 (0.40–0.59)	0.66 (0.51–0.84)	0.53 (0.44–0.64)
Cancer	0.90 (0.68–1.18)	0.72 (0.58–0.89)	0.77 (0.72–1.27)	0.79 (0.64–0.98)
Stomach or duodenal ulcer	0.55 (0.41–0.73)	0.56 (0.47–0.69)	0.58 (0.34–0.79)	0.63 (0.51–0.76)
Parkinson's disease	0.35 (0.14–0.88)	0.34 (0.18–0.64)	0.38 (0.15–0.96)	0.36 (0.19–0.67)
Hip fracture/femoral fracture	0.49 (0.29–0.80)	0.47 (0.34–0.67)	0.52 (0.31–0.86)	0.51 (0.36–0.72)
Alzheimer's disease/dementia	0.23 (0.07–0.74)	0.39 (0.21–0.72)	0.26 (0.08–0.84)	0.47 (0.25–0.88)
	Women			
Heart attack	0.54 (0.46–0.65)	0.57 (0.50–0.66)	0.61 (0.51–0.73)	0.66 (0.57–0.75)
Hypertension	0.81 (0.73–0.90)	0.68 (0.63–0.74)	0.90 (0.81–1.00)	0.76 (0.70–0.83)
High blood cholesterol	0.79 (0.70–0.89)	0.75 (0.68–0.82)	0.87 (0.77–0.99)	0.86 (0.78–0.94)
Diabetes	0.65 (0.55–0.77)	0.53 (0.47–0.61)	0.73 (0.61–0.86)	0.61 (0.53–0.70)
Chronic lung disease	0.60 (0.48–0.75)	0.69 (0.59–0.81)	0.67 (0.54–0.84)	0.76 (0.65–0.90)
Cancer	0.71 (0.56–1.00)	0.85 (0.72–1.01)	0.75 (0.59–1.00)	0.89 (0.75–1.06)
Stomach or duodenal ulcer	0.67 (0.53–0.85)	0.77 (0.65–0.92)	0.77 (0.61–0.98)	0.87 (0.74–1.04)
Parkinson's disease	0.08 (0.12–0.61)	0.44 (0.22–0.88)	0.10 (0.01–0.71)	0.51 (0.26–1.03)
Hip fracture/femoral fracture	0.50 (0.33–0.75)	0.60 (0.45–0.81)	0.53 (0.35–0.80)	0.63 (0.47–0.85)
Alzheimer's disease/dementia	0.27 (0.11–0.68)	0.25 (0.12–0.52)	0.28 (0.11–0.69)	0.25 (0.12–0.51)

Abbreviation: OR, odds ration; CI, confidence interval.
Model 1: Analyses were adjusted for age, marital status, educational level, place of residence, smoking, and country. Model 2: Analyses were adjusted for age, marital status, educational level, place of residence, smoking, country, and the presence of others chronic diseases. Physical activity ''less than once a week'' was the reference category.

Furthermore, as even the practice of VPA once a week seems to have health benefits, it could be of interest for future studies to investigate the minimum amount of VPA for reduced odds of having chronic diseases in older adults. VPA is associated with lower risk mortality in adults and older adults regardless age.[30] Therefore, future studies have to analyse if the impact of VPA on chronic disease is also the same in adults and older adults.

This study has some limitations. The main limitation is the lack, or the shortage, of information on physical activity type, duration and frequency, which limits a more precise calculation of physical activity volume. Chronic diseases and physical activity were self-reported which is susceptible to bias, and the measurement of VPA includes only frequency, but not duration making it impossible to evaluate adherence to the guidelines. However, self-reported

Table 4 Prospective parameters estimate the association of VPA and chronic diseases

	Model 1. OR (95% CI)		Model 2. OR (95% CI)	
Doctor said you had (in 2013)	**Once a week**	**More than once a week**	**Once a week**	**More than once a week**
	Men			
Heart attack	0.69 (0.58–0.83)	0.62 (0.54–0.70)	0.73 (0.61–0.88)	0.69 (0.60–0.79)
Hypertension	0.92 (0.81–1.04)	0.76 (0.69–0.83)	0.97 (0.86–1.11)	0.84 (0.77–0.93)
High blood cholesterol	0.85 (0.74–0.98)	0.72 (0.65–0.80)	0.90 (0.78–1.05)	0.83 (0.75–0.93)
Diabetes	0.88 (0.74–0.104)	0.62 (0.54–0.70)	0.94 (0.79–1.12)	0.69 (0.61–0.79)
Chronic lung disease	0.66 (0.52–0.85)	0.53 (0.44–0.64)	0.70 (0.55–0.90)	0.58 (0.48–0.70)
Cancer	0.86 (0.65–1.15)	0.67 (0.54–0.84)	0.93 (0.70–1.23)	0.75 (0.60–0.93)
Stomach or duodenal ulcer	0.63 (0.44–0.90)	0.50 (0.38–0.65)	0.70 (0.49–1.01)	0.59 (0.45–0.77)
Parkinson's disease	0.36 (0.17–0.79)	0.36 (0.21–0.60)	0.38 (0.17–0.84)	0.36 (0.21–0.61)
Hip fracture/femoral fracture	0.69 (0.40–1.18)	0.60 (0.40–0.89)	0.72 (0.42–1.23)	0.65 (0.44–0.97)
Alzheimer's disease/dementia	0.15 (0.05–0.46)	0.53 (0.34–0.83)	0.16 (0.05–0.51)	0.61 (0.39–0.95)
	Women			
Heart attack	0.58 (0.48–0.70)	0.57 (0.48–0.64)	0.64 (0.53–0.77)	0.63 (0.55–0.73)
Hypertension	0.84 (0.76–0.93)	0.72 (0.67–0.78)	0.92 (0.83–1.03)	0.80 (0.74–0.87)
High blood cholesterol	0.83 (0.74–0.94)	0.78 (0.71–0.85)	0.92 (0.82–1.04)	0.90 (0.82–0.99)
Diabetes	0.64 (0.55–0.76)	0.55 (0.48–0.62)	0.71 (0.60–0.84)	0.62 (0.54–0.71)
Chronic lung disease	0.69 (0.55–0.86)	0.61 (0.51–0.72)	0.75 (0.60–0.94)	0.66 (0.56–0.79)
Cancer	0.72 (0.55–0.93)	0.85 (0.70–1.03)	0.77 (0.59–1.01)	0.91 (0.75–1.11)
Stomach or duodenal ulcer	0.57 (0.42–0.76)	0.70 (0.57–0.85)	0.64 (0.48–0.86)	0.79 (0.65–0.97)
Parkinson's disease	0.20 (0.06–0.64)	0.53 (0.30–0.94)	0.21 (0.07–0.67)	0.54 (0.31–0.97)
Hip fracture/femoral fracture	0.41 (0.25–0.67)	0.52 (0.37–0.73)	0.45 (0.28–0.74)	0.56 (0.40–0.80)
Alzheimer's disease/dementia	0.48 (0.28–0.83)	0.43 (0.27–0.69)	0.51 (0.29–0.89)	0.45 (0.28–0.72)

Abbreviation: OR, odds ratio; CI, confidence interval.
Model 1: Analyses were adjusted for age, marital status, educational level, place of residence, smoking and country. Model 2: Analyses were adjusted for age, marital status, educational level, place of residence, smoking, country and the presence of others chronic diseases in 2011. Physical activity ''less than once a week'' was the reference category.

physical activity is considered a reliable method for epidemiologic studies,[31] and is still the backbone of surveillance studies.[32] The follow-up was shorter than that of previous prospective studies.[10,22,27]

The current investigation also had its strengths. A major strength of this study was the SHARE database that includes a large and representative sample size of various European countries, as well as several socio-demographic characteristics of the study sample. Another strength, considering the sample size and the heterogeneity of the participants, is the generality of these results. Furthermore, due to the large sample, there was an adequate statistical power. Prospective analysis allows for the examination of the cause and effect relationship between VPA and chronic diseases.

In conclusion, results from this large and statistically powerful study suggest that VPA is associated with a reduced risk of chronic diseases in men and women. Even the practice of VPA once a week seems to be sufficient to reduce the risk of chronic diseases.

Acknowledgements

The authors thank Professor Bruce Jones for revising the document.

Conflicts of interest: None declared.

Key points

- There is evidence that vigorous-intensity physical activity (VPA) is associated with a greater decrease in the risk of incidence of major chronic diseases than moderate-intensity physical activity.
- VPA per week is associated with lower odds of having chronic diseases such as heart attack, chronic lung disease, Parkinson's disease, and Alzheimer's disease among both men and women.
- Even the practice of VPA once a week seems to be sufficient to reduce the risk of chronic diseases, regardless of adherence to prevailing physical activity guidelines.

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The European Journal of Public Health, Vol. 28, No. 5, 955–961

doi:10.1093/eurpub/cky113 Advance Access published on 9 July 2018

Mediterranean diet and health outcomes: a systematic meta-review

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Background: The Mediterranean diet (MeDi) is considered a healthy dietary pattern, and greater adherence to this diet may improve health status. It also may reduce the social and economic costs of diet-related illnesses. This meta-review aims to summarize, synthesize and organize the effects of MeDi pattern on different health outcomes. **Methods:** This meta-review was performed following the PRISMA guidelines. A systematic search was conducted in the electronic databases PubMed, Web of Science and Scopus. Two researchers screened all the records to eliminate any duplicate, and they selected the articles to be fully reviewed. A third researcher was consulted to resolve discrepancies and so reach a consensus agreement. **Results:** Thirty-three articles were included, nine were systematic reviews and twenty-four were meta-analyses. Most of the diseases analysed are catalogued as non-communicable diseases (NCD), and the impact of these in populations may have major financial consequences for healthcare spending and national income. The results showed that the MeDi may improve health status, and it also may reduce total lifetime costs. **Conclusion:** MeDi has been shown to be a healthy dietary pattern that may reduce risk related to NCD. The effect is larger if the pattern is combined with physical activity, and tobacco and excessive alcohol consumption are avoided. Promoting the MeDi as a healthy dietary pattern presents challenges which need the collaboration of all levels of society.

Introduction

Diet and nutrition are important factors in the promotion and maintenance of good health throughout the entire life course,[1] and should be promoted jointly with physical activity,[2] and the avoidance of other risk factors like tobacco and excessive alcohol consumption.[3] The social and economic costs of diet-related