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Distribution and determinants of sedentary lifestyles in the European Union

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Background Many studies have shown the health burden of a sedentary lifestyle. The main goal of this study was to determine the prevalence of sedentary lifestyles in the 15 Member States of the European Union (EU) and to identify the main correlates of a sedentary lifestyle.

Methods Nationally representative samples (n ≈ 1000 subjects in each country; >15 years) completed a questionnaire concerning attitudes to physical activity, body weight, and health; in total 15 239 subjects. Sedentary people were defined in two ways: (1) those expending less than 10% of their leisure time expenditure in activities involving ⩾4 metabolic equivalents (MET). (2) Those who did not practice any leisure-time physical activity and who also were above the median in the number of hours spent sitting down during leisure time. Logistic regression models were fitted to analyse the association between sedentary lifestyles and gender, age, body mass index (BMI), educational level, weight change in the last 6 months, and marital and smoking status.

Results Percentages of sedentary lifestyles across European countries ranged between 43.3% (Sweden) and 87.8% (Portugal) according to the first definition. According to both definitions, a lower prevalence of sedentary lifestyle was found in Northern countries (especially Scandinavian countries) as compared with Mediterranean countries, whereas the prevalence was higher among older, obese, less educated, widowed/divorced individuals, and current smokers. Similar relative differences between countries and socio-demographic groups were found independently of the method used to define a sedentary lifestyle.

Conclusion Prevalence of sedentary lifestyle in the EU is high, especially among inhabitants of some Mediterranean countries, obese subjects, less-educated people, and current smokers. This high prevalence involves important public health burdens and preventive strategies are urgently needed.

Keywords Physical activity, sedentary lifestyle, body mass index, Europe

Among unhealthy lifestyles, smoking and the lack of regular physical activity are of major importance in public health because they are highly prevalent and potentially modifiable.[1]

Physical inactivity has been related to all-cause mortality,[2–6] to lower quality of life,[7–12] and to a higher risk of obesity, diabetes, hypertension, coronary heart disease, osteoporosis, fractures, colon cancer, breast cancer, prostate cancer, psychiatric disorders,[2,5,10–19] and an overall higher risk of hospitalization.[20]

In spite of its importance, there is a scarcity of international epidemiological studies assessing the prevalence of sedentary lifestyles. In addition, the definition of a sedentary lifestyle is not a simple task. Up to now, the approach to the problem of assessing the prevalence of sedentary lifestyles in populations

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has faced two important barriers. The first one is the lack of a clear and universal definition of a sedentary lifestyle. Some authors have tried to determine the prevalence of sedentary lifestyles analysing the number of hours that individuals spend sitting down in a typical day, or the number of hours expended walking or in other specific physical activities. Other researchers have investigated the energy expended climbing stairs, or how many times a week they participated in an activity that induced sweating. All these measurements lack specificity and could lead to ambiguity as they are not complete. A second barrier is that previous studies have not assessed geographical variations across large areas. A cross-sectional study reported the prevalence of 'sedentarism' in Geneva (Switzerland), and also proposed a new definition for 'sedentarism', using a measure of low-energy expenditure (LEE),[21] but, to our knowledge, there are no previous international representative studies determining the prevalence of a sedentary lifestyle in the adult population all over Europe.

In order to improve existing knowledge about the distribution and determinants of a sedentary lifestyle, further investigations are needed. These investigations should incorporate: (1) definitions of 'sedentarism' based in a more detailed quantitative assessment of energy expenditure (i.e. metabolic equivalents or MET-h/wk); and (2) standardized instruments devised to assess this issue homogeneously across different countries.

Taking into account these two issues, our aim was to determine the prevalence of a sedentary lifestyle in the 15 Member States of the European Union (EU). Another objective was to study two alternative definitions of a sedentary lifestyle and analyse differences in the prevalence of a sedentary lifestyle according to the geographical distribution of participants and to some socio-demographic variables, such as gender, age, marital status, and the highest educational level attained.

Methods

The methods used to conduct this cross-sectional study have been described elsewhere.[22–24] Nationally representative samples of approximately 1000 subjects (individuals >15 years) were recruited from each member state of the EU, using multistage stratified cluster sampling with quotas applied on samples in each country, to ensure they were nationally representative. Quotas were defined in each country based on demographic factors using the most recent census data available. In total, 15 239 subjects were surveyed, and completed an interview-assisted face-to-face questionnaire, that was translated into all relevant European languages. Interviews in all countries were completed between March and April 1997. The questionnaire included 12 closed-ended questions about attitudes to physical activity, body weight, and health. In addition further information was requested in the questionnaire from respondents on several socio-demographic characteristics (gender, age, education level, marital and smoking status, weight changes in the last 6 months …).

Leisure-time physical activity was calculated by asking participants to report their average weekly participation in various physical activities including: athletics, cycling, dancing, equestrian sports, fishing, football, gardening, golf, hill-walking, climbing, aerobics, jogging, martial arts, racquet sports, rowing, canoeing, skiing, skating, swimming, team sports, water sports, and walking. Information about leisure-time sedentary activities (number of hours sitting down) was also requested from participants, as well as the lack of any physical activity.

To quantify the amount of physical activity, metabolic equivalents (MET) was used; the number of hours spent participating in each activity was multiplied by the MET score[25,26] specific to each activity, thus obtaining the weekly amount of physical activity in MET-hours. Metabolic equivalents represent the ratio of energy expended during a physical activity to the metabolic rate of sitting quietly, and are independent of body weight.

The above mentioned study that analysed the prevalence of a sedentary lifestyle in an urban population in Switzerland[21] proposed a new definition for 'sedentarism' based on LEE. Taking into account their proposal, we considered two alternative definitions of sedentary people. The first definition (LEE) classified as sedentary individuals those who expended less than 10% of their leisure-time energy expenditure in activities requiring ⩾4 MET (all activities included in the questionnaire except golf, gardening, and fishing). Walking requires 4.5 MET according to the above referenced compendium.[25,26] The ratio between the amount of leisure-time energy expenditure involved in activities using ⩾4 MET and the total energy expenditure in leisure time was used to assess the relative degree of exposure to a sedentary lifestyle for each participant in the study. When this ratio was lower than 0.1 i.e. when the participant expended <10% of his/her leisure-time physical activity in activities using ⩾4 MET, he/she was classified as '*sedentary*'. Whereas, subjects whose ratio was >0.1 were classified as '*active*'.

However, we considered that the overall time that a subject spends sitting down during leisure-time provides a quantitative indicator that should be also taken into account in a definition of 'sedentariness'. In fact, the original meaning of the word 'sedentary' is related to the higher propensity to be sitting down. In the third National Health and Nutrition Examination Survey (NHANES III)[27] participants who reported no participation in any leisure-time physical activity during the last month were classified as 'physically inactive'. Therefore, taking into account both the original meaning of the word 'sedentary' and the definition used by NHANES III we built a second definition that required these two criteria (no participation in activities and long time sitting down, NP + LSD) and classified as sedentary those individuals who did not practice any physical activity during their leisure time AND in addition spent a total number of hours sitting down higher than the median (6 h/wk) of the distribution of hours sitting down a week during leisure time for all participants.

Overall and specific percentages of sedentary people and their 95% CI were calculated for each European country. We studied the distribution of sedentary lifestyle across strata of socio-demographic characteristics (country of origin, gender, age, educational level, and marital status), and also by categories of body mass index (BMI), smoking status, and body weight change during the last 6 months. The Pearson χ^2 test and a linear trend test were used to assess statistical significance.

We fitted logistic regression models with 'sedentary lifestyle' as the dependent variable and gender, age, BMI, educational level, weight change in the last 6 months, and marital and smoking status as independent factors by means of indicator variables for those variables with more than two categories. We ran these analyses using both definitions of sedentary lifestyle.

The models were adjusted for country and for age, adding a quadratic term to account for non-linear relationships. Effect modifications (multiplicative interactions) were assessed introducing product-terms in the fully adjusted logistic models; *P*-values < 0.05 were considered significant.

Results

Table 1 shows the percentage of sedentary people in the EU according to some socio-demographic variables, and their distribution by gender. Similar overall percentages of sedentary people were found for both men and women (62.4%) when we used the first definition (LEE), although women (15.6%) showed a higher prevalence of sedentary lifestyle than men (14.5%) when measured by the second definition (NP + LSD).

Individuals with normal BMI (20–25 kg/m^2) or low BMI (<20 kg/m^2), showed the lowest prevalence of a sedentary lifestyle in both genders. On the other hand, obese people (BMI >30 kg/m^2) were more sedentary according to both definitions.

Participants belonging to primary level education group were more sedentary than those with higher levels of education, with greater differences among women. Thus, percentages ranged between 54.5% (LEE definition) or 10.6% (NP + LSD) in women with university-level education to 69.6% (21.8%) in women attaining only primary educational level. Interactions between educational level and gender were analysed, but the association was not significant ($P = 0.15$ for the multiplicative term in the multivariate logistic model). Smokers showed higher percentages of sedentary lifestyle than non-smokers or ex-smokers.

Table 2 reports the total number and percentage of sedentary people in each of the 15 Member States of the EU, together with the distribution by gender. The lowest percentage of sedentary people was found among Swedish women (39.9%, LEE definition), and the highest percentage in Portuguese women, with 90% of sedentary people. This means that according to the first definition (LEE), only 10% of Portuguese women can be considered as active people. Comparing both genders, we usually found higher percentages of sedentary lifestyle among men than among women in most countries with lower levels of sedentary lifestyle (Sweden, Ireland, Austria, Finland, and The Netherlands). Conversely, women tended to be more sedentary in countries with higher overall percentages of sedentary people.

Results of the multivariable analysis for both definitions are shown in Table 3 for men and Table 4 for women. In men, following the first definition (LEE), obese (odds ratio [OR] = 1.37; 95% CI: 1.14–1.65) and lean (OR = 1.25; 95% CI: 1.01–1.56) people showed statistically significant higher levels of sedentary lifestyle than men with normal weight (reference group). Similar results were found in women, where higher levels of sedentary lifestyle were found in obese (OR = 1.35; 95% CI: 1.14–1.60) and lean (OR = 1.15; 95% CI: 1.00–1.32) people compared with those with normal weight (reference group). Among women also, overweight participants (OR = 1.19; 95% CI: 1.06–1.34) seemed to be more sedentary than the reference group.

A higher educational level (secondary or third level) was significantly associated with a lower level of sedentary lifestyle both among men and women.

No significant association was found between a sedentary lifestyle and marital status among men. In contrast, married (or cohabiting) women, or those widowed or divorced showed a higher prevalence of a sedentary lifestyle.

Both in men and women, smokers showed a statistically higher prevalence of a sedentary lifestyle than non-smokers.

Comparing the sedentary lifestyle indexes according to weight changes in the last 6 months, we only found a statistically significant association for men; those men who lost weight in the last 6 months showed lower levels of sedentary lifestyle than those who had kept the same weight.

Results of the multivariable analysis for the second definition (NP + LSD) were very similar to what we found using the first definition (LEE). In men, obese people (OR = 1.53; 95% CI: 1.22–1.93), those attaining only primary level education (OR = 1.72; 95% CI: 1.39–2.14), widowed or divorced people (OR = 1.36; 95% CI: 1.03–1.80), and smokers (OR = 1.90; 95% CI: 1.63–2.22) showed a statistically significant higher prevalence of sedentary lifestyles.

Among women, a significantly higher prevalence of a sedentary lifestyle was found among obese women (OR = 1.53; 95% CI: 1.25–1.88), among those who achieved only primary level education (OR = 1.71; 95% CI: 1.37–2.13), among widowed and divorced participants (OR = 1.64; 95% CI: 1.31–2.04), and among smokers (OR = 1.61; 95% CI: 1.39–1.86).

When we also adjusted the models for 'country' (using both definitions of a sedentary lifestyle), the results of the logistic regressions shown in Tables 3 and 4 did not substantially change.

Discussion

The purpose of the present study was to estimate the prevalence of sedentary lifestyle in the EU, and to explore the socio-demographic conditions that determine this prevalence. This survey appears to be the first attempt to comprehensively analyse sedentary lifestyle all over Europe, with nationally representative samples of the population >15 years.

Other previous studies estimating the prevalence of physical inactivity have not used representative samples of the European population due to their local approach or to the selection of individuals from specific population groups,[21,28–32] although they have provided important contributions to the investigation on physical inactivity.

The prevalence of sedentary lifestyle with our first definition (LEE) ranged between 54.5% and 71% across subgroups, and between 43.3% and 87.8% across countries. A recent report based in the results from the US, NHANES III[27] showed that the prevalence of physical inactivity in the US was about 23%. This result is markedly different to the prevalence of inactivity shown here, but unfortunately both results are not directly comparable, since the measurement of physical activity was carried out in very different ways, and the criteria used for the definition of 'inactivity' or 'a sedentary lifestyle' also differed. In NHANES III, the definition of sedentary was based in reporting no participation in any leisure-time physical activity. This definition is more similar to NP + LSD. Accordingly, when we used the NP + LSD definition, our results tended to be more similar to the US estimates, although they still were different. The application of varying measures and protocols to estimate prevalence of physical activity/inactivity makes results difficult to compare and interpret, since large differences in estimates are obtained.[33–35] When we used MET-h/wk to assess leisure-time physical

Table 1 Percentage of sedentary people in the European Union taking into account two definitions for sedentary people (low energy expenditure [LEE], and no participation in activities and long time sitting down [NP + LSD]), according to gender, age, body mass index (BMI) category, educational level, marital status, smoking status, and recent weight change

		Percentage of sedentary people (95% CI)					
		According to LEE criteria[a]			According to NP + LSD criteria[b]		
	N	Total	Men	Women	Total	Men	Women
Gender							
Men	7155	62.4 (61.2–63.5)			14.5 (13.7–15.3)		
Women	8077	62.4 (61.3–63.5)			15.6 (14.8–16.4)		
Age (years)							
15–24	2634	60.9 (59.1–62.8)	60.5 (57.9–63.2)	61.3 (58.6–63.9)	9.4 (8.3–10.6)	7.5 (6.2–9.1)	11.3 (9.7–13.1)
25–34	3079	63.3 (61.6–65.0)	64.8 (62.3–67.3)	61.9 (59.5–64.2)	13.3 (12.2–14.6)	14.5 (12.8–16.4)	12.3 (10.7–13.9)
35–44	2917	61.7 (60.0–63.5)	61.6 (59.0–64.2)	61.8 (59.4–64.2)	12.8 (11.6–14.1)	12.6 (10.9–14.5)	13.0 (11.4–14.7)
45–54	2526	61.3 (59.4–63.2)	64.0 (61.2–66.8)	59.2 (56.6–61.7)	14.8 (13.5–16.3)	15.5 (13.5–17.7)	14.3 (12.6–16.2)
55–64	2165	61.1 (59.0–63.1)	60.5 (57.5–63.5)	61.5 (58.6–64.3)	17.6 (16.0–19.3)	18.0 (15.8–20.4)	17.2 (15.0–19.5)
65+	1914	67.0 (64.8–69.1)***	62.4 (59.2–65.5)	71.2 (68.4–73.9)***	26.4 (24.5–28.4)***	21.9 (19.3–24.6)***	30.6 (27.8–33.5)***
BMI (kg/m^2)							
<20	1650	63.8 (61.4–66.1)	66.8 (62.2–71.2)	62.7 (59.9–65.3)	12.7 (11.1–14.3)	13.6 (10.6–17.2)	12.3 (10.6–14.3)
20–25	7354	60.2 (59.0–61.3)	60.8 (59.2–62.4)	59.6 (58.0–61.1)	13.6 (12.8–14.4)	13.3 (12.2–14.5)	13.9 (12.8–15.0)
25–30	4651	63.6 (62.2–65.0)	62.3 (60.4–64.2)	65.2 (63.1–67.2)	15.9 (14.8–16.9)	14.5 (13.2–15.9)	17.5 (16.0–19.2)
>30	1416	67.5 (65.0–69.9)***	67.2 (63.5–70.8)***	67.7 (64.4–70.9)***	21.7 (19.6–23.9)***	21.0 (18.0–24.4)***	22.2 (19.4–25.2)***
Educational level							
Third level/university	2658	55.9 (54.1–57.8)	57.3 (54.7–60.0)	54.5 (51.8–57.2)	10.3 (9.2–11.5)	10.1 (8.6–11.8)	10.6 (9.1–12.4)
Secondary level	7777	60.8 (59.7–61.9)	61.3 (59.7–62.9)	60.4 (58.9–61.9)	13.2 (12.4–13.9)	13.0 (11.9–14.1)	13.3 (12.3–14.4)
Primary level	4768	68.6 (67.3–69.9)***	67.4 (65.4–69.3)***	69.6 (67.8–71.4)***	20.8 (19.7–22.0)***	19.7 (18.0–21.4)***	21.8 (20.2–23.4)***
Marital status							
Single	4794	59.8 (58.5–61.2)	61.3 (59.4–63.1)	58.2 (56.2–60.3)	11.9 (11.0–12.8)	11.7 (10.5–13.0)	12.1 (10.8–13.5)
Married/cohabiting	8763	62.5 (73.0–74.9)	62.5 (61.1–64.0)	62.5 (61.2–63.9)	14.8 (14.1–15.6)	15.1 (14.1–16.3)	14.6 (13.6–15.6)
Widowed/divorced	1675	69.0 (66.7–71.1)***	66.7 (62.4–70.9)†	69.8 (67.2–72.4)***	25.3 (23.2–27.4)***	23.4 (19.8–27.4)***	25.9 (23.5–28.5)***
Smoking status							
Non-smoker	8108	60.4 (59.6–61.3)	58.2 (56.8–59.6)	61.9 (60.8–63.1)	13.3 (12.5–14.0)	10.7 (9.7–11.8)	15.0 (14.0–16.0)
Ex-smoker	1920	59.6 (57.8–61.5)	60.4 (57.9–62.7)	58.6 (55.7–61.5)	13.2 (11.8–14.8)	13.9 (12.0–16.1)	12.3 (10.1–14.7)
Smoker	5159	66.6 (65.5–67.6)***	68.1 (66.6–69.5)***	64.7 (63.1–66.3)**	18.6 (17.5–19.6)***	19.1 (17.7–20.6)***	18.0 (16.5–19.6)***
Weight change in the last 6 months							
Same weight	9123	62.2 (61.3–63.2)	62.5 (61.1–63.8)	62.0 (60.6–63.4)	15.0 (14.3–15.7)	12.2 (10.3–14.4)	15.6 (14.6–16.7)
Lost weight	2423	59.3 (57.3–61.3)	59.7 (56.5–62.7)	59.1 (56.6–61.6)	13.3 (12.0–14.7)	14.4 (13.4–15.4)	14.1 (12.4–15.9)
Gained weight	3357	63.4 (61.8–65.1)***	62.3 (59.7–64.9)	64.2 (61.1–66.3)**	15.3 (14.1–16.5)†	15.2 (13.3–17.2)	15.3 (13.8–16.9)

[a] LEE criteria = Low energy expenditure criteria considered as 'sedentary' individuals expending <10% of their leisure-time expenditure in activities requiring ⩾4 metabolic equivalents (MET). Otherwise they were considered as 'active'.

[b] NP + LSD criteria = No participation in activities + long time sitting down criteria considered as 'sedentary' individuals who did not practice any physical activity during their leisure time and in addition spent a total number of hours sitting down higher than the median (6 h/wk) of the distribution of hours sitting down a week for all participants. Otherwise they were considered as 'active'.

P-values for Pearson χ^2 test and linear trend test; † $P = 0.05$–0.10; * $P = 0.01$–0.05; ** $P = 0.01$–0.001; *** $P < 0.001$.

Table 2 Percentage of sedentary people and 95% CI in each of the 15 Member States of the European Union. Two definitions: (low energy expenditure [LEE], and no participation in activities and long time sitting down [NP + LSD])

		LEE[a]			NP + LSD[b]		
Country	n	Total	Men	Women	Total	Men	Women
Sweden	1001	43.3 (40.2–46.3)	48.1 (43.4–52.9)	39.7 (35.7–43.7)	6.4 (5.0–8.0)	9.4 (6.9–12.4)	4.2 (2.8–6.1)
Ireland	1001	44.1 (41.0–47.1)	47.6 (43.2–52.0)	40.6 (36.3–44.9)	7.4 (5.9–9.1)	7.4 (5.4–10.0)	7.4 (5.3–9.9)
Austria	931	46.8 (43.6–50.4)	48.5 (43.7–53.4)	45.5 (41.2–49.8)	7.9 (6.3–9.8)	8.0 (5.7–11.0)	7.9 (5.8–10.4)
Finland	979	48.6 (45.5–51.8)	53.6 (49.1–58.1)	44.0 (39.8–48.4)	6.2 (4.8–7.9)	6.6 (4.6–9.2)	5.9 (4.1–8.2)
Luxembourg	518	57.5 (53.2–61.7)	56.1 (49.6–62.5)	58.3 (52.5–64.0)	9.8 (7.5–12.6)	12.7 (8.9–17.5)	7.4 (4.8–10.9)
UK	1490	59.4 (56.9–61.9)	59.4 (55.7–63.1)	59.4 (56.0–62.7)	16.6 (14.8–18.5)	14.9 (12.4–17.7)	18.0 (15.5–20.7)
Denmark	1147	61.4 (58.5–64.2)	61.3 (57.20–65.3)	61.4 (57.5–65.3)	16.5 (14.4–18.7)	15.6 (12.7–18.8)	17.3 (14.5–20.5)
Netherlands	1010	62.0 (59.0–64.9)	62.6 (58.2–66.9)	61.4 (57.2–65.5)	14.4 (12.3–16.6)	14.2 (11.3–17.6)	14.5 (11.7–17.6)
France	1003	68.5 (65.6–71.3)	64.6 (60.2–68.8)	72.1 (68.1–75.8)	16.4 (14.2–18.7)	14.8 (11.8–18.2)	17.8 (14.7–21.2)
Italy	1000	69.3 (66.4–72.1)	68.0 (63.7–72.1)	70.5 (66.5–74.3)	18.4 (16.1–20.9)	17.9 (14.6–21.5)	18.9 (15.7–22.4)
Greece	1011	70.0 (67.1–72.8)	68.5 (64.1–72.7)	71.2 (67.4–74.8)	17.4 (15.2–19.8)	16.6 (13.4–20.3)	18.0 (15.0–21.4)
Germany	1159	71.0 (68.3–73.6)	70.2 (66.3–73.9)	71.8 (68.1–75.3)	22.6 (20.3–25.1)	20.7 (17.5–24.3)	24.3 (21.0–27.8)
Spain	1000	71.0 (68.1–73.8)	68.5 (64.4–72.4)	73.7 (69.6–77.5)	18.0 (15.7–20.5)	17.2 (14.1–20.7)	18.8 (15.5–22.5)
Belgium	982	71.7 (68.8–74.4)	67.5 (63.2–71.5)	75.9 (71.9–79.5)	18.3 (16.0–20.8)	15.3 (12.3–18.7)	21.3 (17.9–25.1)
Portugal	1007	87.8 (85.7–89.7)	85.2 (81.8–88.2)	90.0 (87.3–92.3)	24.1 (21.6–26.8)	22.3 (18.7–26.2)	25.7 (22.2–29.6)

[a] LEE criteria: For definition see footnote to Table 1.

[b] NP + LSD criteria: For definition see footnote to Table 1.

Table 3 Variables independently associated with sedentary lifestyle among men in the European Union. Two definitions: (low energy expenditure [LEE], and no participation in activities and long time sitting down [NP + LSD]). Age-adjusted odds ratio (OR) and 95% CI, also adjusted for all the variables shown in the Table

	LEE[a] as the outcome		NP + LSD[b] as the outcome	
	OR (95% CI)	*P*-value[c]	OR (95% CI)	*P*-value[c]
Body mass index (kg/m^2)				
<20	1.25 (1.01–1.56)	0.043	1.18 (0.87–1.61)	0.283
20–25	1 (ref.)			
25–30	1.09 (0.98–1.22)	0.125	1.00 (0.85–1.17)	0.965
>30	1.37 (1.14–1.65)	0.001	1.53 (1.22–1.93)	<0.001
Educational level attained				
Primary level	1.50 (1.29–1.73)	<0.001	1.72 (1.39–2.14)	<0.001
Secondary level	1.14 (1.00–1.30)	0.045	1.25 (1.01–1.54)	0.038
Third level/university	1 (ref.)			
Marital status				
Single	1 (ref.)			
Married/cohabiting	1.07 (0.95–1.21)	0.258	0.94 (0.79–1.13)	0.503
Widowed/divorced	1.27 (1.01–1.60)	0.038	1.36 (1.03–1.80)	0.029
Smoking status				
Non-smoker	1 (ref.)			
Ex-smoker	1.07 (0.93–1.24)	0.352	1.06 (0.85–1.31)	0.621
Smoker	1.49 (1.34–1.67)	<0.001	1.90 (1.63–2.22)	<0.001
Weight change last 6 months				
Same weight	1 (ref.)			
Gained weight	0.98 (0.86–1.11)	0.714	1.13 (0.94–1.35)	0.186
Lost weight	0.86 (0.75–1.00)	0.044	0.81 (0.66–1.01)	0.061

Adjusted for age and country (a quadratic term for age was also added taking into account that the relationship was not linear).

[a] LEE criteria: For definition see footnote to Table 1.

[b] NP + LSD criteria: For definition see footnote to Table 1.

[c] Likelihood ratio test.

Table 4 Variables independently associated with sedentary lifestyle among women in the European Union according to two definitions (low energy expenditure [LEE], and no participation in activities and long time sitting down [NP + LSD]). Age-adjusted odds ratio (OR) and its 95% CI, also adjusted for all the variables shown in the Table

	LEE[a] as the outcome		NP + LSD[b] as the outcome	
	OR (95% CI)	*P*-value[c]	OR (95% CI)	*P*-value[c]
Body mass index (kg/m^2)				
<20	1.15 (1.00–1.32)	0.048	0.95 (0.78–1.17)	0.639
20–25	1 (ref.)			
25–30	1.19 (1.06–1.34)	0.003	1.10 (0.94–1.28)	0.250
>30	1.35 (1.14–1.60)	0.001	1.53 (1.25–1.88)	<0.001
Educational level attained				
Primary level	1.72 (1.48–2.00)	<0.001	1.71 (1.37–2.13)	<0.001
Secondary level	1.20 (1.06–1.37)	0.005	1.16 (0.94–1.43)	0.161
Third level/university	1 (ref.)			
Marital status				
Single	1 (ref.)			
Married/cohabiting	1.27 (1.13–1.43)	<0.001	1.16 (0.97–1.38)	0.112
Widowed/divorced	1.55 (1.31–1.85)	<0.001	1.64 (1.31–2.04)	<0.001
Smoking status				
Non-smoker	1 (ref.)			
Ex-smoker	0.94 (0.80–1.10)	0.424	0.92 (0.72–1.16)	0.471
Smoker	1.23 (1.10–1.37)	<0.001	1.61 (1.39–1.86)	<0.001
Weight change last 6 months				
Same weight	1 (ref.)			
Gained weight	1.10 (0.98–1.27)	0.092	1.01 (0.87–1.18)	0.894
Lost weight	0.89 (0.79–1.01)	0.068	0.91 (0.76–1.08)	0.265

Adjusted for age and country (a quadratic term for age was also added taking into account that the relationship was not linear).

[a] LEE criteria: For definition see footnote to Table 1.

[b] NP + LSD criteria: For definition see footnote to Table 1.

[c] Likelihood ratio test.

activity, we found more similar results in the EU as compared with the US estimates.[24]

Assessment of leisure-time physical activity has been controversial and there is still a lack of a universal measurement. Most studies are based on self-reported physical activity from questionnaires, since they are easier, cheaper, and more reproducible than other methods, although the trend to over-report the actual level of physical activity is well known.[36] This might be a limitation of the present study. Nevertheless, exact indexes were calculated for each participant providing the possibility of individual comparisons and avoiding the risk of misclassification in an erroneous category (active/sedentary lifestyle). In any case, a potential misclassification bias could have happened if participants were likely to over-report their physical activities, thus the problem of physical inactivity in the EU is likely to be even greater. Few activities involving an energy expenditure of <4 MET were included in our questionnaire and this fact could be viewed as a potential limitation of our methods. Nevertheless, when we classified 'walking' (the most prevalent activity) as a sedentary activity, the estimations of relative prevalence did not substantially change.

We chose these two measures (LEE and NP + LSD) because previous studies had used and proposed definitions based on the percentage of total energy expenditure used in activities involving ⩾4 MET[21] (which is similar to our LEE definition) or were based on no participation in any activity[27] (which is included in our NP + LSD definition). We think that both definitions help to clarify the issue of a standard definition because both incorporate a quantitative assessment and go beyond simpler methods of classification. In addition they are easily appraised using a relatively simple questionnaire which is friendly and convenient for the participant. Most previous assessments are probably affected by gross misclassification because they used a single question with only two or three categories, such as 'inactive/regular', 'not vigorous/vigorous'[34] or 'low/moderate/high physically active'.[7,16,37]

We think that the first definition (LEE) is a better measure to appraise the absolute prevalence of the problem of a sedentary lifestyle because the second definition (NP + LSD) uses the sample median of hours spent sitting down as the cut-off point. Therefore, an internal standard is used in this second definition, thus limiting its performance as an *absolute* measure. Nevertheless, it is interesting to find that both definitions are consistent regarding *relative* estimates.

In summary, the LEE definition is most helpful in public health terms and should be chosen to determine what the prevalence of sedentary lifestyle in Europe is. Accordingly, this prevalence really represents a substantial problem in the EU with estimates higher than 50% for 11 countries and higher than 70% for 5 of them.

Our results confirm the well-known relationship between a sedentary lifestyle and overweight-obesity,[38–40] as we have also previously reported.[23] In both men and women, BMI was associated with an increased likelihood of being sedentary.

To calculate BMI for each subject we used self-reported values for weight and height. Large samples make direct measurements difficult and unaffordable. When asked for their weight and height, participants may tend to over-report height and under-report weight, but despite this tendency self-reported

height and weight have been found to be sufficiently accurate for use in epidemiological studies involving comparative and relative measures, and their errors do not induce significant effects on measures of association.[41]

Use of self-reported weight and height may cause an independent non-differential misclassification that produces a bias towards the null value. In cases where there are many categories or when the misclassification is extreme, the direction of bias can go beyond the null value and even reverse direction, but this possibility is not usual in most situations, provided that the misclassification is independent of other errors.[42–44]

Educational level was markedly associated with sedentary lifestyle in both men and women. Participants who achieved higher educational levels showed lower prevalence of a sedentary lifestyle. This result is consistent with previous reports[27] and confirms that education influences health through lifestyle behaviours, although this correlation is not entirely understood.

The direct association of smoking status with levels of inactivity was also very apparent. Other authors had previously reported the close relationship between physical inactivity, smoking, and other aspects of an unhealthy lifestyle that tend to be simultaneously present in some individuals. This clustering of risk factors results in an increased morbidity and shorter life expectancy.[2,4,7]

Marital status has only rarely been included in studies about physical activity. Our results confirm a previous report assessing the association between marital status and prevalence of physical inactivity,[45] in which the authors found that being single was associated with high physical activity levels. In the present study, in both genders, the logistic regression model showed significantly higher levels of sedentary lifestyle among widowed and divorced individuals than in the reference group (single).

Wide inter-country differences were observed in the prevalence of sedentary lifestyle. Northern European countries showed lower prevalences of sedentary lifestyle as compared with some Mediterranean countries for both genders. Cultural and demographic differences are still high between North and South countries and could explain great part of the difference in the prevalence of sedentary lifestyles. Part of the differences might also be due to different interpretation of several words or terms from the questionnaire in various countries, although a great effort was made in translating the questionnaire and piloting it on a small sample in each country to ensure it had retained the original meaning. Moreover, women from some Mediterranean countries (Portugal, Spain, Greece) are probably more likely to be engaged in housework, and obviously this was not considered as 'leisure time' in our survey, although housework can be considered a moderate intensity physical activity (2.5–3.5 MET in the RS Paffenbarger compendium of physical activities). Unfortunately we did not have those data at our disposal, so it was impossible to analyse those relations. Further research is needed to explore the underlying reasons for these geographical disparities.

The US Surgeon General's report[10] includes the recommendation that every adult should accumulate at least 30 minutes of moderate to vigorous activity on most, and preferably all, days of the week. Already active people would obtain health benefits by improving their actual physical activity expenditure. But the first step towards promoting physical activity is to know the current prevalence of a sedentary lifestyle in adult population, and the main characteristics of sedentary people. In this way prevention strategies can be specifically designed for certain target groups.

With the present study, we found that the prevalence of sedentary lifestyle shows the same trends in all subjects and across groups, independently of the measurement method used to asses this prevalence.

In summary, we provide estimates of the distribution of sedentary lifestyles in the EU and their association with several socio-demographic characteristics that should be taken into account for future intervention and the prevention efforts that are urgently needed.

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KEY MESSAGES

- The prevalence of sedentary lifestyles in the European Union is high, especially among obese subjects, less-educated people, and current smokers. This involves important public health burdens and preventive strategies are urgently needed.
- The prevalence of sedentary lifestyles shows similar trends in all subjects and across groups independently of the definition used to assess this prevalence.
- Wide inter-country differences were observed, with Portugal, Belgium, Spain, Germany, and Greece exhibiting the highest prevalences. Cultural and demographic differences are still high between North and South countries and could explain a great part of this difference in the prevalence of sedentary lifestyles.

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