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## Article

# Adherence to physical activity recommendations and its associated factors: an interregional population-based study

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## Significance for public health

This manuscript describes the prevalence of physical activity level of adult population from three European regions, Luxembourg, Wallonia and Lorraine, based on the adherence to the WHO physical activity recommendations. It identifies the potential demographic, socioeconomic, perceptive and behavioural factors associated with meeting physical activity recommendations. This study hence has a significant public health interest; as it constitutes a first step to help decision-makers and health authorities to target at-risk populations and to guide the development of preventive programs. Preventing physical inactivity in the Greater Region, the fourth leading cause of mortality, can reduce cardiovascular disease burden and substantially improve overall health of a big segment of the European population.

## Abstract

**Background.** Though the influence of physical activity in preventing cardiovascular diseases is well documented, only a few comparative studies have determined the degree of adherence to physical activity recommendations among populations and identified the demographic, socioeconomic, behavioural and health-related factors associated with good compliance.

**Design and methods.** Cross-sectional interregional NESCaV survey of 3133 subjects compared three populations, Luxembourg, Lorraine (France) and Wallonia (Belgium), by using the International Physical Activity Questionnaire. Age and gender prevalence rates of physical activity were standardized to the European population.

**Results.** The likelihood to meet the recommendations was higher in Luxembourg, after adjustment for age, gender, education, employment, weight status, morbidity score, health perception and level of importance attributed to the practice of physical activity ( $P < 0.0001$ ). The odds for meeting the recommendations were significantly higher among those with secondary than tertiary education. Compared to good self-health perception, subjects with poor or fair self-perceived health were less likely to meet the recommendations; this also applied to those attributing little or enough importance to physical activity compared with great importance.

**Conclusions.** Region, education, self-perceived health and perception of importance of physical activity were emerged as independent determinants of meeting the recommendations. Awareness of the positive health effects of physical activity might thus be crucial for motivating the people to become more active. Further research is needed to explore potential region-specific factors which might explain the difference in population behaviours with respect to physical activity.

## Introduction

There is now overwhelming evidence that regular physical activity has extensive health benefits, which range from reduced risk of chronic diseases and some cancers to enhanced mental health, and improved quality of life.<sup>1-4</sup> Physical activity is related to health benefits in a linear dose-dependent manner, suggesting that every bit of exercise counts towards better health, with greater benefits at higher energy expenditures.<sup>5</sup> In contrast, physical inactivity is associated with an increased risk for multiple causes of mortality, chronic morbidity and disability.<sup>6</sup> In high income countries, physical inactivity is the fourth leading risk factor for mortality, causing an estimated 3.2 million deaths globally.<sup>7</sup> This potentially modifiable unhealthy lifestyle has been directly linked to cardiovascular risk factors, including arterial hypertension, hypercholesterolemia, hyperglycaemia, overweight and obesity.<sup>8</sup>

Over the past decade, increasing physical activity level has become a public health concern that led to publication of many national and international recommendations. The World Health Organization (WHO) recommends a minimum 30 minutes of physical activity of moderate intensity on most days of the week, where activities should be performed for at least 10 minutes consecutively.<sup>7</sup>

Only a few European and international studies have determined the degree of adherence to current recommendations among general populations, and generally with inconsistent findings.<sup>9-12</sup> The main reasons may be related to the heterogeneity of study designs, as well as to the conceptual differences in the assessment of physical activity.<sup>10</sup>

The European policies aim to stimulate interregional cooperation and promote social, economic and health development to overcome the discrepancies between the European populations. The so-called *Greater Region*, encompasses about 11.4 million people over an area of 65,400 km<sup>2</sup>. Despite the apparent cultural homogeneity of the population residing in the Greater Region, no scientific evidence supports this observation in terms of lifestyles, particularly practicing physical activity. NESCaV study (*Nutrition, Environment and Cardiovascular Health*) is a cross-border cardiovascular health monitoring project, including three neighbouring regions; Grand-Duchy of Luxembourg, Wallonia in Belgium, and Lorraine in France. It is the first cross-sectional, population-based survey carried out in the central zone of Europe, based on a standardised method of recruitment, and validated data collection tools, enabling a relevant inter-regional comparison, in terms of cardiovascular health and lifestyle-related risk factors.<sup>13</sup>

Based on the current state of knowledge, we hypothesized that interregional discrepancies with regards to practice of physical activity

exist, which may be explained by several socio-economic and health-related behaviours and perceptions. The objectives of the present paper were to assess the physical activity level of adult population from three European regions, Luxembourg, Wallonia and Lorraine, based on the adherence to the WHO physical activity recommendations, and secondly, to identify potential demographic, socioeconomic, perceptive and behavioural factors associated with meeting physical activity recommendations.

This study has a significant public health interest; it constitutes a first step that may help decision-makers and health authorities to target at-risk populations and guide the development of preventive programs. Preventing physical inactivity in the Greater Region, the fourth leading cause of mortality,<sup>8</sup> can reduce cardiovascular disease burden and substantially improve overall health of a big segment of the European population.

## Design and Methods

### Study population

We calculated that in each of the regional surveys, a minimal necessary representative sample of 1000 participants would provide region-specific estimates with a statistical precision of at least 2% at the 95% confidence level,<sup>14</sup> *i.e.*, a total NESCaV sample of 3000 participants to ensure statistical power for examining the prevalence of various cardiovascular risk factors of interest, including physical inactivity. Pregnancy and institutionalization were defined as exclusion criteria. A description of the study protocol has been detailed elsewhere.<sup>13</sup> Briefly, a stratified random sample of 3133 subjects, aged 18-69 years, was recruited from the respective national registries of the adult population of Luxembourg, Lorraine and Wallonia, constituting an important segment of the Greater Region population. Data were collected between 2008 and 2012, over an average period of 12 months for each region, so that to reduce the effect of seasonal variation. The three populations (1432 subjects from Luxembourg, 1017 subjects from Wallonia and 684 subjects from Lorraine) were representative with regards to gender distribution, but older people were overrepresented in Luxembourg and Lorraine samples.

Subjects were invited via personal mail and a follow-up phone call to fix an appointment in one of the study centres. Participants were asked to fill out a questionnaire with the help of trained research nurses. The original French version of the questionnaire was translated into German, English and Portuguese, to incorporate the linguistic diversity of the population in Luxembourg. Validity was ensured through backward translation into French. At the study field, each participant received information on the aims of the study and the procedures of data collection.

Information was collected about age, gender, country of birth, marital status, educational level, employment status, and resource perception, smoking status, personal medical history and medication intake, self-perceived health, and the importance of physical activity on health. Blood pressure and anthropometric parameters were measured in addition to blood sampling. All were done according to standard operating procedures.

### Physical activity assessment

Physical activity was determined using the International Physical Activity Questionnaire (IPAQ), tested for validity and reliability to measure the intensity, frequency and duration of physical activity during the preceding week before the interview.<sup>11,15,16</sup> The IPAQ considers all domains of physical activity; at work, household, transport and leisure time physical activity. Total metabolic equivalent (MET-

min/week) for vigorous-intense, moderate-intense and walking was calculated to categorise the studied populations into three levels:<sup>17</sup> *active*, *moderately active* and *inactive*, in line with the IPAQ scoring criteria.<sup>18</sup>

### Compliance to physical activity recommendations

The WHO recommends at least 150 minutes per week of moderate-intense physical activity for adults, or accumulating a minimum 30 minutes of moderate intense physical activity on at least five days per week.<sup>19</sup> According to IPAQ scoring criteria, a person who is physically *active* or *moderately active* was considered as a complier to the WHO physical activity recommendations.

### Covariates

Body mass index (BMI) was calculated as body weight divided by height in meters squared ( $\text{kg/m}^2$ ) and classified in three categories according to WHO guidelines,<sup>20</sup> *i.e.* normal weight ( $<25 \text{ kg/m}^2$ ), overweight ( $25-29.9 \text{ kg/m}^2$ ), and obese ( $\geq 30 \text{ kg/m}^2$ ). Education level, based on the highest diploma obtained, was classified into three groups: *tertiary level* equivalent to university or more; *secondary level* equivalent to classical or technical qualification; and *primary level* corresponding to non-academic qualification (but at least first 9 years of mandatory schooling). Resource perception was used as an indirect indicator for subjective economic status, which may help to overcome the cross-regional discrepancy in terms of income. Subjects were asked to indicate how well their current income allows them to provide for their needs, *i.e.* very difficult, fairly difficult, fairly easy, or very easy. Due to few cases, the categories were regrouped into *difficult* and *easy*. Marital status was categorised as *married/living with partner* or *living alone* (including single, divorced and widowed). Smoking status was determined as *current smoker*, *former smoker*, *occasional smoker*, and *never smoked*. Morbidity was examined via a score composed of three important risk factors (hypertension, diabetes and dyslipidaemia). It ranged from 0 (absence) to 3 (presence of all three diseases). Self-perceived health was reported as very good, good, fair, poor and very poor, which was collapsed into 3 categories *good*, *fair*, and *poor*. The study also assessed the importance people attribute to physical activity on health; *great*, *enough*, *little* or *no importance* to participate in physical activities such as exercise, sports and games. Further covariates were gender, age (continuous), and the three regions.

### Ethical aspect

Each subject gave signed written informed consent beforehand. The study was approved by the *Comité National d'Ethique et de Recherche* for Luxembourg, the *Comité de Protection des Personnes Est-III* for Lorraine, and the *Comité d'Ethique Hospitalo-Facultaire Universitaire de Liège* for Wallonia.

### Statistical analysis

Initially, the participants' characteristics were compared by using the chi-square test. Then, the comparison of physical activity levels (low, moderate and high) across the three regions was plotted in a column chart. To ensure a meaningful interregional comparison between the three populations, with different age and gender composition, the direct standardization method was applied, using the European population as a reference.<sup>21</sup>

Univariate and multivariable logistic regression analyses, expressed as odds ratios with 95% confidence intervals (CI), were performed to identify factors significantly associated with the adherence to physical activity recommendations (dependent outcome variable). A set of potential predictor variables was selected, including age, gender, marital status, education level, region, subjective economic resources, smoking habits, BMI, morbidity, general health perception and partici-

part's awareness of the importance to participate in physical exercise. Young age women, married, with tertiary education, having easy resources perception, non-smokers, living in Luxembourg region, having normal weight status, having no cardiovascular disease (hypertension, diabetes or dyslipidaemia), having good health perception, and giving great importance to participation to physical activity exercises were considered as referent. Selection of the variables in the multivariable logistic regression model was based on literature review and on statistical criteria (variable showing  $P < 0.10$  in the univariate analyses).

All tests were two-sided and statistical significance was determined when  $P < 0.05$ . Data were analysed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp. Armonk, NY, USA).

## Results

### Description of the *Nutrition, Environment and Cardiovascular Health* study population

Table 1 displays the characteristics of the study participants. Luxembourg (1432 participants) represented the largest share of the study population, followed by Wallonia (1017 participants), and Lorraine (684 participants), constituting 45.7%, 32.5%, and 21.8% of the total interregional sample, respectively.<sup>22-24</sup> The distribution of gender was not significantly different across the three regions. However, participants from Lorraine were much older, as the 50-69 years age group constituted 75.5% compared to 34.1% in Luxembourg and 38.2% in Wallonia. The three samples differed significantly in terms of demographic, socio-economic, health status, lifestyle behaviours and health perception.

Considering the three regions together, the majority (54.9%) were overweight or obese. Nearly 46% of them had at least one important risk factor (diabetes, hypertension or dyslipidaemia). Positively, more than half of the sampled populations were never smokers, though the smoking status was remarkably different between the three regions ( $P < 0.0001$ ). Most participants rated their health as good (69.2%). Concerning the importance attributed to physical activity for health, 37.7% gave great importance and 44.5% enough importance.

About 77% of the studied subjects were conformed to physical activity recommendations, with a significantly higher adherence in Luxembourg (82%) than in Lorraine (74%) and Wallonia (71%).

### Interregional comparison of physical activity levels

Figure 1A displays the age and gender standardized prevalence of physical activity levels in the three regions. The distribution of physical activity levels differed substantially between the three regions, with lowest physical inactivity recorded in Luxembourg. While 54% of the subjects were physically active in Luxembourg, the majority (40%) were moderately active in Lorraine. With respect to Wallonia, the proportions of active and moderately active people (34%) were equal. For the three regions, there was gender-specific difference in the distribution of physical activity levels, observed in Luxembourg, where the proportion of inactive women were significantly higher than the men (Figure 1B).

### Factors related to adherence to physical activity recommendations

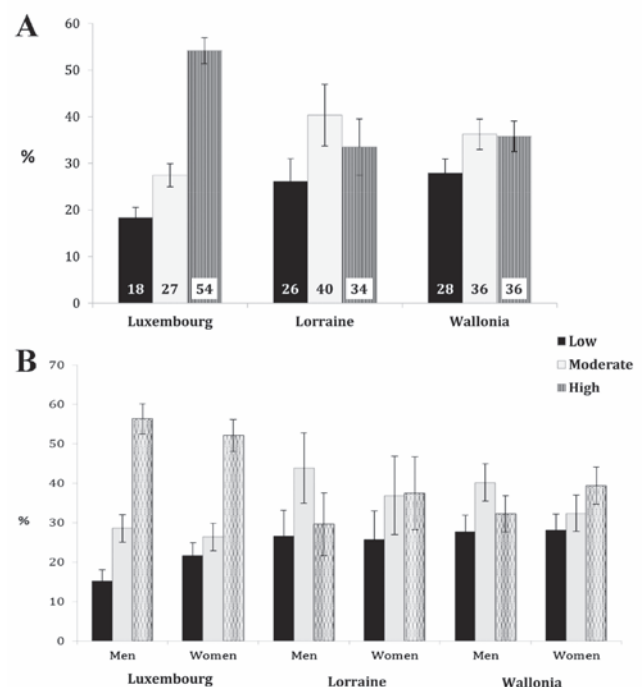
Table 2 represents the demographic, socioeconomic, behavioural and health-related factors associated with meeting physical activity recommendations among the population of the Greater Region.<sup>22-24</sup> In the univariate analyses, the adherence to physical activity recommendations differed significantly according to region ( $P < 0.0001$ ), age

groups ( $P = 0.033$ ), education level ( $P < 0.0001$ ), employment status ( $P = 0.003$ ), weight status ( $P = 0.033$ ), self-perceived health ( $P < 0.0001$ ) and the importance agreed by the subjects to a regular practice of exercises and sports ( $P < 0.0001$ ).

In the adjusted model, region, education level, self-perceived health and importance of physical activity on health remained significantly related to meeting the recommendations. Subjects from Lorraine and Wallonia were less likely to meet the recommendations (OR=0.57; 95% CI: 0.42-0.74 and OR=0.50; 95% CI: 0.40-0.63) respectively compared to Luxembourg ( $P < 0.0001$ ). Subjects with secondary education were significantly more likely to meet the recommendations compared to those with tertiary education (OR=1.60; 95%CI: 1.30-1.98). Although statistically borderline, obese subjects were less likely to meet physical activity recommendations, compared to normal weight subjects (OR=0.76; 95%CI: 0.58-1.00,  $P = 0.054$ ). Subjects self-reporting their health as fair or poor were less likely to meet the recommendations than those self-reporting their health as good (OR=0.74; 95% CI: 0.59-0.92 and OR=0.43; 95% CI: 0.25-0.72, respectively). Likewise, the odds for meeting the recommendations were significantly lower for subjects attributing little and enough importance to physical activity compared to great importance (OR=0.39; 95% CI: 0.30-0.52 and OR=0.57; 95% CI: 0.46-0.71, respectively).

## Discussion

It is well documented that regular physical activity has substantial health benefits and reduces risk of many chronic diseases. Therefore, the current states' strategies support the WHO guidelines to formulate recommendations on the duration and intensity of health-enhanced



**Figure 1. A) Prevalence of physical activity levels in Luxembourg, Lorraine and Wallonia; B) Gender-specific prevalence of physical activity levels in Luxembourg, Lorraine and Wallonia (age and gender standardised to the European population).**

Table 1. Characteristics of the Nutrition, Environment and Cardiovascular Health study population, 2007-2012.

	Luxembourg		Lorraine		Wallonia		Three regions combined		P
	N. (1432)	% (45.7)	N. (684)	% (21.8)	N. (1017)	% (32.5)	N.* (3133)	% (100)	
<b>Demographic characteristics</b>									
Age group, years									<0.0001
18-29	221	15.4	55	8.0	178	17.5	454	14.5	
30-49	723	50.5	113	16.5	450	44.2	1286	41.2	
50-69	488	34.1	516	75.5	389	38.2	1385	44.3	
Gender									0.66
Men	697	48.7	325	47.5	506	49.8	1522	48.7	
Women	735	51.3	359	52.5	511	50.2	1603	51.3	
<b>Socio-economic characteristics</b>									
Education level									<0.0001
Primary	380	26.8	38	5.7	49	4.8	467	15.0	
Secondary	667	47.0	380	56.9	497	48.9	1544	49.8	
Tertiary	371	26.2	250	37.4	471	46.3	1092	35.2	
Marital status									<0.0001
Single/live alone	435	30.4	141	20.6	423	41.6	999	31.9	
Married/ living with partner	997	69.6	543	79.4	594	58.4	2133	68.1	
Employment status									<0.0001
Employed	925	65.9	317	47.0	681	69.1	1923	62.8	
Student	91	6.5	14	2.1	49	5.0	154	5.0	
Unemployed	33	2.4	33	4.9	78	7.9	144	4.7	
Retired	176	12.5	291	43.2	141	14.3	608	19.9	
At home	178	12.7	19	2.8	36	3.7	233	7.6	
Resource perception									0.040
Difficult	282	20.8	123	18.1	235	23.2	640	21.0	
Easy	1073	79.2	557	81.9	778	76.8	2408	79.0	
<b>Health status and lifestyle factors</b>									
Weight status									0.044
<25 kg/m <sup>2</sup>	623	43.5	298	43.8	489	48.1	1410	45.1	
25-29.9 kg/m <sup>2</sup>	483	33.8	246	36.1	341	33.6	1070	34.2	
>30 kg/m <sup>2</sup>	325	22.7	137	20.1	186	18.3	648	20.7	
Morbidity score, §									<0.0001
0 risk factor	308	22.0	47	7.1	266	26.8	621	20.4	
1 risk factor	612	43.8	382	57.8	417	42.0	1411	46.2	
2 risk factors	427	30.5	206	31.2	258	26.0	891	29.2	
3 risk factors	51	3.6	26	3.9	51	5.1	128	4.2	
Smoking status									<0.0001
Never	757	52.9	340	49.7	519	51.0	1616	51.6	
Former	368	25.7	238	34.8	245	24.1	851	27.2	
Occasional	46	3.2	25	3.7	54	5.3	125	4.0	
Regular	261	18.2	81	11.8	199	19.6	541	17.3	
<b>Health perception</b>									
Self-perceived health									<0.0001
Good	878	62.8	533	78.0	731	72.2	2142	69.2	
Fair	464	33.2	139	20.4	256	25.3	859	27.8	
Poor	56	4.0	11	1.6	26	2.6	93	3.0	
Self-perceived health									<0.0001
Good	878	62.8	533	78.0	731	72.2	2142	69.2	
Fair	464	33.2	139	20.4	256	25.3	859	27.8	
Poor	56	4.0	11	1.6	26	2.6	93	3.0	
Importance of PA for health									<0.0001
Great importance	556	38.9	253	37.1	370	36.4	1179	37.7	
Enough importance	571	39.9	350	51.3	471	46.4	1392	44.5	
Little or no importance	303	21.2	79	11.6	175	17.2	557	17.8	
Compliance to PA recommendations	1120	81.99	424	73.99	623	71.04	2167	76.95	<0.0001

PA, physical activity. \*Note that the total number of cases differs due to missing data on some variables; P value indicates the comparison between the 3 regions. § Morbidity score includes three major cardiovascular risk factors: diabetes, hypertension or dyslipidaemia. Participants were classified as diabetics if they reported taking anti-diabetic medications and/or had fasting plasma glucose  $\geq 126$  mg/dL.<sup>22</sup> Participants were classified as having elevated blood pressure if they reported taking anti-hypertensive medications and/or had SBP $\geq 140$  mmHg and/or DBP $\geq 90$  mmHg.<sup>23</sup> Subjects with dyslipidaemia were defined as having at least one of the following anomalies: total cholesterol  $\geq 190$  mg/dL, triglycerides  $\geq 150$  mg/dL, LDL-cholesterol  $\geq 115$  mg/dL, and HDL-cholesterol  $< 40$  mg/dL for men and  $< 46$  mg/dL for women, and/or taking hypo-lipid medications.<sup>24</sup>

**Table 2. Demographic, socio-economic, behavioural and health-related determinants of subjects meeting the physical activity recommendations in the Greater Region, 2007-2012.**

	Univariate analyses			Multivariable analyses		
	Crude OR	(95% CI)	P	Adjusted OR*	(95% CI)	P
<b>Demographic characteristics</b>						
Age, years			0.033			0.13
18-29 (n. 409)	Ref.			Ref.		
30-49 (n. 1172)	0.721	(0.54-0.96)		0.74	(0.52-1.04)	
50-69 (n. 1235)	0.688	(0.52-0.91)		0.67	(0.45-0.99)	
Gender			0.091			0.19
Women (n. 1440)	Ref.			Ref.		
Men (n. 1376)	0.86	(0.72-1.03)		0.86	(0.70-1.05)	
Region			<0.0001			<0.0001
Luxembourg (n. 1366)	Ref.			Ref.		
Lorraine (n. 573)	0.63	(0.50-0.79)		0.57	(0.42-0.74)	
Wallonia (n. 877)	0.54	(0.44-0.66)		0.50	(0.40-0.63)	
<b>Socio-economic characteristics</b>						
Education level			<0.0001			<0.0001
Tertiary (n. 1006)	Ref.			Ref.		
Secondary (n. 1361)	1.57	(1.29-1.90)		1.60	(1.30-1.98)	
Primary (n. 429)	1.37	(1.05-1.80)		1.31	(0.94-1.84)	
Employment status			0.003			0.099
Employed (n. 1731)	Ref.			Ref.		
Student (n. 143)	1.53	(0.98-2.38)		0.91	(0.54-1.56)	
Unemployed (n. 113)	1.03	(0.66-1.61)		1.34	(0.83-2.17)	
Retired (n. 545)	1.12	(0.89-1.41)		1.26	(0.94-1.70)	
Housewife (n. 220)	2.13	(1.42-3.20)		1.72	(1.01-2.70)	
Resource perception			0.60			
Easy (n. 2177)	Ref.					
Difficult (n. 561)	1.06	(0.85-1.33)				
Marital status			0.48			
Married/living with partner (n. 1923)	Ref.					
Single/ live alone (n. 892)	0.94	(0.78-1.13)				
<b>Health status and lifestyle factors</b>						
BMI, kg/m <sup>2</sup>			0.003			0.054
Normal weight (n. 1281)	Ref.			Ref.		
Overweight (n. 953)	0.937	(0.77-1.15)		1.05	(0.83-1.33)	
Obesity (n. 577)	0.685	(0.55-0.86)		0.76	(0.58-1.00)	
Morbidity score §			0.066			0.70
0 risk factor	Ref.			Ref.		
1 risk factor	0.93	(0.74-1.18)		1.04	(0.80-1.35)	
2 risk factors	0.96	(0.74-1.28)		1.16	(0.84-1.61)	
3 risk factors	0.56	(0.36-0.87)		0.95	(0.55-1.64)	
Smoking status			0.47			
Never (n. 1469)	Ref.					
Former (n. 772)	1.03	(0.84-1.26)				
Occasional (n. 117)	1.49	(0.91-2.45)				
Regular (n. 458)	1.04	(0.81-1.33)				
<b>Health perception</b>						
Self-perceived health			<0.0001			<0.001
Good (n. 1932)	Ref.			Ref.		
Fair (n. 762)	0.76	(0.63-0.92)		0.74	(0.59-0.92)	
Poor (n. 87)	0.42	(0.27-0.65)		0.43	(0.20-0.72)	
Importance of physical activity on health			<0.0001			<0.0001
Great importance (n. 1064)	Ref.			Ref.		
Enough importance (n. 1249)	0.58	(0.47-0.71)		0.57	(0.46-0.71)	
Little importance (n. 501)	0.45	(0.35-0.57)		0.39	(0.30-0.52)	

OR, odds ratio; CI, confidence interval. Only variables showing  $P < 0.1$  in the univariate analyses were introduced in the multivariable logistic regression model. The gaps in the table indicate that these variables (resources perception, marital status and smoking) were not introduced in the adjusted model. \*OR adjusted for age, gender, region, education level, employment status, BMI, morbidity score, self-perceived health and importance of physical activity on health. § Morbidity score includes three major cardiovascular risk factors: diabetes, hypertension or dyslipidaemia. Participants were classified as diabetics if they reported taking anti-diabetic medications and/or had fasting plasma glucose  $\geq 126$  mg/dL.<sup>22</sup> Participants were classified as having elevated blood pressure if they reported taking anti-hypertensive medications and/or had SBP  $\geq 140$  mmHg and/or DBP  $\geq 90$  mmHg.<sup>23</sup> Subjects with dyslipidaemia were defined as having at least one of the following anomalies: total cholesterol  $\geq 190$  mg/dL, triglycerides  $\geq 150$  mg/dL, LDL-cholesterol  $\geq 115$  mg/dL, and HDL-cholesterol  $< 40$  mg/dL for men and  $< 46$  mg/dL for women, and/or taking hypo-lipid medications.<sup>24</sup>

physical activity.<sup>25</sup> To date, no data have evidenced and directly compared the prevalence of adherence to physical activity recommendations among the residents of the Greater Region, encompassing Luxembourg, Lorraine and Wallonia. This information is however crucial for decision-makers and health professionals to implement effective synergistic prevention strategies, tackling *high-risk groups*. The outcome may have a medium to long term impact on the global health of the Greater Region population, in terms of prevention and health care policies as well as on the future economy.

### Meeting recommend levels of physical activity

The present cross-border study demonstrated that more than three quarters of the Greater Region sample are meeting the recommendations, *i.e.* they perform at least 30 minutes of moderately intense physical activity, or 20 minutes of high intense physical activity on most days of the week. The physical activity compliance rate was 82% in Luxembourg, followed by Lorraine (74%) and Wallonia (71%). The European *Eurobarometer* survey, compared the level of physical activity among different European countries by using the IPAQ, reported slightly lower prevalence rates; about 74% of the Luxembourgish, 57% of the French and 60% of the Belgian population adhere to the WHO physical activity recommendations.<sup>12</sup> An international comparative study, measuring physical activity with the IPAQ in 20 countries worldwide, found 57% adherence rates in Belgium, which is slightly lower than our findings for Wallonia.<sup>26</sup> A French study, measured physical activity with the Modifiable Activity Questionnaire (MAQ), reported an adherence rate of 62% for men and 52% for women.<sup>27</sup> This variation might be related to a difference in the practice of physical activity between regional and national level, especially in Lorraine, which displays a rather small part of France. Application of different measurement tools may also explain the inconsistent findings. Further, the time frame for recalling physical activity could also influence the results. While the IPAQ asks for physical activity during the preceding week to avoid recall bias, other studies take a longer recalling period, and refer to the last twelve months.<sup>9,27</sup> Nevertheless, it should be considered that some of previous studies dated back a decade ago. The results from the present study may suggest an actual increase in physical activity compliance, as awareness of the benefit of exercise possibly increased through intensive public efforts.

### Factors associated with meeting the physical activity recommendations

In the present study, age, gender, resources perception, employment, marital status weight status and morbidity were not related to meeting physical activity requirements, suggesting that these factors have no significant impact on the adherence to physical activity among the residents of the Greater Region. This lack of association was also observed in a study using the METh/week score as the outcome of interest.<sup>9</sup> The present study indicated that education level was an important determinant of compliance to physical activity in our studied interregional population. Subjects with secondary education were almost twice as likely to be active and meet physical activity recommendations compared to those with tertiary education, in the multivariate model considering the employment status. Therefore, it is less probable that those with secondary education might be more engaged in manual labour, whereas those with university education might be more often performing intellectual and sedentary tasks that involve little or no physical activity during working hours. Among women, being a housewife was considerably more likely to be active and thus conform to the physical activity recommendation than the employed, probably due to the daily involvement in heavy domestic duties. Therefore, it is important to foster physical activity among sedentary occupations; the workplace can generally be a good starting point for interventions as people spend a con-

siderable amount of time at work.<sup>28-31</sup>

A large proportion of the people in the three regions perceived physical activity as important to health and this was translated by their adherence to the recommended level of physical activity.<sup>32,33</sup> Similar findings were reported by an American study of a positive relationship between leisure time physical activity and the perceived importance of physical exercise.<sup>34</sup> Investigating self-perceived health with respect to meeting physical activity requirements, our study indicated that people with poor or fair health perception were less likely to be physically active, compared to good-health perceived subjects. Other studies have also evidenced that higher physical activity was related to better self-health perception.<sup>35,36</sup> This relationship may be reciprocal; poor self-perceived health can be the result of not being sufficiently physically active and physical inability to be active may prevent the subject from being happy and feel well. Physical activity of any kind is supportive to health, and the adequate level of physical activity depends on the level of personal fitness. Anyone can be active at his own tailored physical fitness level, and consequently his own perceived health and well-being. Therefore, it is relevant to give adequate information to the public on the various forms of affordable physical activity, which could easily be integrated into their everyday life, rather than focussing efforts on high-cost leisure activities.

Interestingly, the present study demonstrated that the region was a significant determinant factor for meeting the physical activity recommendations; resident people in Lorraine and Wallonia were less likely to meet physical activity recommendations compared to those in Luxembourg. A possible explanation could be that sports and physical activity facilities differ between the three regions, hence influencing physical activity level to be higher in one region (Luxembourg) than the others. The findings of Eurobarometer study would support this hypothesis, as 64% of Luxembourgers strongly agree that the area where they live offers opportunities to be physically active, compared to 49% of Belgian and 51% of French respondents.<sup>37</sup> In addition, different political and public health interventions on promoting physical activity could also lead to disparities between the regions. Again from Eurobarometer study, 75% of respondents from Luxembourg disagreed that their local authority does not do enough for their citizens in relation to physical activity compared to 63% Belgian and 67% French respondents.<sup>37</sup>

Physical activity provides great health benefits, decreasing all-cause mortality, cardiovascular diseases, cancer, as well as improving mental health and quality of life. To increase adherence to physical activity recommendations, and stimulate better health promotion for the population of the Greater Region, there is a need for a cross-border holistic physical activity strategy, involving decision-makers and stakeholders to work together to inform adults about the importance of physical activity and to provide them with structures and facilities allowing for sustainable engagement, with a special focus on the subgroup at risk.

The present study entails some limitations. First, similar to most nationwide population-based studies, data have been retrieved via a self-administered questionnaire. Subjects generally tend to overestimate their physical activity level and may give socially desirable answers.<sup>38</sup> Though the IPAQ has been tested for validity and reliability to measure physical activity,<sup>11,15,16</sup> the self-reported data might have led to overrated levels of physical activity. Second, generalization of findings to the whole Grand Region population should be considered with caution, as older age groups were over represented in Lorraine and Luxembourg samples. Third, the study cannot determine a cause-effect relationship, as data were collected in a cross-sectional manner. Finally, though the study provided an extensive number of potential influencing factors, it is possible that other unexplored factors have a role in determining differences in physical activity between the three populations, such as occupational or cultural differences.

The strength of this study was the recent and homogeneous design

of data collection including three large randomly selected samples from three neighbour regions. We performed age and gender data standardization to European population to permit meaningful cross-regional comparability. As previous international data were mainly collected on the country level, NESCaV is the first cross-regional comparative study demonstrating that the level of physical activity may differ substantially between regional and national scales.

## Conclusions

In conclusion, the majority of the resident population of the Greater Region met the physical activity recommendations. Region, education level, self-health perception and subject's awareness of the importance to practice exercises and sport emerged as independent factors associated with adherence to physical activity recommendations. This study suggests awareness of the positive health effects of physical activity might be crucial for motivating the people to become more active.

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