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Environmental and psychosocial correlates of physical activity in Portuguese and Belgian adults

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Abstract

Objectives: To investigate differences in reported physical activity levels and in perceived environmental and psychosocial correlates of activity between Portuguese and Belgian adults; and to analyse the relative contribution of environmental and psychosocial variables in explaining physical activity within different contexts in Portugal and Belgium.
Design: Cross-sectional study.
Setting: One city in Portugal (Oeiras) and one in Belgium (Ghent).
Subjects: In total 526 participants, 247 from Portugal and 279 from Belgium, completed the long International Physical Activity Questionnaire and a validated questionnaire on environmental and psychosocial correlates.
Results: For the sum of all activities of at least moderate intensity, a significantly higher mean level of activity was found in Belgian adults ($P < 0.001$). However, comparable percentages of the Belgian (38%) and Portuguese (42%) samples did not meet the recommendation of 30 min per day. The variance explained by environmental factors was lower (1% to 8%) than by psychosocial factors (maximum 42%). Regression analyses showed activity-specific relations with environmental variables which were analogous in both countries. Walking/cycling for transportation and walking for recreation were related to social support from family and/or friends and to walkability and walking facilities in the neighbourhood. Recreational physical activity was mainly determined by social support, self-efficacy, and perceived benefits and barriers.
Conclusions: Activity campaigns addressing psychosocial determinants are needed to encourage leisure-time activity, while a combination of neighbourhood design changes and encouragement of social support in walking is warranted to increase walking in different contexts.

Keywords
Physical activity
Environment
Psychosocial
Determinant
Europe

After several decades of recommending 20 min of vigorous physical activity three times per week for physical fitness, public health officials in several countries have adopted an additional guideline that encourages all people to accumulate at least 30 min of moderate-intensity physical activity on preferably all days of the week[1–3]. Despite the feasibility of this new recommendation, and the extensively documented health benefits of regular physical activity[4,5], a large proportion of the population maintains a sedentary lifestyle, achieving neither the old nor the new guideline. The prevalence of sedentary living habits among adolescents, adults and older people in Europe, as well as in other parts of the world, is relatively high, with estimates of 30 to 60% of the population being completely sedentary or irregularly physically active[6,7]. Effective intervention strategies are urgently needed. The success of intervention strategies aimed at increasing the prevalence of physical activity in most countries will be partly dependent on a good understanding of the factors that influence physical activity[8].

In past decades many studies have investigated psychosocial correlates of health-related physical activity to determine factors within the individual that are responsible for changing behaviour in the desired direction[9]. These psychosocial correlates often failed to explain the variance in daily physical activity of moderate intensity such as walking or cycling. More recently, some studies showed that physical environmental variables may also play a key role in understanding physical activity. Research in the health behaviour and promotion field and reports from urban planning and transportation studies have revealed associations between the physical environment and physical activity of different intensity and within different contexts[10–12].

Recent ecological models suggest that the combination of psychosocial and environmental variables will best

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explain physical activity[13]. As attributes associated with walking for exercise are different from those associated with walking for transportation[12] or from sports activities[14], the relative contribution of psychosocial and environmental variables in explaining activities of different intensities and within different contexts should be studied[15].

Most studies on the environmental correlates of physical activity have been conducted in the USA and Australia. However, there is a need to examine the great variation in environmental factors related to physical activity across countries. To our knowledge, only very few studies have looked at these relationships in Europe[16,17]. Although results of European studies on the psychosocial correlates of physical activity were very similar to findings from the USA, Australia and Canada[18], the physical environment in Europe is very different from that in these other parts of the world. In the present paper, the relationship between the environment and physical activity is studied in one country of middle Europe (Belgium) and one of southern Europe (Portugal). Previous studies showed that both countries have relatively low levels of physical activity[19,20]. However, this was only true for vigorous activities, as half of the population did report regular moderate activities and walking[21].

The aims of the present study were (1) to investigate differences in reported physical activity levels and in perceived environmental and psychosocial correlates of activity between Portuguese and Belgian adults, and (2) to analyse the relative contribution of environmental and psychosocial variables in explaining physical activity within different contexts in Portugal and Belgium.

Method

Sample and procedure

Participants were recruited in a city in Portugal (Oeiras) and one in Belgium (Ghent). Oeiras is located about 20 km north of Lisbon, it has about 162 000 inhabitants and covers 46 km^2, having a population density of about 3500 inhabitants per km^2. Ghent is located in the middle of the Dutch-speaking part of Belgium (north), it has about 224 000 inhabitants, covers 150 km^2 and has a population density of about 1500 inhabitants per km^2. Both cities have a city centre, suburbs and a more rural part. A convenience sample of adults was drawn through worksites, libraries and socio-cultural societies. The researchers recruited participants at the site, explained the rationale of the study to them and gave them a questionnaire to complete in the coming week. After one week the questionnaires were collected personally at the site. This personal approach was used to increase participation and make the sample more representative. The final sample consisted of 526 participants, 247 from Portugal and 279 from Belgium. Table 1 shows the descriptive characteristics. No differences were found between both samples for gender ($\chi^2 = 0.12$, not significant (NS)), age ($t = 1.79$, NS), education ($\chi^2 = 0.63$, NS), body mass index (BMI) in females ($t = 1.54$, NS) and living environment ($\chi^2 = 4.77$, NS). Differences were found for employment status, with more participants employed in Portugal ($\chi^2 = 31.1$, $P < 0.001$); for occupation, with more white-collar workers in Belgium ($\chi^2 = 4.85$, $P < 0.05$); and for BMI in males, with a higher mean BMI in Portuguese males ($t = 4.24$, $P < 0.001$). The Belgian sample was somewhat higher educated compared with the Belgian population (30% higher education in the population), resulting in a somewhat higher occupational status (55.4% white-collar workers in the population). Mean BMI for men and women was comparable to the population value (25.6 vs. 25.3 kg m^{-2} in men, and 23.4 vs. 24.4 kg m^{-2} in women). The Portuguese participants were more educated (40.4% vs. 27.8% of people with higher education) than the general population. Adiposity (BMI) was similar to the Portuguese population mean in the male group (25.6 vs. 25.7 kg m^{-2}) and somewhat lower for females (23.4 vs. 25.2 kg m^{-2}). Women are over-represented in both the Belgian and Portuguese sub-samples, compared with the gender distribution of the general population in both countries (51.1% women in Belgium and 52.2% in Portugal).

Table 1 Descriptive characteristics of the samples (% or mean with standard deviation in parentheses)

	Portuguese sample ($n = 247$)	Belgian sample ($n = 279$)
Gender		
Female	64.5	65.9
Male	35.5	34.1
Age (years)	35.1 (11.5)	37.2 (12.3)
Education		
No higher education	59.6	56.2
Higher education	40.4	43.8
Employment status*		
Employed	90.1	70.3
Not employed	9.9	29.7
Occupation*		
Blue collar	34.3	24.5
White collar	65.7	75.5
Body mass index (kg m^{-2})		
Females	23.4 (3.9)	22.8 (3.2)
Males*	25.6 (4.3)	23.1 (3.3)
Living environment		
City centre	15.1	18.3
Suburbs	28.6	34.8
Countryside	56.3	46.8

* Significant difference between samples.

Measures

The questionnaire used in this study was designed to obtain information on physical activity and on the environmental and psychosocial correlates of physical activity. It was based on previous instruments[16,22].

Environmental correlates

Neighbourhood environmental variables included residential density, land-use mix diversity (of uses), land-use mix access (to local shopping), ease to walk to public

transportation stop, availability of sidewalks, availability of bike lanes, neighbourhood aesthetics, perceived safety from crime, perceived safety from traffic, connectivity of the street network, satisfaction with neighbourhood services and emotional satisfaction with neighbourhood. In addition, environmental factors believed to be related mainly to recreational physical activity included characteristics of the worksite environment, physical activity supplies in the home environment and convenience of physical activity facilities. A separate study was executed to assess reliability and validity of the environmental questionnaire in a Belgian sample. The scales, scale composition, items and response categories are also reported in this separate study. The questionnaire showed acceptable to good reliability and acceptable validity[16].

Psychosocial correlates

Four major categories of psychosocial correlates were included in this study: social variables, self-efficacy, perceived benefits and perceived barriers. To measure social variables, scores were calculated for modelling, social norm and social support from family and friends, scored on a 5-point rating scale. Principal components analysis revealed two self-efficacy factors, one including self-efficacy towards internal barriers (e.g. if you are tired) and one including self-efficacy towards external barriers (e.g. if family or friends need help). The items were scored on a 3-point rating scale. Principal components analysis resulted in a six-factor structure for perceived benefits (measured by the subcategories: competition, appearance, psychological, health, pleasure and social) and a five-factor structure for perceived barriers (measured by the subcategories: external obstacles, lack of time, lack of interest, psychological and health problems), scored on a 5-point rating scale.

Cronbach's α of scales was moderate to high in both countries for social variables (ranging from 0.58 to 0.92), self-efficacy (ranging from 0.80 to 0.86), perceived benefits (ranging from 0.61 to 0.83) and perceived barriers (ranging from 0.50 to 0.80). A pilot study showed good reliability and validity of the measures of the four major categories of psychosocial variables[23].

Physical activity

To obtain information on physical activity, the International Physical Activity Questionnaire (IPAQ) was used. Validity and reliability results demonstrated that the IPAQ has comparable reliability and validity to other self-report measures[24,25]. The long usual week version of the IPAQ was chosen to provide more detailed information on physical activity in different settings. Minutes of physical activity of different intensity and within different contexts were computed for a usual week (see Craig *et al.*[25] for further details).

Demographic variables included gender, age, education, employment status, occupation, living environment, weight and height.

The questionnaires were translated using a translation and back-translation protocol with English as the original language.

Statistical analyses

Analyses were carried out using SPSS 11.5 software (SPSS Inc., Chicago, IL, USA). Independent samples *t*-tests were carried out to analyse differences in physical activity and environmental and psychosocial variables between the Portuguese and Belgian samples. For the *t*-tests, the *P*-value was set at 0.01 to balance between type 1 and type 2 errors for multiple testing on correlated variables.

Before running the regression analyses, all variables with non-significant bivariate correlations with a given type of physical activity were omitted. Next, intercorrelations were computed between all selected predictors. For predictors showing intercorrelations higher than 0.50, only the predictor with the highest bivariate correlation with the criterion was kept, the others were removed from the model to reduce multicollinearity. Multiple regression analyses were executed within both countries, to determine the variance explained in four dependent variables: active transport, walking in leisure time, moderate to vigorous activity in leisure time, and total physical activity of at least moderate intensity. Demographic variables (gender, age and education) were always entered as the first block in the regressions. Two series of multiple regressions were run. In the first series, environmental variables were included as a second block in the regression, followed by the psychosocial variables. This allows first an estimation of the contribution of the environmental variables, and second an estimation of the contribution of the psychosocial variables beyond the variance accounted for by environmental variables. In the second series, psychosocial variables were included as a second block in the regression, followed by the environmental variables, estimating the contribution of the environmental variables beyond the variance accounted for by psychosocial variables. The reverse sequence of variable blocks in the two analyses gives more specific information about the relative importance of both groups of variables for physical activities within different contexts which can be used in guiding public health interventions. The tables present the semi-partial correlations, along with the adjusted R^2 values. Conforming to similar studies[16,18,26–28], a logarithmic transformation was used to improve the normality of the distribution for the dependent variables. A *P*-value of ≤ 0.05 was considered to be significant.

Results

Differences in physical activity

Table 2 shows differences in physical activity within different contexts between Portugal and Belgium. The Belgian adults reported more moderate to vigorous activity at work, more cycling for transportation, more

Table 2 Differences in physical activity between Portuguese and Belgian samples (mean with standard deviation in parentheses)

Physical activity/inactivity	Portuguese sample ($n = 247$)	Belgian sample ($n = 279$)	*t*-value and significance
Moderate to vigorous activity at work (min week^{-1})	195 (368)	321 (478)	3.42**
Cycling for transportation (min week^{-1})	14 (78)	73 (134)	6.31**
Walking for transportation (min week^{-1})	168 (228)	89 (152)	−4.75**
All active transport (min week^{-1})	182 (262)	162 (217)	−0.95
Moderate to vigorous activity in garden (min week^{-1})	55 (104)	97 (123)	4.25**
Walking in leisure time (min week^{-1})	86 (187)	62 (124)	−1.72
Moderate activity in leisure time (min week^{-1})	31 (84)	64 (132)	3.49**
Vigorous activity in leisure time (min week^{-1})	101 (174)	78 (149)	−1.69
All moderate to vigorous activity in leisure time (min week^{-1})	147 (231)	152 (230)	0.26
Total activity of at least moderate intensity (min week^{-1})	406 (509)	601 (616)	3.97**
Vigorous activity for 20 min (times week^{-1})	1.4 (1.6)	1.8 (1.9)	2.83*
Moderate activity for 30 min (days week^{-1})	1.5 (1.7)	2.4 (2.0)	5.2**
Sitting (min week^{-1})	2307 (1107)	2191 (1057)	−1.22

*, $P < 0.01$; **, $P < 0.001$.

moderate to vigorous activity in the garden, and more moderate activity in leisure time (all $P < 0.001$). The Portuguese adults reported more walking for transportation ($P < 0.001$). No differences were found for the sum of all active transport, for the sum of all moderate to vigorous activity in leisure time, and for the total number of minutes sitting per week. For the total sum of all activities of at least moderate intensity, a significantly higher mean level of activity was found in the Belgian adults ($P < 0.001$). However, a comparable percentage of the Belgian (38%) and Portuguese (42%) sample did not meet the recommendation of 30 min of physical activity of at least moderate intensity per day.

Differences in psychosocial and environmental variables

The Belgian adults perceived a stronger social norm, more modelling and self-efficacy, more pleasure related to physical activity, and more lack of time to be (more) physically active, compared with Portuguese adults. In contrast, the Portuguese respondents perceived more psychosocial, health, appearance and competition benefits related to physical activity (all $P < 0.001$). No significant differences between both samples were found for social support, social benefits and most barriers (lack of interest, external, health problems, psychological problems) (Table 3).

The Portuguese respondents perceived their environment to be of higher density, reporting a higher residential density, a higher land-use mix diversity, a more easy access to public transportation stops and a higher street connectivity ($P < 0.001$) than the Belgian respondents. In contrast, the Belgian adults perceived a higher availability of bike lanes ($P < 0.001$), more beautiful environments ($P < 0.01$), more physical activity equipment in the home environment ($P < 0.001$), and a higher satisfaction with the neighbourhood ($P < 0.001$) and neighbourhood services ($P < 0.01$). No significant differences between the two countries were found for access to local shopping, availability of sidewalks, perceived safety from crime or from traffic, convenience of physical activity facilities and the worksite environment (Table 3).

Relative contribution of environmental and psychosocial correlates

High intercorrelations (above 0.50) were found in both countries for land-use mix diversity, residential density, ease to walk to public transportation stop, availability of sidewalks and connectivity. Only the predictor with the highest correlation with the dependent variable was included in the regression analyses.

Results of the first series of regression analyses, entering the environmental variables first after the demographics followed by the psychosocial correlates, are summarised in Table 4. All regression analyses yielded significance. Four per cent of the variance in active transport was explained in the Portuguese sample and 12% in the Belgian sample. In both countries more walking and/or cycling was related to higher land-use mix diversity. In the Portuguese sample it was related to more social support from friends, and to more modelling in the Belgian sample. In the Belgian sample active transport also decreased with age. For walking in leisure time, 11% of the variance was explained in Portugal and 5% in Belgium. More walking in leisure time was predicted by a higher availability of sidewalks, more social support from family members and more pleasure related to physical activity in the Portuguese sample. In the Belgian sample, more walking in leisure time was related to land-use mix diversity and also social support from family members. For moderate to vigorous activity in leisure time, a total of 41% of the variance was explained in the Portuguese sample. Only psychosocial variables explained all variance. More physical activity in leisure time was mainly associated with the perception of a stronger social norm towards participation in physical activity. In addition, more social

Table 3 Differences in psychosocial and environmental correlates of physical activity between Portuguese and Belgian samples (mean with standard deviation in parentheses)

	Portuguese sample ($n = 247$)	Belgian sample ($n = 279$)	*t*-value and significance
Psychosocial correlates†			
Social factors			
Social norm	2.7 (1.5)	3.2 (1.1)	4.12**
Modelling	2.3 (1.0)	3.1 (0.9)	9.07**
Social support from family	2.2 (0.7)	2.3 (0.9)	1.52
Social support from friends	2.5 (0.9)	2.5 (0.9)	−0.01
Perceived benefits			
Psychosocial	4.0 (0.8)	3.4 (0.8)	−8.67**
Health	4.3 (0.8)	4.0 (0.7)	−5.25**
Appearance	3.7 (0.8)	3.3 (0.9)	−5.73**
Social	3.6 (0.9)	3.5 (0.9)	−0.65
Competition	3.2 (0.8)	2.9 (0.9)	−3.81**
Pleasure	3.6 (0.8)	4.0 (0.9)	5.26**
Perceived barriers			
Lack of time	2.9 (1.0)	3.1 (1.0)	2.57*
Lack of interest	2.3 (0.8)	2.5 (0.9)	1.89
External	2.2 (0.8)	2.3 (0.8)	0.46
Health problems	1.8 (0.9)	1.9 (0.8)	0.47
Psychological problems	2.0 (0.7)	1.9 (0.7)	−0.29
Self-efficacy			
External factors	2.0 (0.6)	2.1 (0.6)	2.62*
Internal factors	1.8 (0.5)	2.0 (0.5)	5.68**
Environmental correlates			
Residential density‡	2.0 (0.5)	1.8 (0.6)	−4.99**
Land-use mix diversity†	3.4 (1.1)	3.0 (1.0)	−4.18**
Land-use mix access§	2.9 (1.1)	2.9 (1.0)	−0.33
Ease to walk to public transportation stop§	3.7 (0.6)	3.2 (0.9)	−7.62**
Availability of sidewalks§	2.9 (1.1)	2.8 (1.0)	−1.14
Availability of bike lanes§	2.0 (0.9)	2.6 (0.7)	9.38**
Neighbourhood aesthetics§	2.5 (0.7)	2.7 (0.6)	3.02*
Perceived safety from crime§	3.2 (0.7)	3.2 (0.5)	0.57
Perceived safety from traffic§	2.5 (0.7)	2.6 (0.6)	1.00
Connectivity§	2.8 (0.8)	2.5 (0.7)	−3.96**
Worksite environment§	3.2 (1.9)	3.4 (2.5)	1.11
Physical activity equipment in home environment¶	3.0 (1.7)	4.5 (1.9)	9.49**
Convenience of physical activity facilities‖	6.3 (4.0)	6.4 (4.4)	0.13
Satisfaction with neighbourhood services††	5.1 (1.2)	5.4 (1.2)	2.68*
Emotional satisfaction with neighbourhood††	4.9 (1.3)	5.3 (1.2)	3.85**

*, $P \leq 0.01$; **, $P \leq 0.001$.
† Five-point scale.
‡ Three-point scale.
§ Four-point scale
¶ Sum of 13 home equipments.
‖ Sum of 18 facilities.
†† Seven-point scale.

support from friends, more pleasure related to physical activity and a higher internal self-efficacy were also associated with more activity in leisure time. A similar pattern was also found in Belgian adults. Men participated more in moderate to vigorous activity in leisure time than women. Only 4% out of 22% of the variance was explained by environmental factors. A higher land-use mix diversity and more physical activity equipment in the home were related to more activity in leisure time. Psychosocial variables explained all the additional variance. In line with the Portuguese sample, a stronger social norm, more social support from friends and more self-efficacy towards internal barriers were related to more activity in leisure time in the Belgian sample. In addition, reports of more lack of time and more lack of interest were associated with lower levels of leisure-time physical activity. For total activity of at least moderate intensity, no environmental variables reached significance in the Portuguese sample. Thirteen per cent of the variance was explained by psychosocial variables. More physical activity was related to the perception of more pleasure and a stronger social norm. In the Belgian sample, 5% out of 8% of the variance was explained by environmental variables. Again more physical activity was related to higher land-use mix diversity and the presence of more physical activity equipment in the home. In addition, less social support from friends and more lack of interest were associated with lower levels of total physical activity.

Results of the second series of regression analyses, entering the psychosocial variables first followed by the environmental correlates, are summarised in Table 5. Again, all regression analyses yielded significance. The

Table 4 Regression analyses of the contribution of demographic (block 1), environmental (block 2) and psychosocial (block 3) variables to different types of physical activity

	Portuguese sample			Belgian sample		
Dependent variables	Significant correlates	Semi-partial correlation	Adjusted cumulative R^2	Significant correlates	Semi-partial correlation	Adjusted cumulative R^2
Active transport: cycling and walking	Environmental variables		0.01	Demographic variables		0.02
	Land-use mix (diversity)	0.13*		Age	−0.13*	
	Psychosocial variables		0.04	Environmental variables		0.10
	Social support from friends	0.19**		Land-use mix (diversity)	0.29***	
				Psychosocial variables		0.12
				Modelling	0.11*	
Walking in leisure time	Environmental variables		0.04	Environmental variables		0.03
	Availability of sidewalks	0.21**		Land-use mix (diversity)	0.13*	
	Psychosocial variables		0.11	Psychosocial variables		0.05
	Social support from family	0.21**		Social support from family	0.14*	
	Benefits (pleasure)	0.19**				
Moderate to vigorous activity in leisure time	Psychosocial variables		0.41	Demographic variables		0.03
	Social support from friends	0.13*		Gender	0.16*	
	Social norm	0.49***		Environmental variables		0.07
	Benefits (pleasure)	0.15*		Land-use mix (diversity)	0.16**	
	Self-efficacy (internal)	0.12*		Presence of physical activity equipment in the home	0.15*	
				Psychosocial variables		0.22
				Social support from friends	0.18**	
				Social norm	0.12*	
				Barrier (lack of time)	−0.15*	
				Barrier (lack of interest)	−0.12*	
				Self-efficacy (internal)	0.15*	
Total activity of at least moderate intensity	Psychosocial variables		0.13	Environmental variables		0.05
	Social norm	0.32***		Land-use mix (diversity)	0.13*	
	Benefits (pleasure)	0.13*		Presence of physical activity equipment in the home	0.12*	
				Psychosocial variables		0.08
				Social support from friends	0.12*	
				Barrier (lack of interest)	−0.14*	

*, $P \leq 0.05$; **, $P \leq 0.01$; ***, $P \leq 0.001$.

Table 5 Regression analyses of the contribution of demographic (block 1), psychosocial (block 2) and environmental (block 3) variables to different types of physical activity

	Portuguese sample			Belgian sample		
Dependent variables	Significant correlates	Semi-partial correlation	Adjusted cumulative R^2	Significant correlates	Semi-partial correlation	Adjusted cumulative R^2
Active transport: cycling and walking	Psychosocial variables		0.03	Demographic variables		0.02
	Social support from friends	0.20**		Age	−0.13*	
				Psychosocial variables		0.05
				Social support from friends	0.20***	
				Environmental variables		0.11
				Land-use mix (diversity)	0.26***	
Walking in leisure time	Psychosocial variables		0.10	Psychosocial variables		0.02
	Social support from family	0.21***		Social support from family	0.15*	
	Benefits (pleasure)	0.18**		Environmental variables		0.05
	Self-efficacy (internal)	0.14*		Satisfaction with neighbourhood services	0.13*	
	Environmental variables		0.12			
	Availability of sidewalks	0.15*				
Moderate to vigorous activity in leisure time	Psychosocial variables		0.42	Demographic variables		0.03
	Social support from friends	0.13*		Gender	0.16*	
	Social norm	0.46***		Psychosocial variables		0.22
	Benefits (pleasure)	0.15**		Social support from friends	0.20**	
				Social norm	0.13*	
				Barrier (lack of time)	−0.15*	
				Barrier (lack of interest)	−0.12*	
				Self-efficacy (internal)	0.18*	
Total activity of at least moderate intensity	Psychosocial variables		0.15	Psychosocial variables		0.08
	Social norm	0.29***		Social support from friends	0.16*	
	Benefits (pleasure)	0.12*		Barrier (lack of interest)	−0.15*	

*, $P \leq 0.05$; **, $P \leq 0.01$; ***, $P \leq 0.001$.

total variance in physical activity explained by the combination of the psychosocial and environmental variables was very comparable with that from the first series of regressions. However, the most noticeable difference is that the contribution of environmental variables was smaller or disappeared completely when entering psychosocial correlates first. For moderate to vigorous activity in leisure time, as well as for total activity of at least moderate intensity, environmental variables no longer contributed in both countries. For walking in leisure time and for active transport, environmental variables remained significant. However, in the Belgian sample, land-use mix diversity did not reach significance ($P = 0.09$). Similarly, land-use mix diversity no longer contributed significantly ($P = 0.09$) in explaining active transportation in Portugal.

Discussion

An ecological model was used to study the personal and environmental correlates of physical activity in two European countries.

The two series of regression analyses showed slightly different results. When environmental variables were entered first into the regression, they contributed significantly to the variance in six of the eight analyses. Higher walkability was positively associated with all four measures of activity in the Belgian sample, and also to active transportation in the Portuguese sample. Walking in leisure time was also associated with the availability of sidewalks in Portugal. This shows that walking for transportation and walking for leisure share some environmental correlates but are also slightly different[12]. Leisure-time physical activity was related to the presence of physical activity equipment in the home in Belgium and convenience of physical activity facilities in Portugal. This is in line with previous studies showing that leisure-time exercise is especially related to the presence of recreational resources[10,15,16,29,30]. However, aspects of neighbourhood design also contributed to explain the variance in leisure-time activity in the Belgian sample. When environmental variables were entered after the psychosocial variables, they remained significant correlates for walking and cycling. Walkability/bikability was related to active transport in Belgium. The availability of sidewalks and satisfaction with neighbourhood services were related to walking in leisure time in the Portuguese and Belgian samples respectively, also after controlling for psychosocial correlates. The environmental variables could not explain additional variance in leisure-time exercise beyond the effect of the psychosocial variables.

Previous studies were often not able to detect a relationship between walking/cycling and psychosocial correlates. In the present study, support from friends was related to active transport and family support to walking in leisure time in both samples. In line with previous studies, social variables such as support from friends, the perception of a positive social norm towards activity and self-efficacy were also related to more leisure-time activity in both samples[9]. In addition, perceived pleasure was related to more activity in Portugal and lack of time and lack of interest in activity were related to less activity in Belgium.

The respondents in Portugal reported a higher residential density, more land-use mix diversity, a higher connectivity of streets and more convenience to walk to public transportation compared with Belgian respondents. Results also showed very high intercorrelations (above 0.50) between these variables. These are key environmental factors that transportation and urban planning researchers have found to be related to non-motorised transport. All these environmental characteristics together distinguish high walkable/bikable environments from lower walkable/bikable environments[11]. In contrast, a higher availability of bike lanes was reported in Belgium compared with Portugal. From this we could argue that the respondents in the Portuguese sample live in a more walkable environment, but that the bikability might be higher in the neighbourhood of the Belgian participants.

Differences in psychosocial correlates are especially present for perceived benefits. Belgian people report more pleasure and believe that being physically active is more fun, compared with Portuguese ones. This suggests that Belgian respondents are more intrinsically motivated and engage in physical activity and sports for the inherent pleasures of the activity. The motives of the Portuguese sample may be more extrinsic and primarily dependent on the external rewards from the activity. From Self-Determination Theory[31] and from previous studies[32–34] we know that intrinsic motives are stronger determinants of current and future activity and may be more important from a health promotion perspective. This was also confirmed by the regression analyses, showing a consistent positive relationship between experiences of pleasure and physical activity in the Portuguese sample.

Thirty-eight per cent of the Belgian sample and 42% of the Portuguese sample did not meet the recommendation of 30 min of physical activity of at least moderate intensity per day. This is in line with the population prevalence data in both countries if not only sports or vigorous activities, but all activity of at least moderate intensity are included[21]. However, differences were found dependent on the context of the activity. Despite the comparable reports in both countries for total minutes of active transportation, more walking was reported in the Portuguese sample and more cycling in the Belgian sample. In the same vein, no difference was found for the sum of all moderate to vigorous activity in leisure time, despite the higher score for gardening and moderate leisure-time activity in Belgium.

In general, the variance explained by environmental factors was rather low, between 1% and 8%. The variance

explained by psychosocial factors was generally much higher, with a peak of 42% in leisure-time activity in Portugal. Based on these percentages it is easy to conclude that psychosocial factors are more important than environmental variables in explaining physical activity. However, given the specific relationships found in the present study, this may be too easily assumed[15]. Environmental factors were clearly related with walking or cycling to get to and from places, and with walking for exercise or recreation, in both European cities. A more walkable/bikable neighbourhood, as defined by higher land-use mix diversity, a higher connectivity of streets and a higher residential density, was related to more walking/cycling within different contexts. In a previous Belgian study, analogous results were found. Availability of sidewalks in males and land-use mix diversity and ease to walk to a public transportation stop in females were related to total walking time[16]. In a recent review of mainly US and Australian studies, Owen *et al.*[12] looked at environmental influences on walking. In line with the present study, accessibility of destinations and convenience of facilities for walking were identified as associates for walking for particular purposes. Two other correlates of walking that arose from this review, aesthetic attributes and perceptions about traffic and busy roads, were not upheld in the present study. From a public health perspective, it is important to notice that regular walking may not (only) be the result of deliberate decision-making but may (also) be an automatic reaction to a supportive neighbourhood. As we know that walking is the most commonly reported physical activity behaviour in Europe[21] with more than half of the population reporting walking for 10 to 60 min on 4 to 7 days per week, and walking can be easily incorporated in daily life which is the ideal activity for sedentary, 'non-sportive' or very busy people, more attention should be paid to building and/or maintaining 'walking-friendly' environments[35]. Although the variance explained may not be overwhelming, environmental changes may affect large populations for a prolonged period of time which may result in population health benefits and reduced health costs.

The present results also show that environmental factors may not be of equal importance in predicting leisure-time physical activity. The presence and convenience of exercise facilities and equipment may be necessary but not sufficient to stimulate people to become or remain active. Psychosocial factors such as social support, self-efficacy, perceived benefits and barriers are of higher importance, and it could be assumed that regular exercise is mostly the result of conscious individual decision-making. If we want to encourage populations to participate in leisure-time sports and fitness activities, education and motivational strategies may be more important than environmental changes. However, the two samples in the present study were drawn from two cities with plenty of sports and exercise facilities. The absence of facilities for example in very rural areas might still have a negative impact on exercise behaviour[15].

The reliance on self-reported information for physical activity and environmental variables, though administered through validated questionnaires, is a limitation of this study. It is essential to use objectively measured environmental variables next to environmental perceptions to enhance understanding of environmental influences on physical activity. A second limitation is that no random samples were drawn, and that the study was conducted in and around two cities, excluding major rural areas. Most US and Australian studies also investigated the relationship between environmental factors and physical activity in cities. More data should be gathered in rural areas to evaluate the full range of environmental and physical activity variables. A third limitation is that causal relations cannot be determined from cross-sectional studies such as this. At this point in time, the conceptualisation and measurement of environmental attributes is still in its infancy compared with the knowledge on psychosocial factors built for about three decades. More research is needed to build comprehensive environmental measures with additional predictive power. Once a consensus is developed on the most promising environmental correlates of physical activity, they should be evaluated in prospective studies.

The strength of the present study was the inclusion of a broad range of potential psychosocial and environmental correlates of physical activity, the measurement of physical activity of different purposes and intensities, and the inclusion of participants from two different European countries. Present results indicated activity-specific relations with environmental variables that were analogous in both countries. Walking/cycling for transportation and walking for recreation were related to social support from family and/or friends and to walkability and walking facilities in the neighbourhood. Recreational physical activity was mainly determined by social support, self-efficacy, and perceived benefits and barriers. This suggests that public education campaigns addressing these psychosocial determinants are needed to encourage leisure-time activity, while a combination of neighbourhood design changes and encouragement of social support in walking is warranted to increase walking in different contexts.

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