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Urban–Rural Differences in Physical Activity in Belgian Adults and the Importance of Psychosocial Factors

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ABSTRACT *Recent research in urban planning and public health has drawn attention to the associations between urban form and physical activity in adults. Because little is known on the urban–rural differences in physical activity, the main aims of the present study were to examine differences in physical activity between urban and rural adults and to investigate the moderating effects of the physical environment on the relationship between psychosocial factors and physical activity. In Flanders, Belgium, five rural and five urban neighborhoods were selected. A sample of 350 adults (20–65 years of age; 35 adults per neighborhood) participated in the study. Participants wore a pedometer for 7 days, and self-reported physical activity and psychosocial data were also collected. Results showed that urban adults took more steps/day and reported more walking and cycling for transport in the neighborhood, more recreational walking in the neighborhood, and more walking for transportation outside the neighborhood than rural adults. Rural adults reported more recreational cycling in the neighborhoods. The physical environment was a significant moderator of the associations between several psychosocial factors (modeling from family, self-efficacy, and perceived barriers) and physical activity. In rural participants, adults with psychosocial scores above average were more physically active, whereas there were no differences in physical activity according to psychosocial factors in urban participants. These results are promising and plead for the development of multidimensional interventions, targeting specific population subgroups. In rural environments, where changing the environment would be a very challenging task, interventions focusing on modifiable psychosocial constructs could possibly be effective.*

KEYWORDS *Physical activity, Physical environment, Adults, Psychosocial factors*

INTRODUCTION

Despite the established health benefits of regular physical activity (PA), the majority of the adult population in Europe, Australia, and the USA does not engage in sufficient levels of PA (30–60% depending on the country). Consequently, the promotion of PA participation has become a public health priority.[1–3]

Ecological models of health behavior focus on the multidimensional correlates of PA to develop effective interventions to increase PA on population level.[4,5]

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According to these models, sociodemographic and psychosocial factors, and physical environmental attributes are important in explaining PA. Recent research in urban planning and public health has drawn attention to the associations between urban form and PA in adults. In that context, the "walkability" of environments and its relationship with PA has been the focus of many studies.[6–10] High walkable environments are characterized by high land use mix, high residential density, and a well-connected street network.[11,12] Traditionally, urban neighborhoods are built in compact pedestrian-orientated forms where high walkability can encourage PA and mainly active transportation.[12,13] Suburban environments are often more automobile-oriented, with reduced population density, higher sprawl of housing, lower land use mix, and lower street connectivity (i.e., less walkable).[14]

Several studies in the USA, Australia, and Europe investigated differences in PA between inhabitants of high walkable urban neighborhoods and less walkable suburban neighborhoods.[7,10,11,15] Strong evidence already exists that high walkable urban neighborhood residents engage more in walking for transportation than less walkable suburban neighborhood inhabitants.[10,11,15] Recently, an increasing number of studies have also found positive associations of neighborhood walkability with cycling for transportation and leisure-time walking.[7,10]

Next to urban and suburban environments, rural neighborhoods are also important to consider. Rural neighborhoods are usually even more automobile-dependent than suburban areas, with low residential density, mainly single land use, and low street connectivity.[12,16] Therefore, based on the environmental characteristics, PA levels could be expected to be lower in rural environments, compared with urban and suburban neighborhoods. In the USA, some studies examined PA differences between rural and urban adults,[17–19] and results consistently showed that rural adults were less physically active than urban adults. However, when looking at aggregated data in the USA, socio-economic status (SES) is generally lower in rural areas compared with urban areas.[20] Because low SES is associated with lower PA levels,[21] this could affect these previous results. In Europe, almost no studies have examined the differences in PA between rural and urban adults until now. Only one study in older Icelanders could be identified, showing no significant differences in PA.[22] In most parts of Western Europe (also in Belgium), SES differences between urban and rural adults are probably much smaller than in the USA.[23] Moreover, geographical characteristics of rural environments in Western Europe cannot be compared with those of rural neighborhoods in the USA or Australia. For example, in European rural environments, distances to the nearest town or city are generally shorter than in other continents. Moreover, European rural areas may be appealing for recreational PA because they usually contain more green spaces than urban and suburban environments.[22] To clarify these issues and their associations with PA, further European research is necessary.

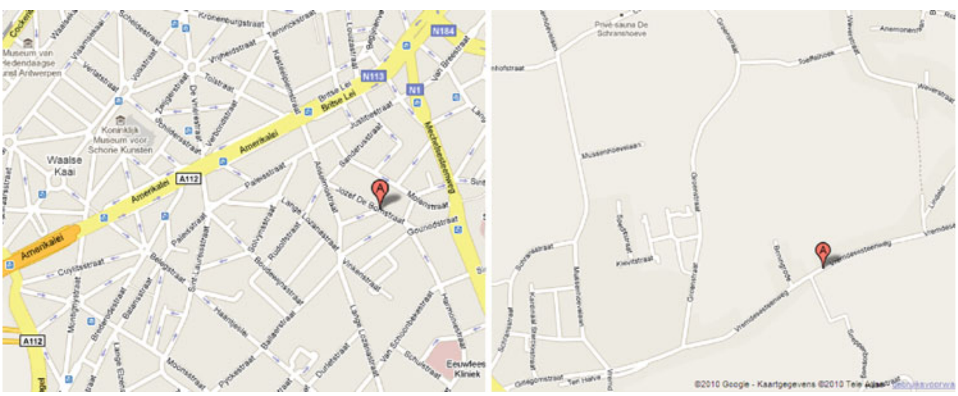
To develop effective PA interventions for specific population subgroups, it remains important to investigate not only physical environmental correlates, but also the interactions with sociodemographic and psychosocial factors.[21] Several researchers have argued for or suggested the existence of interaction effects between psychosocial factors (mainly social support and perceived barriers) and the physical environment (urban versus rural),[17,24] but, until now, no studies have examined these possible interactions. In a previous study, we investigated the interactions between walkability and transport-related psychosocial factors in urban and suburban adults.[25] The main finding was that, in the low walkable suburban neighborhood, adults with a preference for active transport and a high intention to use active transportation took more steps/day than those with a preference for passive transport and a low intention. In the high walkable urban neighborhood, step counts/day were generally high, independent of psychosocial factors. This finding is hopeful, since it suggests that, for adults living in less walkable environments, psychosocial interventions might be effective to increase PA. However, to draw conclusions, much more research on these interactions in different environments is needed.

Considering the limitations of the current literature, the main aims of this study were (1) to investigate differences in PA between rural and urban Belgian adults and (2) to study whether the relationship between psychosocial factors and PA is moderated by the physical environment (urban versus rural).

METHODS

Procedures

For this study, five urban and five rural neighborhoods were selected in Flanders, Belgium. Neighborhood selection was based on cadastral data of population density (number of inhabitants per square kilometer) and on geographical map data of street connectivity (number of intersections per square kilometer). The five urban neighborhoods were located in the city centers of Ghent (224,000 inhabitants; 1,519 inhabitants/km²; two neighborhoods selected), Antwerp (489,500 inhabitants; 2,308 inhabitants/km²; two neighborhoods selected), and Aalst (78,000 inhabitants; 1,002 inhabitants/km²; one neighborhood selected). The five rural neighborhoods were located in Boechout-Vremde (2,416 inhabitants; 357 inhabitants/km²; two neighborhoods selected), Oordegem (2,809 inhabitants; 321 inhabitants/km²; two neighborhoods selected), and Zaffelare (3,500 inhabitants; 290 inhabitants/km²; one neighborhood selected). Objectively measured street connectivity was higher in the urban neighborhoods than the rural neighborhoods. An example map of the differences in street connectivity between the neighborhoods is shown in Figure 1. For the rural neighborhoods, distances to the nearest city or metropolitan area ranged from 11.0 to 15.2 km. Measures of population density and street connectivity are frequently used to define the walkability of environments.[26] Consequently, the urban neighborhoods can be considered as high walkable, and



Urban neighborhood Rural neighborhood

FIGURE 1. Map images of an urban and a rural neighborhood.

the rural neighborhoods as low walkable environments. Data collection took place between October 2008 and March 2009.

The local government provided an address list of all adults (20–65 years) living in the selected neighborhoods. In each neighborhood, 150 randomly selected adults received a letter with information on the study. Two to 6 days after posting the letters, possible participants were visited at home. Adults who agreed to participate filled out a written informed consent form. During the home visit, the interview version of the Neighbourhood Physical Activity Questionnaire (NPAQ)[27] was completed. The participants were also asked to complete a questionnaire on psychosocial and sociodemographic correlates of PA by themselves.[28] Moreover, they were instructed to wear a pedometer on the right hip for seven consecutive days. They were asked to reset the pedometer to zero at the beginning of each day, to remove the pedometer only while bathing, showering, or swimming, and to complete an activity log at the end of each day. The completed questionnaires, pedometers, and activity logs were collected during a second home visit, 1 week after the first one. Home visits were carried out until 35 participants were recruited in each neighborhood. To recruit 350 participants, 1,150 possible participants needed to be approached (response rate=30.4%; ranging from 28.4% to 32.9% across neighborhoods).

Instruments

Pedometers. The Yamax Digiwalker SW-200 pedometer (Yamax, Tokyo, Japan) was used to collect objective data on PA. The Yamax pedometer is reliable and accurate for counting steps. Reliability coefficients range between 0.56 and 0.99.[29,30] Also, the association between step counts and self-reported amounts of PA is good.[31]

Activity Log. Participants were asked to complete a daily activity log for the 7 days they wore the pedometer. They filled in the total number of steps taken each day and the time spent cycling and swimming. For every minute of cycling or swimming reported, 150 steps were added to the day's total number of steps.[31,32] All participants reported pedometer data for at least 4 days, including minimum one weekend day. Based on the recommendations of Tudor-Locke and colleagues,[33] who concluded that a minimum of 3 days of pedometer data is sufficient to estimate adult pedometer-determined PA, data of all participants were included in the dataset.

Physical Activity Questionnaire. Self-reported information on walking and cycling for recreation and transport inside and outside the neighborhood was collected using a Dutch version of the NPAQ usual week questionnaire.[27] The questionnaire has acceptable reliability, with kappa coefficients ranging from 0.67 to 0.95. “Neighborhood” was defined as “the direct environment, everywhere within a 10–15 min walk of your home.” First, frequency (number of days) and duration (minutes per day) of walking for transport in the neighborhood were assessed. Then, these questions were repeated for walking for transport outside the neighborhood, walking and cycling for recreation in and outside the neighborhood, and cycling for transport in and outside the neighborhood. Frequency and duration of leisure-time moderate- and vigorous-intensity PA were collected using the corresponding items of the International Physical Activity Questionnaire (IPAQ) usual week version. The IPAQ has good reliability (intra-class range from 0.46 to 0.96). Criterion validity is fair-to-moderate with a median rho=0.30.[34]

Demographic Variables. Self-reported demographic variables included gender, age, education, living situation, working situation, working status, height, and weight.

Psychosocial Variables. All questions on psychosocial correlates were derived from previous studies in adults and adolescents.[28,35,36] Five categories of psychosocial variables were included: modeling from family and friends, social support, self-efficacy, perceived benefits, and perceived barriers towards PA. Modeling from family (one item) and friends (one item) was measured by asking participants how frequently family and friends participated in PA. To investigate social support, participants were asked how often their family (four items, $\alpha=0.73$) and friends (four items, $\alpha=0.82$) did PA together with them, invited them to do PA together, reminded them to do PA, and encouraged them to participate in PA. The level of self-efficacy was obtained by asking participants how confident they were to do PA under 14 potentially difficult situations (e.g., being tired, if the weather is bad; 14 items, $\alpha=0.88$). Perceived benefits and barriers towards PA were investigated by asking respondents to rate their agreement with possible positive effects of PA (21 items) and the frequency with which barriers prevented them from exercising (22 items). Factor analysis resulted in a five-factor structure for perceived benefits: psychological (seven items, $\alpha=.84$), health (four items, $\alpha=.76$), appearance (three items, $\alpha=.76$), social (two items, $\alpha=.79$), and pleasure (five items, $\alpha=.86$). Factor analysis also resulted in a five-factor structure for perceived barriers: lack of interest (six items, $\alpha=0.81$), external barriers (four items, $\alpha=0.80$), time-related barriers (five items, $\alpha=0.80$), health barriers (four items, $\alpha=0.72$), and psychological barriers (three items, $\alpha=0.73$). All psychosocial correlates were rated on a five-point Likert scale, except for self-efficacy (three-point scale). Descriptive statistics of the different psychosocial variables are shown in Table 1. Due to lack of normality in the responses for modeling from family and friends, social support from family and friends, self-efficacy, perceived benefits and perceived barriers, dichotomous variables were constructed for further analyses, based on the median values of the different variables.

Data Analysis

All analyses were conducted using SPSS 15.0 for Windows. Because all PA variables were positively skewed, logarithmic transformations (log10) were used to improve normality.[37] For step counts, average values of more than 20,000 steps/day were recorded as 20,000 to limit unrealistically high averages.[33] Because prior chi-square tests and independent sample *t* tests showed that the urban and rural samples were comparable on all sociodemographic characteristics except for educational level ($p<$ 0.001) and working situation ($p<0.01$), three-way interactions between the physical environment (urban versus rural), psychosocial factors (modeling from family and friends, social support from family and friends, self-efficacy, perceived benefits ([five factors] and perceived barriers [five factors]), and SES (low versus high education) in relation to PA were investigated using ANOVA models. Because none of the three-way interactions were significant, educational level was included as a covariate in all analyses instead of including it as an extra fixed factor. The physical environment (urban versus rural) was a fixed factor in every analysis, and the dichotomised psychosocial variables were successively added as fixed factors. In case of significant interactions, separate models were fitted for rural and urban adults. For all analyses,

TABLE 1 Descriptive characteristics for the urban and rural neighborhoods

	Urban participants (*n*=175)	Rural participants (*n*=175)
Gender (%)		
Male	37.9	41.1
Female	62.1	58.9
Age, mean (SD)	41.7 (13.5)	43.1 (12.8)
Education (%)		
Primary	2.3	6.9
Secondary	20.9	43.7
College/university	76.8	49.4
Employment status (%)		
Employed	67.8	68.6
Not employed	32.2	31.4
Occupation (%)		
Blue-collar	10.6	28.0
White collar	89.4	72.0
Body mass index, mean (SD)		
Males	24.5 (3.7)	25.2 (2.8)
Females	23.3 (3.9)	24.1 (4.5)
Psychosocial variables, mean (SD)		
Modeling from family	3.5 (1.1)	3.3 (1.2)
Modeling from friends	3.4 (0.9)	3.1 (1.0)
Social support from family	2.4 (0.8)	2.3 (0.8)
Social support from friends	2.4 (0.8)	2.2 (0.8)
Self-efficacy	2.0 (0.5)	2.0 (0.5)
Interest-related barriers	2.4 (0.8)	2.3 (0.8)
External barriers	1.7 (0.7)	1.8 (0.7)
Time-related barriers	2.9 (0.8)	2.9 (0.8)
Health-related barriers	2.1 (0.7)	1.9 (0.7)
Psychological barriers	1.9 (0.8)	2.1 (0.9)
Psychological benefits	3.8 (0.7)	3.6 (0.8)
Health-related benefits	4.3 (0.6)	4.2 (0.6)
Appearance-related benefits	3.4 (0.9)	3.3 (0.9)
Social benefits	3.2 (0.9)	3.3 (1.0)
Pleasure-related benefits	2.6 (0.9)	2.9 (0.9)

SD standard deviation

statistical significance was set at 0.05. *P* values between 0.10 and 0.05 were considered as trends towards significance.

RESULTS

In total, 350 adults (60.5% females; 42.4±13.2 years) participated in the study. Sociodemographic characteristics of the urban and rural adults are shown in Table 1. Mean income data ranged from €15,000 to €16,700 per inhabitant for the rural communities (Boechout-Vremde, Zaffelare, Oordegem) and amounted to €13,000 (Antwerp), €15,000 (Ghent), and €16,000 (Aalst) per inhabitant for the city centers.[23] When investigating the sociodemographic characteristics of the study sample, urban and rural participants were comparable for all characteristics, except for educational level and working situation. These parameters were significantly lower in the rural study sample.

Differences in PA between Rural and Urban Participants

As shown in Table 2, participants living in the urban neighborhoods took significantly more steps on weekdays than participants living in the rural neighborhoods ($p<0.05$). Moreover, a trend towards significance was found for mean step counts/day ($p=0.09$). On average, urban participants took more steps/day than rural participants. Mean weekend day step counts did not differ significantly between urban and rural adults.

Urban adults reported more walking for transport in ($p<0.001$) and outside the neighborhood ($p<0.01$), more walking for recreation in the neighborhood ($p<0.001$), and more cycling for transport in the neighborhood ($p<0.001$). Rural adults reported more cycling for recreation in the neighborhood ($p=0.09$). However, this difference did not reach statistical significance. For self-reported walking for recreation outside the neighborhood, cycling for transport, and recreation outside the neighborhood, overall moderate-intensity leisure-time PA and overall vigorous-intensity leisure-time PA, no differences between the neighborhoods were found.

Interactions between the Physical Environment (Urban Versus Rural) and Psychosocial Correlates in Relation to PA

Table 3 shows all significant interactions between the physical environment (urban versus rural) and the dichotomous psychosocial factors (self-efficacy, modeling from family and friends, social support from family and friends, and perceived benefits and perceived barriers to PA) in relation to PA. The results showed that the associations of modeling from friends, social support from family and friends, and perceived benefits with PA were not moderated by the physical environment.

TABLE 2 Differences in physical activity between the urban and rural neighborhoods

Physical activity measures	Urban neighborhoods, mean (SD)	Rural neighborhoods, mean (SD)	*F* Value
Pedometer step counts (steps/day)			
Weekday	9,933 (3,862)	9,111 (4,337)	4.6**
Weekend day	7,730 (4,068)	7,914 (4,056)	0.8
Step counts per day	9,323 (3,473)	8,775 (3,942)	2.8*
Self-reported PA (min/week)			
In neighborhood			
Walking for transport	97.5 (96.4)	21.9 (72.3)	241.8****
Walking for recreation	36.2 (77.7)	15.5 (65.2)	22.3****
Cycling for transport	80.1 (107.7)	22.3 (67.2)	33.4****
Cycling for recreation	8.7 (34.8)	26.8 (88.2)	2.9*
Outside neighborhood			
Walking for transport	43.5 (102.9)	11.1 (35.5)	10.1***
Walking for recreation	25.7 (64.5)	27.0 (81.8)	0.1
Cycling for transport	25.6 (66.6)	23.0 (67.5)	0.1
Cycling for recreation	13.1 (73.3)	9.4 (40.2)	0.2
General PA measures			
Moderate-intensity LTPA	36.6 (108.7)	26.6 (80.1)	0.5
Vigorous-intensity LTPA	53.4 (118.5)	38.6 (76.8)	0.2

Logarithmic transformations were applied for all physical activity measures

PA physical activity, *LTPA* leisure-time physical activity, *SD* standard deviation

*$p<0.1$, **$p<0.05$, ***$p<0.01$, ****$p<0.001$

For mean steps/day, a significant interaction was found between the physical environment and modeling from family ($p<0.05$) and between the physical environment and perceived time-related barriers ($p<0.05$). For self-reported walking for recreation outside the neighborhood, a significant interaction was found between the physical environment and self-efficacy ($p<0.05$) and between the physical environment and perceived interest-related barriers ($p<0.05$). Moreover, a significant interaction was found between the physical environment and self-efficacy in relation to self-reported cycling for recreation in the neighborhood ($p<0.01$). For self-reported moderate-intensity leisure-time PA, results showed a significant interaction between the physical environment and interest-related barriers ($p<0.05$). All interactions were in the same direction: In urban participants, no differences in PA behaviors were found between adults with psychosocial scores above average and adults with scores below average. However, in rural participants, adults with psychosocial scores above average performed significantly more PA (p values from $p=0.056$ to $p<0.01$) than adults with scores below average.

DISCUSSION

The first aim of this study was to examine PA differences between adults living in urban neighborhoods and adults living in rural neighborhoods. The main finding was that urban adults reported on average 75 min/week more walking and 58 min/week more cycling for transportation in the neighborhood, 20 min/week more recreational walking in the neighborhood, and 32 min/week more walking for transportation outside the neighborhood than rural participants. Rural adults reported 18 min/week more recreational cycling in the neighborhood (marginally significant). Moreover, on weekdays, urban adults took on average about 800 steps/day more than rural adults. For mean steps/day, a trend towards significance was found. Urban adults took on average about 600 more steps/day than rural adults.

Generally, the findings showed that urban individuals were more physically active than rural participants. This is similar to the results of the US studies that have been executed,[17–19] but not to the Icelandic study[22] where no differences in overall PA were found between rural and urban older adults. This could be due to the age differences across the samples. In the Icelandic study, only older adults (>65 years) participated, while in the present study, mean age was 42.4 years. Moreover, studies executed in different countries need to be compared cautiously, as the definition and content of “a rural neighborhood” is not univocal across countries and continents.

Regarding self-reported PA, mainly differences in active transportation were found between neighborhoods, with higher levels of active transportation in urban adults. This could be expected because neighborhood selection was based on residential density and street connectivity, which have both been found to be strongly associated with active transportation.[11] Moreover, strongest results were found for PA inside the neighborhood, which is logical as the environmental characteristics of the local neighborhood were the basis of this study. The assumption that European rural environments may be more appealing for recreational PA than urban environments was not confirmed. Although a trend towards significance was found for recreational cycling in the neighborhood, the average minutes of recreational cycling were low in both types of neighborhoods (26.8 min/week versus 8.7 min/week). Moreover, the amount of leisure-time moderate- and vigorous-intensity PA did not differ between neighborhoods, and urban adults even walked more for recreation in the neighborhood. Other studies examining differences in leisure-time

TABLE 3 Significant interactions between the physical environment (urban versus rural) and psychosocial correlates in relation to PA

			ANCOVAs for separate groups (urban–rural)			
Dependent variable	Interaction	*F* Value	Physical environment	Psychosocial factor	Mean (SD)	*F* Value
Step counts per day	Physical environment × modeling from family	4.6**	Urban	High modeling	9,581 (3,847)	0.3
				Low modeling	8,989 (2,949)	
			Rural	High modeling	9,649 (3,885)	12.0***
				Low modeling	7,805 (3,797)	
	Physical environment × time-related barriers	3.8**	Urban	Few barriers	9,343 (3,677)	0.1
				Many barriers	9,220 (3,144)	
			Rural	Few barriers	9,432 (3,996)	4.2**
				Many barriers	8,181 (3,831)	
Self-reported walking for recreation outside neighborhood	Physical environment × self-efficacy	8.8***	Urban	High self-efficacy	17.9 (50.9)	1.2
				Low self-efficacy	30.0 (71.9)	
			Rural	High self-efficacy	41.7 (98.6)	9.6***
				Low self-efficacy	14.7 (63.9)	
	Physical environment × interest-related barriers	4.4**	Urban	Few barriers	18.6 (49.0)	0.4
				Many barriers	24.3 (56.6)	
			Rural	Few barriers	34.5 (89.2)	5.9**
				Many barriers	9.7 (35.2)	
Self-reported cycling for recreation inside neighborhood	Physical environment × self-efficacy	3.4**	Urban	High self-efficacy	9.9 (42.1)	0.2
				Low self-efficacy	6.2 (26.2)	
			Rural	High self-efficacy	43.2 (116.3)	6.2**
				Low self-efficacy	12.2 (50.4)	
Self-reported moderate-intensity leisure-time PA	Physical environment × interest-related barriers	4.4**	Urban	Few barriers	20.4 (48.4)	0.9
				Many barriers	26.6 (48.5)	
			Rural	Few barriers	45.5 (87.6)	3.6*
				Many barriers	21.5 (91.4)	

Logarithmic transformations were applied for all dependent variables (physical activity measures)
*$p<0.1$, **$p<0.05$, ***$p<0.01$
PA physical activity

PA between rural and urban adults showed mixed results. Some studies found that the amount of leisure-time PA was lower in rural adults,[17,18,22] and in one Australian study, no differences in recreational walking were found between urban and rural residents.[15] Nevertheless, most of the existing studies were executed in North American or Australian contexts and did not differentiate between different types of leisure-time PA, so further research is still needed.

Regarding objectively assessed PA (step counts), the differences between urban and rural participants (600–800 steps/day) were smaller than the differences found for self-reported PA. This could be due to the fact that work-related and household-related PAs were not captured in the NPAQ. Arnadottir and colleagues[22] found higher levels of work-related PA and higher levels of domestic PA for rural adults than for urban adults, while total PA levels did not differ between the two groups. A similar mechanism could apply to the present study population, with higher levels of work-related PA and household-related PA in rural areas and higher levels of transport-related PA in urban areas. This hypothesis is supported by the fact that somewhat more blue-collar workers lived in the rural areas than in the urban areas in the present study. Moreover, because of the lower residential density in rural environments, parcel sizes are larger in rural neighborhoods than in urban neighborhoods.[38] Consequently, rural residents probably have more responsibilities involving household-related PA. Nevertheless, the differences in step counts between urban and rural residents were significant, so physical environmental characteristics are associated with overall PA. Because cycling, swimming, and other static activities reported in the activity log were added to the end-of-day total number of steps recorded by the pedometer, the found differences in step counts between neighborhoods could also be partly explained by differences in these behaviors.

The second aim of the study was to examine whether the relationship between psychosocial factors and PA was moderated by the physical environment. Results showed significant interactions between the environment and the psychosocial factors for steps/day, walking for recreation outside the neighborhood, cycling for recreation in the neighborhood, and moderate-intensity leisure-time PA. The psychosocial factors that were part of the interactions were self-efficacy, modeling from family, interest-related barriers, and time-related barriers. For social support, modeling from friends, and perceived benefits, no significant interactions were found. All interactions were in the same direction: In the urban neighborhoods, no differences in PA were found between inhabitants with psychosocial scores above or below average. In the rural areas, adults with scores above average performed more PA than adults with scores below average. Moreover, relatively large differences in PA were found in the rural neighborhoods: adults with high levels of modeling from family and adults who perceived few time-related barriers took on average 1,850 and 1,250 more steps/day respectively than adults with below average scores on these factors. Also for self-reported PA, the differences between participants with above-average and those with below-average scores on the psychosocial factors ranged on average from 24 to 31 min/week.

It is difficult to compare these findings with results of other studies, as no other studies investigating these interactions could be identified. Nonetheless, the present results are very similar to our previous study, where the interactions between transport-related psychosocial factors and the physical environment (urban versus suburban) were examined in relation to physical activity.[25] Results of that study showed that only in the suburban neighborhood, did adults with a high intention and a preference for active transport take more steps than those with a low intention and a preference for passive transport. In the urban neighborhood, no differences in step counts were found according to personal factors.

The similarities in the results across these two studies are promising because it appears that in less-walkable physical environments, individual-based interventions focusing on psychosocial factors like self-efficacy, perceived barriers, and modeling could be effective to increase PA. Because changing the physical environment of rural areas would be a time-consuming, expensive, and even almost impossible process where collaboration among health researchers, urban planners, and city governments would be needed, it could be effective to focus on the modifiable psychosocial constructs in these population groups. The present results also emphasize the need for multidimensional, ecological approaches to develop interventions focusing on specific determinants in specific population subgroups.[4,5,39] If the present results are confirmed in future studies, researchers could combine the possible strengths of psychosocial interventions (strong short-term effects)[4] and physical environmental interventions (possible long-term effects in large populations)[5] to develop multi-dimensional interventions, targeting both psychosocial and physical environmental factors. While taking into account the feasibility of changing the physical environment (e.g., in rural environments), the main focus could balance between psychosocial and physical environmental factors.

The findings showed that the physical environment was a significant moderator of the associations of self-efficacy, perceived barriers, and modeling from family with PA. This is not surprising as many other studies already emphasized the importance of these psychosocial factors in explaining PA levels in adults.[21,40] Moreover, significant interactions were only found for different types of recreational PA and steps/day. This was not unexpected because a general questionnaire on psychosocial correlates was used. Consequently, participants tended to consider only the psychosocial correlates of recreational PA. To detect interactions for active transportation, more specific psychosocial determinant questions (targeting active transportation) might be necessary.[5] Moreover, since psychosocial factors have been shown to be mainly related to recreational PA, while physical environmental factors are associated with active transportation and recreational PA, it is plausible that combining both factors in an analysis resulted in significant findings for recreational PA only.

It is also important to note that all interactions remained significant after controlling for educational attainment. Thus, it appears that PA levels of rural adults depend more on psychosocial factors than those of urban adults, independent of individual SES. This opens perspectives for future interventions in rural populations.

The strengths of this study first include the use of both self-reported and objective measures of PA. In that way, both general (objective) and behavior-specific (self-reported) information on PA could be collected. Second, representativity of the PA levels was supported. The present sample took on average 9,050 (3,712) steps/day and 37.9% of the sample reached the 10,000 steps/day standard on an average day. This is comparable to the mean step counts found in two other Belgian studies.[25,31]

The present study also has some limitations. First, no Geographic Information Systems database was used to collect objective data on the physical environmental attributes in the different neighborhoods. Instead, geographical map data and cadastral data were used to obtain an objective view of the environment. Second, it remains difficult to give a univocal definition of “a rural neighborhood.” Because of the discrepancies in the content of the term “rural” across studies, it is difficult to compare findings between studies. Moreover, due to the high residential density in

Belgium, it is possible that Belgian rural environments would be categorized as suburban environments in an Australian or US context. A third limitation was the cross-sectional nature of the study, which precluded determination of causality. Fourth, the use of pedometers has some limitations. Pedometers cannot capture time spent in cycling, swimming, and static activities, which was solved to some extent by using an activity log in addition to the pedometer. Fifth, data collection took place from November until March. Mainly in rural adults, PA levels can be lower in these months because PA in the garden is less common compared with springtime and summer. Moreover, urban adults possibly have better access to indoor PA facilities, which could influence their PA levels, especially during winter. Sixth, the representativeness of the study sample can be questioned because educational level and working situation were significantly lower in rural participants than in urban participants, while community-level income data showed only small differences between the urban cities and the rural communities.

In the future, further research on PA behaviors in residents of different geographical environments in different countries should be encouraged. Moreover, it could be important to develop a univocal definition of "a rural neighborhood" in order to make comparisons across studies more plausible. To conclude, we would like to emphasize the importance of research regarding the multidimensional correlates/determinants of PA once again. The present study showed that PA levels are lower in rural than in urban adults and that psychosocial factors could be especially important for adults who live in a rural neighborhood. If future research can confirm these findings and if longitudinal studies can verify the temporal nature of the associations, multidimensional interventions targeted to specific population subgroups might be most promising and most effective for health promotion.

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