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Associations between Social and Physical Environments, and Physical Activity in Adults from Urban and Rural Regions

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ABSTRACT

Objectives: This study investigates investigated the relationship between social and physical environments, and moderate to vigorous physical activity (MVPA) amongst adults in both rural and urban areas within Korea.
Methods: A sample of 128,735 adults from the 2013 Community Health Survey (CHS) was analyzed using a multilevel logistic analysis.
Results: Urban residents with higher satisfaction in public transportation satisfaction and rural residents with more access to sports parks, hiking trails, and bike cycle paths were more likely to be active. The MVPA of adults from rural areas correlated urban adults was uncorrelatedwith neighborhood factors, but that of rural adults was whereas no correlations were observed in adults from urban areas.
Conclusion: These differences should be considered when developing interventions strategies to enhance adult physical activity in different communities.

Introduction

Diseases and disabilities caused by physical inactivity are major public health problems worldwide, reducing quality of life and increasing financial burdens [1,2]. Conversely, regular physical activity not only lowers the risk of early death by 20%-30%, it also reduces the risk of chronic diseases related to cardiovascular disorders, diabetes, and cancer by 50% [2,3].

The WHO recommends that adults aged 18-64 years of age should engage in at least 150 minutes of moderate physical activity, or 75 minutes of vigorous intensity physical activity weekly. Unfortunately, only two-thirds of the world's adult population meets these physical activity guidelines [2]. The National Health Statistics from 2013 reported that adult compliance with the recommended moderate or vigorous physical activity (MVPA) was only 52.0% among men and 42.4% among women, and this rate has been in constant decline for the past 10 years [4,5].

In order to develop effective intervention programs to promote adult physical activity, it is necessary to understand the motivations behind increasing physical activity. According to an ecological model, increasing physical activity is a complex behavior determined by interactions amongst various personal, social, and environmental factors. Hence, a multilevel approach is needed to identify individual and various environmental factors associated with physical activity behavior. Understanding these factors is crucial in developing intervention strategies to reduce disease burden caused by insufficient physical activity [1,6].

McNeill's study identified dimensions of the social environment that influence an individual's behavior, which comprise various social determinants including, interpersonal relationships (e.g., social support, social networks), social inequalities (e.g., socioeconomic status), and a sense of community in the neighborhood (e.g., social cohesion, neighborhood factors) [7]. According to previous studies, perceived social environment, (social support from family, friends, or neighbors), frequency of contact with other members of the social network, and social cohesion, were positively related to engaging in physical activity [8-10]. A neighborhood environment that provides a place for

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physical activity or supports daily activities (walkable destinations, trails, parks, pleasant aesthetics, and transportation/safety) refers to the physical environment, and where there is close proximity to these leisure facilities, positive associations are made between the physical environment and physical activity [3,11].

Multiple studies conducted in urban settings in Korea have confirmed the direct and indirect effects of social and physical environments on physical activity [12-14]. Rural populations may suffer from insufficient physical activity due to a lack of social and physical environmental resources compared with urban areas [11,15].

According to previous studies that examined the associations between both urban and rural environmental features with physical activity, the prevalence of chronic diseases (cardiovascular disease, arthritis, obesity, and diabetes) was higher among rural residents than urban residents. This was thought to be primarily because rural residents have a lower socioeconomic status and therefore lack the resources, thus limiting physical activity [15,16].

In Korea, mortality and obesity have been found to be higher in rural areas than in urban areas, and these regional differences in health status are thought to stem from social and environmental differences, including the residents' socioeconomic status and the region's health-related infrastructure [17]. However, no previous study in Korea has examined the associations between rural and urban environmental factors, and adult physical activity using an ecological approach.

The aim of this study was to examine the potential strategies for community-level intervention, by investigating the effects of social and physical environments on adult physical activity, and to examine urban-rural differences according to environmental factors. A multilevel analysis must be performed to analyze the associations amongst multilevel factors using an ecological approach at the regional level [6].

Utilizing data from the 2013 Community Health Survey (CHS) this study aimed to identify social and physical environmental factors at a community-level, that affected the physical activity of rural and urban adults.

Materials and Methods

1. Study design

A cross-sectional design was used to identify the effects of individual- and community-level factors on MVPA in rural and urban adults via a multilevel analysis. As is common in an ecological approach, individual-level factors comprised demographic and health-related features, while community-level factors included social and physical environmental features.

2. Data source and subjects

Data from the 2013 CHS were used for this study [18]. The CHS is a nationwide health interview survey that has been conducted every year since 2008 by the Korea Centers for Disease Control and Prevention under the Korean Ministry of Health and Welfare. The CHS had a 2-stage sampling process to obtain a representative sample of adults aged 19 years and older. First, primary sample units corresponding to the smallest administrative areas were randomly selected using a probability proportional sampling method. Next, 5 to 8 households within each primary sample unit were randomly selected using a systematic sampling method. After obtaining written, informed consent for the survey, a face-to-face interview was conducted by trained interviewers. A total of 228,781 adults aged 19 and older were included in the survey.

In this study, 197 cities (urban areas) and counties (rural areas) were extracted from a total of 253 nationwide, after eliminating complex, urban-rural cities. The data of male and female adults aged 19 to 64 years (n=128,758) were then extracted. After excluding questionnaires that contained omissions for items related to the dependent variable (physical activity), a total of 128,735 people (n=82,695 urban residents and n=46,040 rural residents) were included in the final analysis.

Obtaining a large sample is important to increase the accuracy of parameter estimates in a multilevel analysis [19], and a minimum of 20 groups is necessary to adequately confirm multilevel effects [20]. The sampling method suggested by Snijders and Bosker, which considers the number of groups (197), number of individuals per group (500), and number of intragroup correlations, revealed the appropriate sample size to be 1,935 people [19]. This study was approved for exemption by the Institutional Review Board of Cheongju University (IRB No. 1041107- 151216- HR-002-01).

3. Measures of physical physical activity

Physical activity was measured using the Korean version of the International Physical Activity Questionnaire (IPAQ) short form with verified reliability and validity [21, 22]. According to the IPAQ scoring protocol, the level of physical activity (PA) was categorized as moderate or vigorous. Participants who engaged in 5 or more days of moderate-intensity activity or who walked at least 30 minutes per day were placed in the moderate PA group. Participants who engaged in at least 3 days of vigorous-intensity activity were placed in the vigorous PA group. The MPVA group included members of both the moderate and vigorous PA groups.

4. Measures of individual-level factors

The socio-demographic variables included gender, age (19–34 years, 35–49 years, 50–64 years), marital status (married, divorced or widowed, single), highest level of education (none, elementary school, middle school, high school, college or higher), occupation (non-manual labor, manual labor, other), and monthly household income (<KR₩ 1 million, KR₩ 1–1.99 million, KR₩ 2–2.99 million, KR₩ 3–3.99 million, > KR₩ 4 million). Health-related variables included body mass index (BMI), perceived health status, and number of diagnosed chronic diseases (none, 1, ≥ 2). BMI was classified as either obese (BMI ≥ 25(kg/m^2) or normal (BMI < 25(kg/m^2) according to the WHO's parameters for Asian adults. Perceived health status was classified into 3 groups: very good and good, neutral, and bad and very bad.

5. Measures of community-level factors

Social environment

Based on a previous study that utilized the social and physical environment data from the 2011 CHS [23], this study used the following community-level variables to determine satisfaction with: safety, the natural environment, the life environment, health services, social cohesion with neighbors, social networking with family and friends, and participation in social activities.

Physical environment

From the town sports facility information in the 2013 National Public Sports Facility Survey [24], data regarding the presence of cycle paths, the number of exercise facilities, the number of sports parks, the number of hiking trails, and the number of urban parks were used.

6. Data analysis

Descriptive statistics and univariate analyses were performed using SPSS 23.0 software, and a multilevel logistic regression was performed using Stata SE 14.0 software. First, individual-level factors and physical activity between urban and rural adults were compared using frequencies and percentages, means and standard deviations, a χ^2-test, and a t-test. Second, associations between physical activity and individual-level and community-level factors in urban and rural adults were examined using a χ^2-test and a t-test. Third, the effects of social and physical environmental factors on physical activity in urban and rural adults were analyzed using a multilevel logistic regression analysis with individual-level (Level 1) and community-level (Level 2) factors. Urban and rural adults were analyzed separately to examine the differences between the 2 populations. All significant individual- and community-level factors in urban and rural areas, with the exception of the number of urban parks, were used in the multilevel analysis as independent variables. Nominal variables were dummy-coded before entering.

Three models were established for the analyses: a basic model (null model), an individual-level model (random effects model), and an individual-community level model (mixed effects model). Model 1, the null model, only included integers without the independent variables; Model 2, the random effects model, only included individual-level independent variables; and Model 3, the mixed effects model, included all individual-level and community-level independent variables. The Intraclass Correlation Coefficient (ICC) was calculated to understand the variance at the community level. Furthermore, the fitness of the models, the fixed effects at the individual- and community-level, and the random effects at the community-level were analyzed.

Results

1. Descriptive statistics and comparison for study analysis of differences in variables between urban and rural areas using descriptive statistics

Approximately 64.2% (82,695) of the participants were urban dwellers, while 35.8% (46,040) were rural dwellers. There were significant differences between urban and rural residents regarding individual- and community-level factors and physical activity. The proportion of men and women in the sample was 46.2% and 53.8%, respectively. The mean age was 47.51 ± 11.67 years for rural residents and 42.33 ± 12.31 years for urban residents, indicating that rural residents were generally older. A higher proportion of rural residents were married, while a higher proportion of urban residents were single.

There were more uneducated individuals, elementary school graduates, middle school graduates, and high school graduates in rural areas than in urban areas, and there were markedly more college graduates or higher in urban areas (52.8%) than in rural areas (28.0%). The proportion of non-manual laborers was higher in urban areas (47.3%), while the proportion of manual laborers was higher in rural areas (47.0%). The proportion of homemakers and unemployed residents was higher in urban areas (31.0%). The proportion of people with a monthly household income >KR₩ 4 million was higher in urban areas (46.0%) than in rural areas (28.9%), while the proportions of people with a monthly household income of <KR₩ 1 million and between KR₩1 to 2 million were higher in rural areas (12.3% and 19.7%, respectively) than in urban areas (4.5% and 12.1%, respectively).

The proportion of obese residents was higher in rural areas (27.5%) than in urban areas (23.4%), and the proportion of people who considered themselves to be in "very good" health was also slightly higher in rural areas (31.3%) than in urban areas (29.2%). Furthermore, the proportion of people with 2 or more chronic diseases was higher in rural areas (13.2%) than in urban areas (8.8%).

Satisfaction with safety (0.87), the natural environment, and the life environment were higher in rural areas, while satisfaction with public transportation and health services were considerably higher in urban areas. Social cohesion was markedly higher in rural areas, and social networks were stronger in rural areas. The number of exercise facilities, trails, and urban parks were higher in urban areas, but the number of sports parks was higher in rural areas. The number of cycle paths was considerably higher in urban areas (18.8%) than in rural areas (9.3%). Approximately 61.6% of urban adults engaged in MVPA, which was higher than in rural areas (58.3%) (Table 1).

2. Associations between individual-level factors and physical activity in urban and rural adults

With the exception of BMI, all individual-level factors were significantly associated with MVPA in urban adults, while only marital status and monthly household income were not significantly associated with MVPA among rural adults, indicating marked differences between the 2 groups (Table 2).

In urban areas, a higher proportion of men, as opposed to women (χ^2=771.11, p<0.001), and a higher proportion of people aged 19–34 and 50–64, as opposed to those aged 35–49, engaged in MVPA (χ^2=123.58, p<0.001). A higher proportion of single, as opposed to married, divorced, or widowed (χ^2=250.50, p<0.001), and a higher proportion of college graduates, as opposed to uneducated residents (χ^2=26.16, p<0.001), engaged in MVPA. Furthermore, a higher proportion of manual laborers (χ^2=88.00, p<0.001) and a higher proportion of people with a monthly household income >KR₩ 4 million, as opposed to <KR₩1 million (χ^2=27.03, p<0.001), engaged in MVPA. A higher proportion of people who perceived themselves to be in good health (χ^2=137.14, p<0.001) and a higher proportion of people with one chronic disease, as opposed to those with no chronic diseases, or 2 or more chronic diseases (χ^2=20.57, p<0.001), engaged in MVPA.

In rural areas, a higher proportion of men, as opposed to women, engaged in MVPA (χ^2=487.99, p<0.001), and a higher proportion of people aged 35–49 or 50–64 engaged in MVPA more frequently, as opposed to those aged 19–34, and the proportion of people engaging in MVPA tended to increase as age increased (χ^2=138.13, p<0.001). A higher proportion of elementary and middle school graduates, as opposed to high school and college graduates, engaged in MVPA, which was different from urban adults where the highest proportion of those engaged in MVPA consisted of college graduates (χ^2=39.18, p<0.001). Higher proportions of manual laborers (χ^2=770.59, p<0.001), people who perceived themselves to be in good health (χ^2=26.56, p<0.001), and people with one chronic disease (χ^2=34.68, p<0.001) were more likely to engage in MVPA, which was in line with the results found among urban adults. A higher proportion of obese people engaged in MVPA than people of normal weight (χ^2=3.87, p=0.049).

3. Associations between community-level factors and physical activity in urban and rural adults

Table 3 illustrates the associations between physical activity and community-level factors (social and physical environments) in urban and rural adults.

In urban areas, people who engaged in MVPA showed higher

Table 1. Descriptive Statistics and Comparison for Study Variables by Area (n=128,735).

Variables	Category	Total	Urban	Rural	χ^2 or t	p
			n (%) or M±SD			
Overall		128,735 (100.0)	82,695 (64.2)	46,040 (35.8)		
Individual level factors						
Gender	Male	59,515 (46.2)	37,589 (45.5)	21,926 (47.6)	55.96	<0.001
	Female	69,220 (53.8)	45,106 (54.5)	24,114 (52.4)		
Age (years)	19-34	31,694 (24.6)	24,385 (29.5)	7,309 (15.9)	4734.94	<0.001
	35-49	46,547 (36.2)	31,118 (37.6)	15,429 (33.5)		
	50-64	50,494 (39.2)	27,192 (32.9)	23,302 (50.6)		
	Mean ± SD	44.18±12.34	42.33±12.31	47.51±11.67	343.81	<0.001
Marital status	Living with spouse	89,930 (69.9)	55,050 (66.6)	34,880 (75.8)	2086.46	<0.001
	Divorced, and bereaved	12,334 (9.6)	7,470 (9.0)	4,864 (10.6)		
	single	26,397 (20.5)	20,126 (24.4)	6,271 (13.6)		
Education	Uneducated	1,308 (1.0)	411 (0.5)	897 (2.0)	11227.84	<0.001
	Elementary school	12,604 (9.8)	4,290 (5.2)	8,314 (18.1)		
	Middle school	14,142 (11.0)	6,958 (8.4)	7,184 (15.6)		
	High school	43,982 (34.2)	27,288 (33.0)	16,694 (36.3)		
	≥ College/University	56,522 (44.0)	43,629 (52.8)	12,893 (28.0)		
Job	Non-manual	53,376 (41.5)	39,112 (47.3)	14,264 (31.0)	8941.17	<0.001
	Manual	39,495 (30.7)	17,879 (21.6)	21,616 (47.0)		
	Housewife, unemployed	35,774 (27.8)	25,636 (31.0)	10,138 (22.0)		
Household monthly income (10,000won)	<100	9,064 (7.3)	3,579 (4.5)	5,485 (12.3)	5945.42	<0.001
	100-199	18,378 (14.8)	9,627 (12.1)	8,751 (19.7)		
	200-299	23,915 (19.2)	14,273 (17.9)	9,642 (21.7)		
	300-399	23,344 (18.8)	15,650 (19.6)	7,694 (17.3)		
	≥400	49,604(39.9)	36,763(46.0)	12,841(28.9)		
Body mass index	Normal (BMI<25 kg/m^2)	95,037 (75.1)	62,766 (76.6)	32,271 (72.5)	260.79	<0.001
	Obesity (BMI≥25 kg/m^2)	31,444 (24.9)	19,189 (23.4)	12,255 (27.5)		
Self-rated health	Very good	38,580 (30.0)	24,178 (29.2)	14,402 (31.3)	1022.98	<0.001
	Neither good nor	51,339 (39.9)	35,269 (42.7)	16,070 (34.9)		
	Poor	38814 (30.2)	23,246 (28.1)	15,568 (33.8)		
No. of Chronic diseases	0	92,973 (72.3)	62,368 (75.5)	30,615 (66.6)	1209.11	<0.001
	1	22,271 (17.3)	12,979 (15.7)	9,292 (20.2)		
	≥2	13,351 (10.4)	7,293 (8.8)	6,058 (13.2)		
Community level factors						
Satisfaction with safety		0.76±0.11	0.70±0.08	0.87±0.06	385.11	<0.001
Satisfaction with natural environment		0.79±0.12	0.74±0.10	0.90±0.06	315.15	<0.001
Satisfaction with life environment		0.79±0.07	0.78±0.07	0.81±0.07	69.84	<0.001
Satisfaction with public transportation		0.71±0.14	0.78±0.10	0.58±0.11	342.02	<0.001
Satisfaction with health service		0.68±0.13	0.73±0.11	0.59±0.11	231,05	<0.001
Social cohesion		0.45±0.25	0.28±0.10	0.75±0.11	777.71	<0.001
Social networks		7.70±1.37	6.87±0.74	9.20±0.89	502.42	<0.001
Social activity participation		0.73±0.07	0.75±0.06	0.69±0.09	142.94	<0.001
Presence of cycle paths		19,837 (15.4)	15,554 (18.8)	4,283 (9.3)	2,050.31	<0.001
Number of exercise facilities		63.84 (67.1)	84.21±72.30	27.24 (33.6)	159.75	<0.001
Number of sports parks		2.26 (3.4)	1.96±3.68	2.53 (2.7)	29.31	<0.001
Number of hiking trails		8.17 (12.7)	10.57±14.96	3.86 (4.8)	93.55	<0.001
Number of urban parks		28.17 (45.8)	42.18±51.55	3.02 (10.7)	161.09	<0.001
MVPA		77,746 (60.4)	50,907 (61.6)	26,839 (58.3)	131.80	<0.001

BMI = body mass index; M = mean; MVPA = moderate or vigorous physical activity; SD = standard deviation.

Table 2. The relationship between individual level factors and moderate or vigorous physical activity of adults in urban and rural areas.

Variables	Category	Urban			Rural		
		n (%)		χ^2 (*p*)	*n* (%)		χ^2 (*p*)
		No	Yes		No	Yes	
Individual factors							
Gender	male	12,515 (33.3)	25,074 (66.7)	771.11	7,977 (36.4)	13,949 (63.6)	487.99
	female	19,273 (42.7)	25,833 (57.3)	(<0.001)	11,224 (46.5)	12,890 (53.5)	(<0.001)
Age (years)	19-34	9,005 (36.9)	15,380 (63.1)	123.58	3,380 (46.2)	3,929 (53.8)	138.13
	35-49	12,715 (40.9)	18,403 (59.1)	(<0.001)	6,684 (43.3)	8,745 (56.7)	(<0.001)
	50-64	10,068 (37.0)	17,124 (63.0)		9,137 (39.2)	14,165 (60.8)	
Martial status	living with spouse	2,204 (40.0)	33,046 (60.0)	250.50	14,533 (41.7)	20,347 (58.3)	0.45
	divorced, and bereaved	2,977 (39.9)	4,493 (60.1)	(<0.001)	2,020 (41.5)	2,844 (58.5)	(0.798)
	single	6,786 (33.7)	13,340 (66.3)		2,639 (42.1)	3,632 (57.9)	
Education	uneducated	167 (40.6)	244 (59.4)	26.16	387 (43.1)	510 (56.9)	39.18
	elementary school	1,655 (38.6)	2,635 (61.4)	(<0.001)	3,311 (39.8)	5,003 (60.2)	(<0.001)
	middle school	2,744 (39.4)	4,214 (60.6)		2,843 (39.6)	4,341 (60.4)	
	high school	10,750 (39.4)	16,538 (60.6)		7,088 (42.5)	9,606 (57.5)	
	≥College/University	16,421 (37.6)	27,208 (62.4)		5,545 (43.0)	7,348 (57.0)	
Job	non-manual	14,930 (38.2)	24,182 (61.8)	88.00	6,399 (44.9)	78,655 (55.1)	770.59
	manual	6,453 (36.1)	11,426 (63.9)	(<0.001)	7,637 (35.3)	13,979 (64.7)	(<0.001)
	Housewife, unemployed	10,378 (40.5)	15,258 (59.5)		5,158 (50.9)	4,980 (49.1)	
Household monthly income (10,000 won)	<100	1,460 (40.8)	2,119 (59.2)	27.03	2,324 (42.4)	3,161 (57.6)	5.23
	100-199	3,730 (38.7)	5,897 (61.3)	(<0.001)	3,605 (41.2)	5,146 (58.8)	(0.265)
	200-299	5,672 (39.7)	8,601 (60.3)		3,954 (41.0)	5,688 (59.0)	
	300-399	5,987 (38.3)	9,663 (61.7)		3,254 (42.3)	4,440 (57.7)	
	≥400	13,870 (37.7)	22,893 (62.3)		5,302 (41.3)	7,539 (58.7)	
Self-rated health	very good	8,594 (35.5)	15,584 (64.5)	137.14	5,761 (40.0)	8,641 (60.0)	26.56
	neither good nor	13,748 (39.0)	21,521 (61.0)	(<0.001)	6,881 (42.8)	9,189 (57.2)	(<0.001)
	poor	9,445 (40.6)	13,801 (59.4)		6,559 (42.1)	9,009 (57.9)	
No. of Chronic diseases	0	24,095 (38.6)	38,273 (61.4)	20.57	12,991 (42.4)	17,614 (57.6)	34.68
	1	4,775 (36.8)	8,204 (63.2)	(<0.001)	3,627 (39.0)	5,665 (61.0)	(<0.001)
	≥2	2,893 (39.7)	4,400 (60.3)		2,553 (42.1)	3,505 (57.9)	
BMI	normal (BMI<25)	24,154 (38.5)	38,612 (61.5)	2.74	13,488 (41.8)	18,783 (58.2)	3.87
	obesity (BMI≥25)	7,257 (37.8)	11,932 (62.2)	(0.098)	4,996 (40.8)	7,259 (59.2)	(0.049)

BMI = body mass index.

Table 3. The relationship between community level factors and moderate or vigorous physical activity of adults in urban and rural areas.

Variables	Urban			Rural		
	M±SD or *n* (%)		t or χ^2 (*p*)	M±SD or *n* (%)		t or χ^2 (*p*)
	No	Yes		No	Yes	
Satisfaction with safety	0.70 ± 0.08	0.71 ± 0.08	2.00 (0.046)	0.86 ± 0.06	0.87 ± 0.06	8.25 (<.001)
Satisfaction with natural environment	0.74 ± 0.10	0.73 ± 0.10	6.69 (<0.001)	0.89 ± 0.06	0.90 ± 0.06	6.75 (<.001)
Satisfaction with life environment	0.78 ± 0.07	0.78 ± 0.07	3.02 (0.003)	0.81 ± 0.07	0.81 ± 0.07	1.30 (0.19)
Satisfaction with public transportation	0.77 ± 0.10	0.79 ± 0.10	21.87 (<0.001)	0.57 ± 0.11	0.58 ± 0.11	10.75 (<.001)
Satisfaction with health service	0.72 ± 0.11	0.74 ± 0.11	16.36 (<0.001)	0.58 ± 0.11	0.59 ± 0.11	11.99 (<.001)
Social cohesion	0.29 ± 0.10	0.28 ± 0.10	7.56 (<0.001)	0.75 ± 0.11	0.76 ± 0.11	11.75 (<.001)
Social networks	6.88 ± 0.77	6.86 ± 0.73	3.98 (<0.001)	9.14 ± 0.88	9.24 ± 0.89	12.44 (<.001)
Social activity participation	0.74 ± 0.06	0.75 ± 0.05	7.68 (<0.001)	0.69 ± 0.09	0.69 ± 0.09	6.35 (<.001)
Presence of cycle paths (Yes)	6,046 (38.9)	9,508 (61.1)	1.50 (0.220)	1,595 (37.2)	2,688 (62.8)	38.72 (<.001)
Number of exercise facilities	85.36 ± 74.32	83.50 ± 70.99	3.61 (<0.001)	27.38 ± 34.75	27.13 ± 32.81	0.76 (0.45)
Number of sports parks	2.25 ± 4.23	1.77 ± 3.28	18.36 (<0.001)	2.46 ± 2.50	2.58 ± 2.78	4.81 (<.001)
Number of hiking trails	11.32 ± 15.08	10.09 ± 14.87	11.48 (<0.001)	3.60 ± 4.25	4.04 ± 5.14	9.65 (<.001)
Number of urban parks	42.14 ± 52.43	42.20 ± 50.99	0.15 (0.878)	3.00 ± 10.99	3.03 ± 10.53	0.34 (0.74)

M = mean; SD = standard deviation.

satisfaction with safety (t=2.00, p=0.046), life environment (t=3.02, p=0.003), public transportation (t=21.87, p<0.001), and health services (t=16.36, p<0.001) but lower satisfaction with their natural environment (t=6.69, p<0.001) compared to those who did not engage in MVPA. Furthermore, people who engaged in MVPA had less social cohesion (t=7.56, p<0.001) and weaker social networks (t=3.98, p<0.001) but higher participation in social activities (t=7.68, p<0.001) compared to those who did not engage in MVPA. Among physical environmental factors, the number of exercise facilities (t=3.61, p<0.001), sports parks (t=18.36, p<0.001), and hiking trails (t=11.48, p<0.001) was higher among people who engaged in MVPA. Meanwhile, the presence of cycle paths and the number of urban parks were not significantly associated with MVPA.

In rural areas, people who engaged in MVPA showed significantly higher satisfaction with safety (t=8.25, p<0.001), their natural environment (t=6.75, p<0.001), public transportation (t=10.75, p<0.001), and health services (t=11.99, p<0.001) than those who did not engage in MVPA. Furthermore, people who engaged in MVPA showed greater social cohesion (t=11.75, p<0.001) and stronger social networks (t=12.44, p<0.001) but lower participation in social activities (t=7.68, p<0.001) than those who did not engage in MVPA. People who lived in regions with cycle paths (χ^2=38.72, p<0.001) and in regions with more sports parks (t=4.81, p<0.001) and hiking trails (t=9.65, p<0.001) engaged more frequently in MVPA. Meanwhile, there were no significant associations between MVPA and satisfaction with life environment, number of exercise facilities, and number of urban parks.

4. Differences in community-level factors that affect the adult's physical activity between in urban and rural areas

Multilevel logistic regression analyses were performed for both urban and rural adults to verify the effects of community-level factors on MVPA in adults and the results are shown in Table 4 (urban) and Table 5 (rural).

Model 1 (null model) was used to verify whether there were variations in MVPA attributable to community-level factors. The ICC for urban areas in Model 1 was 0.040, which was statistically significant (χ^2=2198.89, p<0.001). In other words, urban community-level variables accounted for 4.0% of the variation in the likelihood of engaging in MVPA in urban adults. The ICC for rural areas in Model 1 was 0.049, which was also statistically significant (χ^2=1472.76, p<0.001). Thus, rural community-level variables explained 4.9% of the variation in the likelihood of engaging in MVPA in rural adults.

In Model 2 (Model 1 + individual level factors), 4.0% (χ^2=2074.46, p<0.001) of urban community-level variables and 4.7% (χ^2=1261.70, p<0.001) of rural community-level variables were accounted for, even after controlling for individual-level variables. There was little difference between urban and rural areas regarding the individual-level factors that affected physical activity. In both urban and rural areas, gender, age, marital status, occupation, monthly household income, perceived health status, and number of chronic diseases were significantly associated with physical activity , but education level and BMI were not.

In Model 3 (Model 2 + community level factors), the effects of individual-level factors were identical to those in Model 2 for both urban and rural areas. In terms of community-level factors, there were differences between urban and rural areas in the social and physical environmental factors that affected MVPA.

The ICC decreased from 4.0% to 2.8% in urban areas (χ^2=1335.99, p<0.001). The likelihood of engaging in MVPA was significantly higher when satisfaction with public transportation was higher (OR=2.83, 95% CI=1.001-7.233).Conversely, MVPA was lower when there were a higher number of sports parks (OR=0.98, 95% CI=0.960-0.995) and hiking trails (OR=99, 95% CI=0.989-0.999).

The ICC decreased from 4.7% to 3.3% in rural areas (χ^2=923.87, p<0.001). The likelihood of engaging in MVPA was lower when satisfaction with safety was higher (OR=0.05, 95% CI=0.003-0.867). In contrast, MVPA was higher with greater social cohesion (OR=4.69, 95% CI=1.216-18.114), the presence of cycle paths (OR=1.33, 95% CI=1.007-1.751), an increased number of sports parks (OR=1.03, 95% CI=1.001-1.058), and an increased number of hiking trails (OR=1.03, 95% CI=1.006-1.044).

Discussion

This study demonstrated that individual-level and community-level factors (social and physical environments) significantly affected the physical activity of urban and rural adults, and that there was a difference between the 2 areas regarding the social and physical environmental factors that affect adult physical activity.

MVPA increased with increasing satisfaction with public transportation in urban adults, which was consistent with previous studies that found that convenient public transportation has positive effects on walking and physical activity [25,26]. In contrast, urban adults engaged in MVPA less frequently when the number of sports parks and hiking trails increased in their residential area, and moreover, the presence of cycle paths and the number of exercise facilities were not related to physical activity. Multiple studies have argued that physical activity is related to individual perceptions of the environment more than the objective measures of the physical environment per se [1]. By the same token, lower levels of physical activity in urban adults seems to be affected by residents' perceptions of their environment, such as the availability, accessibility, and convenience of public transportation, rather than by the actual physical environmental factors, because urban areas are adequately equipped with exercise and leisure facilities [1].

On the other hand, rural adults engaged in higher levels of physical activity when there was a larger number of sports parks and hiking trails and when cycle paths were present in their residential areas. This is attributable to the relative lack of exercise and leisure facilities in rural areas. Increasing the numbers of leisure or exercise facilities, such as walkable trails or parks in rural areas, are thought to have positive effects on walking and exercise [11].

Rural adults reported higher levels of physical activity when they lived in regions with higher social cohesion where people trust and help their neighbors (OR=4.693). This is in line with previous findings that greater trust and cohesion amongst rural residents with their neighbors strengthened their health behaviors, such as walking or exercise [10,27,28]. Such findings imply that intervention strategies to promote trust and cohesion among neighbors may be effective in facilitating adult physical activity in rural areas. However, physical activity in urban adults was not significantly associated with their social environment, such as social networks, social cohesion, and participation in social activities. Descriptive statistics showed that the degree of social cohesion was markedly lower in urban areas compared to rural areas. It is speculated that social relationships have no effect on physical activity in adults living in urban areas, who tend to have little rapport with their neighbors. As shown here, the neighborhood characteristics of social environments have minimal effect on urban adults. Interpersonal social support via family, friends, and colleagues, may be a more effective alternative for

Table 4 Effects of individual and community level factors upon moderate or vigorous physical activity: a multilevel analysis; urban.

		Model 1		Model 2		Model 3	
		OR	95% CI	OR	95% CI	OR	95% CI
Fixed effect							
Individual level							
Gender	Male (ref)						
Age(years)	19-34 (ref)						
Marital status	Living with spouse (ref)						
Education	uneducated			1.02	0.861-1.205	1.02	0.861-1.206
Job	non-manual						
Household income	<100						
Self-rated health	poor						
No. of	0						
BMI	obesity			0.97	0.939-1.009	0.97	0.939-1.009
Community level							
Satisfaction with safety						1.36	0.256-5.941
Satisfaction with natural environment						0.45	0.159-1.378
Satisfaction with life environment						2.60	0.382-17.314
Satisfaction with public transportation						2.83	1.001-7.223
Satisfaction with health service						0.93	0.357-2.288
Social cohesion						0.66	0.308-1.477
Social networks						0.97	0.876-1.072
Social activity participation						2.53	0.768-14.318
Presence of cycle paths (ref=no)						0.99	0.815-1.148
Number of exercise facilities						1.00	0.996-1.001
Number of sports parks						0.98	0.960-0.995
Number of hiking trails						0.99	0.989-0.999
Community level random effect							
Between community variance(SE)		0.14 (0.03)		0.14 (0.03)		0.09 (0.02)	
ICC		0.040		0.040		0.028	
Statistics for the model fit							
Log likelihood		-53990.09		-50962.91		-50943.40	
Likelihood-ratio test							
χ^2 (p)		2198.89 (<0.001)		2074.46 (<0.001)		1339.29 (<0.001)	

BMI = body mass index; CI = confidence interval; ICC = intra-class correlation.

promoting physical activity such as walking and exercise [9,29,30].

Physical activity declined among rural adults as their satisfaction with safety (e.g., crime and traffic accidents) increased, which is contradictory to previous findings where perceived safety pertaining to crime and traffic, had positive effects on physical activity and walking [9,11,31]. Rural adults indicated high satisfaction (86.6%) with safety regarding crime and traffic accidents but this had minor effects on physical activity (OR=0.043). In contrast, urban adults tended to engage in – but not to a statistically significant extent – higher levels of physical activity when satisfaction with safety was higher. According to Bauman's systematic literature review to analyze environmental factors related to physical activity, perception of safety (crime and traffic) was not associated with physical activity [1]. Furthermore, Eichinger et al also found a negative correlation between adult physical activity and perception of safety[32].

A couple of factors may contribute to the lack of consistency in the relationship between safety and physical activity. First, subjective perceptions of safety may differ across subjects and situations. In addition, the effects may differ according to how physical activity – the dependent variable – is measured, e.g., leisure activities, walking, and transportation activities [1]. Because our study also defined MVPA to encompass walking, occupational activities, physical activity during leisure time, and high-intensity exercise, future studies should classify physical activity into subcategories to analyze their individual associations with safety.

Individual-level factors that affect MVPA did not differ greatly between urban and rural adults. Participation in MVPA was higher

Table 5. Effects of individual and community level factors upon moderate or vigorous physical activity: MVPA from a multilevel analysis; rural.

		Model 1		Model 2		Model 3	
		OR	95% CI	OR	95% CI	OR	95% CI
Fixed effect							
Individual level							
Gender	Male(ref)						
Age(years)	19-34(ref)						
Marital status	Living with spouse(ref)						
Education	uneducated			1.02	0.861-1.205	1.02	0.861-1.206
Job	non-manual						
Household income	<100						
Self-rated	poor						
No. of Chronic diseases							
BMI	obesity			0.99	0.941-1.031	0.99	0.941-1.031
Community level							
Satisfaction with safety						0.05	0.003-0.867
Satisfaction with natural environment						4.40	0.741-26.156
Satisfaction with living environment						0.28	0.061-1.253
Satisfaction with public transportation						2.60	0.781-8.680
Satisfaction with health service						1.73	0.592-5.039
Social cohesion						4.69	1.216-18.114
Social networks						1.02	0.913-1.158
Social activity participation						0.52	0.203-1.303
Presence of bikecycle paths (ref=no)						1.33	1.007-1.751
Number of exercise facilities						2.00	0.994-1.001
Number of sports parks						1.03	1.001-1.058
Number of hiking trails						1.03	1.006-1.044
Number of urban parks						1.01	0.993-1.016
Community level random effect							
Between community variance(SE)		0.17(0.03)		0.16 (0.03)		0.11 (0.03)	
Intra-class correlation(ICC)		0.049		0.047		0.033	
Statistics for the model fit							
Log likelihood		-30539.61		-27952.83		-27937.74	
Likelihood-ratio test							
$\chi^2(p)$		1472.76(<0.001)		1261.70(<0.001)		882.40 (<0.001)	

ICC = intra-class correlation; CI = confidence interval.

in men in both urban and rural areas and higher in the 50–64 age group than in other groups for urban areas, while it was higher in the 35–49 and 50–64 age groups than in other groups for rural areas. Compared to married individuals, single individuals (urban and rural) or widowed or separated (urban only) individuals engaged in more MVPA. In both urban and rural areas, manual laborers participated in more MVPA compared to non-manual laborers. Homemakers and unemployed residents in rural areas did not often engage in MVPA. In both urban and rural areas, participation in MVPA was higher among those with higher monthly household incomes and those who perceived themselves to be in neutral or very good health. In urban areas, those with 2 chronic diseases, as opposed to those who did not have a chronic disease, engaged in MVPA less frequently, while in rural areas, those with one or 2 chronic diseases engaged in MVPA at higher levels. These results are in line with many previous studies [1,13].

The results from this large Korean sample suggest that individual factors, including gender, age, marital status, monthly household income, job, number of chronic diseases, as well as community-level social and physical environmental factors, including the presence of cycle paths, the number of sports parks and hiking trails, satisfaction with public transportation, participants'

satisfaction with safety, and social cohesion were associated with MVPA among Korean adults in urban and rural areas, and the specific social and physical environmental factors that affect physical activity differ between urban and rural adults.

Therefore, this study is meaningful in that it sheds light on the importance of considering differences in the effects of environmental variables on urban and rural adults when developing interventions to promote adult physical activity.

This study has a few limitations. First, it cannot infer causal relationships between physical activity and social and physical environments due to the cross-sectional design. Second, data based on self-reporting may have reduced accuracy. Although the IPAQ, whose reliability and validity were verified and used to measure physical activity, there is still a possibility of measurement errors. Finally, this study did not consider the usability and proximity of exercise facilities.

Cconflicts of interest

No potential conflict of interest relevant to this article was reported.

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