Multilevel analysis and regional variation of physical activities in Korean adults based on the 4th Korea National Health and Nutrition Examination Survey

Min-Young Jang[*], Moo-Sik Lee[*†], Jee-Young Hong[*],

Hyunsoo Kim[*], Kwang-Hwan Kim[**], Seok-Hwan Bae[***]

[*] *Department of Preventive Medicine, College of Medicine, Konyang University*
[**] *Department of Hospital Management, Konyang University*
[***] *Department of Radiology, Konyang University*

<Abstract>

Objectives: Physical activity is well known as one of the most effective health behaviors for maintaining and promoting health. The purpose of this study was to investigate the regional variation, compositional and contextual factors on physical activities in Korea. **Methods:** This study analyzed data of 6,353 adults in 4th-1, 2 Korea National Health and Nutrition Examination Survey (KNHANES). Independent variables were compositional factors that included general characteristics, health behaviors, health status, and contextual factors that included physical environment, political environment, and social safety net. Dependent variables were vigorous physical activity, moderate physical activity, and walking activity. Multilevel analysis were used to determine a variation of physical activity between levels of compositional factors and contextual factors. **Results:** Physical activities of the Korean people were affected by the regional variables. Financial independence and population density were related with moderate physical activity significantly. Population density, school sport or rally spaces, cultural facilities, and social safety concerns were related with walking activity significantly. These variables impacted on physical activities along with variables at the individual level. Variance Partition Coefficient were 9.94% at moderate physical activity and 2.91% at walking activities, respectively. **Conclusions:** The results suggest that the regional variables should be considered when planning public intervention to promoting physical activities in Korean adults.

Key words: physical activity, regional variation, multilevel analysis, Korean

Ⅰ. Introduction

Physical activity as a tool of health promotion, is easily accessible and cost effective. Individual health problems like chronic degenerative diseases due to the lack of physical activity and national medical cost issues are being reported(Lalonde, 1974), so a worldwide effort to increase the physical activity is actively conducted. In a population health, population is considered as more important determinant of health than individual factors(Kindig & Stoddart, 2003).

Studies regarding physical activity and health related issues were conducted by taking into account various different variables and several individual factors; physical activity and mortality rate(Paffenbarger et al., 1983), inactive life and health(Larry et al., 1993; Hancox et al., 2004), physical activity and heart disease(Leon et al.,1996), physical activity and hypertension(Hagberg et al., 1989), physical activity and diabetes(Manson et al., 1992).

Most of these studies were focused on individual traits to discover the socio-economic factors or the threatening factors

---

Corresponding author : Moo-Sik Lee
    Department of Preventive Medicine, College of Medicine, Konyang University
    158 Gwanjeodong-Ro, Seo-Gu, Daejeon, Korea
    주소: (35365) 대전광역시 서구 관저동로 158 건양대학교 의과대학 예방의학교실
    Tel: +82-42-600-6404, Fax: +82-42-600-6401, E-mail: mslee@konyang.ac.kr

of lifestyle from the individual level. However human beings live in a specific region while relating with other people, then it is essential that we should take account not only individual trait but also regional variables when studying an individual's health(Robert, 1998). To resolve the problems of regional variation analysis and compare the effect of residential factors, a multilevel analysis could be employed since it could minimize errors by confounders, and analyze individual traits and regional traits separately.

Therefore we conducted to investigate the determinant of physical activity and regional variation of physical activity that included compositional and contextual factors in KNHANES by multilevel analysis(King et all, 2008; Diez-Roux et al., 1998; Diez-Roux , 2000) on the basis of precious studies(Salis et al.,1996; Cho et al., 1991; Cho et al., 1994; Yoon et al., 2003; Nam et al.,1999; Kim et al., 2006).

Ⅱ. Methods

1. Data and participants

In this study, we used the raw data of KNHANES 4th-1(2007), 4th-2(2007) from Korea Centers for Disease Control and Prevention and major regional variables of the 16 metropolitan cities and provinces from Statistics Korea, 2005-2008. Dependent variables of this study were vigorous physical activity, moderate physical activity, and walking activity. Independent variables of regional variation were consisted with compositional and contextual variables. Compositional variables were selected by the same way. For the contextual variables, we got the 2005-2008 data from Statistics Korea. Preliminary data included 5,409 households and 14,338 subjects. Finally, we analyzed 6,353 subjects because 8,085 subjects did not measure or insufficient information of physical activities.

2. Measures

We had selected below variables to find out the effect of compositional factors and contextual factors of 16metropolitan cities and provinces on physical activities. The dependent variables were physical activities which were categorized 'vigorous physical activity', 'moderate physical activity', and 'walking activity' which were the same concepts used in KNHANES(Jang, 2011). The independent variables were consisted of general characteristics, compositional variables, and contextual variables(Jang, 2011). The variables of general characteristics were socio-demographic variables which were a gender, age, type of household, household income status, marital status, type of social security, regional type of residence, number of family members, educational attainment, and administrative districts. The composition variables were categorized into 'health behaviors', 'mental health', 'health status', 'limitation of activities', and 'accident and poisoning'. The variables of health behaviors were current status of tobacco smoking, high risk drinking of alcohol, and efforts for weight maintenance. The variables of mental health were the awareness on the stress, experience of depression, suicidal thoughts. The variable of accident and poisoning was the experience of accident and poisoning. The variables of health status and limitation of activities were subjective health status, health screening, and limitation of activities.

The contextual variables were categorized into physical environment, political environment, and social safety net. The variables of physical environment were population density, area of city parks, pavement area of the road, area of school sports and rally, and the number of registered cars per capita. The variables of political environment were financial reinforcement, labor participation rates, average life expectancy, internet utilization rate, the number of culture facilities, and the number of welfare service institution for elderly. The variables of social safety net were the incidence of crime, incidence of traffic accidents, the number of traffic accidents against a person, and the subjective perception on social safety.

3. Statistical analyses

We accessed the variation of physical activities among Korean adults by the logistic multilevel analysis model through SPSS version 18.0(Statistical Package for the Science, Inc, Chicago, IL, USA) and SAS version 9.1(Statistical Analysis Software Inc, NC, USA). A p-value <0.05 was considered

statistically significant. First of all, we estimated and compared the size of regional variation through the standardized rate of physical activities, compositional factors, and contextual factors. The distribution of general characteristic of study subjects were analyzed by frequency analysis and chi-square test between dependent and independent variables. The patterns of regional variation were analyzed by bivariate analysis between dependent variables and region, and general characteristics and region. Secondly, chi-square test and correlation analysis were used when the physical activities and independent variable had a linear relationship. For contextual factors, spearman's rank correlation analysis was conducted. Thirdly, multiple logistic regression analysis was applied for analyzing regional variation of physical activities because of confounding effect and the existence of actual variation couldn't be found only by the single variable. Lastly, we identified the effect of region on physical activities by multilevel analysis which was null model, random-coefficient regression model, and intercepts and slope as outcomes model.

Ⅲ. Results

1. The general characteristics of study subjects

The general characteristics of study subject, as seen in Table 1. Female subjects were 3,211(50.5%), the 30s was the largest group(1,584, 24.9%), over 70s was the smallest group(505, 7.9%), by the regional criteria, the dong-region was 4,801(75.6%). By the marital status, the subject who married and living together category was 4,675(73.6%). By educational status, high school graduate category was highest (2,477, 39.0%). By the number of persons per household, over 4 peoples were 3,236(50.9%). Residents in provinces were 3,542(55.8%). By administrative district, residents in Gyong-gi province was the highest(1,284, 20.2%). Comparing the general characteristics of study subjects by gender, age, marital status, educational level, region(dong, eup, myon, the 16 metropolitan city and province respectively), family number, and residential type showed significant difference(p<0.05)<Table 1>.

<Table 1> General characteristics of study subjects by gender

Unit: N(%)

Variable	Male	Female	Total
Age(years)*			
19~29	428 (13.6)	557 (17.3)	985 (15.5)
30~39	736 (23.4)	848 (26.4)	1,584 (24.9)
40~49	694 (22.1)	734 (22.9)	1,428 (22.5)
50~59	537 (17.1)	515 (16.0)	1,052 (16.6)
60~69	453 (14.4)	346 (10.8)	799 (12.6)
≥ 70	294 (9.4)	211 (6.6)	505 (7.9)
Marital status*			
Single	539 (17.2)	463 (14.4)	1,002 (15.8)
Married	29 (77.3)	2,246 (69.9)	4,675 (73.6)
Divorced	174 (5.5)	502 (15.6)	676 (10.6)
Educational attainment*			
≤ Elementary school	536 (17.1)	777 (24.2)	1,313 (20.7)
Middle school	383 (12.2)	352 (11.0)	735 (11.6)
High school	1,217 (38.7)	1,260 (39.2)	2,477 (39.0)
≥ College	1,006 (32.0)	822 (25.6)	1,828 (28.8)
Type of social security			
Self-employed	1,236 (39.3)	1,238 (38.6)	2,474 (38.9)
Industrial workers	1,828 (58.2)	1,864 (58.1)	3,692 (58.1)

Variable	Male	Female	Total
Others	78 (2.5)	109 (3.4)	187 (2.9)
Regional type of residence*			
Dongs	2,331 (74.2)	2,470 (76.9)	4,801 (75.6)
Ups & Myons	811 (25.8)	741 (23.1)	1,552 (24.4)
Number of person per household*			
One	140 (4.5)	198 (6.2)	338 (5.3)
Two	728 (23.2)	608 (18.9)	1,336 (21.0)
Three	741 (23.6)	702 (21.9)	1,443 (22.7)
≥ Four	1,533 (48.8)	1,703 (53.0)	3,236 (50.9)
Type of house*			
Detached dwelling	1,041 (33.1)	925 (28.8)	1,966 (30.9)
Apartment	1,377 (43.8)	1,516 (47.2)	2,893 (45.5)
Others	724 (23.0)	770 (24.0)	1,494 (23.5)
Household income status(quartile)			
1th(lowest)	524 (16.7)	522 (16.3)	1,046 (16.5)
2nd	794 (25.3)	838 (26.1)	1,632 (25.7)
3rd	881 (28.0)	890 (27.7)	1,771 (27.9)
4th(highest)	943 (30.0)	961 (29.9)	1,904 (30.0)
Adminstrative district			
Seoul	511 (16.3)	559 (17.4)	1,070 (16.8)
Busan	192 (6.1)	231 (7.2)	423 (6.7)
Daegu	161 (5.1)	166 (5.2)	327 (5.1)
Incheon	164 (5.2)	172 (5.4)	336 (5.3)
Gwangju	137 (4.4)	131 (4.1)	268 (4.2)
Daejeon	96 (3.1)	123 (3.8)	219 (3.4)
Ulsan	75 (2.4)	93 (2.9)	168 (2.6)
Gyeonggi	643 (20.5)	641 (20.0)	1,284 (20.2)
Gangwon	113 (3.6)	103 (3.2)	216 (3.4)
Chungbuk	116 (3.7)	105 (3.3)	221 (3.5)
Chungnam	146 (4.6)	126 (3.9)	272 (4.3)
Jeonbuk	121 (3.9)	114 (3.6)	235 (3.7)
Jeonnam	181 (5.8)	173 (5.4)	354 (5.6)
Gyeongbuk	210 (6.7)	204 (6.4)	414 (6.5)
Gyeongnam	202 (6.4)	207 (6.4)	409 (6.4)
Jeju	74 (2.4)	63 (2.0)	137 (2.2)
Metropolitan city & province*			
Metropolitan city	1,336 (42.5)	1,475 (45.9)	2,811 (44.2)
Province	1,806 (57.5)	1,736 (54.1)	3,542 (55.8)
Total	3,142 (49.5)	3,211 (50.5)	6,353 (100.0)

* $p < 0.05$, by χ^2-test

2. Results of logistic regression on the physical activities

The significant variables were selected by the logistic regression analysis for the physical activities as below. Gender and the marital status in the general characteristics, effort or not effort for weight maintenance and subjective health status in the compositional variables were selected for vigorous physical activity. Age, marital status, type of household in the general characteristics, effort for weight maintenance, subjective health status in the compositional variables were selected for moderate physical activity. Gender, age, marital status, type of household in the general characteristics, subjective health status in the compositional variables was selected for walking activity. In the vigorous physical activity, male experienced 1.42 times more than female; who not married of marital status experienced 1.91 times more than divorced, who married experienced 1.37 times more than divorced; who lost weight or with effort for weight maintenance experienced 1.93 times more than who not effort;

who were unhealthy experienced 0.81 times more than healthy subjective status(p<0.05). In the moderate physical activity, 19-29 age group experienced 1.79 times more than above 70 age group; 50-59 age group experienced 1.70 times more than above 70 age group; who married of marital status experienced 1.50 times more than divorced; detached dweller experienced 1.39 times more than other type of household; who were unhealthy experienced 0.58 times more than healthy subjective status(p<0.05).In the walking activity, male experienced 1.14 times more than female; 19-29 age group experienced 0.70 times, 30-39 age group experienced 0.60 times,40-49 age group experienced 0.58 times more than above 70 age group respectively; who not married(single) of marital status experienced 1.80 times more than divorced; detached dweller experienced 1.17 times more than other type of household; who were unhealthy experienced 0.70 times more than healthy subjective status(p<0.05)<Table 2>.

<Table 2> Logistic regression analysis on the physical activities by type of physical activity

Unit: Odds ratio(95% confidence interval)

Variable	Vigorous		Moderate		Walking	
Gender						
Female	1				1	
Male	1.42	(1.23 - 1.63)			1.14	(1.02 - 1.26)
Age(years)						
≥ 70	1		1		1	
19~29	.82	(.54 - 1.25)	1.79	(1.15 - 2.79)	.70	(.51 - .95)
30~39	1.09	(.78 - 1.53)	1.37	(.94 - 1.98)	.60	(.47 - .78)
40~49	1.27	(.91 - 1.78)	1.37	(.96 - 1.95)	.58	(.45 - .74)
50~59	1.37	(.98 - 1.91)	1.70	(1.22 - 2.36)	.91	(.73 - 1.15)
60~69	1.27	(.90 - 1.79)	1.32	(.95 - 1.85)	.88	(.70 - 1.11)
Marital status						
Divorced	1		1		1	
Single	1.91	(1.32 - 2.75)	.97	(.65 - 1.46)	1.80	(1.38 - 2.36)
Married	1.37	(1.05 - 1.77)	1.50	(1.12 - 2.00)	1.19	(.98 - 1.44)
Educational attainment						
≤ Elementary school			1		1	
Middle school			.88	(.68 - 1.14)	.88	(.73 - 1.07)
High school			.81	(.64 - 1.04)	.98	(.82 - 1.18)
≥ College			.67	(.51 - 0.88)	.82	(.68 - 1.00)

Variable	Vigorous		Moderate		Walking	
Awareness on the stress						
Severe					1	
Mild					1.04	(.92 - 1.17)
Experience of depression						
Severe					1	
Mild					1.08	(.92 - 1.27)
Suicidal thought						
Yes					1	
No					1.12	(.96 - 1.31)
Regional type of residence						
Dongs			1			
Ups & Myons			1.12	(.94 - 1.34)		
Number of person per household						
One			1		1	
Two			1.25	(.82 - 1.91)	1.14	(.87 - 1.49)
Three			1.16	(.76 - 1.78)	1.11	(.85 - 1.45)
≥ Four			1.18	(.77 - 1.81)	1.14	(.87 - 1.48)
Type of house						
Others			1		1	
Detached dwelling			1.39	(1.13 - 1.71)	1.17	(1.02 - 1.35)
Apartment			.92	(.75 - 1.11)	.97	(.85 - 1.10)
Income(quartile)						
1th(lowest)	1					
2nd	1.18	(.93 - 1.48)				
3rd	1.16	(.91 - 1.47)				
4th(highest)	1.14	(.90 - 1.45)				
Effort for weight maintenance						
No effort	1		1			
Lost weight with effort	1.93	(1.68 - 2.23)	1.24	(1.07 - 1.44)		
Health screening						
No			1			
Yes			1.13	(.98 - 1.32)		
Subject health status						
Healthy	1		1		1	
Unhealthy	.81	(.71 - .93)	.58	(.50 - .67)	.70	(.63 - .77)
Limitation of activity						
Yes	1					
No	1.06	(.86 - 1.31)				
Constant	.07		.09		.91	

3. Results of multilevel analysis for the physical activities

Gender, marital status, efforts for weight maintenance, subjective health status among individual variables, number of registered vehicles, average of life expectancy(age) among regional variables were included in multilevel analysis on vigorous physical activity. Variance of the random effect was 0.003, 0.013, 0.002 in Model 1(provincial level), Model 2(individual level), Model 3(provincial and individual level), respectively. Variance Partition Coefficients which was the explanatory scale of regional variance regarding additional variables were 0.30%, 1.30%, 0.20% in Model 1(provincial level), Model 2(individual level), Model 3(provincial and individual level), respectively. It could not be used as the variables of regional level and individual-level on vigorous physical activity<Table 3>.

<Table 3> Multilevel analysis for the vigorous physical activity by the type of model

Unit: Odds ratio(95% confidence interval)

Independent variable	Model 1*		Model 2		Model 3	
Fixed effect						
Individual level						
Gender						
Female			1.00		1.00	
Male			1.46	(1.27 - 1.67)	1.45	(1.27 - 1.67)
Marital status						
Single			1.00		1.00	
Married			.96	(.81 - 1.15)	.96	(.81 - 1.15)
Divorced			.68	(.51 - .91)	.67	(.50 - .90)
Effort for weight maintenance						
Lost weight with effort			1.00		1.00	
No effort			.50	(.43 - .57)	.50	(.43 - .57)
Subject health status						
Healthy			1.00		1.00	
Unhealthy			.81	(.71 - .92)	.80	(.70 - .91)
Provincial level						
Number of cars						
Low area					1.00	
High area					.93	(.79 - 1.11)
Average of life expectancy						
Low area					1.00	
High area					.92	(.59 - 1.44)
Random effect						
Variance(SE)	.003(0.01)		.013(.01)		.002(.01)	
VPC†	0.30		1.3		.20	
Explained %	-		3.3		56.6	
Model fitness						
-2 log-likelihood	30,386.91		30,790.82		30,838.82	

* null model : include only 16 metropolitan cities & provinces
† Variance Partition Coefficient

<Table 4> Multilevel analysis for the moderate physical activity by the type of model

Unit: Odds ratio(95% confidence interval)

Independent variable	Model 1*		Model 2		Model 3	
Fixed effect						
Individual level						
Age(year)						
≥ 70			1.00		1.00	
19～29			1.69	(1.09 - 2.62)	1.69	(1.09 - 2.61)
30～39			1.29	(.90 - 1.85)	1.29	(.90 - 1.85)
40～49			1.35	(.96 - 1.91)	1.35	(.96 - 1.91)
50～59			1.70	(1.22 - 2.35)	1.69	(1.22 - 2.35)
60～69			1.36	(.97 - 1.90)	1.36	(.97 - 1.89)
Marital status						
Single			1.00		1.00	
Married			1.57	(1.15 - 2.15)	1.57	(1.15 - 2.14)
Divorced			.99	(.66 - 1.49)	.99	(.66 - 1.48)
Educational attainments						
University			1.00		1.00	
≤ Elementary school			1.42	(1.08 - 1.87)	1.41	(1.07 - 1.86)
Middle school			1.28	(.97 - 1.69)	1.27	(.97 - .68)
High school			1.22	(1.01 - 1.47)	1.22	(1.01 - 1.47)
Type of house						
Others			1.00		1.00	
Detached dwelling			1.32	(1.08 - 1.63)	1.31	(1.06 - 1.61)
Apartment			.90	(.74 - 1.10)	.90	(.74 - 1.09)
Effort for weight maintenance						
Lost weight with effort			1.00		1.00	
No effort			.80	(.69 - .93)	.80	(.69 - .93)
Subject health status						
Healthy			1.00		1.00	
Unhealthy			.63	(.55 - .73)	0.63	(.55 - .73)
Provincial level						
Financial reinforcement						
Low area					1.00	
High area					.68	(.49 - .95)
Population density						
Low area					1.00	
High area					.92	(.66 - 1.28)
Random effect						
Variance(SE)	.19(0.08)		.13(.08)		.08(.07)	
VPC†	5.46		14.44		9.94	
Explained %	-		27.82		52.77	
Model fitness						
-2 log-likelihood	31579.71		31858.81		31874.73	

* null model : include only 16 metropolitan cities and provinces

† Variance Partition Coefficient

Age, marital status, housing status, educational maintenance, and efforts for weight maintenance among individual variables, financial reinforcement and population density among regional variables were included in multilevel analysis on moderate physical activity. Variance of the random effect was 0.19, 0.13, 0.08 in Model 1(provincial level), Model 2(individual level), Model 3(provincial and individual level), respectively. Variance Partition Coefficients which was the explanatory scale of regional variance regarding additional variables were 5.46%, 14.44%, 9.94% in Model 1(provincial level), Model 2 (individual level), Model 3(provincial and individual level), respectively. As a result, it showed that individual level variables and regional variables for moderate physical activity were explainable<Table 4>.

Age, marital status, type of household, educational attainment, efforts for weight maintenance variables among individual variables, financial reinforcement independency and population density were included in multilevel analysis on walking activity. Variance of the random effect was 0.06, 0.05, 0.03 in Model 1(provincial level), Model 2(individual level), Model 3 (provincial and individual level), respectively. Variance Partition Coefficients which was the explanatory scale of regional variance regarding additional variables were 5.65%, 4.76%, 2.91% in Model 1(provincial level), Model 2(individual level), Model 3(provincial and individual level), respectively. It could be explained by the individual-level variables and regional variables on walking activity<Table 5>.

Ⅳ. Discussion

This study was based on the evidence that "in an ecological model, the determinant of the physical activities consists of individual, behavioral, socio-cultural, and environmental factors(Yoon, 2003), and these factors were correlated with physical environmental factors(King, et al., 2008), individual behavioral factors, socio-cultural factors(Kang, 2009; Kim, 2002; Jung et al., 2010; Kim & Cho, 2008; Lee & Cho, 2009; Kim & Yoon, 2008; Kim,& Cho, 2007), and additionally the time factor should be included"(Sallis & Owen, 1996). This study tried to analyze the regional variance of physical activities of 16 major cities and provinces in Korean adults by the multilevel analysis model.

Regional data was selected from KNHANES data(KHNANES 3rd, 4rd) and contextual data from cities and provincial statistics(Statistics Korea, 2005-2008). The regions were divided into sub-regions such as location of medical facility(dental facility included), topographical region, medical service region, and many others. The sub-region variance analysis enables the comparison between city, state, and gu, between urban and rural regions, and between the metropolitan cities and provinces(Cho, & Kim, 1991; Cho et al., 1994; Yoon, 2003; Kim et al., 2006).

The individual variables used in this study included the socio-demographic factors referred to pre-existing studies, which were divided into gender, age, household income status, marital status, type of social security, type of household, number of family numbers, educational attainment, and regional type of residence. The dependent variables were selected from data of KNHANES(KCDC,2009-2010), which were divided into vigorous physical activity, moderate physical activity, and walking activity. Regional variables, as contextual factors referred from existing studies included "dynamic model for the welfare policy analysis"(Dever,1991) to select 19 variables of the physical environment, policy environment, and social safety net in 16 the metropolitan cities and provinces.

Because of cross-sectional design of this study, there were the limitation that it couldn't prove whether such physical activities were influenced from the change of individual and contextual variables or the individual and contextual variables were influenced from the physical activities.

Regarding the relationship between physical activity and general characteristics, it corresponds with the results of Korea Center for Disease Control and Prevention on 2010, which indicates that men showed the tendency of having more vigorous activity, moderate activity, and walking activity than women in all age group in spite of slight differences by the time of survey.

<Table 5> Multilevel analysis for the walking activity by the type of model

Unit: Odds ratio(95% confidence interval)

Independent variable	Model 1*		Model 2		Model 3	
Fixed effect						
Individual level						
Sex						
Female			1.00		1.00	
Male			1.04	(1.03 - 1.27)	1.41	(1.03 - 1.27)
Age(year)						
≥ 70			1.00		1.00	
19~29			.69	(.52 - .91)	.69	(.52 - .91)
30~39			.58	(.46 - .72)	.58	(.46 - .72)
40~49			.56	(.45 - .70)	.56	(.45 - .70)
50~59			.90	(.72 - 1.12)	.90	(.72 - 1.12)
60~69			.88	(.70 - 1.11)	.88	(.70 - 1.11)
Marital status						
Single			1.00		1.00	
Married			.67	(.55 - .82)	0.67	(.55 - .82)
Divorced			.55	(.42 - .72)	0.55	(.42 - .72)
Type of household						
Others			1.00		1.00	
Detached dwelling			1.16	(1.10 - 135)	1.16	(1.10 - 1.35)
Apartment			.96	(.84 - 1.10)	.96	(.84 - 1.10)
Subject health status						
Healthy			1.00		1.00	
Unhealthy			.70	(.63 - .78)	.70	(.63 - .78)
Provincial level						
Population density						
Low area					1.00	
High area					.71	(.41 - 1.21)
School sport/rally space						
Low area					1.00	
High area					.86	(.51 - 1.48)
Cultural facilities						
Low area					1.00	
High area					1.11	(.75 - 1.64)
Welfare service for elderly						
Low area					1.00	
High area					.65	(.45 - .95)
Social security concerns						
Low area					1.00	
High area					.79	(.54 - 1.15)
Random effect						
Variance(SE)	.06(.03)		.05(.02)		.03(.02)	
VPC†	5.65		4.76		2.91	
Explained %	-		16.70		50.00	
Model fitness						
-2 log-likelihood	26,930.85		27,150.48		27,172.24	

* null model : include only 16 metropolitan cities and provinces

† Variance Partition Coefficient

In consideration of the household income status, peoples of the high income group had the number of proportions of vigorous physical activity group, but it was not statistically significant in the logistic regression analysis. Peoples of middle-high income group were highest number of proportions of moderate physical activity group, peoples of low income group were highest number of proportions of the walking activity group, while peoples of the low income group took up the less number of proportions in vigorous physical activity and moderate physical activity population (Kennedy & Kaplan et al., 1996).

We examined the relationship between physical activities and individual variables. High-risk alcohol drinker spent more time doing vigorous physical activity, peoples who experienced less depression symptoms and who did not have suicidal ideation spent more time doing walking activity. Peoples who answered that their health was good or very good spent more time doing vigorous, moderate, and walking activity. This result corresponds with the result of 3rd KNAHANES(Yang et al., 2005).

Also, we analyzed the relationship between physical activity and regional explanatory variables. High density of population had a significant negative effect on physical activities, number of cultural facilities had an obvious positive relationship with walking activity. However, if peoples felt some anxiousness on the overall social safety, it effected an obvious negatively on walking activity. This result indicated that peoples would like to have physical activity because of sufficient number of cultural facilities. If there's an anxiousness on the social safety, peoples would not leave there houses, so it leads to the decline of walking activity which was related to the people's psychology.

There was a significant relationship positively between the number of welfare service institution for elderly and walking activity, which tells us that sufficient supply of such facilities would be effective policy for health promotion not only in the cities and provinces level but also in the local government levels too. This findings was the same results with Cunningham et al's study (2004) which showed a surrounding environments effect on the physical activity of the aged peoples. However,

there were controversies surrounding the directionality of the which could be found in Sallis' argument(Sallis & Owen,1996)that 'regional environments can encourage physical activity but it could also negative influence on the physical activity'.

The results of logistic regression analysis on vigorous physical activity showed that men were 1.42 times more likely to have to vigorous physical activity than women. The finding were the same result with other study(Yang et al., 2005). In logistic regression analysis on moderate physical activity, peoples who got married or spouse more likely to have moderate physical activity which also corresponds with the study(Yang et al., 2005). It would be an important result in the future research on physical activities.

The results of the logistic regression analysis on walking activity showed that men were 1.14 times higher than women, and men did more like to walk when they get older. This result corresponds with the result which showed the significance of elementary, middle, and high school playgrounds, the number of welfare service institution for elderly on walking activity. Therefore, it was very important to prepare an effective plan of 'physical activity promotion for public health'.

We examined the multilevel analysis which could explain the variance on physical activities of the individual and regional level. In vigorous physical activity, variance of Model 1 was lower than Model 2 and the same with Model 3, which made it impossible to explain by the variance of random effect. We should consider measurement errors, data collection and selecting variables, cause of excluding individual level variables in future and further studies.

Variances of moderate physical activity were 0.19(Model 1), 0.13(Model 2), and 0.08(Model 3), and VPC were 5.46% (Model 1), 4.91%(Model 2), and 4.08%(Model 3), respectively. It would approximately influence 4.08% on moderate physical activity when we include the variables of individual and regional level.

Variances of walking activity were 0.06(Model 1), 0.05(Model 2), and 0.03(Model 3), and VPC were 5.65%(Model 1), 4.76% (Model 2), 2.91%(Model 3), respectively. It would influence

somewhat when we include the variable of individual and regional level. These results were similar to Lee et al's study(2002), he stated that the difference of residing region caused approximately 3.2% variance of subjective health status as dependent variable. Values of ICC(VPC) are calculated by the correlation coefficient. If values of ICC(VPC) are above 0.05, it can be assumed that there is a substantial difference between group or region. Therefore our results showed that variables of the individual and regional level were related with moderate physical activity, and walking activity.

This study had several limitations as below; Firstly, these results showed that the regional characteristic itself can work as a factor that determine an individual's health. Since the questions of KNHANES did not distinguish between work time and leisure time physical activity, so we don't know whether individual or regional variables have the relationship with physical activities. Also, if the type and amount of physical activities could influence to the physical activities, the size of effect could be counterbalanced or exaggerated.

Secondly, there were remained still regional variances that can't be explained by compositional effect. Although we identified some contextual effect, however, this study failed in analyzing through a specific division between urban and rural regions, and these results failed in showing the possibility of compositional effect, sufficient description on regional discrepancy, and a sufficient explanation on specific pathogenesis and possibility of intervention, which calls for further sophisticated research.

Ⅴ. Conclusion

Physical activities of the Korean people were affected by the regional variables, such as financial independence, population density for physical activities of moderate intensity, population density, school sport or rally spaces, cultural facilities, and social safety concerns for walking exercises; the effects of these variables, along with variables at the individual level, are 9.94% and 2.91% at moderate and walking level of

physical activities, respectively. The results suggest that the levels of the regional variables should be considered when planning public intervention to promoting physical activities in Korean adults.

References

Cho, W. H., & Kim H. J. (1991). Small area variation. *Korean J Health Policy & Administration, 1*(1), 42-53.

Cho, W.H., Lee S. H., Park, E. C., Shon, M. S., & Kim, S, R. (1994). An analysis of small area variation of hospital services utilization in Korea. *J Prev Med Public Health, 27*(3), 609-626.

Cunningham, G. O., & Michael, Y. L. (2004). Concepts guiding the study of the impact of the built environment on physical activity for older adults: a review of the literature. *Am J Health Pro ,18,* 435-443.

Dever. (1991). *A Community Health Analysis. Second Edition, Am Aspen Publication*.

Diez-Roux, A. V. (1998). Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *Am J Public Health, 88*(2), 216-222.

Diez-Roux, A. V. (2002). Multilevel analysis in public health research. *Annu Rev Public Health, 22,* 172-192.

Hagberg, J. M., Montain, S. J., Martin, W. H., & Ehsani, A. A. (1989). Effect of exercise training on 60-69 year old persons with essential hypertension. *Am J Cardiol, 64,* 348-353.

Hancox, R. J., Milne, B. J., & Poulton, R. (2004). Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. *Lancet, 364,* 257-261.

Jang. M.Y. (2011). The Determinants and Regional Variation of Physical Activity in Korea. Graduate School of Konyang University(Korean), 32- 40.

Jung, J. H., Kwon, S. M., Kim, K. H., Lee, S. K., & Kim, D. S. (2010). Impact of health insurance type on the quality of hemodialysis service: multilevel analysis. *J Prev Med Public Health, 43*(3), 245-256.

Kaplan, G. A., Pamuk, E. R., & Lynch, J. W. (1996). Inequality in incomed mortality in the United States: analysis of mortality and potential pathways. *BMJ, 312,* 999-1003.

KCDC (2007). KHNANES 3rd: Health behavior adults. *Korea Centers for Disease Control& Prevention*. 107-265

KCDC (2007). KHNANES 3rd: Illness of adults. *Korea Centers for Disease Control& Prevention*. 107-120

KCDC (2007). KHNANES 4th-1 the KNHANES(2007). *Korea Centers for Disease Control& Prevention*. 77-621

KCDC (2010). *The comparison of physical activity by socioeconomics factors*: KHNANES 2001, 2005, 2007. *Public Healthy Weekly Report 3*(8), 122-129.

KCDC (2010*). Health behaviors in Korea adults: smoking, drinking and physical activity. Public Healthy Weekly Report, 2*(5), 729-733.

KCDC (2009*). Highlights of 2008 Community Health Survey. Public Healthy Weekly Report, 2*(21), 321-324.

Kennedy, B. P., Kawachi, I., & Prothrow-Stith, D. (1996). Income distribution and mortality: cross sectional ecological study of the Robin Hood Index in the United States. *BMJ, 312,* 1004-1007.

Korean Ministry of Health & Welfare(2009). *KCDC. KNHANES 4th-2 the (2008),* 3-610.

Kim, Y. H., & Cho, Y. T. (2008). Impacts of area characteristics on the health of vulnerable population in Seoul. *Korean J of Population Research, 1,* 1-26.

Kang, Y. J. (2009). Multilevel analysis of the relationship between income inequality and health: Using Korean Labor and income panel study data [dissertation]. Graduate School of Administration, Seoul National University(Korean).

Kim, J. H., & Yoon, T. H. (2008). Comparisons of health inequalities in small area with using the standardized mortality ratios in Korea. *J Prev Med Public Health, 41*(5), 102-107.

Kim, M. H., & Cho, Y. T. (2007). Social determinants of oral pain and dental service utilization among elderly Seoul residents: A multilevel study. *Korean Academy of Oral Health, 31*(1), 103-114.

Kim, M. H. (2002). A multilevel analysis on the association between socioeconomic factors and the metabolic syndrome [dissertation].Graduate School of Hanyang University(Korean).

Kim, C. S., Yoon, S. C., Kim, H. L., & Kang, Y. H. (2006). Multilevel study on the relationship between the residential distribution of high class(power elites) and smoking in Seoul. *J Prev Med Public Health, 391*(1), 30-38.

Kindig, D. A., & Stoddart. (2003). What is population health? *Am J Public Health ;93*:366-369.

King, A. C., Stariano, W. A., & Marti J, Zhu. (2008). Multilevel modeling of walking behavior: Advanced in understanding the interactions of people, place, and time. *Med. Sci. Sports Exerc , 40*(7), 584-593.

Lalonde, M. (1974). *A new perspective on the health of Canadians. A working document. Ottawa; Government of Canada.*

Larry, A. T. (1993). Television viewing and physical fitness in adults. *Res Q Exerc Sport, 25,* 71-80.

Leon, A. S., Casal D, & Jacobs D, Jr (1996). Effects of 2,000 kcal per week of walking and stair climbing on physical fitness and risk factors for coronary heart disease. *J Cardiopulm Rehabil , 16,* 183-192.

Lee, C. G., & Cho, Y. T. (2009). Relationship between perceived neighborhood characteristics and vigorous physical activity among adult Seoul resident. *J Prev Med Public Health; 42(4)*:215-222.

Lee, S. H. (1994). An analysis of small area variation of health services utilization in Korea [dissertation]. Department of Preventive Medicine & Public health, Graduate School of Public Health, Yonsei University(Korean).

Manson, J. E., Nathan D, M., Krolewski A. S., Stampfer M. J., Willett W.C., & Hennekens C. H. (1992). A prospective study of exercise and incidence of diabetes among US male physicians. *JAMA, 268,* 63-67.

Nam, J. M., Lee, S. H., & Cho, W. H. (1999). A study on the statistical distribution and testing of variation indices at the small area. *J Prev Med Public Health , 32*(1), 80-87.

Paffenbarger, R. S., Wing, A. L.,Hyde, R. T., & Jung D.L. (1983). Physical activity and incidence of hypertension in college alumni. *Am J Epidemiol, 117,* 245-257.

Robert, S. A.(1998). Community-level socioeconomic status effects on adult health. *J of Health and Soc Behavior, 39*(1), 18-37.

Sallis, J. F., & Owen, N. (1996). Ecological models. In Health Behavior and Health Education: theory, research and practice, 2nd Edition; Glanz K., Lewis., Rimer, F. M., Eds, B. K.; Jossey-Bass: San Francisco, USA.

Sallis, J. F., Hovell, M. F., Hofstetter, C. R., Faucher P, Elder J. P., & Blanchard, J. (1989). A multivariate study of determinants of vigorous exercise in a community‐sample. *Prev Med, 18,* 20-34.

Statistics Korea(2005, 2006, 2007, 2008.). *Community of statistics (administrative district).*

Yang, Y. J., Yoon, Y. S., Oh, S. W., & Lee, Y. S. (2005). The amount of physical activity of Korean adults measured from the 2001 KNHANES. *Korean J Fam Med ;26*:22-30.

Yang, Y. J., Jin, Y. S., Choi, D. H., Cho, S. I., Seong, B. J., Ko, B. G., Lee, Y. S. (2007). *Development of physical activity questionnaire and guideline for Korean adults.* Korean Ministry of Health & Welfare.

Yoon, T.H. (2003). The relationship between social class distribution on mortality. *Korean J Health Policy & Administration 13(4),* 99-114.