



Sleep Duration and Self-Rated Health are Independently Associated with Physical Activity Level in the Korean Population

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Abstract

Background: The purpose of this study was to examine the relationship of physical activity levels with sleep duration (SD), and self-rated health (SRH) using the fifth Korean National Health and Nutrition Examination Survey data from 2010 and 2011.

Method: Overall, 12,188 Korean people were evaluated in relation to meeting guidelines for vigorous PA (MVPA), moderate PA (MMPA), and low PA (MLPA) associated with SD and SRH.

Results: The adjusted odds ratio (AOR) of males who slept seven hours with MMPA (AOR=0.84) and MLPA (AOR=0.85) and eight hours with MMPA (AOR=0.76) and MLPA (AOR=0.78) significantly decreased compared to subjects who sleep 6 hours/day. In females, an AOR of less than 5 (AOR=1.40) and 6 hours (AOR=1.12) with MVPA was significantly increased compared to 7 hours sleep/day, while sleeping more than 8 hours/day was significantly decreased with MLPA (AOR=0.73). Compared to the very good SHR, the AORs of more negative SHR status with MVPA, MMPA, and MLPA in males and with MMVP and MLVP in females decreased significantly.

Conclusions: Sleeping 6-8 hours/day for MMPA and MLPA in males and 7-8 hours/day for MVPA and MLPA in females, and a very good SRH for MVPA, MMPA, and MLPA in males and for MMPA and MLPA in females are recommended to participate physical activity for the Korean population. We therefore, the independent association between PA levels and SD or SRH according to gender supports public health program to participate physical activity for the Korean population.

Keywords: Physical activity, Sleep duration, Self-rate health, Odds ratio, KNHANES

Introduction

Physical activity (PA) is one of the most important factors in long-term weight loss and regular PA is associated with a reduced risk of cardiovascular disease, coronary heart disease, type 2 diabetes mellitus, depression, anxiety, and all-cause mortality (1-3). Kim et al. (4) reported that PA is an effective prevention measure because it improves general physical and mental health. Apart from considerable physical health-related benefits, a number of psychological benefits have been identified, with the most evidence concerning

depression and anxiety (5, 6). For these reasons, national health-promotion programs have recommended an increase of PA (7-9). Therefore, helping people who do not have established patterns of physical activity to acquire healthy habits for increasing PA is useful in terms of public health. Inadequate sleep duration (SD) is associated with multiple consequences such as attention difficulties, cognitive disruptions, and mood disturbances (10). In recent years, sleep curtailment has also gained attention as a potential contributor to the

obesity epidemic in both adults and children (11, 12). It is not known whether sleep loss directly affects the risk of obesity, through changes in function and levels of metabolic hormones such as glucagon-like peptide-1, resulting in increased food intake, or if common behavioral or environmental factors such as hypo- or hyperactivity and other types of stressors are involved, causing both sleep and weight disturbances (13-15). However, current information on the relationship between daytime activity and sleep in adults is scarce and contradictory. Higher levels of PA were associated with shorter sleep latency (16), but no associations were found between the mean level of PA and SD (11).

Self-rated health (SRH) ostensibly provides only a subjective assessment of individual health status, but it is also a good predictor of mortality and functional loss, independent of objective health and psychosocial and demographic variables (17). SRH is strongly associated with several biological components, such as interleukin-1 β , interleukin-1ra, and tumor necrosis. These cytokines are higher in persons with a lower SRH. In addition, while the decision to rate health is driven by psychological factors, it appears that respondents mainly consider physical health problems when rating their health status (18). In practical terms, SRH is readily measured using single-item questions and is thus often included in health surveys and as an outcome in many studies (18-20).

The mechanism underlying the reported association between SRH and SD is not known. It is possible that at least part of the association between insufficient sleep and mortality may be mediated by poor SHR (20). However, relatively few studies have examined the association between SD and SRH, and the results have not been consistent. Some studies reported that SRH was worse when slept for either more or less than seven hours (20, 21). Some studies found no evidence of an association between quality of wellbeing and long SD (22, 23).

However, to the best of our knowledge, no study has examined the association between PA level and SD or SHR in a nationally representative sample of the Korean population. Therefore, this study aimed to investigate whether the level of PA is associated with SD and SHR in the Korean population using na-

tional data from the fifth Korean National Health and Nutrition Examination Survey (KNHANES-V) in 2010 and 2011.

Methods

Participants

KNHANES-V was divided into four parts; the Health Interview Survey, the Health Behavior Survey, the Nutrition Survey, and the Health Examination Survey. KNHANES-V was conducted using a systematic stratified cluster sampling design in 2010 and 2011. The sampling framework was based on the 2009 National Census Registry. Totally, 1,052 districts were selected and enumerated, taking into account administrative districts and habitation sites (apartment houses/general houses). The study protocol was approved by the Korean Ministry of Health and Welfare and was conducted in accordance with the Ethical Principles for Medical Research Involving Human Subjects, as defined by the Helsinki Declaration. Study participants provided written informed consent. For this study sample, the subjects in the present study consisted of 12,188 people from the Korean population (5,211 males and 6,977 females) aged over 19 years who completed the Health Interview Survey and the Health Behavior Survey.

Dependent variables

KNHANES-V consists of eight questions about PA. The eight questions which measure PA patterns in the sample of the Korean population are listed in Table 2. PA was compared with the guidelines of the American College of Sports Medicine (ACSM). The ACSM recommends 20 minutes of vigorous PA three days/week, 30 minutes of moderate PA at least five days/week, and 30 minutes of walking at least five days/week for adults (24). Participants were divided into two groups: one that met the requirements and one that did not.

Independent variables

Information regarding sleep duration and self-

rated health was obtained in interviews. Information about KNHANES-V self-reported sleep duration was obtained in interviews. The participants were asked to self-report their SD from 1.0 to 24.0 hours. We classified SD into five groups as ≤ 5 , 6, 7, 8, and ≥ 9 hours per day. The self-rated health information as subjective health status of KNHANES-V was “very good, good, fair, poor, or very poor”. Participants were asked to rate their health.

Covariate variables

Information regarding age, education, family socio-economic status, subjective health status, tobacco usage, and alcohol consumption was collected in interviews. Height and weight were measured with the subjects wearing light clothing and no shoes. Body mass index (BMI) was then calculated as their weight (kg) divided by the square of their height. In accordance with the WHO Asia-Pacific standard of obesity, individuals were classified into underweight, normal, overweight, and obese groups based on BMIs of < 18.5 , $18.5 - 22.9$, $23.0 - 24.9$, and ≥ 25.0 , respectively (25). Education was categorized as lower than a middle school graduate, middle school graduation, high school graduation, and college graduation or higher. Family socio-economic status was divided into four groups as low, average, middle high, and high. Tobacco use was divided as yes or no. The general characteristics of the participants are presented in Table 1.

Statistical analyses

The statistical software SPSS version 18.0 was used in all analyses. All descriptive statistics are presented as frequencies and percentages for the categorical variables. A chi-square test was performed to test level differences in all variables. To assess associations between the reference group and the other group, multiple logistic regression methods were implemented using logistic regression analysis. However, the ratio of the subject over nine hours was not fit to perform logistic regression, so we merged variables of eight hours and more than nine hours. Adjustments were successively made for age, body mass index,

education, family socio-economic state, tobacco use, alcohol consumption, and SHR (Model 1) or SD (Model 2). A $P < .05$ was considered an indicator of statistical significance.

Results

General Characteristics of Study Participants

General characteristics are summarized in Table 1. Of the total of 12,188 Korean people, 5,211 were male and 6,977 were female. Males showed higher levels of body weight, education, family socio-economic, tobacco use, alcohol consumption, and positive subjective health status compared to females, whereas the SD of males were shorter compared to those of females.

Patterns of Physical Activity

The patterns of PA according to physical activity type are presented in Table 2. More males participated in vigorous, moderate, and low PA. The participation ratios of no vigorous and no moderate PA during the last 7 days in males and females were, respectively, 61.1% and 77.3%, 58.3% and 66.8%, while that for no walking were 16.5% and 18.0%. In addition, 62.6% of males and 83.4% of females reported that they do not exercise for muscle strength, and 44.9% of males and 49.3% of females answered they do not exercise for flexibility. In addition, significant differences were noted in the meeting of vigorous and low PA guidelines according to gender.

Relationship between Sleep Duration and Self-rated Health

Table 3 shows the relationship between SD and SRH in the Korean population. Males who sleep six and seven hours/day and females who sleep eight and over nine hours/day show the highest ratio in the level of very good SRH (6.7% and 6.7% in males, and 4.6% and 4.6% in females). Males and females who self-reported their health as very poor showed the highest ratio when slept under five hours/day (5.4% in males, and 9.0% in females). In addition, significant differences in levels according to SD level were noted in SHR status in males and females.

Table 1: General characteristics of the Korean population

Characteristics	Males (n = 5,211)	Females (n = 6,977)	Total (n =12,188)	χ^2 value	P value
Age (yr)					
19 – 49	2,512 (48.2)	3,432 (48.2)	5,943 (48.7)	1.898	.594
50 – 64	1,467 (28.2)	1,940 (27.8)	3,407 (28.0)		
65 ≤	1,232 (23.6)	1,606 (23.0)	2,838 (23.3)		
Body mass index (kg/m²)					
Underweight (BMI<18.5)	158 (3.0)	406 (5.8)	564 (4.6)	190.314	<.001
Normal weight(18.5≤BMI<23.0)	1,900 (36.5)	3,070 (44.0)	4,970 (40.8)		
Overweight (23.0≤BMI<25.0)	1,330 (25.5)	1,468 (21.0)	2,798 (23.0)		
Obesity (25.0≤BMI)	1,823 (34.9)	2,033 (29.2)	3,856 (31.6)		
Education					
< Middle school	920 (17.7)	2,234 (32.0)	3,154 (67.8)	335.247	<.001
Middle school	631 (12.1)	711 (10.2)	1,342 (11.0)		
High school	1,843 (35.4)	2,194 (31.5)	4,037 (33.1)		
College ≤	1,817 (34.9)	1,833 (26.3)	3,650 (30.0)		
Family socio-economic status					
Low	950 (18.4)	1,477 (21.4)	2,427 (20.1)	17.243	.001
Average	1,339 (25.9)	1,755 (25.4)	3,094 (25.7)		
Middle high	1,467 (28.4)	1,848 (26.8)	3,315 (27.5)		
High	1,406 (27.2)	1,819 (26.4)	3,225 (26.7)		
Tobacco user					
Yes	2,178 (41.8)	365 (5.1)	2,543 (20.8)	2,439.095	<.001
No	3,033 (58.2)	6,612 (94.9)	9,645 (79.2)		
Alcohol consumption					
Never	839 (16.1)	2,629 (37.6)	3,468 (28.5)	2,466.508	<.001
>1 time/month	510 (9.8)	1,789 (25.6)	2,299 (18.9)		
2 – 4 times/ month	1,851 (35.5)	1,973 (28.4)	3,824 (31.3)		
4 times/week ≤	2,011 (38.6)	586 (8.4)	2,597 (21.3)		
Self-rated health					
Very good	300 (5.8)	273 (3.9)	573 (4.7)	132.100	<.001
Good	1,700 (32.6)	1,925 (27.6)	3,625 (29.7)		
Fair	2,386 (45.8)	3,183 (45.6)	5,569 (45.7)		
Poor	705 (13.5)	1,274 (18.3)	1,979 (16.2)		
Very poor	120 (2.3)	322 (4.6)	442 (3.6)		
Sleep duration					
≤ 5 hours/day	690 (13.2)	1,212 (17.4)	1,902 (15.6)	59.891	<.001
6 hours/day	1,471 (28.2)	1,690 (24.2)	3,161 (25.9)		
7 hours/day	1,541 (29.6)	1,953 (28.0)	3,494 (28.7)		
8 hours/day	1,133 (21.7)	1,529 (21.9)	2,662 (21.8)		
9 hours/day ≤	376 (7.2)	593 (8.5)	969 (8.0)		

Note: Data are presented as n (%)

Table 2: Patterns of physical activity during the last seven days

Variables	Males (n = 5,211)	Females (n = 6,977)	Total (n = 12,188)	χ^2 value	Pvalue
Q1. How many days did you perform at least 10 min. vigorous physical activity?					
1. No vigorous physical activity	3,186 (61.1)	5,391 (77.3)	8,577 (70.4)	409.552	<.001
2. Once or twice per week	1,139 (21.9)	789 (11.3)	1,925 (15.8)		
3. Thrice or 4 times per week	473 (9.1)	450 (6.5)	923 (7.6)		
4. Over 5 times per week	413 (7.9)	347 (4.9)	763 (6.2)		
Q2. How many days did you perform at least 10 min. moderate physical activity?					
1. No moderate physical activity	3,038 (58.3)	4,661 (66.8)	7,699 (63.2)	145.819	<.001
2. Once or twice per week	1,033 (19.8)	945 (13.5)	1,978 (16.2)		
3. Thrice or 4 times per week	566 (10.9)	625 (7.0)	1,291 (9.8)		
4. Over 5 times per week	574 (11.0)	746 (11.3)	1,320 (11.3)		
Q3. How many days did you perform at least 10 min. walking?					
1. No walking	858 (16.5)	1,257 (18.0)	2,115 (17.4)	50.187	<.001
2. Once or twice per week	879 (16.8)	1,224 (17.5)	2,103 (17.2)		
3. Thrice or 4 times per week	992 (19.0)	1,482 (21.2)	2,474 (20.3)		
4. Over 5 times per week	2,482 (47.7)	3,014 (43.4)	5,496 (45.1)		
Q4. How many days did you do exercise for muscle strength?					
1. No exercise for muscle strength	3,260 (62.6)	5,822 (83.4)	9,082 (74.5)	720.155	<.001
2. Once or twice per week	854 (16.4)	580 (8.3)	1,434 (11.8)		
3. Thrice or 4 times per week	615 (11.8)	358 (5.1)	973 (8.0)		
4. Over 5 times per week	482 (9.3)	217 (3.2)	699 (5.7)		
Q5. How many days did you do exercise for flexibility?					
1. No exercise for flexibility	2,338 (44.9)	3,440 (49.3)	5,778 (47.4)	73.692	<.001
2. Once or twice per week	1,060 (20.3)	1,421 (20.3)	2,481 (20.3)		
3. Thrice or 4 times per week	838 (16.1)	1,150 (16.5)	1,988 (16.3)		
4. Over 5 times per week	975 (18.7)	966 (13.9)	1,941 (15.9)		
Q6. I met vigorous physical activity guidelines¹⁾	863 (16.6)	756 (10.9)	1,619 (13.3)	84.425	<.001
Q7. I met moderate physical activity guidelines²⁾	515 (9.9)	654 (9.4)	1,169 (9.6)	.853	.365
Q8. I met low physical activity guidelines³⁾	2,122 (40.8)	2,490 (35.8)	4,612 (38.0)	31.261	<.001

Note; Data are presented as n (%)

- 1) 20 minutes vigorous physical activity \geq 3 times/week
- 2) 30 minutes moderate physical activity \geq 5 times/week
- 3) 30 minutes walking \geq 5 times/week

Table 3: Relationship between sleep duration and self-rated health

Variables	Males ^{a)}					Females ^{a)}				
	≤ 5 hours/day (n = 690)	6 hours/day (n = 1,471)	7 hours/day (n = 1,541)	8 hours/day (n = 1,133)	9 hours/day ≤ (n = 376)	≤ 5 hours/day (n = 1,212)	6 hours/day (n = 1,690)	7 hours/day (n = 1,953)	8 hours/day (n = 1,529)	9 hours/day ≤ (n = 593)
Very good	35 (5.1)	99 (6.7)	91 (6.7)	61 (5.4)	14 (3.7)	49 (4.0)	58 (3.4)	69 (3.5)	70 (4.6)	27 (4.6)
Good	199 (28.8)	476 (32.4)	540 (35.0)	376 (33.2)	109 (29.0)	243 (20.0)	506 (29.6)	567 (29.0)	453 (29.9)	156 (26.3)
Fair	294 (42.6)	700 (47.6)	716 (46.5)	515 (45.5)	161 (42.8)	505 (41.7)	769 (45.5)	949 (48.6)	713 (46.6)	247 (41.7)
Poor	125 (18.1)	170 (11.6)	178 (11.6)	158 (13.9)	74 (19.7)	306 (25.2)	298 (17.6)	301 (15.4)	238 (15.6)	131 (22.1)
Very poor	37 (5.4)	26 (1.8)	16 (1.0)	23 (2.0)	18 (4.8)	109 (9.0)	59 (3.5)	67 (3.4)	55 (3.6)	32 (5.8)

Note: Data are presented as n (%), a) means significant difference of sleep duration levels by self-rated health status at level of < 0.001

Table 4: Level of sleep duration and self-rated health according to level of physical activity

Variables	Males				P value	Females			
	Vigorous physical activity ¹⁾ (n=863)	Moderate physical activity ²⁾ (n=515)	Low physical activity ³⁾ (n=2,122)			Vigorous physical activity (n=756)	Moderate physical activity (n=654)	Low physical activity (n=2,490)	P value
≤ 5 hours/day	100 (11.6)	80 (15.5)	306 (14.4)		.345 ⁴⁾	139 (11.5)	111 (9.2)	436 (36.0)	.293 ⁴⁾
6 hours/day	256 (29.7)	164 (31.8)	634 (29.9)		.040 ⁵⁾	184 (10.9)	157 (9.3)	624 (37.0)	.990 ⁵⁾
7 hours/day	245 (28.4)	128 (24.9)	601 (28.3)		.015 ⁶⁾	206 (11.6)	189 (9.7)	752 (38.5)	<.001 ⁶⁾
8 hours/day	201 (23.3)	112 (21.7)	446 (21.0)			178 (10.6)	143 (9.4)	526 (34.5)	
9 hours/day ≤	61 (7.1)	31 (6.0)	135 (6.4)			49 (8.5)	54 (9.4)	152 (26.5)	
Self-rated health									
Very good	76 (25.4)	44 (14.7)	159 (53.2)		<.001 ⁴⁾	43 (15.8)	44 (16.2)	125 (46.0)	.002 ⁴⁾
Good	336 (19.8)	201 (11.8)	753 (44.3)		<.001 ⁵⁾	220 (11.4)	200 (10.4)	737 (38.4)	<.001 ⁵⁾
Fair	338 (14.2)	192 (8.1)	901 (37.8)		<.001 ⁶⁾	329 (10.4)	224 (7.1)	1,120 (35.3)	<.001 ⁶⁾
Poor	104 (14.8)	68 (9.7)	266 (37.9)			123 (9.7)	153 (12.0)	403 (31.7)	
Very poor	9 (7.6)	10 (8.3)	43 (35.8)			41 (12.9)	33 (10.3)	105 (33.0)	

Note: Data are presented as n (%); *, ** and *** denote p < 0.05, p < 0.01 and p < 0.001

- 1) 20 minutes vigorous physical activity ≥ 3 times/week
- 2) 30 minutes moderate physical activity ≥ 5 times/week
- 3) 30 minutes walking ≥ 5 times/week
- 4) Significant level difference according to meet vigorous physical activity guideline
- 5) Significant level difference according to meet moderate physical activity guideline
- 6) Significant level difference according to meet low physical activity guideline

Level of Sleep Duration and Self-rated Health according to Physical Activity Levels

Table 4 shows the level of SD and SRH according to PA levels in the Korean population. Males who sleep six hours and females who sleep seven hours show the highest ratio in meeting guidelines for vigorous, moderate, and low PA (29.7%, 31.8%, and 29.9% in males, and 11.6%, 9.7%, and 38.5% in females). Significant differences in SD with moderate and low PA were observed in males, and SD with low PA in females according to meeting PA guidelines. Males and females who self-reported their health as very good showed the highest ratio in meeting guidelines for vigorous, moderate, and low PA (25.4%, 14.7%, and 53.2% in males, and 15.8%, 16.2%, and 46.0% in females). In addition, significant differences in levels

according to meeting PA guidelines were noted between SHR status and vigorous, moderate, and low PA in males and females.

Adjusted Multiple Logistic Regression Models of Physical Activity Levels with Sleep Duration and Self-rated Health

Table 5 presents adjusted multiple logistic regression models of PA levels with SD (Model 1) and SRH (Model 2). In the Model 1, the adjusted odds ratio (AOR) of males who sleep seven hours and more than 8 hours significantly decreased with meeting guideline of moderate (seven hours; AOR 0.84, more than eight hours; AOR 0.76) and low PA (seven hours; AOR 0.85, more than eight hours; AOR 0.78) compared to six hours of sleep.

Table 5: Adjusted multiple logistic regression models of sleep duration and self-rated health according to physical activity level as ORs and 95% CI

Variables	Males, OR (95% CI)			Females, OR (95% CI)		
	Vigorous physical activity ³⁾	Moderate physical activity ⁴⁾	Low physical activity ⁵⁾	Vigorous physical activity	Moderate physical activity	Low physical activity
Model 1¹⁾						
Sleep duration						
≤5 hours/day	0.90 (0.67-1.17)	1.07 (0.78-1.45)	0.89 (0.81-1.20)	1.40*** (1.10-1.79)	0.94 (0.64-1.79)	0.90 (0.77-1.05)
6 hours/day	Reference	Reference	Reference	1.12* (1.02-1.49)	0.93 (0.74-1.27)	0.93 (0.81-1.07)
7 hours/day	1.12 (0.92-1.36)	0.84* (0.59-0.98)	0.85* (0.73-0.99)	Reference	Reference	Reference
8 hours/day ≤	0.96 (0.79-1.16)	0.76* (0.65-0.99)	0.78** (0.67-0.91)	1.13 (0.92-1.39)	1.01 (0.82-1.26)	0.73*** (0.64-0.83)
Model 2²⁾						
Self-rated health						
Very good	Reference	Reference	Reference	Reference	Reference	Reference
Good	1.34* (1.01-1.81)	1.23 (0.85-1.76)	1.33* (1.03-1.71)	1.13 (0.55-1.16)	1.36* (1.05-1.98)	1.14 (0.60-1.18)
Fair	1.68*** (1.48-2.69)	1.50** (1.31-2.72)	1.70*** (1.32-2.18)	1.27 (0.80-1.55)	1.78*** (1.30-2.63)	1.51* (1.15-2.03)
Poor	2.00*** (1.19-2.37)	1.72*** (1.01-2.28)	1.88*** (1.42-2.94)	1.76 (0.56-2.13)	1.98*** (1.27-2.90)	1.58*** (1.45-2.77)
Very poor	2.70*** (1.28-5.73)	1.80*** (1.14-3.63)	2.37*** (1.50-3.74)	1.34 (0.81-2.22)	2.46*** (1.80-3.14)	1.98*** (1.18-2.95)

*, **, and *** denotes $p < .05$, $p < .01$, and $p < .001$

1) Adjusted for age, body mass index, education, family socio-economic status, tobacco user, alcohol drinking, and self-rated health

2) Adjusted for age, body mass index, education, family socio-economic status, tobacco user, alcohol drinking, and sleep duration

3) 20 minutes vigorous physical activity ≥ 3 times/week

4) 30 minutes moderate physical activity ≥ 5 times/week/ 5) 30 minutes low physical activity ≥ 5 times/week

Compared to the subjects who sleep for seven hours, the AOR of females who slept less than five hours and six hours significantly increased with meeting the vigorous PA guideline (less than five hours; AOR 1.40, six hours; AOR 1.12), while those who sleep more than eight hours per day significantly decreased in terms of meeting low PA guideline (AOR 0.73). On the other hand in the Model 2, the AORs of males between meeting guidelines for vigorous (good; AOR 1.34, fair; AOR 1.68, poor; AOR 2.00, very poor; AOR 2.70) and low (good; AOR 1.33, fair; AOR 1.70, poor; AOR 1.88, very poor; AOR 2.37) PA with good, fair, poor, and very poor showed significant increasing compared to a very good SHR. In addition, AORs between meeting guidelines for moderate PA in males (fair; AOR 1.50, poor; AOR 1.72, very poor; AOR 1.80) and low PA in females (fair; AOR 1.51, poor; AOR 1.58, very poor; AOR 1.91) with fair, poor, and very poor noted a significant increase compared to a very good SHR. However, the AOR of vigorous PA with SHR status in females did not show significant changing.

Discussion

The present study is the first to report that PA levels are associated with SD and SHR status in the Korean population. Six hours sleep/day in males and seven hours sleep/day in females indicated highest efficiency in terms of SD for meeting vigorous, moderate, and low PA guidelines. However, sleeping six hours/day in males and seven hours sleep/day in females showed an independent association according to PA level. In addition, a very good SRH is the most efficient for meeting guidelines of vigorous, moderate, and PA in males and females. However, SRH status is also independently associated with PA levels.

Men, compared to women, showed relatively high values for PA-related variables such as vigorous PA, moderate PA, walking as low PA, exercise for muscle strength, and exercise for flexibility. These results indicated that Korean men are more active than Korean women. This

tendency was found in almost all previous studies and is thought to result from Korean cultural and social environments which encourage men to be more active than women (26, 27). The effects of PA on health are well documented. Regular PA is associated with a lower risk of all-cause mortality (1-3). Our results suggest that research on programs for promoting Korean women's participation in PA is necessary to help this segment of the population to improve health.

Good sleep practices are developed within the family culture and associated with better sleep throughout life (28). Korean women slept longer than Korean men, which is consistent with other findings (14, 28, 29). It is still unknown whether young women have a greater physiological need for sleep than men, or if the difference is due to social cultural influences. However, there is some support for such socio-cultural differences between men and women that may affect sleep. In the current study, seven hours sleep in males and eight hours sleep in females were found to be associated with very good/good SRH. Short as well as long sleep duration was found to be associated with negative SRH status. Short and long SD has been reported to be related to poor SRH by impairing mood and cognitive function or because of an increase in fatigue (20-23). The outcome of interest in the current study that SRH and SD were not consistent to participate PA. Six hours sleep/day in males and seven hours sleep/day in females indicated highest efficiency in terms of SD for meeting vigorous, moderate, and low PA guidelines, while seven hours sleep/day in males and eight hours sleep/day in females indicated the most efficient for a very good/good SRH in males and females. When considering only the terms of physical activity levels, six hours sleep/day in males and seven hours sleep/day in females were found to be associated with meeting vigorous, moderate, and low PA guidelines. Based on these results, sleeping six hours/day in males and seven hours/day in females were considered as the references in the Table 5.

In our study, an AOR of less than five hours and six hours with vigorous PA in females were

significantly increased compared to seven hours. In addition, females who slept more than eight hours per day significantly reduced their risk of not meeting low PA guidelines compared to seven hours. A possible explanation may be that some people have generalized physiological hyper arousal and stress, which in turn may be due both to environmental and to hereditary factors (28, 29). Physically active people who report better physical and mental health may be a useful adjunct to encourage people to maintain and increase their levels of PA. However, PA is continuously on the decline as aging occurs (27). From a public health perspective, it is also important to consider the environmental factors associated with participation in PA including PA levels for Korean people. The AORs of subjects with more than six hours including six, seven, and eight hours per day while meeting guidelines for moderate and low PA in males significantly decreased. This means that a tendency for Korean males to sleep more than six hours per day and Korean females to sleep more than seven hours per day indicated the most positive PA profiles. Generally, sleeping between 6~8 hours per day is known as a good indicator for general health while a high proportion of intense PA during the day was positively related with SD (30). These associations between high daytime PA and improved sleep the following night are supported by experimental evidence in adults as well as children (31-33). Our findings indicate that time spent and frequency in low-to-high intensity activity may promote good sleep efficiency the subsequent night. However, PA levels are significantly and independently associated with SD according to gender.

Several studies have advocated that SRH is a valid measure of subjective health status, being related to, for instance, the risk of death, psychological well-being and overall health as mentioned previously. People with a good or excellent SRH and higher values of health-related quality of life tend to report higher vitality, a more positive attitude, less vulnerability to illness, more frequent regular exercise, and higher levels of education and income (22, 34). Thus, it was

considered that a better understanding of the correlates of these subjective health statuses could help healthcare professionals to tailor health promotion and disease prevention interventions for specific populations. In this study, men tended to have higher values for SRH than women. And more men are meeting the guidelines for PA and reporting good or excellent SRH statuses compared to women. These results indicate that better a SRH are associated with higher PA in Korean people. Recent studies have indicated that PA is associated with subjective and objective health status (4-7). SRH is subjective, and it is equally dependent upon the interpretations and perceptions of the individual (18). After adjusting for confounding factors, when men did not perform vigorous and moderate, and low PA recommendations, the AOR of the good, fair, poor, and a very poor SRH rate of men was significantly higher than the very good SRH rate. In addition, for women, when women did not perform moderate PA recommendation, the AOR of good, fair, poor, and a very poor SRH was significantly higher than the very good SRH rate, while the AOR of fair, poor, and a very poor SRH was significantly higher when they did not perform low PA recommendation. The relationship between PA and mental health is important for planning public health interventions designed to promote PA and offer advice to people who are experiencing the adverse health consequences of a sedentary lifestyle (1-3). The long-term effects of PA are well known, and such effects may not be sufficiently taken into account. Highlighting that physically active people report better physical and mental health may be a useful adjunct to encourage people to maintain and increase their PA.

The present study has several limitations that should be considered. First, the study was cross-sectional in nature, implying that it is impossible to establish cause-effect relationships between PA and SD or SRH. Thus, reverse causation cannot be excluded. Second, PA, SD, and SRH were documented on a self-reported basis, with a focus on lifestyle-related subjective opinions, which may have affected the level of information accuracy and weakened the effect of chronic disease on PA,

SD, and SRH. However, we did not exclude them. Third, it is difficult to compare our results with those of other studies because no studies have examined PA levels in relation to the SD or SHR in a nationally representative sample of Korean people. Nonetheless, the study was conducted on a nationwide basis, and the associations between PA and SD or SRH were analyzed after adjusting for confounding factors. Even though this study has some limitations, this study is the first to report that SD and SRH are independently associated with PA levels in the Korean population. Future studies should include other factors that can affect the PA levels.

Conclusion

Sleeping 6-8 hours /day for moderate and low PA in males and 7-8 hours/day for vigorous and low PA in females, and a very good SRH for vigorous, moderate, and low PA in males and for moderate and low PA in females are recommended to participate PA for the Korean population. We therefore, the independent association between PA levels and SD or SRH according to gender supports public health program to participate PA for the Korean population.

Ethical consideration

Ethical issues (including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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