

Research article

## Physical Activity and Suicide Attempt of South Korean Adolescents - Evidence from the Eighth Korea Youth Risk Behaviors Web-based Survey

Kang-Ok Cho ✉

Department of Physical Education, Hanyang University, Ansan, S. Korea

### Abstract

Suicide is the leading cause of death among South Korean adolescents. The purpose of this study was to examine the relationship between suicidal thoughts (ST) and suicidal attempts (SA) with the level of physical activity (PA) among South Korean adolescents. Based on data from the eighth Korea Youth Risk Behaviors Web-Based Survey, 74,186 South Korean adolescents were evaluated in terms of their relationship between meeting guidelines for vigorous PA (VPA), moderate PA (MPA), and low PA (LPA) and in respect of ST and SA status. The adjusted odds ratio in adolescents who thought about suicide increased significantly with PA levels (1.02 in males, 1.21 in females with VPA, 1.10 in males, 1.18 in females with MPA, and 1.16 in males, 1.20 in females with LPA) compared to participants who did not think about suicide. In addition, the AOR in adolescents who attempted suicide increased significantly with PA levels (1.16 in males, 1.36 in females with VPA, 1.13 in males, 1.15 in females with MPA, and 1.26 in males, 1.15 in females with LPA) compared to participants who did not attempt suicide. These results show that VPA, MPA, and LPA are positively associated with ST and SA prevention in South Korean adolescents. Therefore, to prevent suicide of South Korean adolescents, we support public health program including PA participation.

**Key words:** Suicide, physical activity, odds ratio, KYRBWS.

### Introduction

South Korea not only has the greatest number of suicides among Organization for Economic Cooperation and Development (OECD) countries, but South Korea's suicide rate is increasing the fastest among OECD countries. The number of South Korean adolescents has decreased since 2000, the suicide rate of this population has been steadily increased, and suicide is currently the leading cause of death among South Korean adolescents (Chen et al., 2014; Jo et al., 2014). Therefore, to prevent suicide of Korean adolescents, it is important to investigate protective factors against of this problem.

Physical activity (PA) is proposed to be an effective prevention measure because it has been suggested to improve general physical and mental health (Brown et al., 2007). Apart from considerable physical health-related benefits, a number of psychological benefits have also been identified (Abell et al., 2009; Abu-Omar et al., 2004; Asztalost et al., 2008; Okano et al., 2003). For this reason, national health-promotion programs have recommended an increase of PA (Eaton et al., 2011; Kim et al., 2012). Physical activity levels are classified as vigorous, moderate, and low PA according to the Metabolic Equivalent of Task

(MET) intensity levels (Ainsworth et al., 2011). Ainsworth et al. (2011) reported that one MET is considered a resting metabolic rate achieved during quiet sitting and PAs range from 0.9 (sleeping) to 18.0 METs (running at 10.9 mph). In addition, they also reported that the value of METs in terms of vigorous PA, moderate PA, and low PAs are 8.0, 6.0, and 3.3 METs, respectively. Currently, these PALs are applied to studies which calculate energy expenditure (Cho et al., 2011). The American College of Sports Medicine (ACSM) recommends that adolescents engage in 20 minutes of vigorous PA three days per week, 30 minutes of moderate PA at least five days per week, and 60 minutes of walking as a form of low PA at least five days per week (ACSM, 2010).

As South Korea experienced rapid economic development, its population underwent significant changes to western lifestyle. Due to these rapid changes to western lifestyle, the importance of increasing PA has been emphasized in adolescents and adults (Cho et al., 2011; 2014; Lee et al., 2012). Much of the current epidemiological evidence on the incidence and prevalence of suicidal ideation and suicidal behaviors is based on data from mainly high-income countries (Chen et al., 2014; Jo et al., 2014; Randall et al., 2014). These researchers have shown that psychosocial factors such as bullying, poverty, substance abuse and weak social relationships are associated with suicidal thoughts and behaviors. However, to the best of our knowledge, no studies to date have examined suicidal thoughts (ST) and suicidal attempts (SA) in relation to physical activity level in a nationally representative sample of Korean adolescents. Therefore, this study aimed to investigate whether the level of PA is associated with SA and ST in South Korean adolescents based on national data from the eighth Korea Youth Risk Behavior Web-based Survey (KYRBS VIII) in 2012.

### Methods

#### Study participants

Raw, cross-sectional data of the KYRBS- VIII in 2012 were used for this study. This dataset provides the basis for understanding the current level of health-risk behaviors in South Korean adolescents and can be used to calculate an adolescent health index for a health-promotion-project plan and evaluation. The KYRBS-VIII is an anonymous, self-administered online survey, which is officially approved by the Statistics Korea (Certificate Number: 11758). It is conducted annually by the Korea Center for Disease Control and Prevention (KCDCP). Details of the data-collection procedures are described by the KCDCP, and this survey has been shown to be valid and reliable

(Bae et al., 2010). The study protocol was approved by the Korean Ministry of Health and Welfare in 2012 and was conducted in accordance with the Ethical Principles for Medical Research Involving Human Participants, as defined by the Helsinki Declaration. The KYRBS- VIII was administered to a nationally representative sample of middle- and high-school students, using a complex sampling design involving stratification, clustering and multi-stage sampling. A representative sample of students from grades 7-12, aged 13-18 was selected; this sample consisted of 78,255 student from 800 middle and high schools. From the selected schools, 74,186 students (38,221 boys and 35,965 girls) completed the questionnaire (response rate: 94.8%); all response were included in the data analysis.

### Dependent variables

The KYRBS- VIII consists of six questions regarding guidelines for vigorous, moderate, and low PA. The PA information was obtained in interviews using questions from the self-administered the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003). The vigorous, moderate, and low PA questions were about weekly frequency of 20 minutes of vigorous PA (e.g., soccer, basketball, aerobics, running, fast cycling, and fast swimming), 30 minutes of moderate PA (e.g., cycling at a regular pace, swimming at a regular pace, slow swimming, noncompetitive volley ball and doubles tennis), and 60 minutes of light PA (e.g., walking) in the past seven days. PA was compared with the ACSM guidelines (ACSM, 2010). These guidelines recommend that adolescents engage in 20 minutes of vigorous PA three days per week, 30 minutes of moderate PA at least five days per week, and 60 minutes of walking as low PA at least five days per week. To analyze for meeting the criterion according to guideline of PA level, participants were divided into two groups: one that met the requirements and one that did not.

### Independent variables

Suicidal thoughts (ST) and suicidal attempts (SA) are used as the independent variables in the present study. Self-reported ST was defined as having seriously thought about attempting suicide at least once in the previous 12 months. SA was defined as at least one attempt at suicide in the previous 12 months. The two possible responses of ST and SA were 'Yes' or 'No'.

### Covariates

The covariates were evaluated for each participant on the basis of responses to eight questions form the self-reported date. School grade, current smoking, and current alcohol consumption were used without modification. Grade point average and family socio-economic status were categorized as high, high middle, middle, low middle, and low. Depression was divided as no and yes. Stress was categorized as very much, somewhat, moderate, very little, and not at all. Self-rated health was categorized as very good, good, fair, poor, and very poor.

### Statistical analysis

Statistical analyses were performed using SPSS, version 18.0 (SPSS, Chicago, IL, USA). All descriptive statistics are presented as frequencies and percentages for categorical variables. A Chi-square test was performed to test level differences according to gender. Multivariate logistic regression analyses, adjusted for the covariate variables were conducted to assess the relationship between meeting guidelines of PA and ST or SA status in male and female adolescents. Statistical significance was set at  $p < 0.05$ .

## Results

### Characteristics of the participants

Characteristics of the participants are summarized in Table 1. In general, females reported more negatively when self-reporting their mental (depression and stress) state and physical health (self-rated health) state compared to males. On the other hand, significantly more males reported smoking and drinking alcohol more than females.

### Patterns of physical activity

Patterns of PA during last seven days are presented in Table 2. More male adolescents participated in PA through vigorous, moderate, and low compared to female adolescents. Self-reported participation of no vigorous and no moderate PA during the previous seven days in male and female adolescents were 14.8% and 40.5%, respectively, and 18.1% and 33.0%, while participation in no walking were 4.5% and 5.2%. On the other hand, percentages of meeting guidelines in male and female adolescents for vigorous PA were 67.4% and 36.5%, moderate PA were 23.4% and 10.6%, and low PA were 81.8% and 76.6%.

### Relationship between suicidal thoughts and suicidal attempts

Table 3 showed the relationship among suicidal behaviors during the previous 12 months. Among of 1,062 male adolescents who had attempted suicide, 66.3% of male adolescents had a suicidal thought whereas 33.7% of male adolescents did not report a suicidal thought. In female adolescents, 1,209 (42.8%) females had a suicide thought, while 1,618 (57.2%) females had not a suicide thought among 2,827 female adolescents who had attempted suicide. In the both of male and females, the significantly independent relationships between ST and SA was observed.

### Suicidal thoughts and attempts according to meeting physical activity guideline

Table 4 shows the percentage of suicide behaviors according to meeting PA guideline. Male and female adolescents who had not thought about attempting suicide showed a higher percentage in meeting guidelines for vigorous PA (males; 86.0%, females; 74.8%), moderate PA (males; 85.8%, females; 73.4%), and low PA (males; 86.3%, females; 76.4%) than adolescents who thought about attempting suicide. In addition, male and female adolescents who did not attempted suicide showed higher

**Table 1.** Characteristics of Korean adolescents. Data are presented as n (%).

Characteristics		Males (n = 38,221)	Females (n = 35,965)	Total (n =74,186)	p value
School Grade	Middle school	19,283 (50.5)	18,014 (50.1)	37,297 (50.3)	.322
	High school	18,938 (49.5)	17,951 (49.9)	36,889 (49.7)	
Current smoking	Nonsmoking	32,059 (83.9)	33,735 (93.8)	65,794 (88.8)	<.001
	Smoking	6,152 (16.1)	2,230 (6.2)	8,382 (11.2)	
Current alcohol consumption	Nondrinking	28,620 (74.9)	29,311 (81.5)	57,931 (78.2)	<.001
	Drinking	9,591 (25.1)	6,654 (18.5)	16,255 (21.8)	
Grade point average	High	4,547 (11.9)	3,373 (9.4)	7,920 (10.7)	<.001
	High middle	8,943 (23.4)	8,659 (24.1)	17,602 (23.7)	
	Middle	9,949 (26.0)	9,905 (27.5)	19,854 (26.8)	
	Low middle	9,481 (24.8)	9,460 (26.3)	18,941 (25.5)	
	Low	5,301 (13.9)	4,568 (12.7)	9,869 (13.3)	
Family socio-economic status	High	3,085 (8.1)	1,698 (4.7)	4,783 (6.4)	<.001
	High middle	9,498 (24.9)	8,001 (22.2)	17,499 (23.6)	
	Middle	17,185 (45.0)	17,699 (49.2)	4,884 (47.0)	
	Low middle	6,407 (16.8)	6,806 (18.9)	13,213 (17.8)	
	Low	2,046 (5.4)	1,761 (4.9)	3,807 (5.1)	
Depression	No	28,499 (74.6)	22,942 (63.8)	51,441 (69.3)	<.001
	Yes	9,722 (25.4)	13,023 (36.2)	22,745 (30.7)	
Stress	Very much	3,478 (9.1)	5,325 (14.8)	8,814 (11.9)	<.001
	Some what	9,853 (25.8)	12,699 (35.3)	22,552 (30.4)	
	Moderate	16,638 (43.5)	13,764 (38.3)	30,402 (41.0)	
	Very little	6,768 (17.7)	3,723 (10.4)	10,491 (14.1)	
	Not at all	1,475 (3.9)	452 (1.3)	1,927 (2.6)	
Self-rated health	Very good	9,617 (25.2)	4,909 (13.6)	14,526 (19.6)	<.001
	Good	18,384 (48.1)	17,251 (48.0)	35,635 (48.0)	
	Fair	8,119 (21.2)	10,640 (29.6)	18,759 (25.3)	
	Poor	1,952 (5.1)	3,031 (8.4)	4,983 (6.7)	
	Very poor	149 (0.4)	134 (0.4)	283 (0.4)	

percentage in meeting guidelines for vigorous (males; 97.3%, females; 93.4%), moderate (males; 97.1%, females; 93.1), and low PA (males; 97.5%, females; 94.5%) than participants who attempt suicide. A chi-square analysis revealed that ST and SA among male adolescents significantly differed by low level of PA. Among female adolescents, ST significantly differed by vigorous PA, moderate PA, and low PA, while SA significantly differed by vigorous and moderate PA.

#### Multiple logistic regression models for physical activity with suicidal thoughts and attempts

Adjusted multiple logistic regression models for PA with ST and SA are presented in Table 5. The adjusted odds ratio (AOR) in male and female adolescents who thought about suicide increased significantly in terms of meeting guidelines for vigorous PA (males; AOR=1.02, females; AOR=1.21), moderate PA (males; AOR=1.10, females; AOR=1.18), and low PA (males; AOR=1.16, females; AOR=1.20) compared to participants who did not think about suicide. In addition, the AOR in adolescents who attempted suicide increased significantly with meeting guidelines for vigorous (AOR=1.16), moderate (AOR=1.13), and low (AOR=1.26) PA in males and vigorous PA (AOR=1.36), moderate PA (AOR=1.27), and low PA (AOR=1.15) in females compared to participants who did not attempt suicide.

#### Discussion

The present study is the first to report that the meeting guideline for vigorous, moderate, and low PA are positively associated with prevention of suicide in South Korean adolescents. Results indicate that male adolescents, compared to female adolescents, showed relatively high values for PA-related variables such as vigorous PA, moderate PA, and low PA. A dose-response relationship between physical activity levels and physical health outcomes is well-accepted (Cho et al, 2011; Lee et al., 2012). In our study, South Korean male adolescents also showed active physical activity and a more positive attitude regarding perceived stress and health status as well as suicidal behaviors such as ST and SA than female adolescents. Korean male adolescents are more active than Korean female adolescents. 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 (Cho et al, 2011; 2014). Because the traditional patriarchal system still remains in South Korean society, such ideological constraints may limit opportunities of female adolescents for physical activity and psychological moment. Previous studies reported that young women have a greater physiological need for controlling mental status than men (Babiyak et al, 2010; Kim et al., 2012). Physically active

**Table 2. Patterns of physical activity level during the last seven days. Data are presented as n (%).**

	Weekly frequency of PA	Males (n = 38,221)	Females (n = 35,965)	Total (n = 74,186)	p value
<b>Vigorous PA</b>	No vigorous physical activity	5,659 (14.8)	14,570 (40.5)	20,229 (27.3)	<.001
	Once or twice	6,803 (17.8)	8,282 (23.0)	15,085 (20.3)	
	Three or four times	14,697 (38.5)	9,658 (26.9)	24,355 (32.8)	
	More than five times	11,062 (28.9)	3,455 (9.6)	14,517 (19.6)	
<b>Moderate PA</b>	No moderate physical activity	6,937 (18.1)	11,889 (33.0)	18,823 (25.4)	<.001
	Once or twice	7,776 (20.3)	8,942 (24.9)	16,718 (22.5)	
	Three or four times	14,581 (38.1)	11,320 (31.5)	25,901 (34.9)	
	More than five times	8,927 (23.4)	3,817 (10.6)	12,744 (17.2)	
<b>Low PA</b>	No low physical activity	1,704 (4.5)	1,875 (5.2)	3,579 (4.8)	<.001
	Once or twice	1,410 (3.7)	1,811 (5.0)	3,221 (4.3)	
	Three or four times	4,117 (10.8)	4,739 (13.2)	8,856 (11.9)	
	More than five times	30,990 (81.8)	27,540 (76.6)	58,530 (78.9)	
<b>Meeting vigorous PA guideline<sup>1</sup></b>	Met the criterion	25,759 (67.4)	13,113 (36.5)	38,872 (52.4)	<.001
	Not met the criterion	12,462 (32.6)	22,852 (63.5)	35,314 (47.6)	
<b>Meeting moderate PA guideline<sup>2</sup></b>	Met the criterion	8,927 (23.4)	3,817 (10.6)	12,744 (17.2)	<.001
	Not met the criterion	29,294 (76.6)	32,148 (89.4)	61,442 (81.8)	
<b>Meeting low PA guideline<sup>3</sup></b>	Met the criterion	30,990 (81.8)	27,540 (76.6)	58,530 (78.9)	<.001
	Not met the criterion	7,231 (18.2)	8,425 (23.4)	15,656 (21.1)	

PA=physical activity. 20 minutes vigorous physical activity ≥ 3 times/week. 30 minutes moderate physical activity ≥ 5 times/week. 60 minutes walking ≥ 5 times/week

people who report better physical and mental health may be a useful means which encourages people to maintain and increase their PA (Brumby et al., 2010; Galan et al, 2010; Taliaferro et al., 2008). In our study, South Korean female adolescents showed inactive physical activity and a more active attitude regarding terms of ST and SA than male adolescents. However, female adolescents who did not meet guidelines for vigorous, moderate, and low PA showed higher risk about suicidal behaviors compared to male adolescents. This result demonstrates that PA is positively associated with suicide among South Korean adolescents, especially in female adolescents who showed inactive physical activity. Therefore, from a public health perspective, it is important to consider environmental factors including participation in PA to prevent suicide in Korean adolescents.

To test of association of ST and SA in South Korean adolescents who meet the criteria of vigorous, moderate, and low PA, we performed multiple logistic regression after adjustment by covariates as confounding factors. The AORs of adolescents who had thought about suicide while meeting guidelines for vigorous, moderate, and low PA decreased significantly compared to adolescents who had not thought about suicide. This means that in the case of South Korean adolescents, all levels of PA can be rec-

ommended to prevent ST. Furthermore, the AORs of male and female adolescents who did attempt suicide decreased significantly compared to participants who did not attempt suicide. Interestingly, the significance AOR values of SA showed higher than the values of ST. This means that all levels of PA are more preventive directly suicidal behavior such as suicidal attempts, while thoughts about suicidal are improved by PA recommendation. Generally, regular exercise is known as a good indicator of general mental health (Brown et al., 2007; Shaffer and Craft, 1999). These associations between PA and improved mental health are supported by experimental evidence in adults as well as children. Although adolescence is a time of dramatic physical and emotional development, most South Korean adolescents undergo psychological stress due to high expectations for academic performance and examinations in middle and high school (Cho et al., 2011). Adolescence is a critical period that requires attentions in suicidal behavior (Brown et al., 2007; Garrison et al, 1993). To prevent suicide of South Korean adolescents, we support public health program including PA participation. Recently, Cho (2014) reported that physical activity levels are independently associated with mental health factors such as perceived health status and sleep duration in the South Korean population. Therefore, to enhance

**Table 3. Relationship between suicidal thoughts and suicidal attempts. Data are presented as n (%).**

	Variables	No suicidal thoughts	Yes suicidal thoughts	Total	P value
<b>Male adolescents</b>	No suicidal attempts	35,981 (94.8)	1,178 (5.2)	37,159 (100.0)	<.001
	Yes suicidal attempts	358 (33.7)	704 (66.3)	1,062 (100.0)	
	Total	36,339 (94.1)	1,882 (5.9)	38,221 (100.0)	
<b>Female adolescents</b>	No suicidal attempts	32,391 (95.7)	747 (4.3)	33,138 (100.0)	<.001
	Yes suicidal attempts	1,618 (57.2)	1,209 (42.8)	2,827 (100.0)	
	Total	34,009 (93.6)	1,956 (6.4)	35,965 (100.0)	

**Table 4. Suicidal thoughts and attempts according to meeting physical activity guideline. Data are presented as n (%)**

Variables	Vigorous PA <sup>1</sup>	Moderate PA <sup>2</sup>	Low PA <sup>3</sup>	P value
<b>Male adolescents</b>	n = 25,759	n = 8,927	n = 30,990	
<b>Suicidal thoughts</b>				.850 <sup>4</sup>
No	22,159 (86.0)	7,657 (85.8)	26,753 (86.3)	.393 <sup>5</sup>
Yes	3,600 (14.0)	1,270 (14.2)	4,237 (13.7)	.001 <sup>6</sup>
<b>Suicidal attempts</b>				.518 <sup>4</sup>
No	25,053 (97.3)	8,669 (97.1)	30,220 (97.5)	.463 <sup>5</sup>
Yes	706 (2.7)	258 (2.9)	770 (2.5)	<.001 <sup>6</sup>
<b>Female adolescents</b>	n = 13,113	n = 3,817	n = 27,540	
<b>Suicidal thoughts</b>				<.001 <sup>4</sup>
No	9,814 (74.8)	2,803 (73.4)	21,051 (76.4)	<.001 <sup>5</sup>
Yes	3,299 (25.2)	1,014 (26.6)	6,489 (23.6)	<.001 <sup>6</sup>
<b>Suicidal attempts</b>				<.001 <sup>4</sup>
No	12,247 (93.4)	3,555 (93.1)	26,027 (94.5)	<.001 <sup>5</sup>
Yes	866 (6.6)	262 (6.9)	1,513 (5.5)	.210 <sup>6</sup>

PA = physical activity. <sup>1</sup>Met the criterion of vigorous physical activity guideline. <sup>2</sup>Met the criterion of moderate physical activity guideline. <sup>3</sup>Met the criterion for low physical activity guideline. <sup>4</sup>Significant level difference according to meet vigorous physical activity guideline. <sup>5</sup>Significant level difference according to meet moderate physical activity guideline. <sup>6</sup>Significant level difference according to meet low physical activity guideline.

**Table 5. Adjusted multiple logistic regression models of suicidal thoughts and attempts with meeting guideline of physical activity as ORs and 95% CI <sup>1</sup>.**

Variables	Males, OR (95% CI)			Females, OR (95% CI)		
	Vigorous PA <sup>2</sup>	Moderated PA <sup>3</sup>	Low PA <sup>4</sup>	Vigorous PA	Moderated PA	Low PA
<b>Suicidal thoughts</b>						
No	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.02* (1.01-1.15)	1.10* (1.02-1.18)	1.16*** (1.08-1.24)	1.21*** (1.14-1.28)	1.18*** (1.09-1.28)	1.20*** (1.04-1.26)
<b>Suicidal attempts</b>						
No	Reference	Reference	Reference	Reference	Reference	Reference
Yes	1.16*** (1.01-1.30)	1.13* (1.03-1.32)	1.26*** (1.05-1.37)	1.36*** (1.23-1.50)	1.27*** (1.01-1.36)	1.15** (1.09-1.23)

PA = physical activity. \* and \*\*\* denotes  $p < .05$  and  $p < .001$ . <sup>1</sup>Adjusted for family socio-economic status, grade point, smoking, alcohol consumption, depression, stress, and self-rated health. <sup>2</sup>Meeting guideline for vigorous physical activity. <sup>3</sup>Meeting guideline for moderate physical activity. <sup>4</sup>Meeting guideline for low physical activity.

mental health especially in relation to suicidal behaviors, integrated approaches to both physical activity and physical activity levels are required for Korean adolescents.

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 ST or SA. Second, PA, ST, and SA 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. Third, it is difficult to compare our results with those of other studies because no studies have examined PA levels in relation to the ST or SA in a nationally representative sample of South Korean adolescents. Even though this study has some limitations, this study is the first to report that participation of PA can prevent of suicidal thought and attempts in South Korean adolescents. Future studies should include other factors that can affect the suicidal behaviors.

## Conclusion

Participation of PA including meeting guidelines for vig-

orous, moderate, and low PA are positively associated with ST and SA prevention in South Korean adolescents. Therefore, we support public health program of PA participation to prevent suicide for South Korean adolescents.

## References

- Abu-Omar, K., Rütten, A. and Lehtinen, V. (2004) Mental health and physical activity in the European Union. *Sozial-und Präventivmedizin* **49**, 301-309.
- Abell, J.E., Hootman, J.M., Zack, M.M., Moriarty, D. and Helmick, C.G. (2009) Physical activity and health-related quality of life among people with arthritis. *Journal of Epidemiology and Community Health* **59**, 380-385.
- Ainsworth, B.E., Haskell, W.L., Herrmann, S.D., Meckes, N., Bassett, D.R. Jr, Tudor-Locke, C., Greer, J.L., Vezina, J., Whitt-Glover, M.C. and Leon, A.S. (2011). 2011 Compendium of Physical Activities: a second update of codes and MET values. *Medicine and Science in Sports and Exercise* **43**, 1575-1581.
- American College of Sports Medicine. (2010) *ACSM's guidelines for exercise testing and prescription*. 8th edition. Baltimore: Lippincott Williams & Wilkins, USA.
- Asztalos, M., Wijndaele, K., De Bourdeaudhuij, I., Philippaerts, R., Matton, L., Duvigneaud, N., Thomis, M., Duquet, W., Lefevre, J. and Cardon, G. (2008) Specific associations between types of physical activity and components of mental health. *Journal of Science and Medicine in Sport* **12**, 468-474.

- Babyak, M., Blumenthal, J.A., Herman, S., Khatri, P., Doraiswamy, M., Moore, K., Craighead, W.E., Baldewicz, T.T. and Krishnan, K.R. (2010) Exercise treatment for major depression: maintenance of therapeutic benefit at 10 months. *Psychosomatic Medicine* **62**, 633-638.
- Bae, J., Joung, H., Kim, J.Y., Kwon, K.N., Kim, Y.T. and Park, S.W. (2010) Test-retest reliability of a questionnaire for the Korea Youth Risk Behavior Web-Based Survey. *Journal of Preventive Medicine and Public Health* **43**, 403-410.
- Brown, D.R., Galuska, D.A., Zhang, J., Eaton, D.K., Fulton, J.E., Lowry, R. and Maynard, L.M. (2007) Physical activity, sport participation, and suicide behavior: U.S. high school students. *Medicine and Science in Sports and Exercise* **39**, 2248-2257.
- Brumby, S., Chandrasekara, A., McCoombe, S., Torres, S., Kremer, P. and Lewandowski, P. (2010) Reducing psychological distress and obesity in Australian farmers by promoting physical activity. *BMC Public Health* **11**, 362-368.
- Chen, Y.Y., Yip, P.S., Chan, C.H., Fu, K.W., Chang, S.S., Lee, W.J. and Gunnell, D. (2014) The impact of a celebrity's suicide on the introduction and establishment of a new method of suicide in South Korea. *Archives of Suicide Research* **18**, 221-226.
- Cho, K.O., Nam, S.N. and Kim, Y.S. (2011) Assessment of nutrient intake and metabolic profiles in Korean adolescents according to exercise regularity using data from the 2008 Korean National Health and Nutrition Examination Survey. *Nutrition Research Practice* **5**, 66-72.
- Cho, K.O. (2014) Sleep duration and self-rated health are independently associated with physical activity level in the Korean population. *Iranian Journal of Public Health* **46**, 590-600.
- Craig, C.L., Marshall, A.L., Sjostram, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F. and Oja, P. (2003) International physical activity questionnaire: 12-country reliability and validity. *Medicine in Science and Sports and Exercise* **35**, 1381-1395.
- Eaton, D.K., Kann, L., Kinchen, S., Shanklin, S., Flint, K.H., Hawkins, J., Harris, W.A., Lowry, R., McManus, T., Chyen, D., Whittle, L., Lim, C. and Wechsler, H. (2012) Youth Risk Behavior Surveillance-United States, 2011. *Morbidity and Mortality of Weekly Report Surveillance Summary* **61**, 1-162.
- Garrison, C.Z., Mckeown, R.E., Valois, R.F. and Vincent, M.L. (1993) Aggression, substance use and suicidal behaviors in high school students. *American Journal of Public Health* **83**, 179-184.
- Galán, I., Mesequer, C.M., Herruzo, R. and Rodríguez-Artalejo, F. (2010). Self-rated health according to amount, intensity and duration of leisure time physical activity. *Preventive Medicine* **51**, 378-383.
- Jo, S.J., Yim, H.W., Lee, M.S., Jeong, H. and Lee, W.C. (2014) Korean Youth Risk Behavior Surveillance Survey: Association between part-time employment and suicide attempts. *Asia Pacific Journal of Public Health* [Epub ahead of print].
- Kim, Y.S., Park, Y.S., Allegrante, J.P., Marks, R., Ok, H., Cho, K. and Barber, C.E. (2012) Relationship between physical activity and general mental health. *Preventive Medicine* **55**, 458-463.
- Lee, D.C., Park, I.H., Jun, T.W., Nam, B.H., Cho, S.I., Blair, S.N. and Kim, Y.S. (2012) Physical activity and body mass index and their association with the development of type 2 diabetes in Korean men. *American Journal of Epidemiology* **176**, 43-51.
- Okano, G., Miyake, H. and Mori, M. (2003) Leisure time physical activity as a determinant of self-perceived health and fitness in middle-aged male employees. *Journal of Occupational Health* **45**, 286-292.
- Randall, J.R., Doku, D., Wilson, M.L. and Peltzer, K. (2014) Suicidal behavior and related risk factors among school-aged youth in the republic of Benin. *PLoS One* **9**, e88233.
- Shaffer, D. and Craft, L. (1999) Methods of adolescent suicide prevention. *Journal of Clinical Psychiatry* **60**, 70-74.
- Taliaferro, L.A., Rienzi, B.A., Miller, M.D., Pigg, R.M. Jr and Dodd, V.J. (2008) High school youth and suicide risk: exploring protection afforded through physical activity and sport participation. *The Journal of School Health* **78**, 545-553.

### Key points

- South Korean male adolescents, compared to female adolescents, showed relatively high values for physical activity-related variables such as vigorous, moderate, and low PA.
- Regardless of gender, more physical activity participation is positively associated with prevention of suicidal thought and attempts of South Korean adolescents.
- To prevent suicide of South Korean adolescents, we support public health program including meeting guidelines for vigorous, moderate, and low physical activity.

### AUTHORS BIOGRAPHY



**Kang-Ok CHO**

**Employment**

Research professor

**Degree**

PhD

**Research interests**

Physical activity and health

**E-mail:** okcho1@snu.ac.kr

✉ **Kang-Ok Cho**

Department of Physical Education, Hanyan University, Ansan, S. Korea