RESEARCH ARTICLE

Prevalence and Correlates of Physical Activity and Sitting Time in Cancer Survivors: 2009-2013 Korea National Health and Nutrition Examination Survey

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Abstract

Objectives: A physically active lifestyle is important for cancer survivors. Therefore, this study was conducted to 1) provide population-based estimates of the prevalence of physical activity and sitting time, and 2) their correlates in Korean cancer survivors. **Materials and Methods:** This study analyzed a cancer survivor subsample (N=1,482) from 2008-2013 Korea National Health and Nutrition Examination Survey (KNHANES), data selected with a complex sampling design. Overall and subgroup-specific prevalences of physical activity and sitting time were estimated. Correlates of moderate- to vigorous-intensity physical activity (MVPA) and sitting time were tested using age-group-specific hierarchical multiple regression models. **Results:** Overall adherence rate to physical activity guidelines was 34.9% (95% CI=31.5-38.4). Age-group-specific adherence rates were 41.1% (95% CI=36.3-45.9) in adults (30-64 years old), and 25.3% (95% CI=21.0-25.3) in older adults (65 years or older). Adults spent 213.33 minutes (95% CI=172.4-254.3) per week on MVPA and 55.3 minutes (95% CI=36.4-64.6) on sitting time per day. In adults, sitting time was significantly associated with employed status (B=28.0, p=0.046), smoking (B=-47.4, p=0.020), and number of comorbidity conditions (B=-13, p=.037). MVPA was significantly associated with marital status (B=134.9, p<0.001), employment status (B=98.12, p=.046), and years since cancer diagnosis (B=104.7, p=0.015). Older adults spent 162.2 minutes (95% CI=119.5-204.8) per week on MVPA and 63.0 minutes (95% CI=45.0-89.5) on sitting time per day. Their significant correlates were sex (B= -45.2, p=0.014), smoking (B=-70.14, p<0.001), and years since cancer diagnosis (B=37.0, p=0.024). Age (B=5.8, p=0.042) and marital status (B=83.8, p=0.033) were also significantly associated with MVPA in older adults. **Conclusion:** A majority of Korean cancer survivors do not sufficiently participate in physical activity. In general, older, unhealthier, non-working, and being unmarried were risk factors for physical inactivity. While this study informs public health policy makers and practitioners about physical activity intervention demand for cancer survivors, future investigations should address psychosocial mediators to better inform intervention programs.

Keywords: Physical activity- sedentary- KNHANES

Asian Pac J Cancer Prev, **17 (12)**, 5295-5302

Introduction

In 2014, the leading cause of premature deaths in South Korea was cancer (150.9 deaths per 100,000 persons; National Cancer Information Center of Korea, 2015). It is estimated that age-adjusted incidence rate of all cancer in Korea was 311.6 per 100,000 in 2013, and 5-year survival rate was 69.4% during 2009-2013. For patients diagnosed with cancer, adopting healthy lifestyle is recommended not only for prolonged survivorship, but also for better chronic health conditions and quality of life (Demark-Wahnefried & Jones, 2008; Stacy et al., 2015). Accordingly, American Cancer Society Guidelines on Nutrition and Physical Activity for Cancer Prevention suggests that cancer survivors engage in regular physical activity, as well as achieve and maintain healthy weight, balance diet, and quit smoking during and after their treatment pathway (Rock, Demartk-Wahnefried, Meyerhardt et al., 2012).

However, research shows that the majority of cancer survivors do not adopt sufficiently active lifestyle for health. According to World Health Organization (WHO, 2010), adults and older adults should participate in at least 150 minutes of moderate-intensity aerobic physical activity, 75 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- to vigorous-intensity physical activity (MVPA) per week. Nevertheless, Moon et al. (2013) reported that only 14.7 and 13.6% of Korean cancer survivors participated in regular moderate- and vigorous-intensity physical activity, respectively. Also, Loprinzi et al. (2013) found that only 13% of US cancer survivors were sufficiently active when physical activity was measured objectively using accelerometer.

Meanwhile, research shows that sedentary behavior is a distinct risk factor for chronic diseases, independent of physical activity (Thorp et al., 2011; George et al., 2014).

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Even though not conclusive yet, in a literature review, Lynch (2010) reported that sedentary behavior may be associated with incidence of colorectal, endometrial, ovarian, and prostate cancer, as well as cancer mortality. Nevertheless, Kim et al. (2013) found that cancer survivors are more likely to engage in sedentary lifestyle than non-cancer counterparts in a national survey in the US.

In sum, cancer survivors' daily life should incorporate sufficient physical activity and less sedentary behaviors for better cancer survivorship and health-related quality of life. Therefore, studies should inform public health policy maker and practitioners about prevalence of physical (in) activity and its determinants. So, the purpose of this study was to 1) provide population-based estimates of physical activity guideline adherence rate, MVPA, and sitting time in cancer survivors, and 2) correlates of MVPA and sitting time in Korean cancer survivors.

Materials and Methods

Data for this study were retrieved from 2008-2013 Korea National Health and Nutrition Examination Survey (KNHANES), an ongoing cross-sectional interview and physical examination released every year. The participants of KNHANES are representative samples of noninstitutionalized South Korean population, selected by complex sampling design. Health interview and physical examination were performed at the mobile examination centers. Nutrition survey and household interview were conducted at the participants' home.

Participants

Among a total of 61,887 participants in the 2008-2013 KNHANES survey and physical examination, the number of samples who met the inclusion criteria (30 years or older, have ever been diagnosed with cancer) was 1,482. After controlling for complex sampling design effect, these samples represent about a million South Korean adult cancer survivors. Population-weighted sample characteristics are presented in the Table 1.

Measures

Correlates of physical activity and sitting time

Age, sex, and marital status (married/living with partner vs. never married/divorced/separated) were measured as demographic covariates. The participants' socioeconomic status was measured by education level (less than high school graduate vs. high school graduate or more), household income, and employment status (employed vs. unemployed). Cancer sites (colon or breast cancer vs. other cancers) and years since cancer diagnosis were self-reported as cancer characteristic variables. Heath status was measured by a single-item perceived health (5-point Likert scale to How would you rate your health?) and perceived stress questionnaires (4-point Likert scale to How much do you feel stressed in everyday life?). Also, the comorbidity index (i.e., the number of co-morbidity conditions) of cancer survivors

Table 1. Population-Weighted Characteristics of the Study Samples

Characteristics	Overall (95%CI)	Adults (95% CI)	Older adults (95% CI)
Sociodemographic variables			
Age	59.6 (58.6-60.7)	51.2 (50.3-52.1)	72.8 (72.3-73.4)
Female (%)	63.7 (60.3-67.1)	70.5 (65.9-75.1)	52.9 (47.6 -58.2)
Married or living with partner (%)	78.2 (75.0-81.3)	84.3 (80.7-87.9)	68.5 (63.4-73.6)
High school graduate (%)	45.4 (41.4-49.4)	60.3 (55.3-65.2)	22.0 (17.5 -26.6)
Employed (%)	38.7 (35.2-42.3)	48.0 (43.2-52.9)	24.1 (19.8 -28.4)
Health behaviors			
Smoking (%)	15.2 (12.8-17.7)	14.3 (11.0-17.5)	16.8 (13.0-20.6)
Drinking alcohol (%)	9.8 (7.4-12.3)	12.7 (8.9-16.5)	5.3 (3.0-7.6)
Physical actvitiy and sitting			
Sitting time (per day)	55.4 (43.2-67.6)	55.3 (36.4-64.6)	63.0 (45.0-89.5)
MPA (per week)	107.0 (86.6-127.4)	113.4 (88.8-138.0)	96.9 (63.7-1311.0)
VPA (per week)	86.4 (69. 3-103.5)	99.9 (75.6-124.3)	65.3 (43.6-86.9)
MVPA (per week)	193.4 (162.6-224.2)	213.3 (172.4-254.3)	162.2 (119.5-204.8)
Health status			
5+ year cancer survivors (%)	54.0 (50.3-57.6)	48.3 (43.4-53.2)	62.9 (57.7-68.0)
Diabetes (%)	12.3 (10.1-14.4)	6.2 (3.8-8.6)	21.8 (17.5-26.1)
Hypertension (%)	29.8 (26.6-33.0)	20.4 (16.1-24.8)	44.5 (39.3-49.6)
Dyslipidemia (%)	11.1 (8.9 -13.4)	10.3 (7.3-13.4)	12.4 (8.8-16.0)
Cardiovascular diseases (%)	4.7 (3.3-6.0)	1.4 (0.3-02.4)	9.8 (6.9-12.8)
Arthritis (%)	21.8 (17.9-24.1)	13.9 (10.5-17.5)	31.6 (27.0-37.0)
Depression (%)	4.8 (3.2-6.3)	5.2 (2.8-7.6)	4.1 (2.4-5.8)
Obesity (%)	30.2 (26.8 -33.5)	31.8 (27.0-36.7)	27.5 (23.0-32.0)
Comorbitity index (count)	1.1 (1.0-1.2)	0.8 (0.7-0.9)	1.5 (1.3-1.6)

was calculated based on self-report and physical examination of the following chronic health conditions: diabetes, hypertension, dyslipidemia, stroke, myocardial infarction, angina, asthma, and arthritis (Loprinzi et al., 2015). Lastly, sleeping duration, smoking (smoked once a month or more vs. not smoking), and binge drinking (7 or more drinks for men and 5 or more drinks for women in a single occasion) were self-reported as health behaviors.

Physical activity and sitting time

Physical activity and sitting time were measured using the short-form International Physical Activity Questionnaire (IPAQ). The IPAQ measures moderate- and vigorous-intensity physical activity (respectively MPA and VPA) as well as time spent in sitting. Adherence to the MVPA guideline was calculated based on metabolic equivalent (MET; the ratio of energy consumption compared to the resting metabolic rate). Since MET values of MPA and VPA in GPAQ are 4 and 8 respectively, time spent in VPA was doubled and combined with time spent in MPA. Validity and reliability evidences of Korean version of short-form IPAQ are provided by Oh et al. (2007) and Chun (2012).

Analyses

All statistical analyses incorporated physical examination sample weights to account for the complex survey design of KNHANES, using Stata 12.0 (College Station, TX, USA). Physical activity adherence rate and average sitting time with 95% confidence interval (CI) were estimated for overall cancer survivors as well as subgroups categorized by demographic, socioeconomic, cancer-related characteristics. Difference in physical activity adherence rate and mean sitting time by subgroups were tested using adjusted Wald-tests. Correlates of MVPA and sitting time were tested using age-group-specific [adults (30-64 years old) vs. older adults (65 years or older)] hierarchical multiple regression models with demographic, socioeconomic, cancer characteristics, and health variable blocks. The final models were selected based on model F-statistics with an alpha level of .05.

Results

Prevalence of physical activity adherence and population-estimates of physical activity and sitting time

Overall adherence rate to the physical activity guideline in Korean cancer survivors was 34.9% (95% CI=31.5-38.4%). Physical activity adherence rate in people without cancer history was 40.7% (95% CI=39.8-41.7), which was significantly higher than the cancer survivor counterparts, $F(1,1167)=11.01$, $p=0.001$. Population-estimates of MVPA per week and sitting time per day in cancer survivors are presented in Table 1.

Subpopulation-estimates of adherence rates with 95% CI by age group are provided in Table 2. Estimated adherence rate to physical activity guideline was 41.12%

Table 2. Prevalence of Adherence to Physical Activity Guideline

Subpopulation	30-64 years old			65+ years old		
	Adherence rate (%)	95% CI	Adjusted Wald-test	Adherence rate (%)	95% CI	Adjusted Wald-test
Overall	41.1	36.3-45.9		25.3	21.0-25.3	
Sex						
Male	37.6	28.2-46.9	F (1,496)=0.81	**31.6**	**25.0-31.6**	F (1,423)=7.61
Female	42.6	37.0-48.2	p=0.368	**19.6**	**14.1-19.6**	p=0.006
Marital status						
Married or living with partner	**22.6**	**13.6-31.6**	F (1,496)=18.07	18.5	11.1-18.5	F (1,423)=4.80
Unmarried or divorced/separated	**44.5**	**39.3-49.7**	p<0.001	28.4	22.8-28.4	p=0.029
Education						
Less than high school	37.0	30.0-43.9	F (1,495)=2.12	21.4	16.6-21.4	F (1,422)=8.00
High school graduate or more	44.0	37.5-50.4	p=0.146	38.2	27.8-38.2	p=0.005
Household income						
Lower	**32.6**	**24.9-40.4**	F (1,490)=8.43	**21.7**	**17.0-21.7**	F (1,414)=6.42
Upper	**47.9**	**41.5-54.2**	p=0.004	**36.4**	**26.4-36.4**	p=0.012
Employment status						
Unemployed	38.3	31.2-45.4	F (1,496)=1.43	24.6	19.4-24.6	F (1,421)=0.21
Employed	44.2	37.7-50.6	p=0.232	27.0	18.4-27.0	p=0.650
Cancer site						
Other than breast/colon	42.2	36.5-47.8	F (1,496)=0.74	25.6	21.0-25.6	F (1,423)=0.05
Breast/colon	37.5	28.5-46.5	p=0.390	24.5	15.1-24.5	p=0.832
Years since cancer diagnosis						
Less than 5 years	38.3	31.3-45.3	F (1,496)=1.36	27.9	20.1-27.9	F (1,423)=0.69
5+ years	44.1	37.4-50.8	p=0.244	23.8	18.5-23.8	p=0.406

Bold text indicates statistical significance (alpha = 0.05)

Table 3. Correlates of Sitting Time (Unstandardized regression coefficients, 30-64 Years Old)

Hiearchical modes	Model 1	Model 2	Model 3	Model 4
	F (3,484)=0.95, p=0.415, R^2=0.012	F (3,484)=1.77, p=0.152, R^2=0.023	F (2,484)=0.86, p=0.422, R^2=0.026	**F (7,484)=3.12, p=0.003, R^2=0.060**
Demographic variables				
Age	-1.0 (-2.6-.61)	-0.5 (-2.2-1.2)	-0.7 (-2.47-1.0)	-0.3 (-2.0-1.5)
Female	-18.9 (-49.5-11.8)	-10.7 (-41.8-20.5)	-11.7 (-43.5-20.0)	-25.7 (-61.6-10.2)
Married/living with partner	-27.8 (-70.3-14.7)	-30.2 (-72.8-12.4)	-30.5 (-72.9-11.8)	-28.8 (-70.3-12.6)
Socioeconomic status				
High school graduate		14.9 (-12.7-42.6)	14.3 (-13.3-42.0)	7.4 (-20.6-35.5)
Upper household income		-7.4 (-33.2-18.4)	-6.3 (-31.5-18.8)	-10.2 (-36.2-15.7)
Employmed		26.7 (0.7-52.7)	24.9 (-1.5-51.3)	**28.0 (0.5-55.6)**
Cancer characteristics				
Breast or colon cancer			-7.2 (-33.7-19.3)	-4.21 (-30.8-22.3)
5+ year since diagnosis			14.7 (-8.9-38.3)	20.0 (-3.8-43.8)
Health status and beavhiors				
Perceived health				5.9 (-6.7-18.5)
Perceived stress				-17.2 (-37.9-3.5)
Sleeping duration				5.8 (-0.8-12.4)
Smoking				**-47.4 (-87.2-7.6)**
Binge drinking				-10.3 (-52.2-31.6)
Depressed				8.2 (-42.3-58.6)
Comorbidity conditions				**-13.7 (-26.6-0.8)**

Bold text, indicates statistical significance (alpha=.05); Model 1, Demographic variables; Model 2, Model 1 + socioeconomic status; Model 3, Model 2 + cancer characteristics; Model 4, Model 3 + health status and behaviors

Table 4. Correlates of Sitting Time (Unstandardized regression coefficients, 65 Years or Older)

Hiearchical modes	Model 1	Model 2	Model 3	Model 4
	F (3,410)=1.94, p=0.123, R^2=0.017	F (3,410)=1.51, p=0.211, R^2=.025	F (2,410)=2.54, p=0.080, R^2=0.037	**F (7,410)=5.436, p<0.001, R^2=0.082**
Demographic variables				
Age	1.8 (-1.3-4.9)	1.8 (-1.2-4.7)	1.7 (-1.2-4.6)	2.4 (-0.6-5.4)
Female	-9.9 (-42.3-22.5)	-9.8 (-43.4-23.9)	**-15.5 (-50.7-19.7)**	**-45.2 (-81.0-9.3)**
Married/living with partner	-37.8 (-81.0-5.4)	-37.2 (-80.8-6.3)	-37.7 (-81.4-5.9)	-37.8 (-83.3-7.8)
Socioeconomic status				
High school graduate		6.7 (-38.9-52.3)	8.0 (-36.9-53.0)	8.4 (-35.5-52.3)
Upper household income		21.1 (-21.5-63.7)	25.8 (-16.5-68.1)	29.2 (-13.6-71.9)
Employmed		-23.4 (-50.1-3.3)	-25.5 (-52.5-1.4)	-23.5 (-51.5-4.6)
Cancer characteristics				
Breast or colon cancer			10.4 (-24.7-45.5)	10.4 (-23.3-44.0)
5+ year since diagnosis			**34.7 (2.0-67.4)**	**37.0 (5.0-68.9)**
Health status and beavhiors				
Perceived health				-1.4 (-20.1-17.2)
Perceived stress				-1.5 (-22.7-19.7)
Sleeping duration				1.0 (-7.0-9.1)
Smoking				**-70.1 (-96.8-43.5)**
Binge drinking				-34.9 (-85.7-16.0)
Depressed				-40.1 (-90.1-9.9)
Comorbidity conditions				**15.5 (-0.6-31.7)**

Bold text, indicates statistical significance (alpha=.05); Model 1, Demographic variables; Model 2, Model 1 + socioeconomic status; Model 3, Model 2 + cancer characteristics; Model 4, Model 3 + health status and behaviors

Table 5. Correlates of MVPA (MVPA 30-64 Years Old)

	Model 1	Model 2	Model 3	Model 4
	$F(3,483)=7.33$ $p<0.001$, $R^2=0.018$	$F(3,483)=2.95$ $p=0.033$, $R^2=0.034$	**$F(2,483)=3.66$ $p=0.027$, $R^2=0.046$**	$F(7,483)=0.98$ $p=0.443$, $R^2=0.059$
Demographic variables				
Age	3.5 (-0.01-6.9)	3.27 (-1.4-7.9)	1.6 (-2.7-5.9)	0.9 (-3.4-5.2)
Female	20.6 (-66.9-108.1)	47.63 (-55.6-150.8)	39.4 (-65.8-144.7)	17.7 (-85.8-121.2)
Married/living with partner	151.1 (87.6-214.7)	137.2 (71.6-202.7)	**134.9 (67.0-202.8)**	124.2 (53.5-194.9)
Socioeconomic status				
High school graduate		-39.1 (-134.6-56.3)	-44.7 (-139.4-50.1)	-50.4 (-146.7-45.9)
Upper household income		24.2 (-52.9-101.2)	31.3 (-46.6-109.1)	43.8 (-34.1-122.7)
Employmed		111.05 (20.7-201.4)	**98.1 (1.8-194.5)**	103.6 (10.2-196.9)
Cancer characteristics				
Breast or colon cancer			-38.5 (-152.6-75.7)	-35.6 (-144.1-73.8)
5+ year since diagnosis			**104.7 (20.5-188.9)**	109.1 (23.6-194.6)
Health status and beavhiors				
Perceived health				44.1 (-7.1-95.3)
Perceived stress				-13.2 (-72.5-46.0)
Sleeping duration				5.2 (-20.1-30.5)
Smoking				22.4 (-114.5-159.3)
Binge drinking				-81.7 (-205.8-42.5)
Depressed				-111.9 (-254.2-30.5)
Comorbidity conditions				14.1 (-27.6-55.7)

Bold text, indicates statistical significance (alpha=0.05); Model 1, Demographic variables; Model 2, Model 1 + socioeconomic status; Model 3, Model 2 + cancer characteristics; Model 4, Model 3 + health status and behaviors

in adult cancer survivors. The adherence rate ranged from 22.6% to 47.9% depending on the subpopulation characteristics. In older adult cancer survivors, the overall estimated adherence rate was 25.3% (95%CI=21.0-25.3%). Subpopulation-estimates of older adults' adherence rate ranged from 18.5% to 38.2%.

Correlates of sitting time

In adult group, among the four hierarchical regression models (model 1: demographic variable block; model 2: model 1+socioeconomic variable block; model 3: model 2+cancer characteristics block; model 4: model 3+health variable block), model 4 fitted significantly better than any other model, $F(7,484)=3.1$, $p=0.003$, $R^2=0.06$. According to the model 4, employed status (employed vs. unemployed; $B=28.0$, $p=0.046$), smoking (vs. non-smoking; $B=-47.4$, $p=0.020$), and number of comorbidity conditions ($B=-13.0$, $p=0.037$) were significant correlates of sitting time in this age group. In older adult group, model 4 also fitted to data significantly better than any other model, $F(7,410)=5.4$, $p<0.001$, $R^2=0.08$. Significant correlates of MVPA were sex (female vs. male; $B=-45.2$, $p=.014$), smoking ($B=-70.1$, $p<0.001$), and years since cancer diagnosis (5+ years vs. 5< years; $B=37.0$, $p=0.024$). The number of comorbidity condition ($B=15.5$, $p=0.059$) was marginally significantly associated with MVPA in older adults.

Correlates of moderate- to vigorous-intensity physical activity

In adult group, model 3 showed significantly better fit to data than model 2, $F(2,483)=3.66$, $p=0.03$, $R^2=0.05$. Statistically significant correlates of MVPA were being married/living with partner (vs. never married/separated/divorced; $B=134.90$, $p<.001$), employed (vs. unemployed; $B=98.1$, $p=0.046$), and years since cancer diagnosis ($B=104.7$, $p=0.015$). In older adults, model1 was selected as the final model, $F(3,410)=5.7$, $p<.001$, $R^2=0.02$. Age ($B=5.8$, $p=0.042$) and marital status ($B=83.8$, $p=0.033$) were significantly associated with MVPA.

Discussion

Research shows that regular physical activity as a part of healthy lifestyle during and after cancer treatment decreases risk for comorbidity conditions and improves health-related quality of life (Blanchard et al., 2008; Ballard-Barbash et al., 2012). Nevertheless, this study showed that a majority of cancer survivors (65.05%) in Korea do not adhere to the physical activity guideline. Theories in health psychology suggests that people are more likely to engage in health lifestyle when they perceive higher vulnerability to serious illness. Nevertheless, the adherence rate of cancer survivors tended to be lower than their non-cancer counterparts.

With regards to the demographic correlates, being one year older was associated with 6 minutes less MVPA per week in older adults. For older population, participating in MVPA may be a challenging task because their fitness level and physical independence decreases. Also, married (vs. unmarried) adults and older adults spent 135 and 84 minutes more MVPA per week, respectively. Research

Table 6. Correlates of MVPA (MVPA 65 Years or Older)

	Model 1	Model 2	Model 3	Model 4
	$F(3,410)=5.69$ $p<0.001$, $R^2=0.025$	$F(3,410)=1.37$ $p=0.253$, $R^2=0.048$	$F(2,410)=0.18$ $p=0.834$, $R^2=0.048$	$F(7,410)=0.79$ $p=0.600$, $R^2=0.066$
Demographic variables				
Age	**-5.8 (-11.4-0.2)**	-4.2 (-10.1-1.7)	-4.2 (-9.1-1.5)	-3.1 (-9.9-1.1)
Female	-56.6 (-152.0-38.3)	-54.6 (-146.4-37.2)	-58.7 (-152.7-35.4)	-19.5 (-110.6-71.6)
Married/living with partner	**83.8 (6.9-160.6)**	70.5 (-7.7-148.7)	70.1 (-6.1-147.1)	61.7 (-11.2-134.7)
Socioeconomic status				
High school graduate		-32.1 (-145.8-81.5)	-31.2 (-143.6-81.2)	-42.2 (-164.0-79.6)
Upper household income		113.3 (-31.02-257.6)	116.6 (-31.5-264.7)	111.9 (-28.3-252.1)
Employmed		108.6 (-23.7-240.1)	107.2 (-18.1-233.3)	91.6 (-25.5-208.7)
Cancer characteristics				
Breast or colon cancer			7.6 (-87.5-102.7)	19.0 (-74.4-112.4)
5+ year since diagnosis			24.4 (-64.5-113.3)	23.1 (-61.3-107.6)
Health status and beavhiors				
Perceived health				-25.5 (-60.2-9.1)
Perceived stress				-17.6 (-86.2-51.1)
Sleeping duration				6.7 (-8.9-22.3)
Smoking				11.1 (-72.8-96.7)
Binge drinking				198.6 (-258.1-655.2)
Depressed				-13.8 (-100.9-73.4)
Comorbidity conditions				-20.5 (-48.1-7.8)

Bold text, indicates statistical significance (alpha=0.05); Model 1, Demographic variables; Model 2, Model 1 + socioeconomic status; Model 3, Model 2 + cancer characteristics; Model 4, Model 3 + health status and behaviors

shows that spouses (or domestic partners) are important providers of emotional (e.g., showing sympathy that PA is important), informational (e.g., helping finding PA program information), and instrumental (e.g., sharing house chores during PA or doing PA together) social support for PA (Trost et al., 2002; Duncan et al., 2005). Therefore, intervention programs should consider incorporating light-intensity physical activity and spouse social support components.

Similar to previous research (Kampshoff et al., 2014), the current study showed that older adult (65+ years old) cancer survivors were less likely to adhere to the physical activity guideline compared to their younger adult (30-64 years old) counterparts. Even though older adult cancer survivors may face more substantial barriers to physical activity due to poor health conditions than younger population (Bauman et al., 2012), it is important to prevent socioeconomic disparities from aggravating health inequities. Nevertheless, this study shows that physical activity disparities do exist by household income in both age groups (i.e., the upper income group was more likely to adhere to PA guideline compared to the lower income group).

In addition, we found that employed (vs. unemployed) adult cancer survivors not only engaged in more MVPA (98 more minutes per week) but also sitting (28 more minutes per day). Unlike the current study, research showed a null or inverse association between employment status and adherence to exercise prescription in cancer survivors (Kampshoff et al., 2014; Hawkes et al., 2015). These discrepancies may be explained by what employment status means to the cancer survivors with regards to health behaviors. Having a paid job implies the cancer survivor is likely to have not only more chance to sit, but also appropriate level of physical and psychological fitness, and economic and environmental resources to participate in health behaviors such as MVPA (Bauman et al., 2012; Mehnert et al., 2013).

In older adults, female cancer survivors spent respectively 45 minutes more sitting time per day than men. Sitting time disparities by sex can aggravate public health burden because the association between physical inactivity and mortality risk were stronger in females than males (Brown et al., 2012). Therefore, studies should identify gender inequalities in sociocultural and psychosocial barriers against physical activity (i.e., decreasing sedentary behaviors) in cancer survivors.

In the current study, 5+ year (vs. 5< year) cancer survivors spent 105 and 37 more minutes of MVPA and sitting time per day, respectively. Research showed that time since cancer diagnosis is inversely related to willingness to participate in lifestyle change interventions (Demark-Wahnefried et al., 2000; Adams et al., 2015). Also, research showed that MVPA and sedentary behavior (or light-intensity physical activity) are independent protective and risk factor for chronic diseases in older adults, respectively (Loprinzi et al., 2013; Schmid et al., 2016). Future study should elucidate in-depth mechanisms by which cancer survival period is associated with different domains of physical activity and sedentary

behaviors.

Among health behaviors and health status, first, smoking (vs. non-smoking) adult and older adult cancer survivors respectively spent 47 and 70 less minutes of sitting time per day. As like people tend to engage in multiple unhealthy behaviors, they do so in multiple health behaviors (Spring et al., 2012), because health behaviors can share the common underlying psychosocial mechanisms (e.g., motivation to stay healthy, self-regulation, social support, etc.). Therefore, even though the prevalence of smoking is low in Korean cancer survivors (15.2%), lifestyle interventions for cancer survivors should target multiple health behaviors to increase their efficiency and effectiveness.

Lastly, adults and older adults with an additional comorbidity condition spent 14 less and 16 more minutes of sitting time per day, respectively. Even though it did not reach the statistically significant level, adults and older adults with more comorbidity conditions tended to participate in more and less MVPA, respectively. Because of cross-sectional study design, the current study results may be interpreted in several different directions: 1) adult cancer survivors with poor health conditions (i.e., having more comorbidity conditions) may have stronger motivation (or health worry) to decrease sitting time; 2) older adults' engagement in sedentary lifestyle may result in poor health conditions; or 3) older adults with poor physical fitness (i.e., fragile older adults) may not have sufficient capacity to engage in active lifestyle. To better understand the association between comorbidity conditions and sedentary behavior in cancer survivors, future study should incorporate longitudinal (e.g., prospective cohort) design and examine psychosocial and physiological mediators.

Cancer site (breast or colon cancer vs. other cancers) was not a significant correlate of either MVPA or sitting time in either age group. According to Physical Activity Guidelines Advisory Committee (2008), a number of research consistently supports that physical activity reduces risk for breast and colon cancer. According to two meta-analytic reviews, regular physical activity participation can reduce risk of colon and postmenopausal breast cancer by and 24% and 13%, respectively (Wolin et al., 2009; Wu et al., 2013). Moreover, in a recent meta-analysis by Schmid and Leitzmann (2013), high (vs. low) level of physical activity after diagnosis reduced cancer mortality by 28% and 39% in breast and colon cancer patients. Therefore, Korean public health policy maker and practitioners should allocate more resources to promote physical activity in breast and colon cancer survivors

The limitations of this study includes cross-sectional design, subjective measure of physical activity and sitting time, and lack of mediating variables. First, due to cross-sectional survey design, the current study cannot determine cause-and-effect associations between physical activity variables and their predictors. Nevertheless, because KNHANES provides population estimates by incorporating complex survey design, generalizability is one of the strengths of this study. Second, even though subjective measure of physical activity is a cost-effective method that requires least effort for the survey participants, it has issues on recall and social desirability biases. Alternatively, accelerometers can provide more precise estimates of sitting time than subjective recall measures, because many sedentary behaviors take place without cognitive process (Buckley et al., 2014). Third, because potential mediators were not tested, this study does not inform specific psychosocial mechanisms that may be useful for intervention design. Also, for cancer survivors, knowledge and psychosocial health are important indicators of well-being per se (Imran et al., 2016; Mandaliya et al., 2016). Therefore, future studies should examine psychosocial variables that may be associated with cancer survivors' demographic, socioeconomic, health behaviors, and health status.

Acknowledgements

This study was supported by 2015 research grant from Sangmyung University.

Statement conflict of Interest

There is no potential conflict of interest relevant to this article.

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