■ Original Article

Risk of Cardiovascular Disease Using Framingham Risk Score in Korean Cancer Survivors

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Background: Cardiovascular disease is an important cause of morbidity and mortality in cancer survivors. The aim of this study was to investigate the modifiable cardiovascular disease risk factors and 10-year probability of the disease based on the Framingham risk score in cancer survivors, compared with the general population.

Methods: A total of 1,225 cancer survivors and 5,196 non-cancer controls who participated in the 2007–2013 Korea National Health and Nutrition Examination Surveys were enrolled. We assessed modifiable cardiovascular disease risk factors including smoking, body mass index, physical inactivity, high blood pressure, high cholesterol, and elevated blood glucose level. The 10-year probability of cardiovascular disease was determined by applying the Framingham cardiovascular disease risk equation among cancer survivors and non-cancer controls, ranging from 30 to 74 years old who had no overt cardiovascular diseases.

Results: The proportion of subjects who had higher fasting glucose levels, hemoglobin A1c levels, systolic blood pressure, and low density lipoprotein cholesterol levels, and those who had lower high density lipoprotein cholesterol levels was significantly higher in the cancer survivors than in the non-cancer controls. The average 10-year probability of cardiovascular disease among the cancer survivors was higher than that in the non-cancer controls in both men and women. The average 10-year probability of cardiovascular disease in relation to the cancer type was significantly higher in patients with hepatic, colon, lung, breast, and gastric cancer.

Conclusion: Cancer survivors have a higher cardiovascular disease risk and 10-year probability of cardiovascular disease than non-cancer controls. Control of cardiovascular disease risk factors and implementation of a well-defined cardiovascular disease prevention program are needed for treating cancer survivors.

Keywords: Cardiovascular Diseases; Risk Factors; Neoplasms; Survivors

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INTRODUCTION

With improvements in cancer screening and treatment, there are currently over 13 million cancer survivors in the Unites States.[1] In Korea, the estimated number of cancer survivors was more than 1 million,[2] and the 5-year relative survival rate was almost 68% in 2012.[3]

Cancer survivors have more co-morbidities and an elevated risk of non-cancer mortality compared to the general population.[4,5] Cardio-vascular disease (CVD) is the most frequent cause of morbidity and mortality in cancer survivors, following second primary cancer.[6,7] and the most common cause of non-cancer mortality in cancer survivors, accounting for 31% of these deaths in Korea.[8]

There are several factors that increase the risk of CVD among cancer survivors. First, cancer survivors are usually older than the general population. Second, cancer survivors have risk factors that are common for both cancer and CVD (e.g., obesity, smoking, and physical inactivity).[7,9] Third, the late cardiotoxic effects of cancer therapies (e.g., radiation and chemotherapy) have been associated with increased CVD risk.[6,7,10,11] Fourth, lifestyle changes after cancer treatment (e.g., weight gain and reduced physical activity) may well exacerbate the risk of CVD.

Therefore, continuous monitoring and aggressive management of modifiable cardiovascular risk factors may reduce some of the CVD burden in cancer survivors.[12] Prior studies have noted suboptimal control of CVD risk factors, such as physical inactivity, smoking habits, and obesity, in cancer survivors.[13,14] Additionally, recent studies have shown that CVD risk factors are more common among cancer survivors than among the general adult population.[6,7]

However, no studies have examined a large set of CVD risk factors or the anticipated overall CVD burden in adult cancer survivors. In this study, to emphasize the importance of prevention and management of CVD in cancer survivors, we assessed modifiable traditional CVD risk factors and the risk of future CVD events among cancer survivors in comparison to the general population. The risk of future CVD events was estimated as the 10-year probability of CVD using the Framingham risk score, derived from the Framingham Heart Study, the most commonly used CVD risk score worldwide.[15,16] We hypothesized that cancer survivors would have a higher CVD risk and 10-year probability of CVD than the control groups.

METHODS

1. Data Source

The current study was based on data obtained from the 2007–2013 Korea National Health and Nutrition Examination Survey (KNHANES IV-VI). The KNHANESs are cross sectional nationwide surveys that represent the general Korean population, and are performed by the Korea Centers for Disease Control and Prevention.

These surveys use a stratified, multistage probability sampling design according to geographic area, sex, and age group to select a representative sample of the civilian, non-institutionalized Korean population. The KNHANES survey is composed of a health interview, health examination, and nutrition survey. We used data from the health interview and health examination survey that asked questions pertaining to socio-demographic characteristics, health status, medical history, and physiological status. This study was conducted under the approval of the institutional review board of the Samsung Medical Center (IRB no. SMC 2015-02-031). Informed consent was waived by the ethics committee because this study was based on a retrospective analysis of existing administrative and clinical data.

2. Study Population

We combined data from the 2007–2013 surveys into a large cross-sectional dataset. A total of 58,423 subjects participated in the KNHANES IV–VI. To limit the analysis to adults, we excluded individuals under the age of 20 years. Participants with missing data were also excluded. Our final study sample consisted of 1,225 cancer survivors and 5,196 subjects with no history of cancer (non-cancer controls) (Figure 1). Patients were considered to be cancer survivors from the time of diagnosis through the remaining years of life, using the definition of the National Coalition for Cancer Survivorship.

3. Definition of Variables

Sociodemographic characteristics included age, sex, education level (high school diploma, beyond high school), marital status (single, married), and household monthly income (<3,000 US dollar [USD],
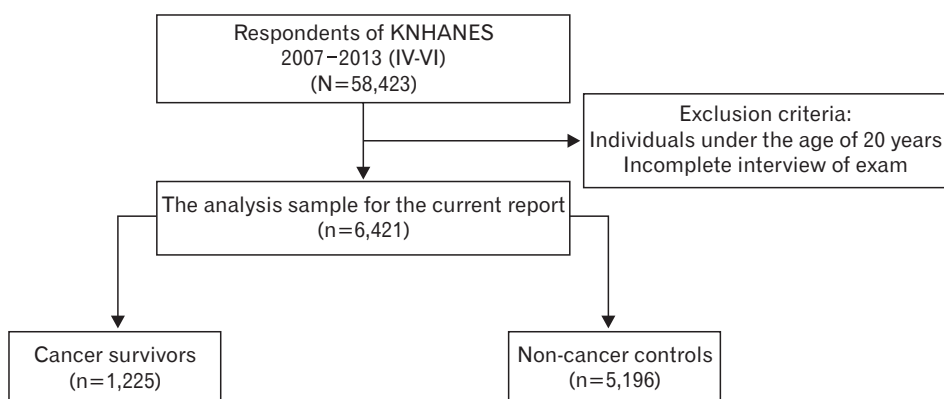

Figure 1. The process used to select the study population. KNHANES, Korea National Health and Nutrition Examination Survey.

≥3,000 USD). Co-morbidities were defined based on self-reported histories of hypertension, stroke, myocardial infarction or angina, and dyslipidemia or diabetes mellitus. Participants consuming alcohol were classified as risky drinkers, nondrinkers, or non-risky drinkers. Risky drinking was defined as alcohol consumption exceeding 3 standard drinks per day. We classified the participants as cancer survivors

Table 1. Baseline characteristics of the cancer survivors and non-cancer controls

Characteristic	Cancer survivors (n=1,225)	Non-cancer controls (n=5,196)	P-value*
Mean age (y)	59.94±0.492	45.36±0.399	<0.001
Sex			
Male	38.6	49.1	<0.001
Female	61.4	50.9	
Baseline co-morbidities			
Hypertension	73.1	16.4	<0.001
Diabetes mellitus	49.8	7.4	<0.001
Dyslipidemia	49.5	10.8	<0.001
Stroke	14.1	2.1	<0.001
Myocardial infarction or angina	23.5	1.8	<0.001
Education			
High school diploma	62.5	48.2	<0.001
Beyond high school	37.5	51.8	
Marital status			
Single	3.8	22.6	<0.001
Married	96.2	77.4	
Monthly house income (USD†)			
<3,000	71.6	51.4	<0.001
≥3,000	28.4	48.6	
Smoking status			
Non-smoker, ex-smoker	79.5	75.5	0.023
Current smoker	20.5	24.5	
Alcohol use‡			
None	77.4	49.2	<0.001
Risky drinking	22.6	50.8	
Physical activity§			
Inactive	79.4	79.9	0.751
Active	20.6	20.1	
Systolic BP (mm Hg)	121.04±0.61	116.38±0.35	<0.001
Diastolic BP (mm Hg)	75.24±0.36	75.00±0.24	0.579
Body mass index (kg/m²)	23.35±0.12	23.70±0.06	0.01
Total cholesterol (mg/dL)	188.26±1.59	187.27±0.67	0.564
High density lipoprotein cholesterol (mg/dL)	50.42±0.468	52.28±0.228	<0.001
Low density lipoprotein cholesterol (mg/dL)	110.15±1.42	107.68±0.60	0.014
Fasting glucose (mg/dL)	100.91±0.84	98.07±0.38	0.002
Hemoglobin A1c (%)	6.16±0.05	5.83±0.01	<0.001
Time since cancer diagnosis (y)			
<5	44.2	-	
5–10	29.1	-	
≥10	26.7	-	
Cancer type			
Gastric	22.5	-	
Hepatic	3.6	-	
Colon	11.8	-	
Breast	14.4	-	
Cervical	14.6	-	
Lung	3.9	-	
Others	32.8	-	

Values are presented as mean±standard error or % of subjects.

USD, US dollar; BP, blood pressure.

*Obtained by Student t-test and chi-square test. †1 USD=approximately 1,100 Korean won, as of 2015. ‡Risky drinking is defined as consumption of more than 3 standard drinks per day. §Classified as active (moderate physical activity for at least 30 minutes per day, 5 days per week or vigorous physical activity for at least 20 minutes per day, 3 days per week) or inactive (inadequate or no physical activity).

if they answered "yes" to the following question: "Have you ever been told by a doctor that you have any kind of cancer?" The type of cancer and the age at diagnosis were also noted. The time since cancer diagnosis was calculated by subtracting the participant's age at the time of diagnosis of cancer from their present age.

CVD risk was assessed based on modifiable cardiovascular risk factors and the 10-year probability of CVD. According to the American Heart Association (AHA)/American College of Cardiology guidelines, tobacco use, physical inactivity, high blood pressure, high cholesterol level, obesity, and elevated blood glucose level are the traditional modifiable cardiovascular risk factors.[17] In this study, a total of 10 cardiovascular risk factors were assessed, and each variable was classified into two groups as follows: Blood pressure was assessed for systolic and diastolic pressures (140 mm Hg and 90 mm Hg, respectively). Smoking status was defined as current, non-, or ex-smoker. Blood chemistry findings were as follows: total cholesterol <200 mg/dL; high density lipoprotein cholesterol (HDLC) <40 mg/dL in males and <50 mg/dL in females; low density lipoprotein cholesterol (LDLC) <160 mg/dL; fasting glucose <126 mg/dL; hemoglobin A1c (HbA1c) <6.5%; and body mass index (BMI) <25 kg/m². Based on physical activity, the subjects were classified into either the active group (moderate physical activity for at least 30 minutes per day, 5 days per week or vigorous physical activity for at least 20 minutes per day, 3 days per week) or the inactive group (no physical activity or insufficient physical activity).

4. Estimation of 10-Year Probability of Cardiovascular Disease

The 10-year probability of CVD was estimated using the Framingham risk score. These scores included the cancer survivors and non-cancer controls aged between 30 and 74 years and without CVD at the baseline examination by the Framingham heart study.[15]

The variables used to calculate the Framingham risk score are age, systolic blood pressure, use of antihypertensive therapy, presence of diabetes mellitus, smoking habits, total cholesterol level, and HDLC level. CVD outcomes included coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, and heart failure.[15]

5. Statistical Analysis

All statistical analyses were performed using the IBM SPSS Statistics software ver. 22.0 (IBM Co., Armonk, NY, USA). Continuous variables were expressed as the mean±standard error. Categorical variables were compared using a chi-square analysis. Univariate logistic analysis was conducted to evaluate related CVD risk factors for the cancer survivors and non-cancer controls. In addition, we estimated the mean value of the 10-year probability of CVD in the subjects using a complex samples general linear model. Statistical significance was defined as a P-value of ≤0.05.

RESULTS

Baseline characteristics of the study population by cancer status are presented in Table 1. After excluding the participants with missing values, a total of 1,225 cancer survivors and 5,196 non-cancer controls were identified (mean age, 59.9 and 45.3 years, respectively). The cancer survivors were more likely to be older, female, married, and have a lower level of education and monthly income. In the cancer survivor group, the percentage of risky drinkers and current smokers, and mean BMI were significantly lower than in the control group, while mean systolic blood pressure and HDLC, LDLC, fasting glucose, and HbA1c levels were significantly higher in the cancer survivors than in the controls. The most common co-morbidity was hypertension. Approximately 37.6% of the cancer survivors had a history of CVD, which included stroke, myocardial infarction, or angina.

Table 2. Univariate analysis of the odds ratios of cardiovascular disease risk in the cancer survivors versus in the non-cancer control group for each risk factor relative to the baseline

Variable	Cancer survivors vs. non-cancer controls
Smoking status	
Non-smoker, ex-smoker	1.0 (Reference)
Current smoker	0.75 (0.65–0.96)
Physical activity*	
Inactive	1.0 (Reference)
Active	1.03 (0.84–1.26)
Systolic BP (mm Hg)	
<140	1.0 (Reference)
≥140	1.65 (1.32–2.07)
Diastolic BP (mm Hg)	
<90	1.0 (Reference)
≥90	0.90 (0.69–1.19)
Body mass index (kg/m²)	
<25	1.0 (Reference)
≥25	0.84 (0.71–1.00)
Total cholesterol (mg/dL)	
<200	1.0 (Reference)
≥200	1.08 (0.90–1.29)
High density lipoprotein cholesterol (mg/dL)	
<40 in males, <50 in females	1.0 (Reference)
≥40 in males, ≥50 in females	0.59 (0.49–0.71)
Low density lipoprotein cholesterol (mg/dL)	
<160	1.0 (Reference)
≥160	1.53 (1.13–2.07)
Fasting glucose (mg/dL)	
<126	1.0 (Reference)
≥126	1.39 (1.03–1.87)
Hemoglobin A1c (%)	
<6.5	1.0 (Reference)
≥6.5	3.20 (2.50–4.10)

Values are presented as crude OR (95% CI). ORs and 95% CIs were estimated using univariate logistic analysis.
BP, blood pressure; OR, odds ratio; CI, confidence interval.
*Classified as active (moderate physical activity for at least 30 minutes per day, 5 days per week or vigorous physical activity for at least 20 minutes per day, 3 days per week) or inactive (inadequate or no physical activity).
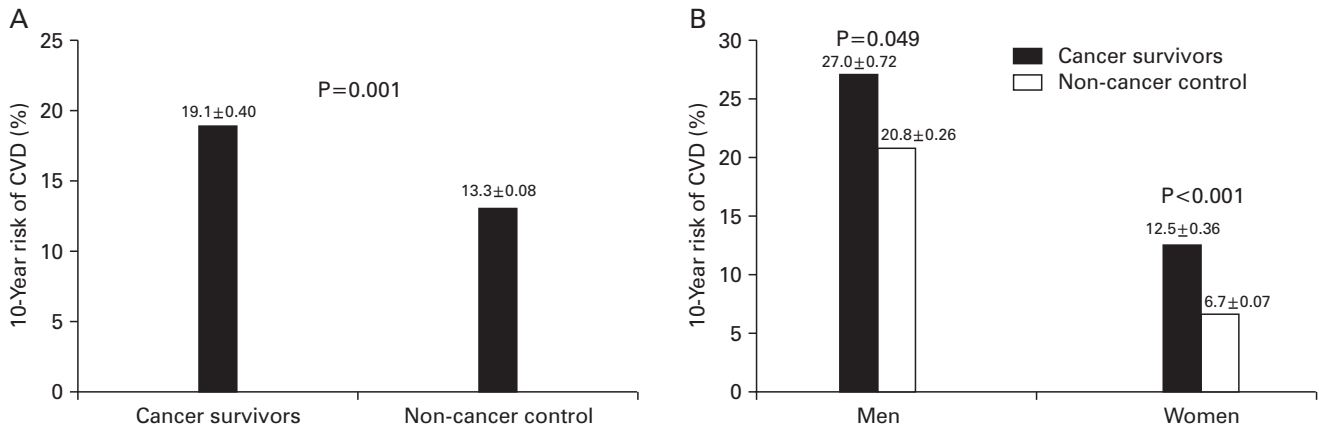
Figure 2. The average 10-year risk of CVD±standard error based on the Framingham risk scores, and adjusted for age, sex, marital status, household income, education, alcohol use, physical activity, and body mass index. (A) Cancer survivors vs. the non-cancer control group. The average 10-year probability of CVD is 19.1% for the cancer survivors and 13.3% for the non-cancer controls. (B) The cancer survivors vs. the non-cancer control group, separated by sex. The average 10-year probability of CVD in men is 27% for cancer survivors and 20.8% for non-cancer controls, and in women, it is 12.5% for cancer survivors and 6.7% for non-cancer controls. CVD, cardiovascular disease. These analyses were compared using t-test.

Of the 1225 cancer survivors, 63.3% reported having one of the following four types of cancer: stomach (22.5%), cervical (14.6%), breast, (14.4%), or colon (11.8%), and 44.2% of the cancer survivors were diagnosed as having had the disease for less than 5 years.

1. The Cardiovascular Disease Risks in Cancer Survivors versus the Control Group

To evaluate the CVD risk in the cancer survivors, a univariate logistic analysis was performed. Smoking status, systolic blood pressure, and fasting glucose, HbA1c, LDLC, and HDLC levels were significantly and independently associated with cancer history (P<0.05). The cancer survivors were more likely to be classified as never- or ex-smokers than the non-cancer controls (odds ratio, 0.75; 95% confidence interval, 0.13 to 0.89). The proportion of subjects who had higher fasting glucose levels, HbA1c levels, systolic blood pressure, and LDLC levels, and lower HDLC levels was significantly higher in the cancer survivors than in the non-cancer controls (Table 2).

2. Ten-Year Probability of Cardiovascular Disease Base on the Framingham Risk Score

The average 10-year probability of CVD was 19.1% for the cancer survivors and 13.3% for the non-cancer controls (Figure 2A). In both men and women, the average 10-year probability of CVD among the cancer survivors was higher than among the non-cancer controls (men: 27.0% for cancer survivors and 20.8% for non-cancer controls, women: 12.5% for cancer survivors and 6.7% for non-cancer controls) (Figure 2B).

The average 10-year probability of CVD according to the cancer type was significantly higher for the patients with hepatic, colon, lung, breast, and gastric cancer than for the non-cancer controls (36.7% for hepatic cancer, 32% for colon cancer, 31.2% for lung cancer, 17.8% for breast cancer, 17.7% for cervical cancer, 5.1% for gastric cancer) (Figure 3).
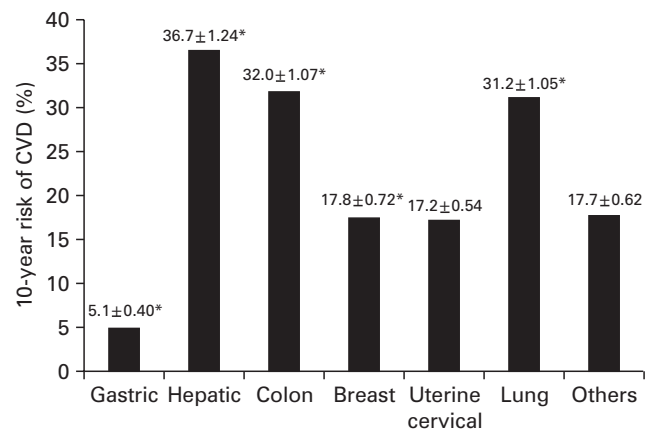

Figure 3. The average 10-year risk of CVD±standard error based on the Framingham risk scores in relation to the cancer type, and adjusted for age, sex, marital status, household income, education, alcohol use, physical activity, and body mass index. The average 10-year probability of CVD according to the cancer type is significantly higher in hepatic, colon, lung, breast, and gastric cancer (36.7% for hepatic cancer, 32.0% for colon cancer, 31.2% for lung cancer, 17.8% for breast cancer, and 5.1% for gastric cancer) than non-cancer controls. CVD, cardiovascular disease. This analysis performed by ANCOVA analysis with post hoc *Dunnett* test between non-cancer subjects and survivors of cancer. *P-value<0.05.

DISCUSSION

The major finding of the present study is that the proportion of subjects who had higher fasting glucose and HbA1c levels, systolic blood pressure, and LDLC levels, and who had lower HDLC levels was significantly higher in Korean cancer survivors than in the non-cancer controls. The 10-year probability of CVD was also higher among the cancer survivors in both men and women, and significant variation existed in relation to the cancer type.

The behaviors related to the risk of CVD among cancer survivors, such as smoking, physical inactivity, and obesity, have been investigated in several surveys. Smoking is a well-known cause of cancer. A sig-

nificant number of studies have reported similar rate of smoking in cancer survivors compared with the general population.[9,13,18,19] In contrast, our study showed that current smoking rates were significantly lower in cancer survivors, which is consistent with prior studies reporting a lower rate of current smoking among cancer survivors.[7,20] These contradictory results might be explained by two possibilities. First, there is the possibility that the smoking rate might be underestimated due to the selective survival and a small number of smoking-related cancers. Second, cancer survivors were more likely to be ex-smokers who had undergone smoking cessation education.

Only 20.6% of the cancer survivors met the AHA recommended level of physical activity, and there was no significant difference in the activity level compared to the non-cancer controls. Similar findings were observed in a recent study in the US.[9] However, these results differ from those of a previous study reporting that 58% of prostate and breast cancer survivors engaged in routine exercise after treatment.[21] The reasons for these differences may be as follows. First, physical activity goals were set differently because there are no definite exercise guidelines for cancer survivors.[14] Second, there are likely to be differences in physical activity in relation to survival time and the type and stage of cancer in cancer survivors.

Weaver et al. found that being overweight and obese was more common in breast, prostate, colorectal, and gynecologic cancer survivors,[7] and several previous studies have reported higher BMI in breast and prostate cancer survivors[22-24] and lower BMI in esophageal and gastric cancer survivors.[25,26] In our study, BMI was lower in the cancer survivors than in the non-cancer controls but the difference was not significant. There is a possibility that a lower BMI in the cancer survivors may be a result of the cancer itself. Additionally, various confounding factors also may distort the relation between BMI and cancer history status.

In addition, our study examined control of the objective CVD risk factors, such as blood pressure, lipid profile, and fasting glucose level among cancer survivors compared with the general population. Except for diastolic blood pressure and total cholesterol level, the other measured CVD risk factors were higher in the cancer survivors. In recent surveys in the US, no significant differences were found in the proportion of cancer survivors with hypertension or hypercholesterolemia.[9] Meanwhile, long-term survivors of metastatic testicular cancer had higher blood pressure and had hypercholesterolemia.[27] In another study, hypertension and diabetes were common in breast, prostate, colorectal, and gynecologic cancer survivors.[7] However, to our knowledge, no study has examined the overall modifiable risk factors for CVD among cancer survivors.

To our knowledge, no study has examined the risk of future CVD events in adult cancer survivors. We predicted the average 10-year probability of CVD using the Framingham risk score.[15] The average 10-year probability of CVD in cancer survivors was higher than in non-cancer controls, in both men and women. Additionally, there was a significant difference in the average 10-year probability of CVD in relation to the cancer type; it was significantly higher in hepatic, colon, lung,

breast, and gastric cancer (listed in decreasing order of probability).

In our study, the average 10-year probability of CVD in men was 27% for cancer survivors and 20% for non-cancer controls, and in women, it was 12% for cancer survivors and 6% for non-cancer controls. Several recent studies have demonstrated that the Framingham risk score overestimates the CVD risk in Asia,[28] including Korea.[29,30] In a recent Korean nationally representative prospective cohort study, the average 10-year risk for coronary heart disease was 1.03% for men and 0.40% for women during an 11.6-year median follow-up, while the Framingham risk score predicted 3–6 times as many coronary heart disease events than observed.[30] Moreover, the non-cancer control group in this study was heterogeneous, including unhealthy individuals with a number of co-morbidities. Therefore, the overall 10-year probability of CVD in our subjects is likely to have been overestimated from the actual incidence of CVD. However, we have to consider that our study also examined the 10-year probability of CVD including stroke, peripheral artery disease, and heart failure, as well as that of coronary heart disease.

This study has some limitations related to the use of the KNHANES data. First, the KNHANES was not designed to evaluate cancer survivorship. Thus, the number of cancer survivors in the study was relatively small that might have limited the significance of the results, the ability to generalize our results to all cancer survivors in Korea, and the conducting of further analysis. Second, we did not have information on CVD risk factors and health behaviors prior to the cancer diagnosis in the KNHAES data. Although CVD risk was higher in cancer survivors, it is difficult to establish a sequential relationship between cancer and CVD risk. Third, the KNHANES did not include information on cancer treatment status. Therefore, we were not able to determine the cancer stage or the proportion of cancer survivors who received active treatment and were eventually symptom free. In addition, we could not evaluate if cancer survivors received treatment methods linked with cardiotoxicity, which may have influenced our results. Therefore, future studies need to examine the control of CVD risk in cancer survivors with a well-documented treatment history. Finally, self-reported cancer, history of other chronic disease, and health behavior are all subject to recall or misclassification bias.

Despite these limitations, our findings suggested that cancer survivors had a higher CVD risk and 10-year probability of CVD than the non-cancer controls. Our study also emphasizes that optimal control of CVD risk factors for preventing CVD and reducing non-cancer-related death is important in treating cancer survivors. These findings suggest that the rates of receiving adequate treatment for CVD risk factors were lower in cancer survivors than in the general population.

Therefore, CVD risk management and a well-defined CVD prevention program are needed for cancer survivors. For this, primary care physicians and cancer specialists should work together to oversee appropriate surveillance and modification of CVD risk factors. Cancer survivors and their caregivers also need to recognize the risk of CVD and manage the risk factors aggressively.

CONFLICT OF INTEREST

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

ACKNOWLEDGMENTS

REFERENCES

1. Siegel R, DeSantis C, Virgo K, Stein K, Mariotto A, Smith T, et al. Cancer treatment and survivorship statistics, 2012. CA Cancer J Clin 2012;62:220-41.

2. National Cancer Center. Cancer facts and figures. Goyang: National Cancer Center; 2014.

3. Jung KW, Won YJ, Kong HJ, Oh CM, Lee DH, Lee JS. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2011. Cancer Res Treat 2014;46:109-23.

4. Shin DW, Cho B, Kim SY, Jung JH, Park JH. Management of cancer survivors in clinical and public health perspectives: current status and future challenges in Korea. J Korean Med Sci 2013;28:651-7.

5. Baade PD, Fritschi L, Eakin EG. Non-cancer mortality among people diagnosed with cancer (Australia). Cancer Causes Control 2006;17:287-97.

6. Fitzgerald KR. Review of article: the prevention of cardiovascular disease in cancer survivors by Iyad N. Daher, MD, Tina R. Daigle, RN, MSN, Nirmanmoh Bhatia, MD, Jean-Bernard Durand, MD (Tex Heart Inst J 2012;39[2]:190-8). J Vasc Nurs 2012;30:100.

7. Weaver KE, Foraker RE, Alfano CM, Rowland JH, Arora NK, Bellizzi KM, et al. Cardiovascular risk factors among long-term survivors of breast, prostate, colorectal, and gynecologic cancers: a gap in survivorship care? J Cancer Surviv 2013;7:253-61.

8. Shin DW, Ahn E, Kim H, Park S, Kim YA, Yun YH. Non-cancer mortality among long-term survivors of adult cancer in Korea: national cancer registry study. Cancer Causes Control 2010;21:919-29.

9. Enright KA, Krzyzanowska MK. Control of cardiovascular risk factors among adult cancer survivors: a population-based survey. Cancer Causes Control 2010;21:1867-74.

10. Yeh ET, Tong AT, Lenihan DJ, Yusuf SW, Swafford J, Champion C, et al. Cardiovascular complications of cancer therapy: diagnosis, pathogenesis, and management. Circulation 2004;109:3122-31.

11. Wolin KY, Colditz GA. Implementing chronic disease prevention amongst cancer survivors. J Intern Med 2011;269:85-7.

12. Landy DC, Miller TL, Lopez-Mitnik G, Lipsitz SR, Hinkle AS, Constine LS, et al. Aggregating traditional cardiovascular disease risk factors to assess the cardiometabolic health of childhood cancer survivors: an analysis from the Cardiac Risk Factors in Childhood Cancer Survivors Study. Am Heart J 2012;163:295-301.e2.

13. Bellizzi KM, Rowland JH, Jeffery DD, McNeel T. Health behaviors of cancer survivors: examining opportunities for cancer control intervention. J Clin Oncol 2005;23:8884-93.

14. Oh MG, Han MA, Park J, Ryu SY, Park CY, Choi SW. Health behaviors of cancer survivors: the Fourth Korea National Health and Nutrition Examination Survey (KNHANES IV, 2007-09). Jpn J Clin Oncol 2013;43: 981-7.

15. D'Agostino RB Sr, Vasan RS, Pencina MJ, Wolf PA, Cobain M, Massaro JM, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. Circulation 2008;117:743-53.

16. Hussain SM, Oldenburg B, Wang Y, Zoungas S, Tonkin AM. Assessment of cardiovascular disease risk in South asian populations. Int J Vasc Med 2013;2013:786801.

17. Goff DC Jr, Lloyd-Jones DM, Bennett G, Coady S, D'Agostino RB, Gibbons R, et al. 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 2014;129(25 Suppl 2):S49-73.

18. Eakin EG, Youlden DR, Baade PD, Lawler SP, Reeves MM, Heyworth JS, et al. Health behaviors of cancer survivors: data from an Australian population-based survey. Cancer Causes Control 2007;18:881-94.

19. Coups EJ, Ostroff JS. A population-based estimate of the prevalence of behavioral risk factors among adult cancer survivors and noncancer controls. Prev Med 2005;40:702-11.

20. Grimmett C, Wardle J, Steptoe A. Health behaviours in older cancer survivors in the English Longitudinal Study of Ageing. Eur J Cancer 2009;45:2180-6.

21. Demark-Wahnefried W, Peterson B, McBride C, Lipkus I, Clipp E. Current health behaviors and readiness to pursue life-style changes among men and women diagnosed with early stage prostate and breast carcinomas. Cancer 2000;88:674-84.

22. Amling CL, Riffenburgh RH, Sun L, Moul JW, Lance RS, Kusuda L, et al. Pathologic variables and recurrence rates as related to obesity and race in men with prostate cancer undergoing radical prostatectomy. J Clin Oncol 2004;22:439-45.

23. Meyerhardt JA, Catalano PJ, Haller DG, Mayer RJ, Benson AB 3rd, Macdonald JS, et al. Influence of body mass index on outcomes and treatment-related toxicity in patients with colon carcinoma. Cancer 2003;98:484-95.

24. Whiteman MK, Hillis SD, Curtis KM, McDonald JA, Wingo PA, Marchbanks PA. Body mass and mortality after breast cancer diagnosis. Cancer Epidemiol Biomarkers Prev 2005;14:2009-14.

25. Oh SW, Yoon YS, Shin SA. Effects of excess weight on cancer incidences depending on cancer sites and histologic findings among men: Korea National Health Insurance Corporation Study. J Clin Oncol 2005;23:4742-54.

26. Trivers KF, De Roos AJ, Gammon MD, Vaughan TL, Risch HA, Olshan AF, et al. Demographic and lifestyle predictors of survival in patients with esophageal or gastric cancers. Clin Gastroenterol Hepatol 2005;3: 225-30.

27. Meinardi MT, Gietema JA, van der Graaf WT, van Veldhuisen DJ, Runne MA, Sluiter WJ, et al. Cardiovascular morbidity in long-term survivors of metastatic testicular cancer. J Clin Oncol 2000;18:1725-32.

28. Liu J, Hong Y, D'Agostino RB Sr, Wu Z, Wang W, Sun J, et al. Predictive value for the Chinese population of the Framingham CHD risk assessment tool compared with the Chinese Multi-Provincial Cohort Study. JAMA 2004;291:2591-9.

29. Ahn KA, Yun JE, Cho ER, Nam CM, Jang Y, Jee SH. Framingham equation model overestimates risk of ischemic heart disease in Korean men and women. Korean J Epidemiol 2006;28:162-70.

30. Jee SH, Jang Y, Oh DJ, Oh BH, Lee SH, Park SW, et al. A coronary heart disease prediction model: the Korean Heart Study. BMJ Open 2014;4: e005025.