Association Between Health Behaviors and Family History of Cancer According to Sex in the General Population

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Introduction: Family history of cancer and modifiable risk factors are each associated with cancer development, but no studies have assessed their association with each other by sex. This study aimed to examine modifiable risk factors in individuals with a family history of cancer compared with those without a family history of cancer, according to sex.

Methods: This study recruited 166,810 participants aged 40−79 years from Korea's Health Examinee Study cohort between 2004 and 2014. Results were calculated as AORs and 95% CIs to determine the relationship between family history of cancer in first-degree relatives and modifiable risk factors. Data analyses were performed in 2018.

Results: The prevalence of modifiable cancer risk factors, including current smoking, drinking alcohol, physical inactivity, obesity, and abdominal obesity, were different according to the presence of a family history of cancer, cancer type of such a family history, and sex. Male participants with a family history of cancer were less likely to be current smokers or obese (AOR=0.95, 95% CI=0.91, 0.99 and AOR=0.95, 95% CI=0.92, 0.99, respectively) than those without a family history of cancer, whereas female participants with a family history of cancer were more likely to be current smokers but less likely to be physically inactive (AOR=1.13, 95% CI=1.03, 1.23 and AOR=0.96, 95% CI=0.93, 0.98, respectively) than those without a family history of cancer.

Conclusions: This study's findings suggest that, in general, males with a family history of cancer show better health behaviors, whereas females with a family history of cancer demonstrate worse health behaviors.
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INTRODUCTION

Cancer is the second leading cause of death worldwide, causing 8.9 million deaths in 2016.[1] Well-known modifiable risk factors, such as smoking, drinking alcohol, physical inactivity, obesity, and abdominal obesity, are known to affect the spectrum of cancer control,[2] and, to a different extent, by sex.[3,4] Changing these modifiable risk factors, which are also associated with personal, community, and social factors, can effectively prevent cancer. More specifically, personal factors such as individual knowledge, attitude, and perceived benefits and risks are particularly important in controlling modifiable factors and reducing the risk of cancer.[5]

Family history of cancer (FHCA) is an important non-modifiable risk factor for cancer[6] and may influence individual health beliefs, including risk perception.[7−9] Because a family with an FHCA shares a common

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environment[10] and also habits related to health, such as diet or physical activities, they may tend to exhibit more unhealthy behaviors compared with a family without FHCA. Conversely, as FHCA also increases individuals' perceived susceptibility to cancer, people with FHCA may show improved health behaviors as a result of a heightened sense of risk.[5] Previous studies regarding the association between FHCA and health behaviors have examined cancer screening uptake among people with any FHCA and FHCA of the breast, colorectum, and skin,[11,12] presenting different effects on cancer screening by the type of FHCA.[12] However, how modifiable risk factors change, and affect primary cancer prevention for people with an FHCA has been studied less, with inconsistent results.[13−17] In addition, studies also showed large differences in these modifiable risk factors by sex.[18] Furthermore, no studies have examined both FHCA and sex, although modifiable risk factors are known to differ by these two major non-modifiable risk factors of cancer.

Cancer development is associated with non-modifiable risk factors, such as FHCA and sex, and with modifiable risk factors, such as smoking, drinking alcohol, physical inactivity, and obesity. Therefore, it is important to understand the relationship between FHCA and modifiable risk factors, while considering the differences by sex.

This study aims to examine modifiable risk factors in individuals who reported having FHCA in first-degree relatives and compare these modifiable risk factors with individuals without FHCA, stratified by type of cancer and sex.

METHODS

Study Population

The study population was selected from the baseline research data of the Health Examinees Study (HEXA), which is a component of the Korean Genome and Epidemiology Study conducted by the Korea Center for Disease Control and Prevention. Recruited subjects for this study were adults aged 40−79 years who agreed to participate and provided written informed consent between 2004 and 2013. Trained research staff collected data through well-structured questionnaires, physical examinations, collection of biological specimens, and laboratory analyses. Details of Korean Genome and Epidemiology Study, HEXA, and their standardized study protocols can be found elsewhere.[19,20]

Of the 173,357 total participants in the HEXA baseline survey, 5,274 participants who had ever been diagnosed with cancer by a physician at the time of the survey were excluded. This was done to avoid possible influences of cancer diagnosis on personal health behaviors and choices.[21] Individuals with FHCA were defined according to cancer diagnosis status of their first-degree relatives. Among the remaining 168,083 cancer-free participants, 1,273 participants with missing information on FHCA were also excluded.

Finally, 166,810 participants (57,521 males and 109,289 females) were included in the current study. Among male

participants, 14,609 had FHCA (25.4%), and among female participants 30,710 (28.1%) had FHCA. The selection process of the study population is described in Appendix Figure 1 (available online). The IRB of Korea's National Cancer Center approved the study protocol (NCC2014-0098).

Measures

FHCA was assessed using the question, *Among your first-degree relatives including parents, siblings, or children, is there any member who has been diagnosed with cancer by a physician?* If a participant answered *yes*, the cancer type of FHCA was also asked. Subgroup analysis was conducted for each cancer type with a sufficient number of cases, and all other cancers were combined into one group (Appendix Figure 1, available online).

Among modifiable risk factors, current smoking, currently drinking alcohol, and physical inactivity were assessed using structured questionnaires. Obesity and abdominal obesity were obtained from physical examination with height, weight, waist circumference, and hip circumference. A current smoker was defined as one who reported to smoke ≥100 cigarettes in their lifetime and smoked at the time of the survey. For drinking alcohol, current drinkers were defined as those who reported to drink regularly (one or more time per month) at the time of survey. Those who performed vigorous exercise less than once a week were defined as physically inactive. Obesity was assessed via BMI, which was calculated as weight (in kilograms) divided by the square of height (in m^2). Participants with BMI ≥25 were considered obese.[22] Waist-to-hip ratio was calculated using waist and hip circumferences, and males and females with waist-to-hip ratio ≥0.90 and 0.80, respectively, were considered to have abdominal obesity.[23]

Demographic and socioeconomic characteristics included were age (40−49, 50−59, 60−79 years), education level (below high school, high school, above high school), monthly household income (<$1,500, $1,500−$2,999, $3,000−$3,999, ≥$4,000; US$1=1,000 Korean Won), current employment condition (yes/no), any chronic disease in the past diagnosed by a physician (yes/no), and self-rated health (healthy, normal, unhealthy). Reproductive factors were additionally considered for female participants, including number of children (zero, one to two, three to four, five or more) and menopausal status (yes/no). Missing values in demographic and SES variables were treated with dummy coding.

Statistical Analysis

All analyses were conducted separately for males and females, and differences in modifiable risk factors for those with any FHCA and those with each cancer type of FHCA (gastric, liver, colorectal, breast, cervical, lung, thyroid, and others) compared with those without any type of FHCA were assessed. Baseline sociodemographic characteristics of participants with and without FHCA and each cancer type of FHCA were presented as numbers and percentages, and were compared using the chi-square test.

To identify whether FHCA and each type of FHCA were independently associated with each modifiable risk factor (current smoking, currently drinking alcohol, physical inactivity, obesity, and abdominal obesity), multivariate logistic regression was conducted. The included covariates were age, education, monthly household income, job status, self-rated health, chronic disease, other health behaviors, and, in the case of females, menopause status and number of children. Dummy variables for missing data on

demographic and SES variables were included in multivariate logistic regression. The results were presented as AORs and 95% CIs. Data analyses were performed in 2018 using SAS, version 9.3.

RESULTS

The baseline sociodemographic characteristics according to FHCA and cancer type of FHCA are shown by sex in Tables 1 and 2. In male participants with an FHCA, distributions of all covariates were significantly different compared with those without an FHCA ($p<0.05$). In females, distributions of all covariates except menopausal status were significantly different between those with and without an FHCA.

Among male participants with an FHCA versus those without an FHCA, the prevalence was as follows for current smoking (31.3% vs 32.2%), drinking alcohol (73.2% vs 72.5%), physical inactivity (42.3% vs 43.9%), obesity (39.4% vs 40.1%), and abdominal obesity (44.2% vs 45.5%) (Table 3). Even in logistic regression controlling for sociodemographic characteristics, male participants with an FHCA were less likely to be current smokers or obese (AOR=0.95, 95% CI=0.91, 0.99 and AOR=0.95, 95% CI=0.92, 0.99) compared with those without an FHCA. Regarding each cancer type of FHCA, current smoking was less prevalent among subjects with an FHCA of the stomach and colorectum (AOR=0.87, 95% CI=0.81, 0.93 and AOR=0.88, 95% CI=0.78, 0.99) compared with those without any FHCA. Physical inactivity was more prevalent among those with an FHCA of the thyroid (AOR=1.54, 95% CI=1.18, 2.02), obesity was less prevalent among those with an FHCA of the stomach (AOR=0.92, 95% CI=0.87, 0.99), and abdominal obesity was more prevalent among those with an FHCA of the lung (AOR=1.11, 95% CI=1.01, 1.22) compared with those without any FHCA.

Among female participants with an FHCA versus those without an FHCA, the prevalence was as follows for current smoking (2.6% vs 2.3%), drinking alcohol (31.6% vs 31.3%), physical inactivity (48.3% vs 50.0%), obesity (28.5% vs 29.5%), and abdominal obesity (71.3% vs 72.4%) (Table 4). Even in logistic regression controlling for sociodemographic characteristics, female participants with an FHCA were more likely to be current smokers (AOR=1.13, 95% CI=1.03, 1.23), but less likely to be physically inactive (AOR=0.96, 95% CI=0.93, 0.98), compared with those without an FHCA. Current smoking was higher among females who had an FHCA of the breast (AOR=1.40, 95% CI=1.08, 1.83) and lung (AOR=1.23, 95% CI=1.01, 1.49). Currently drinking alcohol was more prevalent among participants with a colorectal FHCA (AOR=1.12, 95% CI=1.02, 1.21). The prevalence of physical inactivity was lower among

females who had an FHCA of the stomach (AOR=0.96, 95% CI=0.92, 1.00), liver (AOR=0.94, 95% CI=0.88, 1.00), breast (AOR=0.91, 95% CI=0.83, 1.00), and others (AOR=0.93, 95% CI=0.89, 0.97). Females with an FHCA of the breast showed higher obesity rates (AOR=1.12, 95% CI=1.01, 1.25) compared with those without any FHCA.

Comparing the relationship between FHCA and health behaviors by sex (Tables 3 and 4), male subjects with an FHCA were less likely to smoke than those without FHCA, especially in those with stomach and colorectal FHCA, but female subjects with an FHCA were more likely to smoke than those without an FHCA, especially in those with breast and lung FHCA. For physical inactivity, no significant relationship existed in males, but females with an FHCA were less likely to be physically inactive. For obesity, males with an FHCA were less likely to be obese, but females with an FHCA had no significant association with obesity.

DISCUSSION

The current study results indicate that the prevalence of modifiable cancer risk factors, including current smoking, drinking alcohol, physical inactivity, obesity, and abdominal obesity, were different according to the presence of FHCA, the cancer type of FHCA, and sex. Interestingly, different associations were observed between FHCA and these factors by sex. Males with an FHCA were less likely to be a current smoker, but females with an FHCA were more likely to be a current smoker compared with those without an FHCA.

Previous studies that examined relationships between modifiable health behaviors and FHCA have consistently shown that people with FHCA did not have better preventive lifestyle behaviors, despite being more likely to undertake screening services.[14,17,24] Furthermore, some studies have shown worse lifestyle behaviors in people with FHCA of the stomach or colorectum.[16,25] The current study showed more unhealthy behaviors in female participants with FHCA, in agreement with previous studies,[16,25,26] suggesting that FHCA is a complex interaction between genetic and environmental risk factors, and that there are missed opportunities for improving the health of a population with increased susceptibility of cancer. A study focused on a genetically high-risk group for breast cancer reported that women with strong FHCA of the breast did not show more preventive behaviors. Particularly, women with moderate or high genetic risk were more likely to smoke than women in the low-risk group.[17]

An unexpected finding of this study was that male participants with an FHCA showed better health behaviors,

Table 1. Demographic and Socioeconomic Characteristics According to FHCA, Including FHCA by Cancer Type in Males Without Cancer (KoGES 2004−2013)

Characteristics	No FHCA (n=42,912)	Any FHCA[a] (n=14,609)	Stomach (n=4,716)	Liver (n=2,161)	Colorectum (n=1,353)	Breast (n=586)	Cervix (n=487)	Lung (n=2,074)	Thyroid (n=229)	Others (n=3,362)
Age, years										
40−49	14,755 (34.4)	5,175 (35.4)	1,437 (30.5)	805 (37.3)	481 (35.6)	245 (41.8)	188 (38.6)	772 (37.2)	116 (50.7)	1,328 (36.3)
50−59	15,100 (35.2)	5,627 (38.5)	1,879 (39.8)	819 (37.9)	523 (38.7)	219 (37.4)	183 (37.6)	836 (40.3)	67 (29.3)	1,396 (38.1)
60−79	13,057 (30.4)	3,807 (26.1)	1,400 (29.7)	537 (24.9)	349 (25.8)	122 (20.8)	116 (23.8)	466 (22.5)	46 (20.1)	938 (25.6)
p-value[b]	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Education										
Below high school	10,474 (24.8)	2,778 (19.2)	1,021 (21.8)	410 (19.1)	244 (18.2)	81 (14.0)	75 (15.4)	373 (18.1)	19 (8.4)	606 (16.7)
High school	14,227 (33.7)	4,854 (33.5)	1,602 (34.3)	768 (35.8)	403 (30.0)	185 (32.0)	169 (34.7)	727 (35.3)	54 (23.8)	1,188 (32.7)
Above high school	17,580 (41.6)	6,843 (47.3)	2,051 (43.9)	966 (45.1)	695 (51.8)	313 (54.1)	243 (49.9)	959 (46.6)	154 (67.8)	1,837 (50.6)
Missing	631 (1.5)	134 (0.9)	42 (0.9)	17 (0.8)	11 (0.8)	7 (1.2)	0 (0.0)	15 (0.7)	2 (0.9)	31 (0.9)
p-value[b]	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Income (US$/month)										
<1,500	6,511 (17.7)	1,804 (14.1)	658 (15.8)	274 (14.4)	174 (14.2)	74 (13.9)	46 (9.9)	219 (11.9)	20 (9.1)	434 (13.3)
1,500−2,999	12,581 (34.3)	4,215 (32.9)	1,409 (33.9)	632 (33.1)	394 (32.1)	156 (29.3)	157 (33.9)	630 (34.4)	70 (32.0)	1,032 (31.5)
3,000−3,999	7,747 (21.1)	2,818 (22.0)	898 (21.6)	427 (22.4)	259 (21.1)	114 (21.4)	106 (22.9)	413 (22.5)	44 (20.1)	733 (22.4)
≥4,000	9,889 (26.9)	3,968 (31.0)	1,190 (28.6)	574 (30.1)	399 (32.5)	189 (35.5)	154 (33.3)	572 (31.2)	85 (38.8)	1,073 (32.8)
Missing	6,184 (14.4)	1,804 (12.3)	561 (11.9)	254 (11.8)	127 (9.4)	53 (9.0)	24 (4.9)	240 (11.6)	10 (4.4)	390 (10.7)
p-value[b]	—	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Job										
No	7,772 (18.6)	2,433 (17.0)	872 (18.8)	337 (15.9)	234 (17.5)	79 (13.6)	91 (18.7)	305 (15.1)	29 (12.7)	592 (16.4)
Yes	34,003 (81.4)	11,880 (83.0)	3,768 (81.2)	1,782 (84.1)	1,104 (82.5)	500 (86.4)	395 (81.3)	1,721 (85.0)	200 (87.3)	3,009 (83.6)
Missing	1,137 (2.7)	296 (2.0)	76 (1.6)	42 (1.9)	15 (1.1)	7 (1.2)	1 (0.2)	48 (2.3)	0 (0.0)	61 (1.7)
p-value[b]	—	<0.001	0.754	0.002	0.302	0.002	0.946	<0.001	0.021	0.001
Self-rated health										
Healthy	19,383 (45.6)	6,333 (43.7)	2,046 (43.6)	921 (42.9)	587 (43.7)	258 (44.2)	208 (43.0)	919 (44.5)	69 (30.1)	1,582 (43.4)
Normal	17,646 (41.5)	6,299 (43.4)	2,008 (42.8)	928 (43.3)	609 (45.3)	238 (40.8)	207 (42.8)	911 (44.1)	135 (59.0)	1,615 (44.3)
Unhealthy	5,460 (12.9)	1,871 (12.9)	643 (13.7)	296 (13.8)	148 (11.0)	88 (15.1)	69 (14.3)	234 (11.3)	25 (10.9)	448 (12.3)
Missing	423 (1.0)	106 (0.7)	19 (0.4)	16 (0.7)	9 (0.7)	2 (0.3)	3 (0.6)	10 (0.5)	0 (0.0)	17 (0.5)
p-value[b]	—	<0.001	0.021	0.047	0.011	0.280	0.439	0.027	<0.001	0.005
Chronic disease[c]										
No	21,897 (51.1)	7,234 (49.5)	2,237 (47.4)	1,043 (48.3)	651 (48.2)	301 (51.5)	224 (46.0)	1,048 (50.6)	112 (48.9)	1,785 (48.7)
Yes	20,982 (48.9)	7,371 (50.5)	2,479 (52.6)	1,117 (51.7)	701 (51.9)	284 (48.6)	263 (54.0)	1,025 (49.5)	117 (51.1)	1,877 (51.3)
Missing	33 (0.1)	4 (0.0)	0 (0.0)	1 (0.1)	1 (0.1)	1 (0.2)	0 (0.0)	1 (0.1)	0 (0.0)	0 (0.0)
p-value[b]	—	0.001	<0.001	0.012	0.035	0.853	0.026	0.649	0.515	0.007

Note: Values are n (%) unless otherwise indicated. Boldface indicates statistical significance (p<0.05).
[a]Any FHCA defined as those who had any type of family history of cancer.
[b]p-values were determined using χ^2 test, excluding missing data. Proportions of covariates were compared between those who had FHCA or each cancer type of FHCA to those without any FHCA.
[c]Chronic diseases included the diagnosis of any kind of chronic diseases by a physician in the past.
FHCA, family history of cancer; KoGES, Korean Genome and Epidemiology Study.

Table 2. Demographic and Socioeconomic Characteristics According to FHCA, Including FHCA by Cancer Type in Females Without Cancer (KoGES 2004−2013)

Characteristics	No FHCA (n=78,579)	Any FHCA[a] (n=30,710)	Stomach (n=9,246)	Liver (n=4,445)	Colorectum (n=2,692)	Breast (n=1,928)	Cervix (n=1,562)	Lung (n=4,132)	Thyroid (n=758)	Others (n=7,741)
Age, years										
40−49	30,485 (38.8)	11,585 (37.7)	3,185 (34.4)	1,604 (36.1)	986 (36.6)	710 (36.8)	538 (34.4)	1,612 (39.0)	339 (44.7)	3,017 (39.0)
50−59	30,510 (38.8)	12,906 (42.0)	3,982 (43.1)	1,866 (42.0)	1,145 (42.5)	817 (42.4)	694 (44.4)	1,729 (41.8)	313 (41.3)	3,262 (42.1)
60−79	17,584 (22.4)	6,219 (20.3)	2,079 (22.5)	975 (21.9)	561 (20.8)	401 (20.8)	330 (21.1)	791 (19.1)	106 (14.0)	1,462 (18.9)
p-value[b]	—	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**
Number of children										
0	881 (1.2)	369 (1.2)	94 (1.1)	49 (1.1)	43 (1.7)	27 (1.5)	19 (1.3)	46 (1.2)	16 (2.2)	109 (1.5)
1−2	49,432 (65.5)	20,202 (68.4)	5,882 (66.1)	2,916 (68.0)	1,772 (68.6)	1,283 (69.8)	1,048 (69.4)	2,752 (69.0)	542 (74.6)	5,191 (70.0)
3−4	22,375 (29.6)	8,126 (27.5)	2,643 (29.7)	1,190 (27.7)	701 (27.1)	476 (25.9)	415 (27.5)	1,087 (27.2)	157 (21.6)	1,949 (26.3)
≥5	2,794 (3.7)	832 (2.8)	285 (3.2)	134 (3.1)	68 (2.6)	53 (2.9)	28 (1.9)	105 (2.6)	12 (1.7)	170 (2.3)
Missing	3,097 (3.9)	1,181 (3.8)	342 (3.7)	156 (3.5)	108 (4.0)	89 (4.6)	52 (3.3)	142 (3.4)	31 (4.1)	322 (4.2)
p-value[b]	—	<**0.001**	0.081	**0.006**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**
Education										
Below high school	31,662 (40.9)	10,976 (36.2)	3,668 (40.2)	1,676 (38.1)	849 (31.9)	598 (31.5)	533 (34.5)	1,457 (35.6)	198 (26.3)	2,448 (31.9)
High school	28,573 (36.9)	11,854 (39.1)	3,533 (38.7)	1,708 (38.9)	1,045 (39.2)	754 (39.7)	611 (39.5)	1,601 (39.1)	277 (36.8)	3,059 (39.9)
Above high school	17,112 (22.1)	7,504 (24.7)	1,933 (21.2)	1,011 (23.0)	769 (28.9)	549 (28.9)	402 (26.0)	1,034 (25.3)	278 (36.9)	2,161 (28.2)
Missing	1,232 (1.6)	376 (1.2)	112 (1.2)	50 (1.1)	29 (1.1)	27 (1.4)	16 (1.0)	40 (1.0)	5 (0.7)	73 (0.9)
p-value[b]	—	<**0.001**	**0.004**	**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**
Income (US$/month)										
<1,500	15,721 (24.5)	5,607 (21.9)	1,888 (24.3)	871 (23.2)	467 (20.6)	344 (20.5)	291 (20.7)	739 (21.2)	106 (15.3)	1,318 (20.0)
1,500−2,999	21,559 (33.6)	8,480 (33.1)	2,613 (33.6)	1,286 (34.2)	702 (31.0)	551 (32.8)	499 (35.5)	1,095 (31.4)	205 (29.6)	2,129 (32.2)
3,000−3,999	12,405 (19.4)	5,135 (20.0)	1,489 (19.1)	721 (19.2)	472 (20.8)	314 (18.7)	273 (19.4)	704 (20.2)	160 (23.1)	1,429 (21.6)
≥4,000	14,403 (22.5)	6,393 (25.0)	1,792 (23.0)	881 (23.4)	624 (27.5)	469 (27.9)	341 (24.3)	946 (27.2)	222 (32.0)	1,727 (26.2)
Missing	14,491 (18.4)	5,095 (16.6)	1,464 (15.8)	686 (15.4)	427 (15.9)	250 (13.0)	158 (10.1)	648 (15.7)	65 (8.6)	1,138 (14.7)
p-value[b]	—	<**0.001**	0.721	0.208	<**0.001**	<**0.001**	**0.009**	<**0.001**	<**0.001**	<**0.001**
Job										
No	8,011 (10.5)	2,817 (9.4)	678 (7.5)	355 (8.2)	182 (6.9)	132 (7.0)	113 (7.3)	276 (6.8)	39 (5.2)	497 (6.6)
Yes	68,301 (89.5)	27,045 (90.6)	8,343 (92.5)	3,991 (91.8)	2,439 (93.1)	1,750 (93.0)	1,437 (92.7)	3,763 (93.2)	712 (94.8)	7,031 (93.4)
Missing	2,267 (2.9)	848 (2.8)	225 (2.4)	99 (2.2)	71 (2.6)	46 (2.4)	12 (0.8)	93 (2.3)	7 (0.9)	213 (2.8)
p-value[b]	—	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**	<**0.001**
Self-rated health										
Healthy	27,414 (35.3)	10,156 (33.4)	3,056 (33.4)	1,473 (33.5)	909 (34.1)	638 (33.3)	535 (34.4)	1,341 (32.8)	276 (36.5)	2,554 (33.3)
Normal	35,462 (45.7)	14,147 (46.5)	4,229 (46.2)	2,005 (45.5)	1,242 (46.6)	904 (47.2)	721 (46.3)	1,892 (46.2)	339 (44.8)	3,564 (46.4)
Unhealthy	14,778 (19.0)	6,098 (20.1)	1,877 (20.5)	925 (21.0)	517 (19.4)	372 (19.4)	301 (19.3)	860 (21.0)	141 (18.7)	1,563 (20.3)
Missing	925 (1.2)	309 (1.0)	84 (0.9)	42 (0.9)	24 (0.9)	14 (0.7)	5 (0.3)	39 (0.9)	2 (0.3)	60 (0.8)
p-value[b]	—	<**0.001**	<**0.001**	**0.002**	0.424	0.200	0.743	<**0.001**	0.788	<**0.001**

(continued on next page)

Table 2. Demographic and Socioeconomic Characteristics According to FHCA, Including FHCA by Cancer Type in Females Without Cancer (KoGES 2004–2013) (continued)

Characteristics	No FHCA (n=78,579)	Any FHCA[a] (n=30,710)	Stomach (n=9,246)	Liver (n=4,445)	Colorectum (n=2,692)	Breast (n=1,928)	Cervix (n=1,562)	Lung (n=4,132)	Thyroid (n=758)	Others (n=7,741)
Menopause										
No	31,904 (41.0)	12,329 (40.4)	3,494 (38.0)	1,711 (38.8)	1,068 (39.9)	754 (39.4)	601 (38.5)	1,720 (41.9)	353 (46.8)	3,209 (41.7)
Yes	45,905 (59.0)	18,159 (59.6)	5,693 (62.0)	2,703 (61.2)	1,606 (60.1)	1,162 (60.6)	959 (61.5)	2,388 (58.1)	401 (53.2)	4,492 (58.3)
Missing	770 (1.0)	222 (0.7)	59 (0.6)	31 (0.7)	18 (0.7)	12 (0.6)	2 (0.1)	24 (0.6)	4 (0.5)	40 (0.5)
p-value[b]	—	0.089	**<0.001**	**0.003**	0.272	0.147	**0.049**	0.271	**0.001**	0.256
Chronic disease[c]										
No	40,018 (50.9)	14,905 (48.6)	4,317 (46.7)	2,112 (47.5)	1,294 (48.1)	949 (49.2)	759 (48.6)	2,042 (49.4)	359 (47.4)	3,790 (49.0)
Yes	38,528 (49.1)	15,794 (51.4)	4,926 (53.3)	2,332 (52.5)	1,398 (51.9)	979 (50.8)	803 (51.4)	2,090 (50.6)	399 (52.6)	3,947 (51.0)
Missing	33 (0.0)	11 (0.0)	3 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (0.1)
p-value[b]	—	**<0.001**	**<0.001**	**<0.001**	**0.003**	0.134	0.065	0.055	**0.049**	**0.001**

Note: Values are *n* (%) unless otherwise indicated. Boldface indicates statistical significance (*p*<0.05).
[a]Any FHCA defined as those who had any type of family history of cancer.
[b]*p*-values were determined using χ^2 test, excluding missing data. Proportions of covariates were compared between those who had FHCA or each cancer type of FHCA to those without any FHCA.
[c]Chronic diseases included the diagnosis of any kind of chronic diseases by a physician in the past.
FHCA, family history of cancer; KoGES, Korean Genome and Epidemiology Study.

such as less smoking and being less obese. Although the chronologic order between behavioral change and FHCA experience is unknown, former smoking and alcohol consumption rates in people with and without an FHCA were used as surrogate indicators of behavioral changes. In male participants, former smoking rates were higher in those with an FHCA compared to those without an FHCA (42.0% and 39.0%, respectively). In females, former smoking rates were similar regardless of FHCA (1.2% and 1.5%, respectively). The former alcohol consumption rate was not different according to FHCA in both males and females (7.0% and 7.0% in males, 2.0% and 2.4% in females; data not shown). Previous studies comparing health behaviors by FHCA did not analyze separately by sex, which might be a possible cause of the nonsignificant association.[14,24] One study found that having FHCA was associated with a higher intention to quit smoking, even though personal history of cancer did not affect smoking cessation efforts. This suggests that people with FHCA could be a target population for health intervention programs, and increased perception of cancer risk may be an intermediate result.[27]

Several previous studies have shown that, in the general population, females have better health behaviors than males.[27–29] In the current study population, most of the unhealthy behaviors, including current smoking, drinking alcohol, and obesity, showed lower prevalence in females than in males, irrespective of an FHCA and types of FHCA. Although several studies have shown that women are more willing to actively search health-related information[30] and change their health behaviors,[31] females with FHCA showed worse health behaviors than those without FHCA in the current study. One possible explanation could be the "choice overload hypothesis," which means that too many choices may cause indecisiveness.[32] Females seek health-related information more actively than males, especially when they have known risk factors[33] and, therefore, females could be overwhelmed by the possible choices of lifestyle modifications. Another possible explanation could be that as the health behaviors of females are generally better than those of males, females who present unhealthy behaviors may not have much improvement potential in changing their behaviors, and those who have an FHCA may have higher behavioral risks aggregated within the family. Conversely, physicians' recommendations may be important for improving health behaviors, yet recommendations from clinicians for women with FHCA may focus more on cancer screening than on changing lifestyle behaviors.[26] A previous study also showed that women with a strong FHCA of the breast were more likely to uptake medical care provided by physicians, such as screening or medication, rather than engage in

Table 3. Comparison of Health Behaviors According to FHCA, Including FHCA by Cancer Type in Males Without Cancer (KoGES 2004–2013)

Characteristics	No FHCA (*n*=42,912)	Any FHCA (*n*=14,518)	Stomach (*n*=4,716)	Liver (*n*=2,161)	Colorectum (*n*=1,353)	Breast (*n*=586)	Cervix (*n*=487)	Lung (*n*=2,074)	Thyroid (*n*=229)	Others (*n*=3,362)
Current smoking										
Yes, *n* (%)	13,835 (32.2)	4,575 (31.3)	1,364 (28.9)	681 (31.5)	399 (29.5)	205 (35.0)	170 (34.9)	680 (32.8)	94 (41.1)	1,148 (31.4)
AOR[b] (95% CI)	ref[a]	**0.95 (0.91, 0.99)**	**0.87 (0.81, 0.93)**	0.93 (0.84, 1.02)	**0.88 (0.78, 0.99)**	1.06 (0.89, 1.27)	1.09 (0.90, 1.33)	1.00 (0.91, 1.10)	1.31 (0.99, 1.72)	0.97 (0.90, 1.04)
p-value	—	**0.016**	**<0.001**	0.124	**0.040**	0.498	0.369	0.981	0.056	0.372
Current alcohol drinking										
Yes, *n* (%)	31,109 (72.5)	10,694 (73.2)	3,417 (72.5)	1,613 (74.6)	974 (72.0)	431 (73.6)	374 (76.8)	1,544 (74.5)	176 (76.9)	2,674 (73.0)
AOR[b] (95% CI)	ref[a]	1.00 (0.96, 1.05)	1.01 (0.94, 1.08)	1.07 (0.97, 1.19)	0.95 (0.84, 1.07)	0.97 (0.80, 1.18)	1.17 (0.94, 1.45)	1.02 (0.92, 1.13)	1.07 (0.78, 1.46)	0.97 (0.90, 1.05)
p-value	—	0.937	0.770	0.184	0.375	0.761	0.169	0.677	0.696	0.509
Physical inactivity										
Yes, *n* (%)	18,848 (43.9)	6,174 (42.3)	1,985 (42.1)	925 (42.8)	580 (42.9)	272 (46.4)	213 (43.7)	853 (41.1)	121 (52.8)	1,500 (41.0)
AOR[b] (95% CI)	ref[a]	0.98 (0.94, 1.02)	0.97 (0.91, 1.04)	0.99 (0.90, 1.08)	1.05 (0.94, 1.18)	1.17 (0.99, 1.39)	1.09 (0.91, 1.32)	0.93 (0.84, 1.02)	**1.54 (1.18, 2.02)**	0.95 (0.89, 1.02)
p-value	—	0.323	0.401	0.802	0.414	0.068	0.351	0.107	**0.002**	0.162
Obesity										
Yes, *n* (%)	17,197 (40.1)	5,762 (39.4)	1,815 (38.5)	878 (40.6)	513 (38.0)	232 (39.6)	196 (40.3)	843 (40.7)	106 (46.3)	1,496 (40.9)
AOR[b] (95% CI)	ref[a]	**0.95 (0.92, 0.99)**	**0.92 (0.87, 0.99)**	0.99 (0.90, 1.09)	0.91 (0.81, 1.02)	0.95 (0.79, 1.13)	1.00 (0.82, 1.21)	0.96 (0.87, 1.06)	1.25 (0.95, 1.66)	1.01 (0.94, 1.09)
p-value	—	**0.025**	**0.020**	0.800	0.109	0.552	0.968	0.390	0.116	0.800
Abdominal obesity										
Yes, *n* (%)	19,494 (45.4)	6,461 (44.2)	2,103 (44.6)	985 (45.6)	572 (42.3)	258 (44.0)	208 (42.7)	967 (46.6)	103 (45.0)	1,614 (44.1)
AOR[b] (95% CI)	ref[a]	0.98 (0.94, 1.03)	0.96 (0.90, 1.03)	1.02 (0.93, 1.12)	0.92 (0.82, 1.04)	1.01 (0.84, 1.20)	0.91 (0.75, 1.10)	**1.11 (1.01, 1.22)**	0.99 (0.75, 1.31)	0.97 (0.90, 1.04)
p-value	—	0.422	0.251	0.682	0.188	0.937	0.328	**0.036**	0.968	0.348

Note: Boldface indicates statistical significance (*p*<0.05) compared to the reference groups.
[a]Reference group was those with no cancer diagnosis by a physician and also with no FHCA at the time of survey.
[b]Multivariate logistic regression was adjusted for age, education, household income, employment condition, chronic disease, and self-rated health.
FHCA, family history of cancer; KoGES, Korean Genome and Epidemiology Study.

Table 4. Comparison of Health Behaviors According to FHCA, Including FHCA by Cancer Type in Females Without Cancer (KoGES 2004–2013)

Characteristics	No FHCA (*n*=78,579)	Any FHCA (*n*=30,710)	Stomach (*n*=9,246)	Liver (*n*=4,445)	Colorectum (*n*=2,692)	Breast (*n*=1,928)	Cervix (*n*=1,562)	Lung (*n*=4,132)	Thyroid (*n*=758)	Others (*n*=7,741)
Current smoking										
Yes, *n* (%)	1,811 (2.3)	783 (2.6)	235 (2.5)	121 (2.7)	71 (2.6)	60 (3.1)	45 (2.9)	114 (2.8)	13 (1.7)	194 (2.5)
AOR[b] (95% CI)	ref[a]	**1.13 (1.03, 1.23)**	1.13 (0.98, 1.30)	1.21 (1.00, 1.46)	1.19 (0.93, 1.52)	**1.40 (1.08, 1.83)**	1.31 (0.96, 1.78)	**1.23 (1.01, 1.49)**	0.74 (0.42, 1.29)	1.11 (0.95, 1.29)
p-value	—	**0.007**	0.088	0.052	0.161	**0.012**	0.086	**0.039**	0.287	0.1869
Current alcohol drinking										
Yes, *n* (%)	24,567 (31.3)	9,712 (31.6)	2,806 (30.4)	1,392 (31.3)	899 (33.4)	626 (32.5)	516 (33.0)	1,322 (32.0)	234 (30.9)	2,488 (32.1)
AOR[b] (95% CI)	ref[a]	1.01 (0.98, 1.04)	0.97 (0.92, 1.02)	1.01 (0.94, 1.08)	**1.12 (1.02, 1.21)**	1.05 (0.95, 1.17)	1.09 (0.97, 1.21)	1.01 (0.94, 1.08)	0.91 (0.78, 1.07)	1.02 (0.97, 1.07)
p-value	—	0.436	0.206	0.781	**0.012**	0.303	0.146	0.882	0.266	0.473
Physical inactivity										
Yes, *n* (%)	39,291 (50.0)	14,846 (48.3)	4,498 (48.7)	2,133 (48.0)	1,264 (47.0)	901 (46.7)	744 (47.6)	2,018 (48.8)	372 (49.1)	3,666 (47.4)
AOR[b] (95% CI)	ref[a]	**0.96 (0.93, 0.98)**	**0.96 (0.92, 1.00)**	**0.94 (0.88, 1.00)**	0.93 (0.86, 1.01)	**0.91 (0.83, 1.00)**	0.94 (0.85, 1.04)	0.97 (0.91, 1.03)	1.03 (0.89, 1.19)	**0.93 (0.89, 0.97)**
p-value	—	**0.001**	**0.047**	**0.033**	0.065	**0.039**	0.214	0.270	0.690	**0.003**
Obesity										
Yes, *n* (%)	23,182 (29.5)	8,754 (28.5)	2,692 (29.1)	1,288 (29.0)	729 (27.1)	574 (29.8)	479 (30.7)	1,179 (28.5)	190 (25.1)	2,140 (27.7)
AOR[b] (95% CI)	ref[a]	0.99 (0.96, 1.03)	0.97 (0.92, 1.02)	1.00 (0.93, 1.07)	0.95 (0.86, 1.04)	**1.12 (1.01, 1.25)**	1.12 (0.999, 1.257)	1.01 (0.94, 1.08)	0.93 (0.78, 1.11)	1.00 (0.95, 1.06)
p-value	—	0.717	0.180	0.995	0.229	**0.032**	0.053	0.853	0.416	0.921
Abdominal obesity										
Yes, *n* (%)	56,852 (72.4)	21,905 (71.3)	6,795 (73.5)	3,187 (71.7)	1,925 (71.5)	1,350 (70.0)	1,128 (72.2)	2,949 (71.4)	519 (68.5)	5,392 (69.7)
AOR[b] (95% CI)	ref[a]	0.97 (0.94, 1.01)	1.02 (0.97, 1.08)	0.95 (0.88, 1.02)	1.02 (0.92, 1.11)	0.92 (0.83, 1.03)	0.97 (0.86, 1.10)	0.98 (0.91, 1.06)	1.00 (0.85, 1.19)	**0.94 (0.89, 0.99)**
p-value	—	0.109	0.503	0.135	0.758	0.144	0.630	0.589	0.975	**0.030**

Note: Boldface indicates statistical significance (*p*<0.05) compared to the reference groups.
[a]Reference group was those with no cancer diagnosis by a physician and also with no FHCA at the time of survey.
[b]Multivariate logistic regression was adjusted for age, education, household income, employment condition, chronic disease, and self-rated health.
FHCA, family history of cancer; KoGES, Korean Genome and Epidemiology Study.

lifestyle modifications.[17] This is partly caused by the fact that current guidelines for management of high-risk individuals primarily include medical options, while somewhat neglecting lifestyle modifications.[34,35] Studies have shown that people with an FHCA of the breast or colorectum were more likely to comply with healthcare providers' recommendations to improve health behaviors, but the absolute number of people who received those recommendations was low.[36,37] In the current study population, females with an FHCA showed a higher education level than those without an FHCA. Smoking rate is known to be higher in more educated women than in those with less education.[38] Men are known to consume more cigarettes than women, but women have greater difficulty in quitting smoking.[39,40] In addition, a previous study reported that women who recently experienced FHCA did improve their behaviors related to physical activity, diet, and alcohol consumption, but did not quit smoking.[41] Females' perception of cancer risk because of FHCA was greater than that for males, but the perceived causes of cancer regarding smoking and alcohol drinking were much lower than that for males.[42] Also, Koreans are known to have strong bonds among family members, and a close familial relationship is regarded as more important in older females. However, a sufficiently large sample size might have resulted in statistically significant differences, despite limited clinical significance in the current study, such as the small, albeit statistically significant, difference in female smoking rates between those with no FHCA and those with any FHCA (2.3% vs 2.6%).

When stratified by cancer type of FHCA, males with an FHCA of the thyroid showed different health behavior patterns, which was worse than those with other types of FHCA. Thyroid cancer has been the most common cancer in Korea since 2008, and a large portion of Korean thyroid cancers is suspected to be from overdiagnosis,[43] suggesting possibly different patient characteristics compared with other types of cancer. In addition, males with an FHCA of the thyroid showed different demographic and socioeconomic characteristics compared with those with other types of FHCA. Although these characteristics were adjusted for in multivariate analysis, overdiagnosed thyroid cancers in family members may still result in different health behavior patterns for those with an FHCA of the thyroid, compared with those with other types of FHCA.

Limitations

Some limitations of this study should be considered. First, as the participants of HEXA were health examinees residing in metropolitan areas or major cities, generalization to the entire Korean population may be limited. In addition,

because this study only includes participants aged more than 40 years, the authors were unable to identify FHCA's effect on health behaviors in the younger population. Second, information regarding FHCA was collected from a self-reported questionnaire. The structure of Korean families has become more nuclear, and thus, exact FHCA status may be inaccurate. However, previous studies have shown that an individual's reported FHCA, especially in the case of first-degree relatives, is highly reliable.[44,45] Additionally, the Korean government offers the National Cancer Screening Program, which provides free cancer screening or a 10% co-payment. Hence, many Koreans are well informed not only of their own cancer status but also of other family members, and minimal information bias is expected. Third, this study is unable to demonstrate any cause and effect relationships between FHCA and health behaviors, as HEXA is cross-sectional data and health behaviors before and after FHCA were not available. Fourth, when health behaviors were compared by cancer type, nine groups were compared simultaneously. When a set of statistical inferences are tested simultaneously, multiple-testing correction may be needed, which was not considered here. However, not adjusting for multiple hypothesis testing has generally been the case in studies similar to this study,[26,46,47] proposing possible application of results without such considerations. Fifth, the adjusted covariates may not all be confounders but rather mediators, or simply just associated with either the outcome variable or other covariates. Including all covariates in multivariate analysis may result in over-adjustment. Thus, sensitivity analyses were performed, including and excluding covariates that did not meet the definition of confounding in the multivariate model, but resulting changes were minimal.

CONCLUSIONS

The current study suggests that modifiable health behaviors may be associated with an FHCA, and that this association may differ by sex. In general, males with an FHCA showed better health behaviors, whereas females with an FHCA showed worse.

Health behaviors are important modifiable risk factors of cancer, and may be associated with an FHCA. To identify whether health behaviors of those with an FHCA have changed because of the effect of FHCA, or whether an FHCA did not influence such health behaviors, further prospective research is needed.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre. 2018.10.017.

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