RESEARCH COMMUNICATION

Current Status of Thyroid Cancer Screening in Korea: Results From a Nationwide Interview Survey

Mi Ah Han[1], Kui Son Choi[2], Hoo-Yeon Lee[2,3], Yeonju Kim[2], Jae Kwan Jun[2*], Eun-Cheol Park[4]

Abstract

Objective: Since 2000, thyroid cancer has been increasing most rapidly in Korea. Although the cause of the increase is not clear, thyroid cancer screening could be identified as one of its causes. The purpose of this study was to examine the screening rate of thyroid cancer and its related factors using nationwide data. Methods: The study population was derived from the 2009 Korea National Cancer Screening Survey (KNCSS), an annual cross-sectional survey that uses a nationally representative random sampling to investigate cancer screening rates. A total of 2,000 Korean adults participated. The screening method of thyroid cancer was restricted to thyroid ultrasonography. Logistic regression was used to identify factors associated with undergoing thyroid cancer screening. Results: Of all participants, 13.2% (8.4% men and 16.4% women) underwent thyroid ultrasonography. On multiple analyses, age, residence, belief in cancer screening, regular health check-ups, smoking, alcohol drinking, and exercise were associated with thyroid cancer screening. Subjects who underwent other cancer screening, such as gastric, colorectal, breast, or cervical, were more likely to have had a thyroid ultrasonogram that those who did not get screened. Conclusions: We presented the number and characteristics of examinees utilized ultrasonography as a thyroid screening tool in Korea. Although these results revealed that cancer screening might play a major role in the increase of thyroid cancer incidence, further research is needed to determine causes of the rapidly increasing incidence of thyroid cancer in Korea.

Keywords: Screening - early detection of cancer - thyroid gland - participation factors - Korea

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Introduction

While the incidence of many head and neck cancers in Korea is decreasing, the incidence of thyroid cancer is rapidly increasing. The age-standardized incidence rate of thyroid cancer in 2007 was 32.8 per 100,000 (9.9 per 100,000 men and 55.6 per 100,000 women), and was the second most common cancer (sixth most common cancer in men and most common cancer in women). The average annual percentage change for 1999-2007 was 25.2% (23.7% in men and 25.7% in women), which shows that thyroid cancer is the most rapidly increasing cancer in Korea. Using database from Globocan 2008, the thyroid incidence rate of Korea is most high in the world (Figure 1). The incidence rate was about 2.1 times higher than those of other countries in men and about 1.3 times higher than those of other countries in women (International Agency for Researchon Cancer). Despite an increasing incidence, mortality from thyroid cancer has remained stable. Thyroid cancer-specific mortality was 0.6 deaths per 100,000 in 2000 and 0.6 per 100,000 in 2007. In addition, the five-year survival rate of thyroid cancer was high and has been continuously increasing (94.2% from 1993 to 1995 and 98.8% from 2003 to 2007) (Jung et al., 2010).

An increase in thyroid cancer incidence has been observed not only in Korea but also in other many parts of the world (Akslen et al., 1993; Colonna et al., 2002; dos Santos Silva and Swerdlow, 1993; Kilfoy et al., 2009;

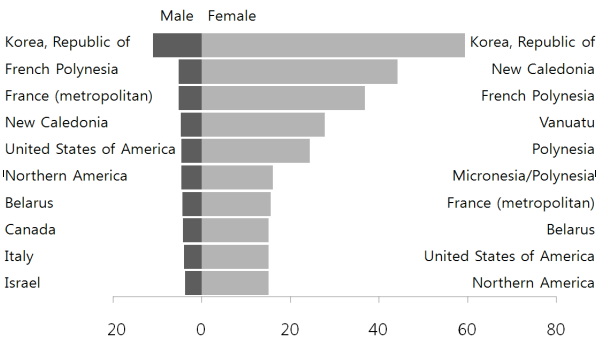

Figure 1. Age-standardized Incidence Rates of Thyroid Cancer per 100,000 of the Top 10 Countries

[1]Department of Preventive Medicine, College of Medicine, Chosun University, Gwangju, [2]National Cancer Control Institute, National Cancer Center, Goyang, [3]Department of Social Medicine, College of Medicine, Dankook University, Cheonan, [4]Department of Preventive Medicine & Institute of Health Service Research, College of Medicine, Yonsei University, Seoul, Korea *For correspondence: jkjun@ncc.re.kr

Montanaro et al., 2006; Pettersson et al., 1991). A recent study compared the thyroid cancer incidence from 1973 to 2002 in 19 populations in the Americas, Asia, Europe, and Oceania using data from Cancer Incidence in Five Continents. Thyroid cancer rates increased from 1973 to 1977 and from 1998 to 2002 for most populations. The average increase was 48.0% in males and 66.7% in females. The age-adjusted international thyroid cancer incidence rates from 1998 to 2002 varied by five-fold for males and nearly ten-fold for females by geographic region. Considerable variation in thyroid cancer incidence was present for most continents (Kilfoy et al., 2009). The increase did not appear to be restricted to a particular region of the world or by underlying thyroid cancer rates. Several explanations have been suggested for the increasing incidence of thyroid cancer. First, it might be a true increase in the incidence of thyroid cancer, which has been observed in the incidence of small, subclinical papillary thyroid carcinoma (Davies and Welch, 2006; Liu et al., 2001). Second, the rising number of cases is apparent only because of changes in medical practice such as increased use of ultrasonography and fine-needle aspiration biopsy (Colonna et al., 2002; Leenhardt et al., 2004). Third, the increase might be attributed to greater exposure to risk factors of thyroid cancer, particularly low-dose radiation from diagnostic X-rays (Berrington de Gonzalez and Darby, 2004; Memon et al., 2010).

Although the reason for the increased incidence may be a combination of these explanations (Chen et al., 2009; Enewold et al., 2009), up to date, more intensive diagnostic activities were the most powerful explanation.

In Korea, the National Cancer Screening Program (NCSP), which has been in place since 1999, provides free screening services for gastric, liver, colorectal, breast, and cervical cancers (Yoo, 2008). In the case of thyroid cancer, however, organized cancer screening and screening guidelines do not exist. Opportunistic screening performed when doctors are asked for or offer a check-up or test could play a major role in the detection of thyroid cancer in Korea. To determine whether the identified patterns suggest a real or apparent change in incidence based on increased screening or diagnostic scrutiny, it is essential to explore the number and behavior related to thyroid cancer screening in Korean population. Therefore, the purpose of the present study was to investigate the screening rate of thyroid cancer and its related factors.

Materials and Methods

Subjects

This study was based on the 2009 Korean National Cancer Screening Survey, an annual cross-sectional survey that uses a nationally representative random sampling to investigate cancer screening rates (including opportunistic as well as organized). A total of 4,484 subjects, including men 40 years of age or older and women 30 years of age or older, were selected based on the 2008 Resident Registration Population data using stratified, multistage, random sampling according to geographic area, age, and gender. The Resident Registration Population is published annually by the Korea National Statistical Office after data are gathered from residents of the registration population every December 31. The publication provides data about changes in population size and structure, and identifies population changes by administrative district (KoreaNationalStatisticalOffice, 2008).

For the current study, investigators from a professional research agency conducted face-to-face interviews in the participants' homes for 14 days from August 19 to September 11, 2009. Study recruitment involved door-to-door contact. We made at least three attempts to contact a resident in each dwelling. Study eligibility was assessed by face-to-face interviews. Eligible participants (without previous cancer diagnosis) were asked about their experiences of screening for common cancers; health behaviors, such as smoking, physical activity, alcohol use, and health status; and socioeconomic and demographic information. Among 4,484 potential study candidates, 3,583 (79.9%) were eligible. Of these, 1,354 (37.8%) refused, and 170 (4.7%) did not complete the interview. Thus, interviews were completed by 2,059 subjects (2,059 (57.5%) of 3,583 eligible candidates) with no previous cancer diagnosis. We excluded some participants due to missing information (59 subjects did not report a cancer screening experience). Finally, 2,000 participants were selected as study subjects. We obtained informed consent from all study participants. This study was approved by the institutional review board of the National Cancer Centre, Korea (NCCNCS-08-129).

Measures

Subjects were asked about lifetime screening rates for gastric, liver, colorectal, breast, cervical, and thyroid cancer. Common screening tests for thyroid cancer include neck palpation and ultasonography to detect nodules. Diagnostic procedures such as scintigraphy and fine-needle aspiration with cytology are generally reserved for persons with evidence of nodular disease or goiter. In this study, the screening method of thyroid cancer was restricted to thyroid ultrasonography and was described in lay terms. Screening experience of thyroid cancer was measured by the following question: "Ultrasonographic evaluation of the front neck is performed to find a thyroid nodule or mass. Did you get screened for thyroid cancer?" To raise understanding of the question, we also provided participants for a picture with performing ultrasonography.

Sex, age, residence (metropolitan, urban, rural), years of education (≤11, 12-15, ≥16), equivalized household income, marital status (with or without spouse), and job (managerial and professional, service and sales, routine and manual, housewife or unemployed) were evaluated. Equivalized household income is a measure that adjusts the total monthly income of the household to account for the number of people in the household. The equivalized household incomes for each household were ranked in ascending order and divided into quartiles, with households having the lowest earnings in the first quartile. The income quartiles were as follows: up to $560; over $560 to $790; over $790 to $1,080; and over $1,080 (US $1 is roughly equivalent to 1,000 won).

Subjects were asked to rate their health as very good,

good, fair, poor, or very poor. The results were then categorized into very good, good, and fair/poor (fair, poor, and very poor). Questions about health insurance coverage and health check-ups or usual sources of care were considered a proxy for ability to afford, have access to, and use care. Therefore, we measured health insurance and private health insurance status by asking participants whether they have insurance (yes or no). We also measured the history of health check-ups by asking whether participants had regular health check-ups even when they were not sick (yes or no).

To measure belief in cancer screening, participants were asked for their opinion on whether cancer screening is helpful for early detection and treatment of cancer. The response was measured on a four-point scale (1 = strongly disagree, 4 = strongly agree).

With regard to health-related behaviors, we measured smoking, alcohol drinking, and regular exercise. For smoking, we asked subjects if they had smoked in their lifetime (yes or no). For alcohol drinking, we asked subjects if they had consumed alcohol within the past 30 days and categorized them into three groups: none, <1 per month, or ≥1 per month. Exercise was measured by asking: "During the past week, other than your regular job, did you do vigorous physical activity (for at least 10 minutes), such as running, mountain climbing, soccer, basketball, or any other activity that causes a substantial increase in breathing or heart rate (yes or no)?"

Statistical analyses

Descriptive statistics were computed for all demographic, socioeconomic, health behavior, and dependent variables, including the frequency distribution for each categorical variable. All descriptive statistics were presented as frequencies and percentages for categorical variables, and as means and standard deviations for continuous variables. The association between subjects' characteristics and thyroid cancer screening behaviors were examined by multiple logistic regressions after adjustment of other variables. All reported odds ratios were considered significant at $p < 0.05$. Data were analyzed using SAS 9.1 (SAS Institute, Cary, NC).

Results

Of the 2,000 survey subjects, approximately 59.1% were women and 40.9% were men. Forty one percent of them undertook health check-ups regularly. The impact of cancer screening on their health was perceived to be more helpful. Seventy four percent of them had private health insurance to supplement the public health insurance program.

Of all participants, 13.2% had received a thyroid ultrasonogram. Of 819 men aged 40 years and older, 69 (8.4%) had undergone thyroid ultrasonography. Of 1,181 women aged 30 years and older, 194 (16.4%) had undergone thyroid ultrasonography. Screening rates by age group were highest in men aged 70 and older and in women aged 50-59 (Figure 2).

Table 1 shows the adjusted odds ratio and 95% confidence interval for thyroid cancer screening according

Table 1. Thyroid Cancer Screening Rate (%) by Subject Characteristics, 2009 Korea National Cancer Screening Survey

	Men (N=819)		Women (N=1,181)	
	Rate	Adjusted OR (95% CI)*	Rate	Adjusted OR (95% CI)*
Age				
30-39	-	-	11.5	0.91(0.55-1.48)
40-49	5.8	1.00	13.8	1.00
50-59	10.3	1.93(0.98-3.83)	26.3	2.22(1.41-3.51)
60+	10.8	2.55(1.11-5.88)	17.0	2.02(1.09-3.72)
Residence				
Metropolitan	5.1	1.00	16.4	1.00
Urban	10.3	2.23(1.19-4.20)	15.7	0.96(0.67-1.35)
Rural	15.5	3.58(1.53-8.39)	20.2	1.35(0.76-2.39)
Education, years				
≤11	11.3	1.00	15.8	1.00
12-15	6.7	0.69(0.27-1.73)	17.0	1.42(0.82-2.47)
≥16	11.2	0.88(0.29-2.68)	15.7	1.71(0.84-3.46)
Equivalised household income† quartile				
Lowest	7.2	1.00	15.1	1.00
2nd	6.4	0.73(0.30-1.74)	16.0	0.95(0.57-1.58)
3rd	8.4	0.91(0.41-2.04)	17.8	1.03(0.61-1.72)
Highest	11.3	1.25(0.57-2.75)	16.6	0.75(0.43-1.29)
Marital status				
Single	7.3	1.00	10.6	1.00
Married	8.5	1.19(0.26-5.49)	17.2	1.70(0.91-3.17)
Job				
Managerial & professional	14.0	1.98(0.67-5.88)	15.4	1.04(0.56-1.93)
Service	5.4	0.95(0.34-2.67)	16.3	1.00(0.68-1.47)
Manual	9.2	1.89(0.69-5.23)	16.5	1.03(0.52-2.03)
Housewife or unemployed	7.5	1.00	16.8	1.00
Self-rated health				
Very good	6.7	1.00	12.9	1.00
Good	8.3	1.24(0.52-2.97)	17.0	1.26(0.74-2.15)
Fair/poor	9.4	1.52(0.62-3.74)	17.0	1.25(0.72-2.19)
Belief in cancer screening‡		0.86(0.53-1.38)		1.55(1.14-2.11)
Regular health check-up				
No	3.8	1.00	11.7	1.00
Yes	14.6	3.72(2.01-6.89)	23.6	2.04(1.46-2.85)
Health insurance				
MAP	5.7	1.00	11.8	1.00
NHI	8.6	1.46(0.28-7.52)	16.7	1.30(0.50-3.35)
Having private (supplementary) health insurance				
No	6.3	1.00	13.3	1.00
Yes	9.5	1.95(0.97-3.91)	17.3	1.27(0.77-2.09)
Smoking				
Never	7.3	1.00	16.2	1.00
Ever	8.8	1.55(0.77-3.10)	21.4	2.4(1.04-5.56)
Alcohol drinking (frequency/month)				
No	11.2	1.00	17.9	1.00
<1	8.3	0.65(0.22-1.94)	18.4	1.11(0.71-1.73)
≥1	7.6	0.46(0.24-0.89)	12.8	0.68(0.46-1.00)
Vigorous exercise				
No	5.9	1.00	14.3	1.00
Yes	11.2	1.88(1.06-3.33)	20.4	1.27(0.90-1.80)

CI, confidence interval; *Adjusted for all variables in the table; †Total monthly household income adjusted for the number of people in the household; ‡ Subjects' opinion on whether cancer screening is helpful (1=strongly disagree, 4= strongly agree); MAP, Medical Aid Program; NHI, National Health Insurance

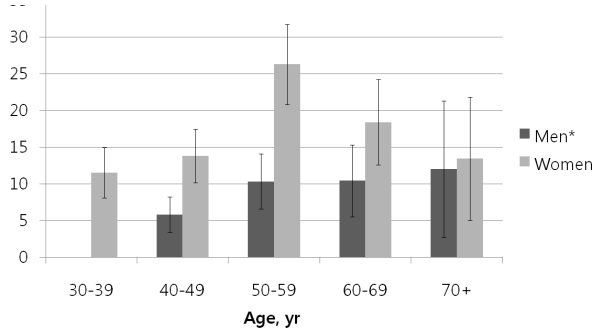

Figure 2. Thyroid Cancer Screening Rate by Age Group. *The screening rate for men aged 30-39 was not calculated. Because they were not included in 2009 Korea National Cancer Screening Survey.

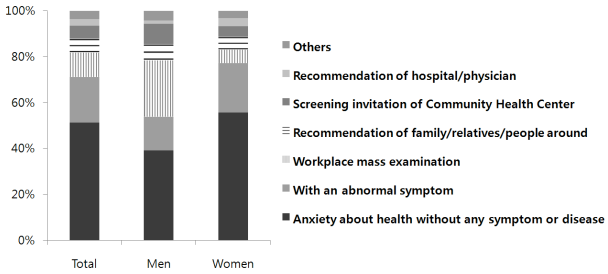

Figure 3. Stated Reasons for Participation in Thyroid Cancer Screening

to the subjects' characteristics. For men, older subjects were more likely to have undergone a thyroid ultrasonogram than those aged 40-49 years; urban and rural residents were more likely to have undergone a thyroid ultrasonogram than metropolitan residents; subjects who had undergone regular health check-ups were more likely to have had a thyroid ultrasonogram than those who had not; and nondrinkers and regular exercisers were more likely to have had an ultrasonogram than subjects who drank more than once a month and nonexercisers, respectively. For women, older subjects were more likely to have undergone a thyroid ultrasonogram than those aged 40-49 years; subjects manifesting high perceived benefits were more likely to have engaged in thyroid cancer screening than subjects with lower perceived benefits; subjects who had undergone regular health check-ups were more likely to have had a thyroid ultrasonogram than those who had not; and subjects who had smoked in their lifetime were more likely to have had a thyroid ultrasonogram than nonsmokers.

Table 2 shows the screening rate by other types of cancer screenings. In both men and women, subjects who had undergone other cancer screenings, such as gastric, colorectal, breast, or cervical, were more likely to have had a thyroid ultrasonogram than those who had not been screened.

Those who had had a thyroid ultrasonogram (69 men and 194 women) were asked to describe their reasons for getting screened. "Anxiety about health without symptoms or disease" was the most commonly stated reason in both men and women (39.1% and 55.7%, respectively). In the case of men, 24.6% reported "workplace mass examination" was the second most-stated reason. In the case of women, 21.6% reported "an abnormal symptom" as the second most-stated reason. Furthermore, 5.7% of subjects reported a reason for uptake as "screening invitation by the Community Health Center" (Figure 3).

Table 2. Thyroid Cancer Screening Rate by Other Cancer Screening, 2009 Korea National Cancer Screening Survey

Cancer screened	Men (N=819) Rate	Men (N=819) Adjusted OR (95% CI)*	Women (N=1,181) Rate	Women (N=1,181) Adjusted OR (95% CI)*
Stomach				
No	1.3	1.00	5.0	1.00
Yes	13.0	10.6(3.80-29.6)	24.5	5.87(3.23-10.6)
Colorectal				
No	2.9	1.00	10.4	1.00
Yes	19.1	7.63(3.33-17.5)	33.6	4.50(2.75-7.37)
Breast				
No			3.9	1.00
Yes			22.0	6.30(3.55-11.2)
Cervix				
No			3.2	1.00
Yes			20.6	7.24(3.63-14.4)

CI, confidence interval; *Adjusted for age and equivalised household income

Discussion

This study is the first to evaluate thyroid cancer screening using nationwide sampling in Korea, which provides us with a more comprehensive picture of the screening rate and its related factors in Korea. In this study, the screening rate of thyroid cancer in Korea was 13.2% of the total (8.4% of men and 16.4% of women).

USPSTF does not recommend thyroid cancer screening for asymptomatic people by means of neck palpation or ultrasonography. They concluded that insufficient evidence exists for screening of asymptomatic persons with a history of external upper body irradiation in infancy or childhood (U.S.PreventiveServicesTaskForce., 1996). Other organizations, such as the American Cancer Society (Smith et al., 2008) and the Canadian Task Force on the Periodic Health Examination (CanadianTaskForceonthePeriodicHealthExamination., 1994), also do not recommend screening. In Korea, a national guideline for thyroid cancer screening has been established and is under review by a task force on thyroid cancer screening.

There are possible explanations about uptake for thyroid cancer screening which is not recommended. First, the screening method for thyroid cancer is relatively easy to perform. It does not require preparation, such as bowel preparation for gastric cancer. Also, there are no inconveniences, such as collecting feces for colorectal cancer (Gorin, 2005). Second, the psychological barrier is lower than those of other cancer screening methods. There is no feeling of shyness or shame, as in the Pap smear for cervical cancer (Kim et al., 2004). There is also no pain, as in the mammogram for breast cancer (Jackson et al., 1988). Third, thyroid cancer screening is conducted along with other examinations. Neck palpation and thyroid ultrasonography, the screening methods of choice for

thyroid cancer, are relatively easy to perform. In particular, overuse of thyroid ultrasonogram is likely to occur because it is relatively inexpensive, accessible, noninvasive, and accurate in describing thyroid morphology (Deandrea et al., 2002). Sometimes, thyroid ultrasonography is conducted along with ultrasonography for other cancers, such as breast cancer, whether patients in Korea request this or not (Im, 2002). Finally, there may have been an increase in awareness and participation with regard to screening. The participation rates of the NCSP have been continuously increasing for these five cancers since 1999. In this study, subjects who participated in other cancer screenings were more likely to undergo thyroid cancer screening.

The thyroid cancer screening rate was highest in subjects aged 50-59 and lowest in subjects in their 30s. The age-specific incidence of thyroid cancer in Korea was quite different from that of others. Generally, cancer incidence increased with age. For example, the incidence of gastric cancer increased with age (gastric cancer incidence per 100,000 persons was 41.0 for those in their forties, 96.3 for those their fifties, and 197.9 for those in their sixties). The gastric cancer incidence was highest in subjects 70 years of age or older (282.0 per 100,000 persons). Also, the incidences of other cancers, such as colorectal, liver, and cervical, increased with age. However, thyroid cancer incidence increased with age until age 50 to 54; the incidence then decreased with age(Jung et al., 2010). The difference in age-specific thyroid cancer incidence, compared to other cancer incidences, may be due to cancer screening. The peak thyroid cancer screening rate was consistent with the peak incidence in this study. Thus, it may be inferred that thyroid cancer screening led to the high incidence. Due to the cross-sectional nature of this study, it is difficult to exclude the possibility that the higher incidence in certain age groups can affect the screening rate in that group.

In this study, subjects manifesting relatively high perceived benefits were more likely to engage in thyroid cancer screening than subjects with lower perceived benefits. The term 'perceived benefits' refers to the idea that a course of action will produce positive outcomes, an idea that is common to many health behavior theories, such as the Health Belief model (Becker and Maiman, 1975; Rosenstock et al., 1988; Strecher and Rosenstock). This result is consistent with findings from other studies. In 2002, James et al. reported that perceived benefits were significantly negative, as related to cancer screening.

Consistent with previous cancer control behaviors among Koreans (Hee-Soon et al.???; Sung et al., 2005), health behavior (e.g., regular exercise and regular health check-ups) is also an important predictor associated with the thyroid cancer screening increase. Those who participate in preventive health behaviors are more likely to undergo cancer screening than those who do not. This may imply that good health behaviors are associated with people seeking continuous preventive health care services.

Additionally, we identified the stated reasons for an increase in thyroid cancer screening. About 51.3% of subjects (39.1% of men and 55.7% of women) reported that the main reason for screening was, "Anxiety about health without symptoms or disease." Insufficient evidence exists to recommend thyroid cancer screening. Screening asymptomatic adults or children for thyroid cancer using either neck palpation or ultrasonography is not recommended by many organizations (CanadianTaskForceonthePeriodicHealthExamination., 1994; U.S.PreventiveServicesTaskForce., 1996). Due to the low accuracy of screening tests, those falsely identified as positive by screening tests must undergo the inconvenience, expense, and anxiety of needless additional testing, including invasive tests such as biopsy, to rule out cancer. Efforts to promote informed decision-making with regard to screening thyroid ultrasonography need to consider the potential benefit and harm to patients. For men, workplace mass examination plays a large role in their increased participation in thyroid cancer screening (24.6%). The purpose of workplace mass examination is to examine disease and risk factors that may affect the health status of employees. The workplace mass examination without thyroid cancer risk factors, such as low-dose radiation exposure (Zielinski et al., 2009), should be avoided due to inconvenience and expense. Approximately 5.7% of subjects reported a reason for the screening increase as, "Screening invitation from the Community Health Center." Some Community Health Centers conduct their own health programs, such as cancer screening and chronic disease health examinations. They should be careful about selecting programs because they are expected to set good examples to hospitals and clinics. Screening that has not been based on evidence or recommendation should be avoided.

Overall, our findings suggest that a substantial portion of thyroid cancer screening in this country is at variance with the major published guidelines. Health care organizations need better mechanisms to reinforce adherence to cancer screening guidelines, and such mechanisms need to go beyond simply monitoring the proportion of subjects screened. The evaluation of thyroid cancer screening by criteria for instituting a screening program (Hamashima et al., 2008; WorldHealthOrganization., 2002) is needed, taking into consideration Korean screening policies and epidemiologic characteristics.

A number of limitations should be considered when reviewing the results of the present study. First, the KNCSS relied on self-reported data and did not report the actual incidence of screening tests for thyroid cancer. Although the questionnaire was discriminative for true screening, it was likely that some of the reported screening tests were actually diagnostic tests following discrete symptoms, especially for tests performed based on physicians' prescriptions. Self-reported accuracy of screening tests may be under-reported (Lipkus et al., 2003) or over-reported (Gordon et al., 1993). Nevertheless, self-reported screening behavior generally is fairly accurate (Etzi et al., 1994; Baier et al., 2000), and many publications rely upon this. Second, we restricted the eligible population for survey to subjects without previous history of any cancer diagnosed. It could cause an underestimation of measuring screening rate, especially in women because of the highest incidence in Korean women. Third, we were unable to explore factors of taking a ultrasonographic

examination or other diagnostic scrutiny in thyroid, such as histories of radiation exposure, or underlying medical conditions related to thyroid. Finally, it was difficult to access a temporal screening rate trend because this was the first study to investigate the thyroid cancer screening rate. Therefore, further study is needed to investigate the screening rate trend and the number of screenings to determine whether the patterns suggest a temporary phenomenon or not.

Despite several limitations of the study, our findings are still meaningful because, to the best of our knowledge, this was the first attempt to measure the thyroid cancer screening rate and its associated factors using a reliable and valid survey method in Korea. Our survey was community-based, which had a broader spectrum of individuals than would have been the case if the survey had been clinic-based.

The thyroid cancer screening rate in Korea was 13.2% of the total population investigated (8.4% of men and 16.4% of women). Our findings from this population-based study of Koreans suggests that older subjects, non-drinkers, lifetime smokers, subjects with positive thoughts regarding cancer screening, subjects who have regular health check-ups, and those who exercise vigorously are more likely to be screened for thyroid cancer. Cancer screening is assumed to play a major role in the increase in thyroid cancer incidence. Although these results reveal the screening rate and its related factors, further research is needed to access the trend of thyroid cancer screening behavior, as related to incidence. Guidelines should also be developed taking into consideration screening policies and epidemiologic characteristics in Korea.

have refused treatment and that some other patients, particularly those living in along the borders with Thailand and Vietnam, might have gone for treatment in these two countries. Nevertheless, this peculiarly high proportion of early-onset CRC, the continuous exposure to hazardous environmental agents, and the prevalent consanguinity in Cambodia justify further research, which will advance our understanding of the risk factors for the disease in young adults. These studies should investigate environmental exposures, family history, and consanguinity as well as explore gene–environment interactions in colorectal cancer carcinogenesis in this high-risk population.

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