

**Measuring factors affecting colorectal
cancer screening behavior and preference
for colorectal cancer screening tests using
the health belief model and a conjoint
analysis**

**A Thesis Submitted to
the Department of Cancer Control and Policy
in Partial Fulfillment of the Requirements
for the Master's Degree of Public Health**

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ABSTRACT

Measuring factors affecting colorectal cancer screening behavior and preference for colorectal cancer screening tests using the health belief model and a conjoint analysis

In Korea, CRC was not only the third most common cancer in 2016, but also the third most common cause of cancer death in 2017. Due to exceedingly low CRC screening rates, an implementation of colonoscopy as the National Cancer Screening Programme (NCSP) has been suggested to increase the screening uptake rate. Thus, this study aims to provide an insight into the feasibility to implement colonoscopy as the NCSP through measuring an individual's preference in CRC screening methods as well as identifying factors associated with colonoscopy screening behavior.

Data were obtained from two sources; Firstly, a total of 500 study subjects were recruited for a face to face interview survey to examine preference in CRC screening tests. Secondly, a total of 800 subjects were recruited for an online survey to investigate an individual's health beliefs on screening colonoscopy. Both surveys included stratified random samplings of those who aged over 45 years. For statistical analysis, non-metric conjoint analysis and a rank-ordered logistic regression were used to elicit study participant's preferences in each attributes of CRC screening tests. To analyze the associations between the health beliefs and colonoscopy screening, multiple logistic regressions were conducted.

From our study results, colonoscopy was the most preferred primary CRC screening method under the NCSP over FOBT (77% vs 23%). The results from the CA demonstrated that ‘CRC mortality reduction (46.3%)’ and ‘Sensitivity (23.5%)’ were the most importantly valued attributes. In overall, a hypothetical CRC screening with a higher CRC mortality reduction, higher sensitivity, lower specificity and a longer screening interval was preferred. The recent uptake rate of screening colonoscopy was 47.1%. ‘Perceived barriers (aOR=0.45, 95% CI=0.24-0.84)’ and ‘cues to action (aOR=4.25, 95% CI=3.01-5.99 respectively)’ were the most significantly associated factors with uptake of screening colonoscopy. In addition, majority of the study participants (77%) had a high intention to have colonoscopy under the NCSP. ‘Perceived severity (aOR=1.58, 95% CI=1.17-2.13)’, ‘Perceived benefits (aOR=3.19, 95% CI=2.31-4.41) and ‘Cues to action (aOR=6.78, 95% CI=4.79-9.57)’ were significantly associated with the future intent to undergo colonoscopy under the NCSP. We also found that the associated factors affecting the intention were different by the study participant’s recent colonoscopy screening status.

In conclusion, we suggested that the implementation of colonoscopy as the national CRC screening programme is feasible. Offering choices through provision of a wide range of CRC screening tests under the NCSP and allowing the participants to make an informed choice will maximize the CRC screening uptake. Moreover, minimizing complications from colonoscopy through improving quality standards and various recommendation strategies will further increase the uptake rate of screening colonoscopy. To increase the eligible people’s future intention to have colonoscopy if it is implemented under the NCSP, increasing knowledge about the benefits of colonoscopy and active recommendation for colonoscopy will be necessary.

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1. Introduction

1.1 Background

1.1.1 Colorectal cancer incidence, mortality and prevalence

Colorectal cancer (CRC) is the third most commonly diagnosed malignancy and the second leading cause of cancer death in the world [1]. Over 1.8 million new CRC cases and 881,000 deaths were estimated to occur in 2018, accounting for about 1 in 10 cancer cases and deaths [2]. The global burden of CRC is further expected to increase by 60% to more than 2.2 million new cases and 1.1 million cancer deaths by 2030 [2].

According to Statistics Korea (2016), a total of 229,180 cases (the Age Standardized Rate (ASR) 286.8 per 100,000) were newly diagnosed with cancer in 2016 [3]. Among other cancers, CRC was the third most frequently diagnosed cancer for both men and women (the ASR 41.6 per 100,000 and 23.3 per 100,000 respectively) following stomach (the ASR 50.9 per 100,000) and lung cancer (42.9 per 100,000 respectively) for men and breast (the ASR 62.5 per 100,000) and thyroid cancers (69.8 per 100,000) for women in 2016 [3].

In 2017, the total number of cancer death was 78,863 accounting for 27.6% of all-cause mortality. For CRC-related mortality, CRC was the third most common cause of death accounting for 11.1% of all cancer deaths following lung (22.8%) and liver (13.6%) [3]. The ASR for CRC was 10.1 per 100,000 following lung cancer (the ASR 20.8 per 100,000), liver cancer (the ASR 13.3 per 100,000) and stomach cancer (the ASR 9.6 per 100,000) in 2017 [4].

In general, the 5-year Relative Survival Rates (RSR) for all cancer combined improved remarkably in both sexes, from 41.2% in 1993-1995 to 70.7% in 2011-2015. For CRC, the RSRs improved in both sexes, from 54.8% in 1993-1995 to 76.4% in 2011-2015 [5]. In addition, the 5-year survival rate significantly varied by the Surveillance Epidemiology and End Results (SEER) stage at the time of diagnosis. For patients diagnosed from 2012 to 2016, the 5-year survival rate only remained at 18.6% in distant metastatic stage whereas it significantly improved up to 94.5% when it was detected in localized stage [3].

The prevalent cases of CRC have gradually increased with an improvement in the 5-year survival rate and the age standardized prevalence rate of CRC was the third highest (261.3 per 100,000) following thyroid and stomach cancers in 2016 (554.0 per 100,000 and 306.0 per 100,000 respectively) [3].

1.1.2 Colorectal cancer screening and guidelines

Most CRC occurs after the prolonged transformation of adenomas into carcinomas. Therefore, early detection and removal of colorectal adenomas are one of the most effective methods to prevent CRC through CRC screening. Such screening also can reduce the rate of complications associated with detection of cancer at a later stage [6].

For CRC screening, there are several methods that are commonly used and available. Firstly, there are stool-based tests to detect blood such as guaiac Fecal Occult Blood Test (gFOBT) and Fecal Immunochemical Test (FIT). Secondly, endoscopic methods, which use optical approaches to directly examine the rectum and colon, include sigmoidoscopy and colonoscopy. In addition, colonoscopy is used as both primary screening tool and as follow-up for persons who have positive test results with other screening methods [7]. Due to this wide range of available CRC screening options, specific CRC screening recommendations are complex as each test has different benefits and limitations.

In Korea, the National Cancer Screening Program (KNCSPP) was launched initially for gastric, breast and cervical cancers without cost to medical aid beneficiaries and in 1999. Additionally, liver and colorectal cancers were further included in the program in 2003 and 2004 respectively. Since 2004, the KNCSPP has provided annual FOBT for adults aged 50 years or older. People with positive results from the FOBT can choose to undergo either colonoscopy or a double-contrast barium enema test, as well as a histological examination if needed [8].

1.1.3 Benefits and harms of colorectal cancer screening

For stool-based tests, there was sufficient evidence of reduction in CRC mortality when screening was conducted every 1 or 2 years; however, the evidence was deemed to be limited when it comes to lowering the incidence [7]. Potential harms of screening with stool-based tests for occult blood were related to psychological harms that person without cancer receives a positive test result (false positive) and complications from unnecessary follow-up colonoscopy [9-11]. In addition, there were several studies reported relatively high rates of false negative results varied from 21.4% to 50% which may indicate that with a relatively high chance, the tests will miss some cancers [12-15].

For endoscopic methods, there was sufficient evidence that a single screening with sigmoidoscopy or colonoscopy reduces both CRC incidence and mortality [7]. However, similar to stool-based tests for occult blood, endoscopic screening may generate psychological harms, along with unnecessary referrals after positive results on endoscopic tests. In addition to this, endoscopy may cause serious complications. The harms of endoscopic screening mainly occurred with colonoscopy. Both direct and indirect harms may occur due to bowel preparation prior to the procedure (eg. electrolyte imbalance and dehydration) and rarely due to the sedation (eg. cardiovascular events), or the procedure itself (eg. perforation and bleeding) [16, 17].

According to the United States Preventive Services Task Force (USPSTF), CRC screening with any of these tests are highly recommended for adults age 50 to 75 years because the benefits of CRC screening substantially outweigh the

potential harms (recommendation A) [18]. On the other hands, the Korea National Cancer Center (KNCC) recommends CRC screening with annual FOBT for adults age 45 to 80 years (recommendation B) or selective use of colonoscopy for colorectal cancer screening with consideration of individual preference and the risk of colorectal cancer (recommendation C) because the benefits of colonoscopy only slightly outweigh the potential harms [19].

For the benefit and harm ratio of CRC screening, the International Agency for Research on Cancer (IARC) concluded that both stool-based (gFOBT and FIT) and endoscopic methods (colonoscopy and flexible sigmoidoscopy) have convincing evidence in reducing CRC-related death and that the benefits outweigh the harms associated with each type of screening [7].

1.1.4 Current issues with Colorectal Cancer Screening

Participation is a key indicator to evaluate a cancer screening programme's acceptance and effectiveness. High uptake in the target population is necessary for a screening programme to achieve the mortality reductions as demonstrated in randomized studies [20].

Despite of the European recommendation for minimum uptake of 45% and a desirable participation rate of 65-70%, only few organized CRC screening programmes and pilot studies met this criteria [21, 22]. According to the NCSP database in Korea from 2002 to 2012, the participation rate of CRC screening had gradually increased since the 2004; however, the participation rate for CRC was the lowest among other cancers in 2012 (25.0%) [8].

For potential reasons of this low rate, firstly, the screening process of FOBT might be related. To undergo FOBT, the invited individuals are required to visit a CRC screening unit at least once in order to collect and return the stool samples, which causes inconvenience to the participants [8]. Secondly, handling of stool and confusing process were also reported as potential barriers [23].

Another reason apart from the NCSP may be due to an increasing number of colonoscopies utilized by individuals through opportunistic screening. According to the Korea National Cancer Screening Survey (KNCSS) in 2012, 43.5% of the respondents answered they ever underwent colonoscopy screening in their lifetime [24]. Moreover, the preference for colonoscopy has further increased as a population-based CRC screening method. This trend can be observed in other western countries such as Germany, Poland and Austria where

colonoscopy has been adapted as population-based screening method [25-27]. Therefore, the need for an implementation of colonoscopy as the NCSP has been increasingly suggested by the experts in order to increase the uptake rate of CRC screening and it has been controversial in Korea.

However, insufficient evidence is available for individual's preferences towards primary CRC screening test among Korean population despite of its potential influence in uptake of a CRC-screening programme. Moreover, several factors such as bowel preparations, pain and fear of complications were previously reported as barriers of participation to colonoscopy [23]. Therefore, it is a key to consider both factors associated with preference for the primary CRC screening tests and the participation to screening colonoscopy prior to the implementation of colonoscopy as the NCSP.

1.1.5 Conjoint Analysis (CA)

Conjoint Analysis (CA) is a survey-based statistical technique that originated in mathematical psychology and developed by Green and Rao in 1971 [28]. In recent 40 years, there have been numerous studies that used the CA to elicit consumer's preferences between various products in marketing industries. The CA allows the estimation of part-worth that consists of each attribute through measuring general preference of consumers and based on this, it can evaluate the relative importance of each attribute's levels [29]. Therefore, the CA is commonly used for development of new products as it helps identify characteristics of the most preferred product over another and moreover, it can predict the choice of customers in a real situation.

The key concepts of the CA are described as follow;

- 1) Attributes: The characteristics of a product such as brand, price, etc.
- 2) Levels: The various values of an attribute. For example, for prices, following values of \$100, \$200, \$300, etc.
- 3) Part-worth: A weighted preference for an attribute in a product, service, or choice-space
- 4) Relative importance: A relative impact of each attribute on consumer choice
- 5) Full factorial design: All possible combinations of attributes and level
- 6) Fractional factorial design: A systematic selection of a subset (fraction) from full profiles to reduce the number of profiles

Recently, there has been a rapid increase in the application of CA in health care services. The CA has been applied successfully to measuring preferences for a various range of health applications such as cancer treatments, human immunodeficiency virus prevention, testing and treatment, dermatology services, asthma medications, genetic counseling, weight-loss programs, diabetes treatment and prevention and CRC screening [30].

As a unique feature of CRC screening, there is the wide range of screening tests available and characteristics are diverse. For example, FOBT has a strong evidence for reducing CRC mortality, is convenient and cheap, but it has low sensitivity to detect precancerous adenomas which means there is no potential for prevention. On the other hands, colonoscopy can visualize the entire colorectum directly and perform prophylactic polypectomy, so that it has the most potential for both CRC prevention and early detection. However, it is time-consuming, expensive, requires sedation and furthermore, it involves complications [31]. Therefore, it is unclear which CRC screening test is superior than another [7, 32, 33]. For these reasons, it is important to identify individual's preferences towards CRC screening tests and in this regard, the application of CA is well suited to elicit CRC screening preferences, especially between FOBT and colonoscopy because it is well designed to measure quantitative trade-offs among multi-attribute choices, including aspects of both process and outcome [34].

1.1.6 Health Belief Model (HBM)

The Health Belief Model (HBM) is a psychosocial model that was developed to explain attitudes and beliefs of individuals in terms of their health behaviors [35]. The model was developed by social psychologists namely, Hochbaum, Kegeles, Leventhal and Rosenstock in the 1950s in order to better explain low levels of participation to screening and immunization programs [36].

Basic constructs of this model contain five basic domains related with individual's beliefs and behaviors. It mainly consists of 'perceived susceptibility' (an individual's subjective risk of developing the condition), 'perceived severity' (an individual's subjective seriousness of the condition and its potential outcomes), 'perceived benefits' (an individual's subjective assessment of positive outcomes from health promoting behaviors), 'perceived barriers' (an individual's subjective assessment of obstacles that discourage adaptation of the promoted behavior) [37]. In addition to these four primary variables above, 'cues to action' (a cue or trigger that promotes individuals to health promoting behaviors) was suggested to be added to the model by Rosentock in 1966 [38].

In recent years, the HBM has been widely adapted to examine preventive health behavior undertaken by people who are well and not experiencing signs or symptoms for the purpose of remaining well, including both medical and non-medical activities. For example, various studies have been conducted to identify individual's health behaviors on breast and cervical cancer screenings [39-42]. For CRC, the HBM was one of the most frequently used theoretical models in

recent studies to predict psychological factors associated with CRC screening adherence [43].

1.1.7. Previous studies

In recent years, various studies were conducted to elicit individual's preferences in CRC screening. Seven studies used the CA to assess people's preferences for CRC screening tests, mostly included FOBT, sigmoidoscopy and colonoscopy [34, 44-49].

For the most frequently used attributes, three studies included what the test involves (what a screening participants would have to go through) [30, 46, 49], preparation and pain or discomfort [30, 46, 47]. In addition to this, performance-related attributes such as sensitivity and accuracy [34, 45, 46, 48], out of pocket costs [44, 46, 48] and CRC mortality reduction [45, 47, 49] were the most commonly used attributes. In most studies, the accuracy and process related attributes (what the test involves) were the strongest determinants for preference in CRC screening tests [34, 46, 48].

In four studies, they used attributes and levels in order to define real tests [49]. Of these four, all defined real stool tests (gFOBT, FIT, Fecal DNA sampling), flexible sigmoidoscopy and colonoscopy and two defined DCBE and two defined CT Colonography [34, 46, 47, 49]. Other remaining three studies used hypothetical tests that did not clearly relate to currently existing test [44, 48, 49].

For the preferences of CRC screening tests, two studies revealed that endoscopic tests including sigmoidoscopy and colonoscopy were the most preferred CRC screening tests over another [47, 49] and the second most

preferred following CT colonoscopy in one study [34]. FOBT was revealed to be the least preferred test in three studies [30, 47, 49].

According to Mansfield (2006), it is necessary to conduct a research that leads to understanding of the most valued attributes of health care intervention in order to design, develop and implement effective program [32]. In this regard, information about the preference and the most importantly valued attributes in CRC screening is important to see the feasibility of implementation of colonoscopy as a primary CRC screening method under the NCSP; however, such evidence is significantly lacking in Korea. Moreover, despite of the effectiveness of the CA in measuring relative importance of different CRC screening characteristics, there has been no single study utilized the CA to investigate this aspect in Korea. Previously, only one study investigated individual's preferences between FOBT and colonoscopy as primary CRC screening [50]. In this study, 68.7% of the study participants preferred colonoscopy whereas 31.3% preferred FIT. Older age was a strong determinant for the preference of FIT while higher income, higher education, knowing someone with CRC were significantly associated with the preference of colonoscopy [50].

On the other hands, in order to increase the national CRC screening uptake rate, it is necessary to identify the psychological factors associated with colonoscopy screening behaviors as well as future intention to undergo colonoscopy under the NCSP among those who previously underwent opportunistic colonoscopy screening.

To identify associated factors with CRC screening, there have been numerous studies conducted to explain low CRC screening rate; however, most studies focused solely on the association between socio-demographic factors and CRC screening [51-54] and there are limited numbers of studies utilized the HBM. For the previous studies that applied the HBM in CRC screening behavior in Korea, two studies identified the association between individual's health beliefs and CRC screening behavior [55, 56]. Lee (2006) examined the effects of health beliefs on CRC screening behavior for middle-aged and elderly adults. In this study, perceived benefits and health motivation were significantly associated with CRC screening uptake [56]. In addition to this, a qualitative study was conducted to understand Korean's health beliefs and knowledge about cancer screening. Perceived susceptibility, perceived benefits, perceived barriers and knowledge of the cause of cancer were identified as the most important themes [55].

Although there were a few studies identified the association between health beliefs and CRC screening, the number of studies that examined people's health beliefs by different CRC screening tests are lacking [57]. According to James et al., (2002), there was a clear difference in a way that people perceive differently depends on the types of CRC screening with respect to the relative importance of perceived benefits versus barriers. This study revealed that barriers were negatively related to recent FOBT and recent sigmoidoscopy whereas benefits were significantly related to having a recent sigmoidoscopy and a recent colonoscopy but not to recent FOBT [58]. Therefore, it is important

to investigate individual's health beliefs according to different CRC screening tests.

However, despite of such importance, there are only few studies examined the association of health beliefs by different CRC screening tools. One previous study examined the association between health beliefs and adherence to FOBT [59]. The result shows that four out of the six-HBM driven factors, including perceived susceptibility, severity, barriers and health motivation had statistically significant associations. For colonoscopy, two previous study examined the associated health belief factors and screening colonoscopy [57, 60]. According to Jeong (2016), perceived severity, barriers and self-efficacy were the significant determinants of colonoscopy [57]. Another study identified compliance to colonoscopy following FOBT-positive results using the HBM [60] and perceived seriousness, barriers and health motivation were the most important factors influencing colonoscopy screening behavior. In overall, perceived barriers were the most prominent HBM construct and other factors such as perceived susceptibility and cues to action were only implicitly shown in the selected observational studies [43].

For the factors associated with an individual's intention to undergo CRC screening, an individual's behavioral intention has been identified as the most predictive determinant of whether that individual performs a specific health behavior in the health promotion and disease prevention literature in a previous study [61]. In addition to this, an individual's intention to be screened has been identified as one of the strongest and consistent factors associated in many

studies such as breast, colorectal and prostate cancer screenings in estimating future cancer screening behaviors [62-66]. Therefore, it is necessary to identify factors affecting individual's intention to undergo primary screening colonoscopy to increase the future CRC screening uptake rate.

However, although it is important to examine an individual's future intention to undergo colonoscopy as a part of the national CRC screening program in order to predict the future CRC screening uptake, none has examined an intention to undergo colonoscopy screening under the NCSP until now in Korea. There were only three previous studies that examined the intention to undergo CRC screening in Korea [67-69]. One study examined the association between socio-demographic variables and CRC screening intention [68]. The result demonstrated that younger age and previous experience of CRC screening with DCBE or colonoscopy were strongly associated with high intention to undergo CRC screening. In addition to this, Kim (2011) revealed that the higher intention was significantly associated with the higher likelihood of colonoscopy screening uptake [69]. Although the major constructs of the HBM are useful for predicting whether and why subjects undergo cancer screening to prevent or control cancer, there was only one study that examined health beliefs related to cancer screening intentions by using the HBM in Korea [70].

In overall, although it is necessary to investigate individual's preferences in different CRC screening tests to provide an insight into the feasibility to implement colonoscopy as the NCSP in Korea, it remains unclear. Moreover, none has used the HBM to suggest factors affecting colonoscopy screening

behaviors as well as an individual's intention to undergo colonoscopy under the NCSP.

1.2 Study objectives

This study aims to provide an insight into the feasibility of implementation of colonoscopy as the NCSP and strategies to improve the national CRC screening uptake rates through identifying factors associated with colonoscopy screening behavior and an individual's intention to undergo colonoscopy screening under the NCSP.

The specific study objectives to achieve this goal are as follow;

- 1) To determine the most preferred CRC screening test as the NCSP and examine the important characteristics of different CRC screening tests that affects individual's preferences using a Conjoint Analysis (CA)
- 2) To provide interventions to improve CRC screening rates through identifying psychological factors associated with the uptake of colonoscopy through opportunistic screening and their intention to undergo colonoscopy under the NCSP using the Health Belief Model (HBM)

2. Methods

2.1 The Conjoint Analysis (CA)

2.1.1 Study design

This study was conducted in a cross-sectional design using the CA. A face to face interview survey was conducted in 2018 in order to determine an individual's preferences in different CRC screening tests.

2.1.2 Study participants

The study participants aged over 45 years were recruited among those who provided a consent to participate to the survey. As a result, a total of 500 study subjects responded to the survey. The study subjects were randomly selected by a stratified multistage according to demographic characteristics such as geographical area, age and sex.

2.1.3 Conceptual framework

The CA was conducted through several steps (Fig 1). The steps involved with undertaking the CA are as follow;

- 1) Definition of key attributes and levels:

The most commonly used attributes for CRC screening were evaluated through literature review and the five attributes (preparation, sensitivity, specificity, CRC mortality reduction and interval) were finally selected through expert consultation. For

each selected attribute, two levels were chosen to define real CRC screening tests including FOBT and colonoscopy from currently available study results and CRC screening guidelines. For example, the sensitivity of colonoscopy ranged from 90%~100% [19] whereas the sensitivity of FOBT were found to range from 52.6%~76.8% in two studies [14, 15] (Fig 3).

2) Construction of task:

The combination of selected attributes and levels allowed 64 possible scenarios in a full factorial design (2^6). Since it is not feasible to present all these possible scenarios, a fractional factorial design was applied to identify a subset of combinations.

3) Experimental design:

As a result of a fractional factorial design, eight scenarios with a level balance (levels of an attribute occur in a regular frequency) and orthogonality (no correlation between any of two levels of different attributes) were selected. An example of eight selected scenarios is presented in the appendix 1.

4) Elicitation of preference:

Prior to the participation of the survey, the respondents were explained about the attributes of each CRC screening test (FOBT and colonoscopy). The concepts of sensitivity and specificity were described as ‘the accuracy of the test if you DO have cancer’ and ‘the accuracy of the test if you DO NOT have cancer’

respectively (Appendix 1). To elicit the participant's preferences, a rank-based CA was used. The respondents were given eight profile cards and they were asked to rank them from the most preferred to the least preferred tests ranged from 1 to 8.

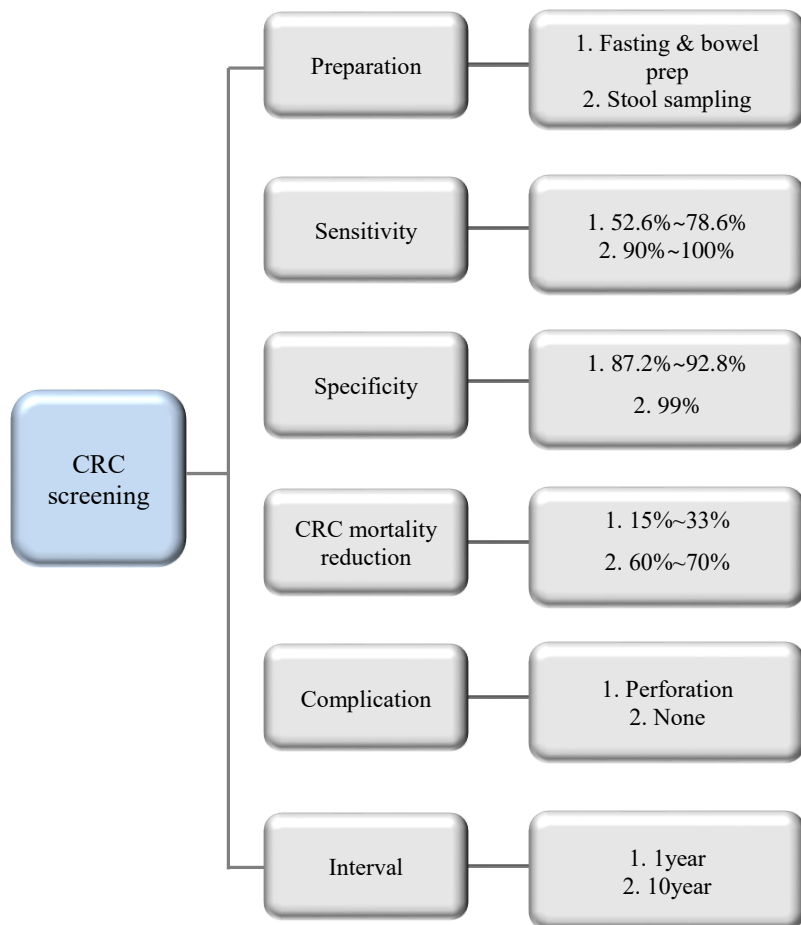


Figure 1. Assigned attributes and levels

2.1.4 Variables

1) Dependent variables

The participants were asked to rank the eight hypothetical CRC screening scenarios ranged from 1 to 8. The lower rank (e.g. 1) indicates a higher preference towards a CRC screening test whereas the higher rank (e.g. 8) indicates a less preferred CRC screening test.

2) Independent variables

The levels for each attribute were categorized as dichotomous variables. If the levels had lower values (e.g. a lower sensitivity) or involved with more invasive procedures (e.g. bowel preparation) were categorized to '0' as a reference, then the levels with higher values and involving less invasive procedures were categorized to '1'.

2.1.5 Statistical analysis

Firstly, descriptive statistics were applied to examine the participant's baseline characteristics and preferred CRC screening tests under the NCSP. Then the significant differences between demographic-characteristics and the preferred CRC screening methods were tested by using Chi-squared and two sample t-test.

Secondly, a non-metric conjoint analysis was used to examine relative importance of each attributes of CRC screening tests.

To identify importantly valued CRC screening attributes and levels to the respondents, a rank-ordered logistic regression was conducted. According to Thurstone (1927), value is assumed to be linear in the attributes, with the coefficients expressing the direction and weight of the attributes [71].

$$\begin{aligned} Value = & \beta_0 + \beta_1 \text{stool sampling} + \beta_2 \text{sensitivity 90\%~100\%} + \beta_3 \text{specificity 99\%} \\ & + \beta_4 \text{CRC mortality 60\%~70\%} + \beta_5 \text{None} + \beta_6 \text{10 year} + \varepsilon \end{aligned}$$

The positive values on the coefficients mean that the subjects assign higher values to it. For example, the positive value to $\beta_1 \text{stool sampling}$ indicates that the subjects assign higher values to stool sampling than to fasting and bowel preparation. The negative values on the coefficients indicate that the respondents assign lower values and non-significant values indicate no preference.

For statistical analysis, STATA (Version. 13.1, College Station, Texas 77845 USA) and SAS (Version 9.4, Cary, NC, USA) were used.

2.2 The Health Belief Model (HBM)

2.2.1 Study design

The association between the health beliefs, colonoscopy screening behavior and an individual's future intention to undergo colonoscopy screening under the NCSP were examined through an online survey.

2.2.2 Study participants

The study participants aged over 45 years were recruited among those who provided a consent to participate to the survey. As a result, a total of 800 study subjects attended to the survey. The study subjects were randomly selected by a stratified multistage according to demographic characteristics such as geographical area, age and sex.

2.2.3 Conceptual framework

Prior to the survey, the participants were explained in terms of what colonoscopy is and benefits and harms of screening colonoscopy. In the questionnaire, the five major constructs of HBM were included to measure the participant's health beliefs by using 5-point Likert scales ranging from "strongly disagree" to "strongly agree" (Table 1). Then, the Cronbach's alpha coefficients were calculated to measure internal consistency of the each HBM component. The five components of HBM (Figure 2) and definitions are as follow;

- 1) Perceived susceptibility to CRC is an individual's perceived risk of developing CRC. Four questions were included to measure the participant's susceptibility to CRC. Higher score indicates that the participants are more susceptible to CRC. The Cronbach's Alpha for perceived susceptibility was 0.88.
- 2) Perceived severity is feelings about the seriousness of contracting CRC and the extent of the negative consequences that will be caused from CRC. Four questions were included to measure perceived severity. Higher score for perceived severity indicates that an individual has a higher fear of CRC. The Cronbach's Alpha coefficients for perceived severity were 0.86.
- 3) Perceived benefits refer to an individual's subjective beliefs of the value or usefulness of colonoscopy to offset the perceived threat. The higher perceived benefits mean the higher likelihood of an individual to engage with colonoscopy screening. Five questions were included and the Cronbach's Alpha coefficients for perceived benefits were 0.87.
- 4) Perceived barriers to colonoscopy screening indicate perceived obstacles that inhibit or prevent an individual from completing colonoscopy screening. It contains five questions and higher scores indicate that individuals have higher barriers to participate to colonoscopy screening. The Cronbach's Alpha coefficients for perceived barriers were 0.83.

- 5) Cues to action is both internal and external trigger that an individual to perform CRC screening when appropriate beliefs are held. The higher score on the cues to action indicates that an individual is more readily to undertake CRC screening. In this study, it consists of five questions and the Cronbach's Alpha coefficients for cues to action were 0.80.

Table 1. Subscales and each component of HBM

Subscale	The number of items	Measurement	Possible score range	Cronbach's Alpha
Perceived Susceptibility	4	5-Point Likert	4-20	0.88
Perceived Severity	4	Scale ranging from strongly disagree to	4-20	0.86
Perceived Benefits	5	strongly agree	5-25	0.87
Perceived Barriers	5	strongly agree	5-25	0.83
Cues to Action	3		3-15	0.80

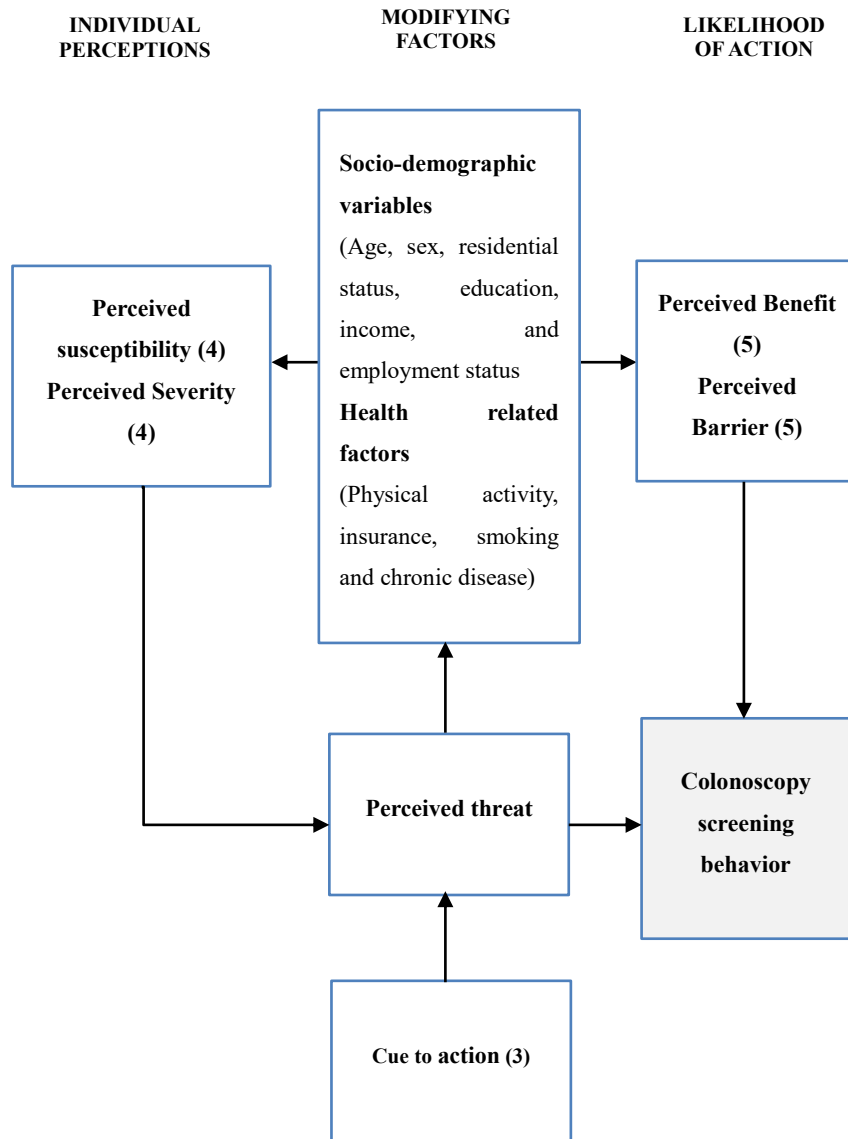


Figure 2. Study design for the HBM

2.2.4 Variables

1) Dependent variables

Firstly, to examine the association between the health beliefs and the participation to screening colonoscopy, the subjects were asked if they ever underwent colonoscopy screening in their lifetime. Among those who answered they ever did, then they were further asked if they underwent colonoscopy screening during the last 10 years (Yes/No). According to their recent colonoscopy screening status, it was coded as dichotomous variable (Yes=1/No=0).

Secondly, an individual's intention to undergo colonoscopy screening under the NCSP was measured based on 5-point Likert scale (strongly disagree=1, disagree=2, neutral=3, agree=4, strongly agree=5) as ordinal variable.

2) Independent variables

As independent variables, the mean of each components of HBM including perceived susceptibility, perceived severity, perceived benefits, perceived barriers and cues to action were calculated. Then, the mean scores of each component were coded as dichotomous variables. If the mean scores were higher than 4, it was coded as 'high (1)' else then as 'low (0)'.

2.2.5 Statistical analysis

Firstly, descriptive statistics were applied to examine the participant's baseline characteristics and mean, standard deviation, median for each score of HBM constructs were calculated. Then, the significant differences between demographic-characteristics, each HBM constructs and the recent colonoscopy screening status were tested by using Chi-squared and two sample t-test. Secondly, in order to test the association between demographic-characteristics, each HBM constructs and an individual's intention to undergo colonoscopy under the NCSP was tested by using Mann-Whitney U test and Kurskal-wallis tests.

Secondly, principal axis factor analysis was conducted to classify each question in the HBM components and the internal reliability of each HBM components was measured by using Cronbach's alpha coefficients. Then, logistic regressions were further conducted to examine the factors associated with colonoscopy screening as well as the future intention to undergo colonoscopy under the NCSP.

For statistical analysis, STATA (Version. 13.1, College Station, Texas 77845 USA) was used.

2.3 Data collection and procedures

The study was approved by Institutional Review Board (IRB) of Seoul National University Hospital on the 16th of July 2018 (The approval number C-1806-094-952). The questionnaires were only distributed to those who provided a consent to participate to the study. Prior to achieve the consent, the information about the purpose, process and benefits and harms of this study were explained. The surveys had been conducted over 4 weeks through a professional survey agency during the period between July 2018 to August 2018. The time required to complete the surveys were less than 10 minutes and the completeness of the questionnaires were checked by the researcher.

3. Results

3.1 The Conjoint Analysis (CA)

3.1.1 Baseline characteristics of the study participants

Among a total of 500 participants, 385 participants (77.0%) responded that they preferred colonoscopy as a primary CRC screening method under the NCSP, whereas 115 participants (23.0%) preferred FOBT. The baseline characteristics of the study participants who attended to the face to face interview survey is shown in the table 2-1. The result shows that a higher proportion of participants aged between 55 and 64 (39.6%) attended to the survey compared to other age groups. In addition, the participants were more likely to reside in non-metropolitan area (54.8%), had a higher education of 6-12 years (66.4%), female (51.4%), employed (62.2%), conduct moderate physical activity (41.4%) and have no chronic diseases (59.6%). Majority of the study participants were non-smokers (84.2%) and had private cancer insurance (79.9%)

Table 2-1. Baseline characteristics of the participants (N=500)

Variable	Frequency	%
Preference for CRC screening tests		
FOBT	115	23.0
Colonoscopy	385	77.0
Age Group		
45-54	154	30.8
55-64	198	39.6
65-84	148	29.6
Residential status		
Metropolitan	226	45.2
Non-metropolitan	274	54.8
Sex		
Male	243	48.6
Female	257	51.4
Years of Education		
6-12 years	332	66.4
More than 13 years	168	33.6
Monthly household income		
Less than \$2,999	199	39.8
\$3,000~\$4,999	204	40.8
More than \$5,000	97	19.4
Employment status		
Unemployed	189	37.8
Employed	311	62.2
Physical activity		
Not at all	126	25.2
Moderate	207	41.4
Regular	167	33.4
Private cancer insurance		
No	102	20.4
Yes	398	79.6
Current smoking status		
No	421	84.2
Yes	79	15.8
Family history of cancer		
No	327	65.4
Yes	173	34.6
Chronic disease		
No	298	59.6
Yes	202	40.4

3.1.2 Comparison of the study participants

Table 2-2 shows the difference in baseline characteristics of the face to face survey participants according to their preference (FOBT or colonoscopy). Among the characteristics, age ($P=0.04$), year of education ($P<0.01$) and private cancer insurance ($P<0.01$) were presented to be significantly associated with the preference in CRC screening tests. Majority of the participants who preferred colonoscopy screening were appeared to be in the age group between 55 and 64 years (40.8%), having higher years of education (>13 years) (44.7%) and having private cancer insurance (83.1%) whereas the aged over 60 years significantly more preferred FOBT (39.1%).

Table 2-2. Comparison of the study participants (N=500)

Variable	Preferred CRC Screening method		<i>P</i> -value
	FOBT (N=115)	COL (N=385)	
Age Group			
Mean, SD	61.2±8.9	58.8±8.2	<0.01
45-54	29 (25.2)	125 (32.4)	0.04
55-64	41 (35.7)	157 (40.8)	
65-84	45 (39.1)	103 (26.8)	
Residential status			
Metropolitan	49 (42.6)	177 (46.0)	0.52
Non-metropolitan	66 (57.4)	208 (54.0)	
Sex			
Male	51 (44.3)	192 (49.9)	0.30
Female	64 (55.7)	193 (50.1)	
Year of education			
6-12 years	39 (33.9)	75 (19.5)	<0.01
More than 13 years	46 (40.0)	172 (44.7)	
Monthly household income			
Less than \$2,999	77 (40.1)	122 (39.6)	0.59
\$3,000~\$4,999	82 (42.7)	122 (39.6)	
More than \$5,000	33 (17.2)	64 (20.8)	
Employment status			
Unemployed	83 (43.2)	106 (34.4)	0.05
Employed	109 (56.8)	202 (65.6)	
Physical activity			
Not at all	29 (25.2)	97 (25.2)	0.06
Moderate	38 (33.0)	169 (43.9)	
Regular	48 (41.7)	119 (30.9)	
Private cancer insurance			
No	37 (32.2)	65 (16.9)	<0.01
Yes	78 (67.8)	320 (83.1)	
Current smoking status			
No	160 (83.3)	261 (84.7)	0.68
Yes	32 (16.7)	47 (15.3)	
Chronic disease			
No	54 (47.0)	148 (38.4)	0.10
Yes	61 (53.0)	237 (61.6)	

CRC= Colorectal cancer; COL= Colonoscopy; FOBT= Fecal Occult Blood Test

3.1.3 Preference in CRC screening tests

The participants were firstly asked ‘if both colonoscopy and FOBT are available as the NCSP, which test would you like to undertake? (Appendix 1)’. Then, the participants were further asked for the reasons of their most preferred/least preferred CRC screening tests (Fig 3 and Fig 4).

Among those who preferred FOBT, the most important reasons for their preference were ‘pain (46.1%)’ followed by ‘preparation (13.9%)’ and ‘complication (13.9%)’. Conversely, ‘sensitivity (46.2%)’, ‘specificity (31.7%)’ and ‘CRC mortality reduction (9.1%)’ were the most important reasons among those who preferred colonoscopy. In other words, the main reasons for the preference in FOBT were due to no pain, no invasive preparation and no complications whereas the main reasons for the preference in colonoscopy were high accuracy and high effectiveness in reducing CRC death.

In opposite to this, the respondents were also asked for their reasons of the least preferred CRC screening tests. Among those who did not choose FOBT, ‘sensitivity (30.1%)’, ‘specificity (22.6%)’ and ‘preparation (13.8%)’ were the reasons of no preference. On the other hands, ‘pain (27.8%)’, ‘preparation (27.8%)’ and ‘complication (12.1%)’ were the reasons for no preference of colonoscopy. In other words, people did not prefer low accuracy and preparation of FOBT, while painful procedures, bowel preparation and potential complications were the least preferred reasons for colonoscopy.

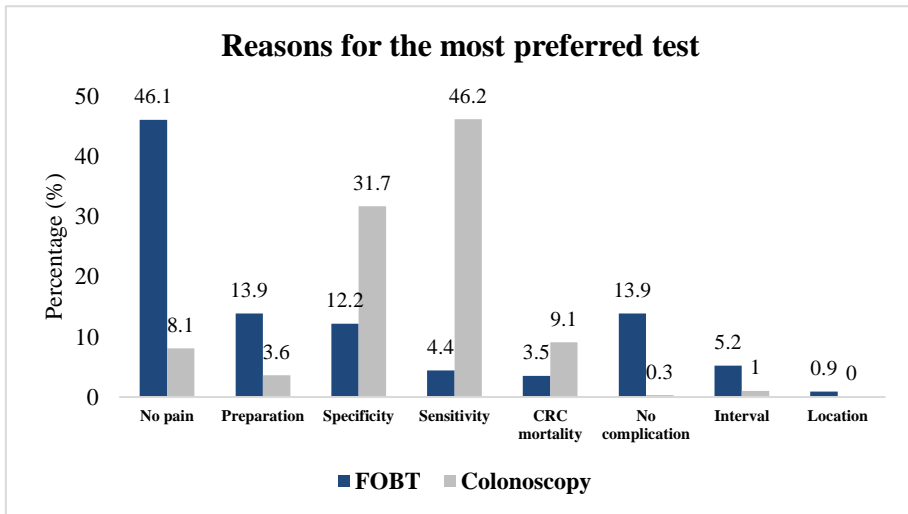


Figure 3. Reasons for the most preferred CRC screening test

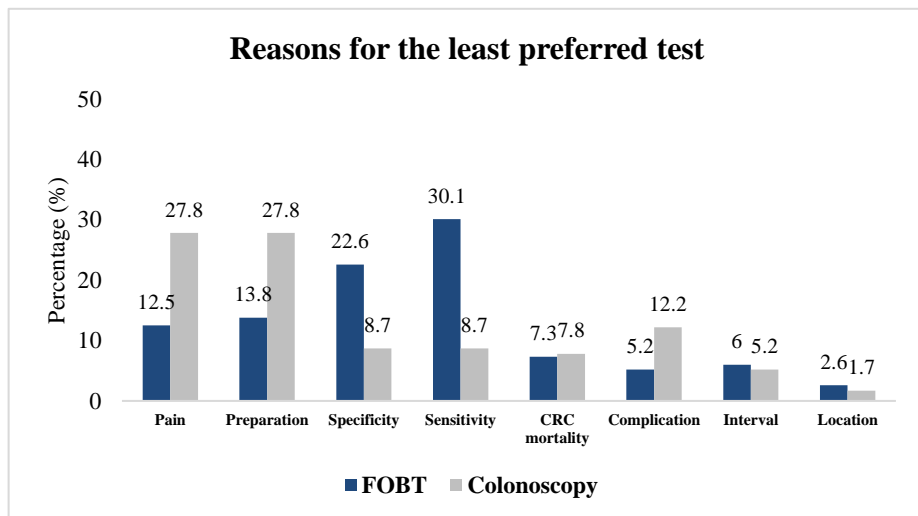


Figure 4. Reasons for the least preferred CRC screening test

3.1.4 The most important attributes of CRC screening

The results on the most importantly valued CRC screening attributes are shown in Figure 5. The relative importance of each attribute was determined to identify which had the greatest influence on CRC screening preference. In overall, ‘CRC mortality reduction (46.4%)’ and ‘sensitivity (23.5%)’ were identified as the most important attributes. Similarly, among those who preferred FOBT, ‘CRC mortality reduction (46.4%)’ was the most important attributes followed by ‘preparation (18.1%)’. On the other hands, ‘sensitivity (27.0%)’ and ‘specificity (8.5%)’ were the important attributes for those who preferred colonoscopy. Commonly, complications were the least important attribute among both who prefer FOBT and colonoscopy (9.6% and 2.7% respectively).

The preference for each level of six CRC screening attributes are presented in Table 6. In overall, a CRC screening test with a higher sensitivity (95% CI=0.04;0.18), a higher CRC mortality reduction (95% CI= 0.24;0.39), a longer screening interval (95% CI=0.02;0.16) and a lower specificity (95% CI= -0.16;-0.02) were significantly preferred. Among those who preferred FOBT, they had more positive attitudes towards a hypothetical CRC screening test with a higher CRC mortality reduction (95%CI=0.09;0.41) and stool sampling (95%CI=0.08;0.38). On the other hands, among those who preferred colonoscopy had more positive attitudes towards a hypothetical CRC screening test with a higher sensitivity (95%CI=0.05;0.22) and a higher CRC mortality reduction (95% CI= 0.24;0.42).

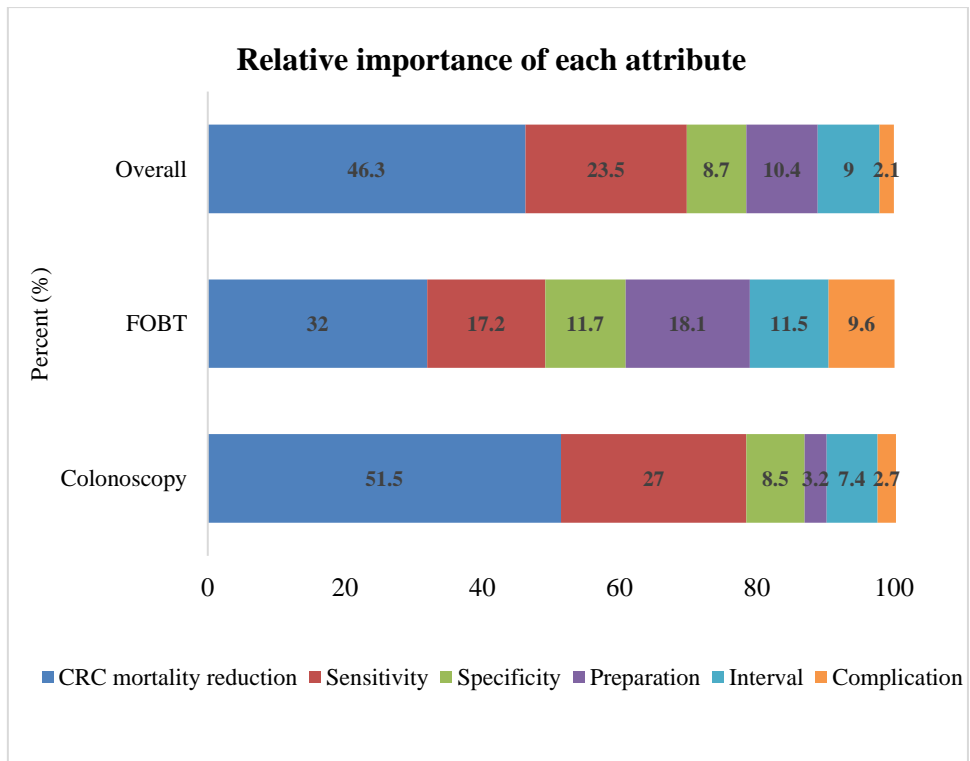


Figure 5. Relative importance of each attribute

Table 2-3. Regression coefficients from a rank-ordered logistic regression

Attribute and levels	Overall		FOBT		Colonoscopy	
	β coefficient	95% CI	β coefficient	95% CI	β coefficient	95% CI
Preparation						
Fasting & bowel prep	ref.		ref.		ref.	
Stool sampling	0.04	(-0.03;0.11)	0.23	(0.08;0.38)	-0.02	(-0.10;0.07)
Sensitivity						
52.6%~78.6%	ref.		ref.		ref.	
90%~100%	0.11	(0.04;0.18)	0.03	(-0.12;0.18)	0.13	(0.05;0.22)
Specificity						
87.2%~92.8%	ref.		ref.		ref.	
99%	-0.09	(-0.16;-0.02)	-0.12	(-0.27;0.02)	-0.08	(-0.16;0.00)
CRC mortality reduction						
15%~33%	ref.		ref.		ref.	
60%~70%	0.31	(0.24;0.39)	0.25	(0.09;0.41)	0.33	(0.24;0.42)
Complication						
Perforation and bleeding	ref.		ref.		ref.	
None	-0.03	(-0.10;0.04)	-0.12	(-0.27;0.03)	-0.01	(-0.09;0.07)
Interval						
1 year	ref.		ref.		ref.	
10 year	0.09	(0.02;0.16)	0.14	(0.00;0.29)	0.07	(-0.01;0.15)

3.2 The Health Belief Model (HBM)

3.2.1 Baseline characteristics of the study participants

The baseline characteristics of the study participants who attended to the online interview survey are shown in the table 3-1. The participants were more likely to reside in non-metropolitan area (53.4%). Among the participants, there were slightly more females (50.9%), the employed (75.9%), non-smokers (72.1%), those who exercise moderately (52.0%), hold private insurance (79.6%) and had no chronic diseases (59.1%).

In addition, relatively younger participants aged between 45 to 54 (39.9%) were more likely to participate to the survey compared to other age groups. In addition, those who attended to the online survey were more likely to have a higher year of education (69.6%) and have higher monthly household income more than \$5,000 (38.0%).

Table 3-1. Baseline characteristics of the study participants (N= 800)

Variable	Number	Percent (%)
Age Group		
45-54	319	39.9
55-64	312	39.0
65-78	169	21.1
Residential status		
Metropolitan	373	46.6
Non-metropolitan	427	53.4
Sex		
Male	393	49.1
Female	407	50.9
Years of Education		
6-12 years	243	30.4
More than 13 years	557	69.6
Monthly household income		
Less than \$2,999	202	25.3
\$3,000~\$4,999	294	36.8
More than \$5,000	304	38.0
Employment status		
Unemployed	193	24.1
Employed	607	75.9
Physical activity		
Not at all	139	17.4
Moderate	416	52.0
Regular	245	30.6
Private cancer insurance		
No	185	23.1
Yes	615	76.9
Smoking status		
No	577	72.1
Yes	223	27.9
Chronic Disease		
No	473	59.1
Yes	327	40.9

3.2.2 Colonoscopy screening rates

The lifetime colonoscopy screening rate and the screening rate with recommendation are shown in Figure 6 and Figure 7. The lifetime colonoscopy screening rate was measured by asking ‘Have you ever underwent colonoscopy for CRC screening in your lifetime?’ As a result, a total of 396 participants (49.5%) answered that they ever underwent colonoscopy screening in their lifetime (Fig 6). In general, the screening rate was higher in men and among the participants aged between 65 and 78 years (61.5%). In addition, the colonoscopy screening rate with recommendation was measured by asking ‘Have you received colonoscopy during the last 10 years for CRC screening?’ A total of 377 participants (47.1%) answered that underwent colonoscopy screening during the last 10 years. Similarly, the screening rate was the higher in men and it was the highest among the participants aged between 65 and 78 (58.0%) (Fig 7).

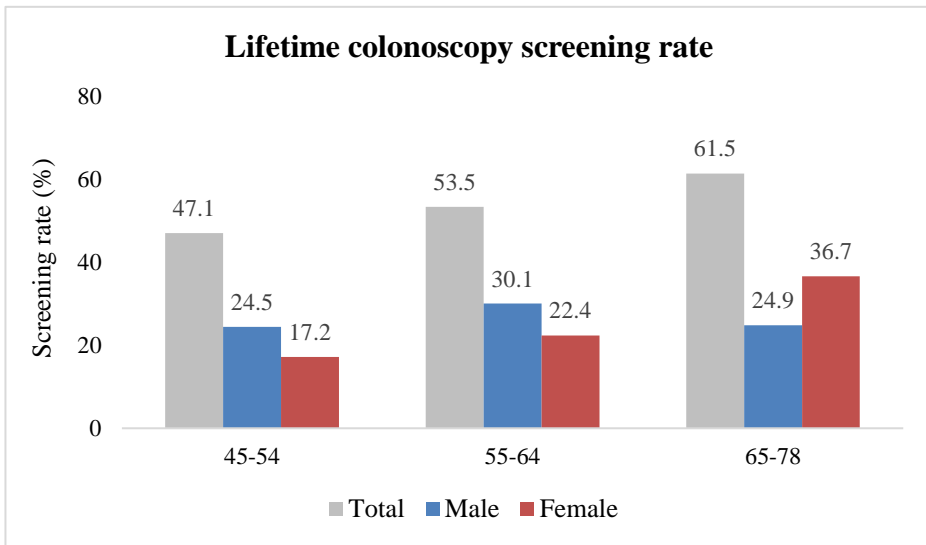


Figure 6. Lifetime colonoscopy screening rate

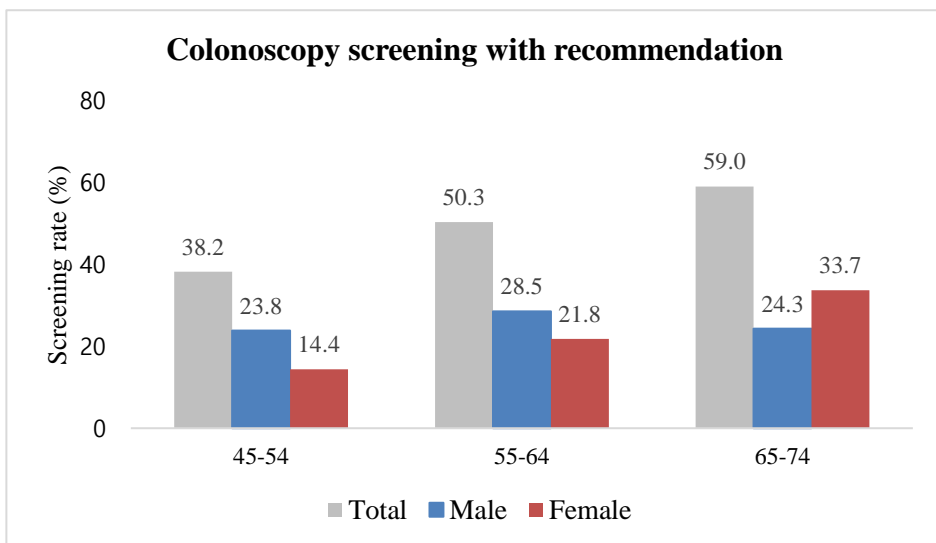


Figure 7. Colonoscopy screening rate with recommendation

3.2.3 Comparison of the study participants

Table 4-1 shows the difference in baseline characteristics of the online survey participants and it was revealed that age ($P<0.01$), sex ($P<0.01$), year of education ($P=0.01$), monthly household income ($P=0.01$), employment status ($P=0.01$), physical activity ($P=0.04$), private cancer insurance ($P=0.03$), current smoking status ($P=0.04$), chronic disease ($P=0.03$) and CRC screening recommendation ($P<0.01$) had statistically significant associations with the colonoscopy screening status. Those who underwent colonoscopy screening during the last 10 years were more likely to be the aged between 55 and 64 years (41.6%), male (54.6%), having higher education (>13 years) (74.4%), having higher monthly household income ($>\$5,000$) (45.6%) and having moderate physical activity (50.7%).

Table 3-2. Comparison of the study participants (N=800)

Variable	Colonoscopy screening during the last 10 years		
	No 423 (52.9%)	Yes 377 (47.1%)	P-value
Age Group			
Mean (SD)	56.95±6.76	59.07±7.44	<0.01
45-54	197 (46.6)	122 (32.4)	<0.01
55-64	155 (36.6)	157 (41.6)	
65-78	71 (16.8)	98 (26.0)	
Residential status			
Metropolitan	198 (46.8)	175 (46.4)	0.91
Non-metropolitan	225 (53.2)	202 (53.6)	
Sex			
Male	187 (44.2)	206 (54.6)	<0.01
Female	236 (55.8)	171 (45.4)	
Year of education			
6-12 years	146 (34.5)	97 (25.7)	0.01
More than 13 years	277 (65.5)	280 (74.3)	
Monthly household income			
Less than \$2,999	135 (31.9)	67 (17.8)	<0.01
\$3,000~\$4,999	156 (36.9)	138 (36.6)	
More than \$5,000	132 (31.2)	172 (45.6)	
Employment status			
Unemployed	119 (28.1)	74 (19.6)	0.01
Employed	304 (71.9)	303 (80.4)	
Physical activity			
Not at all	83 (19.6)	56 (14.9)	0.04
Moderate	225 (53.2)	191 (50.7)	
Regular	115 (27.2)	130 (34.4)	
Private cancer insurance			
No	111 (26.2)	74 (19.6)	0.03
Yes	312 (73.8)	303 (80.4)	
Current smoking status			
No	318 (75.2)	259 (68.7)	0.04
Yes	105 (24.8)	118 (31.3)	
Chronic Disease			
No	361 (85.3)	299 (79.3)	0.03
Yes	62 (14.7)	78 (20.7)	

3.2.4 Health beliefs on colonoscopy screening behavior

In table 3-3, principal axis factor analysis using a Varimax orthogonal rotation was conducted to classify each factor in the HBM model. A rotated factor loading of 0.70 was used and the factor loading values lower than 0.7 were removed. As a result, four questions for perceived susceptibility, four questions for perceived severity, five questions for perceived benefits, five questions for perceived barriers and three questions for cues to action were retained.

Table 3-3. Principal axis factor analysis

HBM constructs	Factor Loadings				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Perceived Susceptibility					
High chance of getting CRC in lifetime	0.01	0.33	0.15	0.73	0.08
High chance of getting CRC in 10 years	0.09	0.15	0.03	0.82	0.06
Having many risk factors of CRC	0.07	0.21	0.02	0.84	0.08
Higher chance of getting CRC than others	0.12	0.15	0.01	0.85	0.11
Perceived Severity					
CRC causes long lasting problems	0.06	0.71	0.16	0.32	0.13
CRC causes negative impacts on relationships	0.05	0.78	0.14	0.23	0.08
CRC Completely changes my life	0.01	0.82	0.16	0.17	0.09
Treatment for CRC is expensive	0.11	0.74	0.05	0.17	0.07
Perceived Benefits					
High chance of survival if CRC is found early	0.12	0.06	0.76	0.01	0.15
Colonoscopy helps early detection of CRC	0.17	0.27	0.70	0.02	0.21
Treatment is not difficult if CRC is found early	0.01	0.09	0.79	0.05	0.14
Colonoscopy will reduce concern about CRC	0.10	0.06	0.78	0.10	0.20
Colonoscopy will reduce CRC death	0.12	0.11	0.79	0.04	0.19
Perceived barriers					
High cost of colonoscopy	0.70	0.04	0.18	0.09	0.02
Lack of awareness of Colonoscopy	0.76	0.04	0.13	0.04	0.08
Colonoscopy is painful	0.71	0.19	0.02	0.02	0.19
Complications of colonoscopy	0.73	0.26	0.02	0.04	0.09
Transportation difficulties	0.74	0.13	0.24	0.10	0.05
Cues to action					
Recommendation from family or friends	0.14	0.10	0.21	0.11	0.79
Recommendation from mass media	0.03	0.02	0.12	0.15	0.81
Concerns about health status	0.12	0.11	0.19	0.17	0.73

Table 3-4 shows the means, standard deviations and median for each question in the HBM components.

- 1) Perceived susceptibility: The mean score of the perceived susceptibility was 3.05 (± 0.76) and the possible score range was from 4 to 20 (Table 2). The question with the highest mean score was 'high chance of getting CRC in lifetime' (3.46 ± 0.84) whereas 'higher probability of getting CRC compare to others' appeared to be the lowest (2.78 ± 0.93).
- 2) Perceived severity: The mean score of the perceived severity was 3.74 (± 0.77) and the possible score range was 4 to 20 (Table 2). The mean score for 'CRC completely changes my life' was the highest as 3.87 ± 0.92 and 'CRC causes long-lasting problems' was the lowest as 3.64 ± 0.94 .
- 3) Perceived benefits: The mean score of the perceived benefits was 4.01 ± 0.57 and the possible score range was 5 to 25 (Table 2). 'Colonoscopy helps early detection of CRC' had the highest mean score of 4.18 ± 0.68 and 'treatment is not difficult if CRC is found early' appeared to be the lowest with the mean score of 3.89 ± 0.74 .
- 4) Perceived barrier: The mean score of perceived barriers was 2.77 ± 0.78 and the possible score range was 5 to 25 (Table 2). 'Complications of colonoscopy' had the highest mean of 3.07 ± 1.02 and the mean score of 'transportation difficulties' was the lowest (2.45 ± 0.97).

- 5) Cues to action: The mean score of cues to action was 3.59 ± 0.68 and the possible score range was 3 to 15 (Table 2). The question that had the highest mean score was 'recommendation from family or friends' (3.68 ± 0.78) and the lowest mean score was 'recommendation from mass media' (3.45 ± 0.81).

Table 3-4. Mean, SD, Median of the each HBM components

HBM components	Mean	SD	Median
Perceived Susceptibility	3.05	0.76	3.0
High chance of getting CRC in lifetime	3.46	0.84	4.0
High chance of getting CRC in 10 years	2.99	0.87	3.0
Having many risk factors of CRC	2.97	0.90	3.0
Higher probability of getting CRC compare to others	2.78	0.93	3.0
Perceived Severity	3.74	0.77	3.75
CRC causes long lasting problems	3.64	0.94	4.0
CRC causes negative impacts on relationships	3.74	0.96	4.0
CRC Completely changes my life	3.87	0.92	4.0
Treatment for CRC is expensive	3.71	0.86	4.0
Perceived Benefits	4.01	0.57	4.0
High chance of survival if CRC is found early	3.99	0.69	4.0
Colonoscopy helps early detection of CRC	4.18	0.68	4.0
Treatment is not difficult if CRC is found early	3.89	0.74	4.0
Colonoscopy will reduce concern about CRC	3.98	0.71	4.0
Colonoscopy will reduce CRC death	3.99	0.72	4.0
Perceived barriers	2.76	0.78	2.8
High cost of colonoscopy	2.64	0.97	3.0
Lack of awareness of Colonoscopy	2.66	1.06	3.0
Colonoscopy is painful	3.02	1.03	3.0
Complications of colonoscopy	3.07	1.02	3.0
Transportation difficulties	2.43	0.97	2.0
Cues to action	3.59	0.68	3.67
Recommendation from family or friends	3.68	0.78	4.0
Recommendation from mass media	3.45	0.81	3.0
Concerns about health status	3.63	0.81	4.0

Note. SD= Standard Deviation

Table 3-5 shows descriptive statistics of the HBM constructs by categories. If the mean score of each HBM construct is higher than 4, it was categorized as ‘high’ else ‘low’. In general, the higher proportion of study participants had low ‘perceived susceptibility (86.5%)’, ‘perceived severity (50.3%)’, ‘perceived barriers (92.6%)’ and ‘cues to action (61.3%)’. In contrast to this, 66.4% of the study participants had highly ‘perceived benefits (66.4%)’

Table 3-5. Descriptive statistics of the HBM constructs by categories

The HBM constructs	Frequency	Percentage (%)
Perceived susceptibility		
Low	692	86.5
High	108	13.5
Perceived severity		
Low	402	50.3
High	398	49.8
Perceived benefits		
Low	269	33.6
High	531	66.4
Perceived barriers		
Low	741	92.6
High	59	7.4
Cues to action		
Low	490	61.3
High	310	38.8

Table 3-6 shows the association between the health beliefs and the colonoscopy screening status. The result shows that there are statistically significant differences in perceived susceptibility, perceived benefits, perceived barriers and cues to action according the colonoscopy screening status. Among those who attended for screening colonoscopy during the last 10 years, the mean scores of perceived susceptibility (3.15 ± 0.75), perceived benefits (4.09 ± 0.59) and cues to action (3.85 ± 0.63) were higher than those who did not. In addition, the mean score of the perceived barrier appeared to be lower in the screened group (2.47 ± 0.79) than the non-screened group.

Table 3-6. Mean difference in health beliefs by colonoscopy screening status

HBM components	Colonoscopy screening during the last 10 years				P-value
	No		Yes		
	Mean	SD	Mean	SD	
Perceived susceptibility	2.96	0.75	3.15	0.75	<0.01
Perceived severity	3.71	0.78	3.77	0.76	0.29
Perceived benefits	3.93	0.54	4.09	0.59	<0.01
Perceived barriers	3.03	0.67	2.47	0.79	<0.01
Cues to action	3.35	0.63	3.85	0.63	<0.01

Note. SD= Standard Deviation

3.2.5 Factors associated with the uptake of screening colonoscopy

Prior to conduct logistic regression analyses, multicollinearity between each question in the HBM components was assessed. Variance of Inflation Factor (VIF) was ranged from 1.64 to 3.02 (<10) which indicated that there were no multicollinearity problems.

Table 6-1 shows the result of a univariate logistic regression to examine the factors associated with colonoscopy screening uptake according to the HBM. The results show that a high perceived benefit (OR= 1.60, 95% CI=1.19-2.16) and a high cue to action (OR=4.16, 95% CI=3.07-5.63) were statistically significant among other HBM components.

Among socio-demographic variables, older age (OR=2.23, 95% CI=1.52-3.26), higher years of education (>13 years) (OR= 1.52, 95% CI=1.12-2.07), higher monthly household income (OR=2.63, 95% CI=1.81-3.80), being employed (OR= 1.60, 95% CI=1.15-2.23), regular physical activity (OR=1.68, 95% CI=1.10-2.55), having private insurance (OR=1.46, 95% CI=1.04-2.03), and having chronic disease (OR=1.61, 95% CI=1.21-2.14) were strong determinants of uptake of colonoscopy screening. On the other hands, it was statistically significant that female was less likely to undertake colonoscopy screening than male (OR=0.66, 95% CI=0.50-0.87).

Table 3-7. Univariate logistic regression for factors associated with colonoscopy screening

Variables	Colonoscopy screening during the last 10 years		
	OR	95% CI	P-value
Perceived susceptibility (Low=ref)			
High	1.48	0.98-2.22	0.06
Perceived severity (Low=ref)			
High	1.18	0.90-1.56	0.23
Perceived benefit (Low=ref)			
High	1.60	1.19-2.16	<0.01
Perceived barrier (Low=ref)			
High	0.60	0.34-1.04	0.07
Cues to action (Low=ref)			
High	4.16	3.07-5.63	<0.01
Age Group (45-54= ref)			
55-64	1.64	1.19-2.24	<0.01
65-78	2.23	1.52-3.26	<0.01
Residential status (Metropolitan= ref)			
Non-metropolitan	1.02	0.77-1.34	0.91
Sex (Male= ref)			
Female	0.66	0.50-0.87	<0.01
Year of education (6-12 years= ref)			
More than 13 years	1.52	1.12-2.07	0.01
Monthly household income (Less than \$2,999= ref)			
\$3,000~\$4,999	1.78	1.23-2.59	<0.01
More than \$5,000	2.63	1.81-3.80	<0.01
Employment status (Unemployed= ref)			
Employed	1.60	1.15-2.23	0.01
Physical activity (Not at all= ref)			
Moderate	1.26	0.85-1.86	0.25
Regular	1.68	1.10-2.55	0.02
Private cancer insurance (No= ref)			
Yes	1.46	1.04-2.03	0.03
Smoking status (No smoker= ref)			
Former Smoker	1.23	0.85-1.86	0.23
Current Smoker	1.48	1.06-2.07	0.02
Chronic Disease (No= ref)			
Yes	1.61	1.21-2.14	<0.01

Note. OR= Odds Ratio; CI= Confidence Interval

All variables from the univariate logistic regression were further included to conduct multivariate logistic regression (Table 3-8). In the model 1, only five HBM components were included for the multivariate logistic regression. The result reveals that the higher perceived barrier (aOR=0.43, 95% CI=0.24-0.80), the lower participation to the colonoscopy screening was found whereas a high cue to action (aOR=4.31, 95% CI=3.10-5.98) were strongly associated with the participation to colonoscopy screening. In the model 2, the demographic variables were included in addition to the model 1. After adjusting the demographic variables, the perceived barrier and cues to action remained statistically significant (aOR=0.45, 95% CI=0.24-0.84 and aOR=4.25, 95% CI=3.01-5.99). Older age (aOR=2.67, 95% CI= 1.71-4.15) and the higher monthly household income (aOR=2.11, 95% CI=1.34-3.30) also had significant associations with colonoscopy screening behavior.

Table 3-8. Multivariate logistic regression for factors associated with colonoscopy screening

Variables	Model 1			Model 2		
	aOR	95% CI	P-value	aOR	95% CI	P-value
Perceived susceptibility (Low= ref)						
High	1.11	0.70-1.77	0.65	0.98	0.60-1.60	0.95
Perceived severity (Low= ref)						
High	0.90	0.66-1.23	0.50	0.83	0.59-1.15	0.26
Perceived benefit (Low= ref)						
High	1.09	0.79-1.52	0.59	0.89	0.63-1.27	0.53
Perceived barrier (Low= ref)						
High	0.43	0.24-0.80	0.01	0.45	0.24-0.84	0.01
Cues to action (Low= ref)						
High	4.31	3.10-5.98	<0.01	4.25	3.01-5.99	<0.01
Age Group (45-54= ref)						
55-64				1.46	1.02-2.07	0.04
65-78				2.67	1.71-4.15	<0.01
Residential status (Metropolitan= ref)						
Non-metropolitan				1.10	0.80-1.50	0.56
Sex (Male= ref)						
Female				0.84	0.59-1.19	0.32
Education level (6-12 years= ref)						
More than 13 years				1.25	0.87-1.81	0.23
Monthly household income (Less than \$2,999= ref)						
\$3,000-\$4,999				1.61	1.05-2.47	0.03
More than \$5,000				2.11	1.34-3.30	<0.01
Employment status (Unemployed= ref)						
Employed				1.39	0.93-2.07	0.10
Exercise (Not at all= ref)						
Moderate				1.03	0.67-1.60	0.89
Regular				1.22	0.76-1.96	0.41
Private cancer insurance (No= ref)						
Yes				1.16	0.78-1.71	0.46
Smoking status (No= ref)						
Yes				1.22	0.84-1.78	0.30
Chronic Disease (No= ref)						
Yes				1.34	0.97-1.85	0.07

Note. aOR= Adjusted Odds Ratio; CI= Confidence Interval; All variables were adjusted

3.2.6 Intention to undergo colonoscopy screening under the NCSP

Table 4-1 shows the distribution of an intention to undergo screening colonoscopy under the NCSP in 5-point Likert scale. About 80% of the study subjects agreed or strongly agreed to undergo screening colonoscopy if it is provided as the NCSP.

An individual's intention has been demonstrated by socio-demographic variables in table 4-1. The intention was highest among the individuals aged between 65 and 78 (4.08 ± 0.80), those who reside in non-metropolitan area (4.02 ± 0.82), male (4.10 ± 0.76), those who had higher monthly household income (4.16 ± 0.16) and the employed (4.02 ± 0.80). In addition, the participants who conduct regular physical activities (4.07 ± 0.82), having private insurance (4.08 ± 0.77), smokers (4.06 ± 0.71) and having chronic diseases (4.10 ± 0.76) had higher intention to undergo colonoscopy screening. The result shows that sex ($P < 0.01$), monthly household income ($P < 0.01$), private cancer insurance ($P < 0.01$) and chronic disease status ($P = 0.02$) had statistically significant association with an individual's intention to undergo colonoscopy screening under the NCSP.

Table 4-1. Intention to undergo colonoscopy in 5-point Likert scale (N=800)

'If colonoscopy is available as the NCSP, would you like to undergo colonoscopy?'	Frequency (%)
Strongly disagree (1)	5 (0.63)
Disagree (2)	22 (2.75)
Neutral (3)	155 (19.38)
Agree (4)	396 (49.50)
Strongly agree (5)	222 (27.75)

Table 4-2. Intention to undergo colonoscopy screening by socio-demographic variables

Intention to undergo COL screening under the NCSP					
Variable	N	%	Mean	SD	P-Value
Age Group					
45-54	319	39.9	3.97	0.79	0.36
55-64	312	39.0	4.01	0.81	
65-78	169	21.1	4.08	0.80	
Residential status					
Metropolitan	373	46.6	3.99	0.80	0.57
Non-metropolitan	427	53.4	4.02	0.80	
Sex					
Male	393	49.1	4.10	0.76	<0.01
Female	407	50.9	3.92	0.83	
Years of Education					
6-12 years	243	30.4	3.93	0.81	0.05
More than 13 years	557	69.6	4.04	0.79	
Monthly household income					
Less than \$2,999	202	25.3	3.76	0.89	<0.01
\$3,000~\$4,999	294	36.8	4.02	0.73	
More than \$5,000	304	38.0	4.16	0.76	
Employment status					
Unemployed	193	24.1	3.97	0.79	0.47
Employed	607	75.9	4.02	0.80	
Physical activities					
Not at all	139	17.4	3.94	0.83	0.20
Moderate	416	52.0	4.00	0.78	
Regular	245	30.6	4.07	0.82	
Private cancer insurance					
No	185	23.1	3.77	0.85	<0.01
Yes	615	76.9	4.08	0.77	
Smoking status					
No	577	72.1	3.99	0.83	0.46
Yes	223	27.9	4.06	0.71	
Chronic Disease					
No	473	59.1	3.95	0.82	0.02
Yes	327	40.9	4.10	0.76	

Note. SD= Standard Deviation

A univariate ordinal logistic regression analysis was conducted to identify the association between the HBM components and an individual's intention to undergo colonoscopy under the NCSP (Table 4-2). The results revealed that four HBM related variables including 'perceived susceptibility (OR=2.42, 95% CI=1.65-3.54)', 'perceived severity (OR=2.40, 95% CI=1.84-3.15)', "perceived benefits (OR=5.36, 95% CI=3.95-7.28)" and 'cues to action (OR=9.66, 95% CI=6.96-13.40)' had strong association with higher intention to undergo colonoscopy. Among demographic variables, higher monthly household income (OR= 2.57, 95% CI=1.82-3.62), having private cancer insurance (OR=2.08, 95% CI=1.52-2.85) and having chronic disease (OR=1.38, 95% CI=1.06=1.81) were significant predictor of colonoscopy screening behavior whereas female were less likely to undergo colonoscopy (OR=0.66, 95% CI=0.51-0.85).

Table 4-3. Univariate ordinal logistic regression for factors associated with intention to undergo colonoscopy under the NCSP

Variables	Intention to undergo COL under the NCSP		
	OR	95% CI	P-value
Perceived susceptibility (Low=ref)			
High	2.42	1.65-3.54	<0.01
Perceived severity (Low=ref)			
High	2.40	1.84-3.15	<0.01
Perceived benefit (Low=ref)			
High	5.36	3.95-7.28	<0.01
Perceived barrier (Low=ref)			
High	1.08	0.66-1.77	0.76
Cues to action (Low=ref)			
High	9.66	6.96-13.40	<0.01
Age Group (45-54= ref)			
55-64	1.12	0.83-1.49	0.47
65-78	1.29	0.91-1.84	0.15
Residential status (Metropolitan= ref)			
Non-metropolitan	1.08	0.83-1.40	0.57
Sex (Male= ref)			
Female	0.66	0.51-0.85	<0.01
Education level (6-12 years= ref)			
More than 13 years	1.33	1.00-1.76	0.05
Monthly household income (Less than \$2,999= ref)			
\$3,000~\$4,999	1.77	1.26-2.49	<0.01
More than \$5,000	2.57	1.82-3.62	<0.01
Employment status (Unemployed= ref)			
Employed	1.18	0.87-1.60	0.29
Physical activities (Not at all= ref)			
Moderate	1.16	0.81-1.67	0.41
Regular	1.41	0.95-2.10	0.09
Private cancer insurance (No= ref)			
Yes	2.08	1.52-2.85	<0.01
Smoking status (No= ref)			
Yes	1.11	0.84-1.48	0.46
Chronic Disease (No= ref)			
Yes	1.38	1.06-1.81	0.02

Note. OR= Odds Ratio; CI= Confidence Interval; COL= Colonoscopy;

All variables included in the univariate ordinal logistic regression were further added for a multivariate ordinal logistic regression analysis (Table 4-2). Model 1 only includes the HBM related variables while model 2 includes socio-demographic variables in addition to the model 1. In the model 1, a high perceived susceptibility (aOR=1.57, 95% CI=1.17-2.09) and a high perceived benefit (aOR=3.39, 95% CI=2.47-4.64) were statistically significant. Moreover, cues to action (aOR=6.94, 95% CI=4.93-9.76) was the strongest determinants of an individual's high intention to undergo colonoscopy under the NCSP. In addition to this, having private insurance (aOR=1.64, 95% CI=1.16-2.33) was a strong predictor of high intention whereas female (aOR=0.62, 95% CI=0.45-0.85) had lower intention to undergo colonoscopy in the model 2.

4-4. Multivariate ordinal logistic regression for factors associated with intention to undergo colonoscopy under the NCSP

Variables	Intention to undergo Colonoscopy under the NCSP					
	Model 1			Model 2		
	aOR	95% CI	P-value	aOR	95% CI	P-value
Perceived susceptibility (Low= ref)						
High	1.33	0.87-2.05	0.19	1.34	0.86-2.10	0.19
Perceived severity (Low= ref)						
High	1.57	1.17-2.09	<0.01	1.58	1.17-2.13	<0.01
Perceived benefit (Low= ref)						
High	3.39	2.47-4.64	<0.01	3.19	2.31-4.41	<0.01
Perceived barrier (Low= ref)						
High	0.65	0.38-1.12	0.12	0.67	0.39-1.17	0.16
Cues to action (Low= ref)						
High	6.94	4.93-9.76	<0.01	6.78	4.79-9.57	<0.01
Age Group (45-54= ref)						
55-64				0.86	0.63-1.18	0.36
65-78				1.26	0.85-1.87	0.26
Residential status (Metropolitan= ref)						
Non-metropolitan				1.16	0.87-1.54	0.30
Sex (Male= ref)						
Female				0.62	0.45-0.85	<0.01
Education level (6-12 years= ref)						
More than 13 years				0.78	0.56-1.09	0.15
Monthly household income (Less than \$2,999= ref)						
\$3,000~\$4,999				1.36	0.93-1.99	0.12
More than \$5,000				1.41	0.94-2.12	0.09
Employment status (Unemployed= ref)						
Employed				0.90	0.63-1.28	0.55
Physical activities (Not at all= ref)						
Moderate				1.08	0.73-1.60	0.69
Regular				1.16	0.76-1.78	0.50
Private cancer insurance (No= ref)						
Yes				1.64	1.16-2.33	0.01
Smoking status (No= ref)						
Yes				0.79	0.56-1.11	0.18
Chronic Disease (No= ref)						
Yes				1.17	0.87-1.57	0.30

Note. aOR= Adjusted Odds Ratio; CI= Confidence Interval; Model 1= only HBM variables were adjusted; Model 2= all variables were adjusted

In overall, the intention to undergo colonoscopy under the NCSP was significantly higher among those who recently attended for screening colonoscopy compared to those who did not (4.26 ± 0.69 vs 3.79 ± 0.82 , $P<0.01$).

Table 4-3 shows mean difference of the study participant's intention to undergo colonoscopy screening under the NCSP by their recent colonoscopy screening experience. In overall, if the study participants recently underwent opportunistic colonoscopy during the last 10 years, their intention to undergo colonoscopy under the NCSP was relatively higher compared to those who did not recently undergo colonoscopy. Among those who recently underwent colonoscopy screening, sex ($P < 0.01$) and monthly household income ($P < 0.01$) had statistically significant association with the intention to undergo colonoscopy under the NCSP. On the other hands, private cancer insurance ($P < 0.01$) was significantly associated with the colonoscopy screening intention among the participants who did not recently underwent colonoscopy.

Table 4-5. Intention to undergo colonoscopy under the NCSP by the recent colonoscopy screening status

Variable	Intention to undergo COL screening under the NCSP					
	Recent COL screening			No recent COL screening		
	Mean	SD	P-Value	Mean	SD	P-Value
Age Group						
45-54	4.21	0.67	0.32	3.82	0.82	0.51
55-64	4.24	0.71		3.78	0.83	
65-78	4.34	0.69		3.72	0.81	
Residential status						
Metropolitan	4.25	0.67	0.73	3.77	0.84	0.57
Non-metropolitan	4.26	0.72		3.81	0.82	
Sex						
Male	4.35	0.65	<0.01	3.83	0.78	0.46
Female	4.14	0.72		3.76	0.86	
Years of Education						
6-12 years	4.19	0.78	0.40	3.77	0.79	0.46
More than 13 years	4.28	0.66		3.80	0.84	
Monthly household income						
Less than \$2,999	3.96	0.86	<0.01	3.67	0.89	0.15
\$3,000~\$4,999	4.24	0.62		3.83	0.77	
More than \$5,000	4.39	0.64		3.86	0.81	
Employment status						
Unemployed	4.22	0.76	0.74	3.83	0.77	0.95
Employed	4.27	0.67		3.78	0.85	
Physical activities						
Not at all	4.27	0.70	0.54	3.71	0.83	0.56
Moderate	4.22	0.72		3.82	0.78	
Regular	4.32	0.65		3.78	0.90	
Private cancer insurance						
No	4.12	0.70	0.05	3.54	0.86	<0.01
Yes	4.29	0.69		3.88	0.79	
Smoking status						
No	4.27	0.71	0.31	3.76	0.85	0.22
Yes	4.22	0.64		3.89	0.74	
Chronic Disease						
No	4.20	0.72	0.11	3.76	0.85	0.52
Yes	4.32	0.66		3.83	0.78	

Note. Recent COL screening= colonoscopy screening during the last 10 years; No recent COL screening= no colonoscopy screening during the last 10 years; SD= Standard Deviation

Table 4-4 shows an individual's intention to undergo colonoscopy screening under NCSP according to their recent colonoscopy screening experience. Among those who underwent colonoscopy screening during the last 10 years, a high perceived severity (OR=2.31, 95% CI=1.56-3.44), a high perceived benefits (OR=10.95, 95% CI=6.33-18.95), a high cue to action (OR=8.59, 95% CI=5.35-13.78), female (OR=0.56, 95% CI=0.38-0.83) and a high monthly household income (OR=3.15, 95% CI=1.78-5.59) were significantly associated with a high intention to have colonoscopy screening. On the other hands, those who did not undergo colonoscopy during the last 10 years were more likely to have a higher intention to undergo colonoscopy under the NCSP if they had a high perceived susceptibility (OR=3.23, 95% CI=1.82-5.76), a high perceived severity (OR=2.44, 95% CI=1.68-3.54), a high perceived benefit (OR=3.35, 95% CI=2.27-4.94), and a high cue to action (OR=7.74, 95% CI=4.75-12.59).

Table 4-6. Univariate ordinal logistic regression by recent colonoscopy screening status

Variables	Intention to undergo COL screening under the NCSP					
	Recent COL screening			No recent COL screening		
	OR	95% CI	P-value	OR	95% CI	P-value
Perceived susceptibility						
High	1.67	0.99-2.82	0.05	3.23	1.82-5.76	<0.01
Perceived severity						
High	2.31	1.56-3.44	<0.01	2.44	1.68-3.54	<0.01
Perceived benefit						
High	10.95	6.33-18.95	<0.01	3.35	2.27-4.94	<0.01
Perceived barrier						
High	0.59	0.26-1.34	0.21	1.89	0.99-3.59	0.05
Cues to action						
High	8.59	5.35-13.78	<0.01	7.74	4.75-12.59	<0.01
Age Group (45-54= ref)						
55-64	1.12	0.72-1.77	0.61	0.91	0.61-1.35	0.64
65-78	1.47	0.88-2.45	0.14	0.74	0.44-1.23	0.24
Residential status (Metropolitan= ref)						
Non-metropolitan	1.07	0.73-1.57	0.73	1.11	0.77-1.59	0.57
Sex (Male= ref)						
Female	0.56	0.38-0.83	<0.01	0.87	0.61-1.25	0.46
Education level (6-12 years= ref)						
More than 13 years	1.22	0.78-1.90	0.39	1.15	0.79-1.67	0.47
Monthly household income (≤\$2,999= ref)						
\$3,000~\$4,999	1.98	1.11-3.55	0.02	1.41	0.91-2.18	0.12
≥ \$5,000	3.15	1.78-5.59	<0.01	1.54	0.97-2.42	0.06
Employment status (Unemployed= ref)						
Employed	1.09	0.66-1.79	0.73	0.99	0.66-1.47	0.95
Physical activities (Not at all= ref)						
Moderate	0.88	0.49-1.56	0.65	1.28	0.80-2.06	0.30
Regular	1.11	0.61-2.03	0.73	1.27	0.75-2.17	0.38
Private cancer insurance (No= ref)						
Yes	1.64	1.01-2.68	0.05	2.18	1.44-3.29	<0.01
Smoking status (No= ref)						
Yes	0.81	0.54-1.22	0.32	1.29	0.85-1.94	0.23
Chronic Disease (No= ref)						
Yes	1.37	0.93-2.02	0.11	1.13	0.78-1.64	0.52

Note. Recent COL screening= Colonoscopy screening during the last 10 years; No recent COL screening= No colonoscopy screening during the last 10 years; OR= Odds Ratio, CI= Confidence Interval

Multivariate ordinal logistic regression analysis was conducted including all variables from the table 4-4. The result shows that a high perceived benefit and a high cue to action were strong determinants of a high intention to undergo colonoscopy screening under the NCSP regardless of the recent colonoscopy screening experience. The higher perceived barrier (aOR=0.35, 95% CI=0.14-0.95), the lower intention to undergo colonoscopy screening under the NCSP was observed among those who underwent colonoscopy during the last 10 years. Moreover, female (aOR=0.44, 95% CI=0.27-0.72) had a lower intention to undergo colonoscopy compared to men whereas those who are aged between 65-78 (aOR=1.95, 95% CI=1.04-3.66) and having a higher monthly household income status (aOR=2.72, 95% CI=1.35-5.49) were significantly more likely to have a high intention to have colonoscopy.

On the other hands, a high perceived susceptibility (aOR=2.10, 95% CI=1.10-4.02) and a high perceived (aOR=1.95, 95% CI=1.29-1.94) were strong predictor if a high intention to undergo colonoscopy among those who did not underwent colonoscopy during the last 10 years.

Table 4-7. Multivariate ordinal logistic regression by recent colonoscopy screening status

Variables	Intention to undergo COL screening as the NCSP					
	Recent COL screening			No recent COL screening		
	aOR	95% CI	P-value	aOR	95% CI	P-value
Perceived susceptibility						
High	1.16	0.60-2.24	0.66	2.10	1.10-4.02	0.02
Perceived severity						
High	1.38	0.86-2.21	0.18	1.95	1.29-2.94	<0.01
Perceived benefit						
High	6.30	3.57-11.11	<0.01	2.37	1.56-3.62	<0.01
Perceived barrier						
High	0.35	0.14-0.90	0.03	0.89	0.43-1.84	0.76
Cues to action						
High	5.89	3.46-10.01	<0.01	5.96	3.57-9.96	<0.01
Age Group (45-54= ref)						
55-64	0.94	0.56-1.57	0.81	0.75	0.49-1.15	0.19
65-78	1.95	1.04-3.66	0.04	0.83	0.48-1.44	0.51
Residential status (Metropolitan= ref)						
Non-metropolitan	1.38	0.88-2.15	0.16	1.10	0.75-1.62	0.62
Sex (Male= ref)						
Female	0.44	0.27-0.72	<0.01	0.73	0.46--1.16	0.18
Education level (6-12 years= ref)						
More than 13 years	0.89	0.52-1.53	0.67	0.73	0.471.13	0.16
Monthly household income (\leq \$2,999= ref)						
\$3,000~\$4,999	1.74	0.88-3.40	0.11	1.25	0.78-2.03	0.36
\geq \$5,000	2.72	1.35-5.49	0.01	0.86	0.50-1.46	0.57
Employment status (Unemployed= ref)						
Employed	0.68	0.37-1.26	0.22	0.92	0.58-1.44	0.71
Physical activities (Not at all= ref)						
Moderate	0.86	0.46-1.63	0.65	1.34	0.80-2.22	0.27
Regular	1.00	0.50-1.98	1.00	1.30	0.73-2.30	0.37
Private cancer insurance (No= ref)						
Yes	1.63	0.92-2.90	0.09	1.64	1.04-2.59	0.03
Smoking status (No= ref)						
Yes	0.68	0.41-1.13	0.14	0.92	0.56-1.51	0.75
Chronic Disease (No= ref)						
Yes	1.21	0.78-1.88	0.40	0.98	0.65-1.47	0.91

Note. Recent COL screening= colonoscopy screening during the last 10 years; No Recent COL screening= No colonoscopy screening during the last 10 years; aOR= Adjusted Odds Ratio; CI= Confidence Interval

4. Discussion

4.1 The CA (Conjoint Analysis)

4.1.1 Preference in CRC screening tests

In this study, we investigated the most preferred CRC screening tests as well as the most importantly valued attributes and levels of different CRC screening tests. This study results provided an insight into the feasibility of implementing primary colonoscopy screening under the NCSP and the strategies to implement primary colonoscopy based on their preference.

Our study findings suggested that colonoscopy was significantly more preferred as primary CRC screening method over FOBT (77.0% vs 23.0%). In agreement with our study results, colonoscopy was the most preferred primary CRC screening for the NCSP over FOBT with a preference ratio of 2.2 to 1 (68.7% vs 31.3%) in one previous study [50]. This higher preference for colonoscopy may be influenced by a high accessibility, low cost of colonoscopy and the availability of experienced colonoscopies. However, this study was conducted in a single center which may implicate the possibility of selection bias; thus, this study result cannot be generalized to the Korean population. Similar finding was also observed in a population-based study in Switzerland that about 75% of the eligible study population significantly preferred colonoscopy than FOBT and flexible sigmoidoscopy [72]. In contrast to this, a meta-analysis of prospective CRC screening studies reported that the overall pooling of participation rates for FOBT and colonoscopy were

42% and 27% respectively [73]. Similarly, two RCT studies demonstrated that the participation rate of FOBT was significantly higher than colonoscopy [27, 74]. These variations in preference in CRC screening tests may be because socio-economic status, the capacity to perform colonoscopy, perceived awareness and knowledge about colonoscopy are different by countries [50]. Therefore, prospective and population-based studies will be imperative to identify individual's preferences in CRC screening tests among Korean population.

4.1.2 The results from the CA

Previously, six studies identified the most importantly valued attributes of CRC screening tests using the CA [34, 44, 45, 49, 75]. In these studies, CRC mortality reduction was the strongest predictor of preference for a screening test [47-49]. Similarly, our study findings demonstrated that efficacy related attributes including CRC mortality reduction and sensitivity were the most valued attributes that determines an individual's preference.

In addition, the study results revealed that sensitivity was the second most importantly valued attribute following CRC mortality reduction in overall, which may explain the reason why colonoscopy was more preferred over FOBT. International agencies such as the Canadian Task Force on Preventive Care, the American Cancer Society and the US Preventive Task Force for CRC screening also concluded that the main reason why colonoscopy was preferred was accuracy and why FOBT was least preferred [76-78]. In accordance with two previous studies, sensitivity was a strong predictor of preference in CRC screening [34, 48].

In overall, the results from the CA suggests that a high CRC mortality reduction and a high sensitivity were the most important characteristics of CRC screening when the study subjects considered their participation to the CRC screening. According to the most recent meta-analysis of observational studies, estimated risk reductions in CRC death with colonoscopy was almost 70% [26]. In addition, the sensitivity of colonoscopy has been known to be the highest among other available CRC screening tests ranged from 90% to

100% [6]. Thus, our study results suggest that colonoscopy is highly preferred as a primary CRC screening test over FOBT and an implementation of primary colonoscopy screening as a part of the NCSP is feasible. Moreover, promoting strategies to increase an individual's awareness in a high accuracy of colonoscopy and its effectiveness on CRC mortality reduction will may increase the future uptake of the NCSP.

On the other hands, preparation was the second most important attribute following CRC mortality reduction among those who preferred FOBT as the NCSP. This study finding demonstrates that there is a clear difference in characteristics of CRC screening tests that affect an individual's preferences. This finding is supported by other CA study that there was a tendency that preparation, discomfort, and cost were more important to patients who preferred a stool test whereas those who preferred colonoscopy had strong preference for high sensitivity [32].

According to the results of a RCT study, the participation rate of CRC screening significantly increased when they were offered a choice of FOBT or colonoscopy (69%, $P<0.001$) compared to recommendation of a specific CRC screening test (FOBT 67% and Colonoscopy 37% respectively, $P<0.001$) [79]. Thus, providing a wide range of CRC screening methods under the NCSP and in-depth information in terms of the characteristics, benefits and harms of each CRC screening methods to the eligible people prior to their participation to the NCSP will have a great impact on improving the CRC

screening uptake rate through enabling them to make an informed choice of their preferred CRC screening test.

4.2 The HBM (Health Belief Model)

4.2.1 Colonoscopy screening rates

According to Statistics Korea, the national CRC screening uptake rate was 36.7% in 2017 [4]. In addition, colonoscopy screening uptake rate has gradually increased to 45.4% while the screening rate of FOBT remained between 25% and 30% in 2018 [80]. In the current study, the lifetime screening rate of colonoscopy and colonoscopy screening with recommendation were found to be 49.5% and 47.1% respectively which are slightly higher than that of a previous study (43.5% and 30.2% respectively in 2012) [24]. In addition, the lifetime CRC screening rate and the CRC screening rate with recommendation in 2010 were 50.5% and 39.7% respectively in one study [68]. However, the screening rates are hardly comparable as this study did not distinguish CRC screening rates by different CRC screening modalities.

Although the colonoscopy screening rates were found to be within the acceptable range as per the recommendations from the EU guideline (>45%), the screening rate is still relatively lower compared to other countries [22, 68]. In the USA in 2016, 55.7% of the eligible people aged over 50 years received sigmoidoscopy or colonoscopy in the preceding 10 years [81]. Moreover, 60.8% of the eligible people received one or both tests in the past 10 years [81].

In the current study, the colonoscopy screening rates were the highest among the age group of 65-78 years and the rate was significantly higher in

women than men in the same age group. Conversely, the colonoscopy screening rate among women was significantly lower in relatively younger age groups (45-54 years and 55-64 years). According to a systematic review, female gender was one of the most frequently reported barrier to participate screening colonoscopy [82]. Thus, strategies that reduce barriers to participate screening colonoscopy for relatively young females will be needed in order to increase the CRC screening rates.

4.2.2 Factors associated with colonoscopy screening uptake

The results from the CA suggested that it is highly feasible to implement colonoscopy as the NCSP with consideration of the study participant's preference and important attributes of CRC screening. Thus, it is necessary to identify factors associated with opportunistic colonoscopy screening uptake as well as an individual's intention to undergo primary colonoscopy screening under the NCSP.

For the factors associated with screening colonoscopy, 'cues to action' including recommendation from family or friends or mass media had a great impact on uptake of screening colonoscopy (aOR=4.25, CI=3.01-5.99) [83, 84]. According to Bae et al., (2008), the likelihood of cancer screening was shown to be 1.41 times higher when family members occasionally recommended cancer screening compared to no recommendation. Notably, the likelihood of screening was significantly increased to 4.93 times when cancer screening was frequently recommended by family members [85]. In addition, physician recommendation has been reported as a strong predictor of colonoscopy screening uptake in numerous studies [84, 86-91]. However, it was reported that even though physician recommendation is important, only 29% of Korean physician "always" recommends CRC screenings compared to the U.S (95%). Primary care physicians, especially those who working at screening units, have the major task of encouraging CRC screening because there is no family medicine system under National Health Insurance Service (NHIS) in Korea [92, 93].

Therefore, primary physicians should be aware of the impact of their endorsement and be encouraged to discuss CRC screening and convey its importance to patients to reduce individual's perceived barriers to participation to colonoscopy screening. Moreover, screening recommendation strategies that target family instead of individuals will be necessary.

Conversely, 'perceived barriers' was found to have negative association with screening colonoscopy (aOR=0.45, 95% CI=0.24-0.84). This result can be interpreted as higher perceived barrier, the lower participation to colonoscopy screening would be observed. From our study results, the fear of complications was identified as the most significant barrier to screening colonoscopy (Table 3-4). According to the recent USPSTF technical review (2016), estimated risks of perforation was 4 per 100,000 (95% CI=2.0-5.0) and major hemorrhage was 8 per 100,000 (95% CI=5.0-14) respectively with screening colonoscopy [16]. To prevent such major complications, the quality assurance and the quality standards of screening colonoscopy should be ensured at a national level.

As one of key quality control standards, the European Society of Gastrointestinal Endoscopy (ESGE) recommended for screening programs to agree a minimum lifetime experience for their screening colonoscopists and set a minimum benchmark for their annual number of screening examinations [94]. According to a population-based study in Canada, risk of complications such as perforation and bleeding was increased threefold higher with colonoscopists who performed fewer than the threshold of 300 colonoscopies

per year [95]. In addition, the UK NHS Bowel Cancer Screening Program requires a minimum lifetime experience of 1,000 examinations and a minimum annual number of 150 screening colonoscopies [94]. However, in Korea, the number of colonoscopies that should be undertaken to meet the quality standard is lower than other countries [19]. Therefore, the quality standards for the minimum number of colonoscopies should be increased in order to improve the quality of screening colonoscopy and to minimize the complications.

4.2.3 Intention to undergo colonoscopy under the NCSP

The current study further applied the HBM to identify the factors associated with the study participant's intent to undergo colonoscopy under the NCSP. In overall, most of the study participants (77%) expressed a strong intention to receive screening colonoscopy if it is implemented as the national CRC screening program.

For the factors associated with an intent to undergo colonoscopy, firstly, perceived severity (aOR=1.58, 95% CI=1.17-2.13) was significantly associated with an individual's increased intention (Table 4-4) which was consistent with results from two previous studies [96, 97]. Fear of asymptomatic CRC and perceived severity of the consequences of developing CRC determined the readiness of CRC screening in three previous studies [57, 68, 98]. Similarly, Jacob (2002) found that the CRC screening rates significantly increased with the higher perceived severity [98]. However, perceived severity was not identified as a significant predictor of CRC screening in a systematic review [43] and the likelihood of undergoing colonoscopy also decreased with higher perceived severity in one study [59]. Janz (1984) explained for these various study outcomes that it is probably because the respondents may have difficulties of understanding this concept when 1) they are asymptomatic; 2) health threats are thought to be long-term and 3) concerning of a medical condition that they had no personal experience [35].

Secondly, the study participants with a high perceived benefit were more likely to state a higher intent to undergo colonoscopy screening (aOR=3.19, 95% CI=2.31-4.41). This finding supports a substantial body of research on the association between benefits and intentions in participating in cancer screening [97, 99]. However, perceived benefits were not identified as a significant factor associated with CRC screening in several studies [57, 89, 100]. For the reasons for these various outcomes, it can be explained by the fact that perceived benefits may be affected by an individual's knowledge about benefits of colonoscopy, a wide availability of CRC screening tests and previous experience of CRC screening. According to Zheng et al., (2006), they demonstrated that knowledge about CRC was positively associated with intention to be screened [101]. In our study, the study participants highly perceived the benefits of colonoscopy, especially its impact on early detection of CRC (Table 3-4). Thus, increasing the knowledge and awareness about the effectiveness of screening colonoscopy on early detection of CRC will help increase the national CRC screening uptake rate.

In the present study, it was found that the future intention for colonoscopy under the NCSP was significantly higher among those who recently underwent colonoscopy through opportunistic screening compared to those who did not have recent experience (4.26 ± 0.69 vs 3.79 ± 0.82 , $P < 0.01$). Similarly, previous studies demonstrated that there were significant association between previous CRC screening status and the eligible people's future intention in CRC screening [51, 67, 68, 102]. According to Han (2011),

those who recently underwent colonoscopy had significantly higher intention to undergo CRC screening (aOR=26.31, 95% CI=15.99–43.25) compared to those who underwent FOBT (aOR=1.71, 95% CI=1.15–2.55).

To identify factors affecting the future CRC screening intention when colonoscopy is implemented as the NCSP, we demonstrated that there were different HBM domains that affect individual's intention to be screened according to their recent colonoscopy screening status (Table 4-7). Among those recently underwent screening colonoscopy in preceding 10 years, perceived barrier was a strong determinant of a low screening intention (aOR=0.35, 95% CI= 0.14-0.90) whereas it was not significant among those who did not recently undergo screening colonoscopy. This study finding may imply that those who had recent experience of colonoscopy have stronger perception about barriers from colonoscopy. In addition, female who received recent screening colonoscopy had a lower intention to participate to screening colonoscopy under the NCSP (aOR=0.44, 95% CI=0.27-0.72). According to Wong (2013), significantly more women than men had feared a positive diagnosis, held embarrassment, pain and risk concerns about colonoscopy [103]. Thus, strategies to reducing barriers, especially considering those who previously underwent colonoscopy and female will be needed.

Among those who did not undergo recent screening colonoscopy, perceived susceptibility (aOR=2.10, 95% CI=1.10-4.02) and perceived severity (aOR=1.95, 95% CI=1.29-2.94) had significant associations with a high intention to participate screening colonoscopy. Perceived susceptibility

was a significant determinant of CRC screening in one previous study [59], but was not identified as an associated factor in another study [57]. For this heterogeneity in study results, Hay (2003) explained that it may be because of a limitation of cross-sectional design as it cannot accurately assess a motivation for future CRC screening [84]. For example, some people are motivated to attend CRC screening because they are at high risk for CRC, whereas others are motivated simply because they typically engage in frequent multiple health behaviors although they think that they are not at high risk. In addition, cross-sectional designs cannot reflect the results of those who previously received negative results on CRC screening. Thus, future studies with a prospective design should be conducted to identify the association between perceived susceptibility and motivation to attend CRC screening [84].

Moreover, fear of CRC was also reported as one of the most important reasons for the attendance of screening colonoscopy in one previous study [68]. According to Bae (2008), it was found that the gastric cancer screening rate increased to 51.2% when the participants had a high anxiety for the occurrence of cancer compared to a low anxiety (33.3%) [104].

This finding may suggest that the highly perceived seriousness and concerns about CRC may have led to a high intention to screening colonoscopy because they did not recently undergo colonoscopy. Thus, it is necessary to increase the awareness about a high chance of getting CRC and the serious consequences of CRC may increase the intention to undergo colonoscopy among those who did not have recent colonoscopy.

Perceived benefits and cues to action appeared to be strong determinants that lead to a high intention for screening colonoscopy under the NCSP regardless of the recent colonoscopy status. Therefore, effective strategies to increase an individual's knowledge in terms of benefits of screening colonoscopy and strong recommendation strategies should be implemented through various means in order to increase their intention for screening colonoscopy when it is implemented as the national CRC programme.

4.3 Strength and limitations

The current study suggested the feasibility of implementing colonoscopy as the NCSP and strategies to increase CRC screening uptake rate through identifying factors associated with an individual's CRC screening behavior and their future intention to undergo colonoscopy screening under the NCSP. To our knowledge, this is the first population-based study that suggested the feasibility of implementation of colonoscopy under the NCSP through the application of the CA in Korea. Although one previous study examined an individual's preferences in primary CRC screening tests, this study was conducted in a single-center without application of a conceptual methodology such as the CA [50]. Moreover, the current study was also firstly conducted to examine factors associated with colonoscopy screening behaviors as well as an individual's intention to undergo colonoscopy as a primary CRC screening method under the NCSP by using the HBM. Therefore, this study results can provide important evidence to the feasibility of implementing colonoscopy as the NCSP and to increase the future CRC screening uptake rates.

As a limitation of our study, although we recruited the study subjects through the stratified random sampling, the sample size was relatively small (N=500 and N=800 respectively for the CA and the HBM). Therefore, future studies with a larger sample size will further support our study findings.

For the CA, we used a rank-based format instead of choice-based format unlike other previous CA studies. Choice-based design allows to include an

option of ‘no screening (opt-out) and it can estimate the willingness of an individuals to undergo no screening. In the rank-based format, an option of ‘no screening’ was not included in the scenarios, in turn the trade-offs between participation to CRC screening and ‘no screening’ could not be measured. However, we estimated the effect of ‘no screening’ by asking their willingness of ‘no screening’ separately. The participants were asked their willingness of ‘no screening’ after determining their preferences between either FOBT or colonoscopy. Only 6% of the participants answered they would undergo ‘no screening’ if there is an available option. Therefore, the effects of ‘no screening’ would be minimum. Interestingly, in our study results, lower specificity (87.2%~92.8%) was more preferred over higher specificity (99%). This may be because there was no significant difference between two values which made the participants difficult to trade off. Therefore, future studies using values with clear differences would be needed. Currently, colonoscopy is only available through opportunistic screening.

An online survey was conducted to examine individual’s health beliefs in screening colonoscopy. Although study participants were randomly selected through stratification, the subjects aged over 45 and with good computer literacy skills were only able to participate to this survey which may indicate a selection bias. Among the study subjects, the proportion of the participants with higher education and income were relatively higher and it may have affected the study outcomes as there have been various studies that investigated the

positive association between higher income and education status and compliance of CRC screening, especially colonoscopy [60, 93].

For the HBM domains, we did not include physician recommendation in cues to action and bowel preparation in perceived barrier which have been identified as either a significant facilitator and the most burdensome part of colonoscopy respectively [43, 106]. If we consider these two factors, the effects of cues to action and perceived barrier may become more significant.

Lastly, the characteristics of colonoscopy used in the current study does not fully reflect the characteristics of colonoscopy under the NCSP (e.g. cost) as colonoscopy is currently available only through opportunistic screening. Therefore, future studies that consider the characteristics of colonoscopy under the NCSP will be necessary.

5. Conclusion

This study provided an insight into the feasibility of implementation of colonoscopy under the national CRC screening programme through identifying the eligible people's preference as well as the most importantly valued attributes of the primary CRC screening methods by applying the CA. The study results revealed that colonoscopy was the most preferred primary CRC screening method under the NCSP. Among various attributes of CRC screening tests, 'CRC mortality reduction' and 'sensitivity' were the most importantly valued attributes which support the reason why colonoscopy was significantly more preferred over FOBT. Therefore, this study results suggest that the implementation of colonoscopy as the NCSP is highly feasible.

In addition, we examined the psychological and demographic factors associated with participation to screening colonoscopy and an individual's future intent to undergo colonoscopy under the NCSP by the HBM. The psychological factors that had a significant impact on an individual's participation to opportunistic colonoscopy screening were fewer barriers and a high cues to action. This finding suggests the need of strict quality control standards for colonoscopy to reduce complications as well as active CRC screening recommendation strategies to improve the future CRC screening rate.

In general, the study participants had a relatively high intention to have colonoscopy if it is implemented as the national CRC screening program me. The study results demonstrated that increasing awareness of the severity of CRC,

benefits of screening colonoscopy and effective screening recommendations will further increase their future intent for screening colonoscopy under the NCSP.

Moreover, we found that there were different factors associated with the future intention according to the study participant's previous experience of colonoscopy. Reducing barriers for those who recently received screening colonoscopy and increasing awareness about a high chance of getting CRC and seriousness of CRC for those who did not have recent colonoscopy will be necessary to increase the future intention to undergo colonoscopy under the NCSP. Increasing an awareness about benefits of screening colonoscopy and effective recommendation strategies were strong determinants of a high intent to undergo colonoscopy regardless of the recent experience of screening colonoscopy.

Appendix 1. Survey for preference in CRC screening

※ The table given below shows the characteristics of currently used colorectal cancer screening tests (FOBT and Colonoscopy). **Please answer the following questions after comparing the characteristics of two colorectal cancer screening tests.**

Characteristics	Fecal Occult Blood Test (FOBT)	Colonoscopy
Methods	Stab at least three places of the stool deeply and take a sample of an adequate amount of feces in a clean container. Store it in a cool place or refrigerated then return it to a doctor or laboratory	A long, flexible tube is inserted into the rectum. A tiny video camera at the tip of the tube allows the doctor to view the inside of the entire colon.
Pain or discomfort	None	You will feel no pain if sedation is given, but you may feel pain or discomfort during the procedure if sedation is NOT given.
Preparation	You are required to collect a container from a medical center and to spread a special paper over the toilet	Before the test, you are required to take laxatives and being fasted for bowel preparation. Also, you may stop taking prescription medicines
Accuracy when you DO NOT have cancer	If you DO NOT have cancer, the test result will say you may have cancer 15 out of 100 times (Specificity 87.2%-92.8%)	If you DO NOT have cancer, the test result will say you may have cancer 1 out of 100 times (Specificity 99%)
Accuracy when you DO have cancer	If you DO have cancer, the test will miss it 35 out of 100 times (Sensitivity from 52.6% to 78.6%)	If you DO have cancer, the test will miss it 5 out of 100 times (Sensitivity from 90% to 100%)
CRC mortality reduction	CRC mortality reduction from 15% to 33%	CRC mortality reduction from 60% to 70%
Complications	None	Bowel perforation (3.8 per 10,000) or/and bleeding (12 per 10,000)
Intervals	Every 1 year	Every 10 year
Location	Home	Hospital or medical center

Q1. Please select all screening tests that you were already aware prior to this survey.

- ① Fecal Occult Blood Test (FOBT) ② Colonoscopy ③ None

Q2. If Both Fecal Occult Blood Test (FOBT) and colonoscopy are available as a National Colorectal Cancer Screening Program, which screening test you would like to receive? (You must select one)

- ① Fecal Occult Blood Test (FOBT) ② Colonoscopy

Q3. If there was an option of 'No screening' in the previous question (Q2), what would you like to select?

- ① I would receive the same test that I selected in the previous question (Q2)
② I would select 'no screening'

Q4. Please rank the reasons of a test that you DID select in Q2.

1st		2nd		3rd		4th	
-----	--	-----	--	-----	--	-----	--

- ① Pain or discomfort during the procedure ② Preparation prior to a test
③ Accuracy when you DO NOT have cancer ④ Accuracy when you Do have cancer
⑤ CRC related mortality reduction ⑥ Complications
⑦ Screening intervals ⑧ Location

Q5. Please rank the reasons of a test that you DID NOT select in Q2.

1st		2nd		3rd		4th	
-----	--	-----	--	-----	--	-----	--

- ① Pain or discomfort during the procedure ② Preparation prior to a test
③ Accuracy when you DO NOT have cancer ④ Accuracy when you Do have cancer
⑤ CRC related mortality reduction ⑥ Complications
⑦ Screening intervals ⑧ Location

Q6. After looking at the eight given cards, please rank them from 1 to 8 according to your preference

1st	Profile card No. _____
2nd	Profile card No. _____
3rd	Profile card No. _____
4th	Profile card No. _____
5th	Profile card No. _____
6th	Profile card No. _____
7th	Profile card No. _____
8th	Profile card No. _____

Attributes	Profile 1	Profile 2	Profile 3	Profile 4
Preparation	Stool Sampling	Stool Sampling	Fasting & Bowel prep	Fasting & Bowel prep
Accuracy if you DO have cancer	52.6%~78.6%	52.6%~78.6%	90%~100%	90%~100%
Accuracy if you DO NOT have cancer	87.2%~92.8%	99%	99%	87.2%~92.8%
CRC mortality reduction	15%~33%	15%~33%	15%~33%	15%~33%
Complication	None	Perforation & Bleeding	None	Perforation & Bleeding
Interval	1 year	10 year	10 year	1 year
Attributes	Profile 5	Profile 6	Profile 7	Profile 8
Preparation	Fasting & Bowel prep	Fasting & Bowel prep	Stool Sampling	Stool Sampling
Accuracy if you DO have cancer	52.6%~78.6%	52.6%~78.6%	90%~100%	90%~100%
Accuracy if you DO NOT have cancer	99%	87.2%~92.8%	99%	87.2%~92.8%
CRC mortality reduction	60%~70%	60%~70%	60%~70%	60%~70%
Complication	None	Perforation & Bleeding	Perforation & Bleeding	None
Interval	1 year	10 year	1 year	10 year

Section2. General information section

※ The questions below are for your general information. Please write or tick √ in appropriate answers

Q7-1. What is your age? _____

Q7-2. What is the highest degree or level of education that you have completed?

- ① Primary school ② Secondary school ③ High school
degree or equivalent
④ Bachelor's degree or Master's degree ⑤ Others ()

Q7-3. What is your marital status?

- ① Married ② Not married ③ Widowed/Divorced/Separated
④ Others ()

Q7-4. Are you employed?

- ① Yes ② No

Q7-5. What is your monthly household income?

- ① Less than \$99 ② \$1,000~\$1,499 ③ \$1,500~\$1,999
④ \$2,000~\$2,499 ⑤ \$2,500~\$2,999 ⑥ \$3,000~\$3,499
⑦ \$3,500~\$3,999 ⑧ \$4,000~\$4,499 ⑨ \$4,500~\$4,999
⑩ \$5,000~\$6,999 ⑪ \$7,000~\$9,999 ⑫ Over \$10,000
⑬ None

Q7-6. Are you currently holding a private insurance (cancer insurance etc.)?

- ① Yes ② No ③ Don't know

Q7-7. What is your general interest in health?

- ① Highly interested ② Normal ③ Not interested in health

Q7-8. Do you exercise regularly?

- ① I regularly exercise
② Sometimes

- ③ I don't exercise

Q7-9. What is your current smoking status?

- ① I am currently smoking
② I used to smoke in the past, but I am not currently smoking
③ I have never smoked

Q7-10. Have you been diagnosed with any following diseases? (You may select multiple answers)

- ① Hypertension ② Diabetes ③ Chronic kidney disease
④ Cerebrovascular diseases (e.g. stroke) ⑤ Inflammatory bowel disease ⑥ None
⑦ Others ()

Section3. Cancer history and colorectal cancer screening section

※ The questions below are for your general information. Please write or tick ✓ in appropriate answers

Q8. Have you been diagnosed with cancer?

① Yes (✗ Move to Q8-1)

② No (✗ Move to Q9)

Q8-1. If you have been diagnosed with cancer, what is the type of cancer?

Q9. Have any of your family members or relatives been diagnosed with cancer or died of cancer?

① Yes (✗ Move to Q9-1)

② No (Move to ✗ Q10)

Q9-1. Who is your family members or relatives who have been diagnosed with cancer or died of cancer? (You may select multiple answers)

① Father ② Mother ③ Grand parents ④ Brothers/Sisters ⑤ Others ()

Q9-2. What is the cancer type that your family members or relatives who have been diagnosed with or died of ?

(If you selected multiple answers in Q 9-1, Please answer by per person)

Q10. Are there any medical staff, family, or friends who recommended colonoscopy screening?

① Yes (✗ Move to Q10-1)

② No (✗ Move to Q11)

Q10-1. Who recommended screening colonoscopy? (You may select multiple answers)

① Medical staff ② Family ③ Friends ④ Others ()

Q11. Have you ever undergone colonoscopy for colorectal cancer screening in your lifetime?

① Yes

② No (✗ End of survey)

Q11-1. Have you received colonoscopy within 10 years for colorectal cancer screening?

- ☒ ① Yes ☐ ② No (~~to~~ End of survey)

Q11-2. If you have received colonoscopy within 10 years, how often do you undergo colonoscopy?

- ① Regularly (every 5 to 10 years)
- ② Not regularly, but I receive it whenever I remember
- ③ Not regularly

Appendix 2. Survey for health beliefs on CRC screening

Section1. Health beliefs on colorectal cancer (CRC) and colorectal cancer screening

A. Colorectal cancer

Q1. Questions below are about **perceived susceptibility** of colorectal cancer. Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) I think I can get CRC	①	②	③	④	⑤
2) I have a chance of getting CRC within 10 years	①	②	③	④	⑤
3) I have many risk factors for CRC	①	②	③	④	⑤
4) I have higher chance of getting CRC compared to others	①	②	③	④	⑤

Q2. Questions below are about **perceived severity** of colorectal cancer. Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) I am afraid of getting CRC	①	②	③	④	⑤
2) CRC will cause long-lasting problems	①	②	③	④	⑤
3) CRC will have negative impacts on relationships with my family and others	①	②	③	④	⑤
4) CRC will change my life completely	①	②	③	④	⑤
5) Once I get CRC, I will die within 5 years	①	②	③	④	⑤
6) CRC is very serious even if it is found early	①	②	③	④	⑤
7) It is expensive to treat CRC	①	②	③	④	⑤

B. Colonoscopy screening

What is colonoscopy?

Colonoscopy is a highly accurate test and biopsy can be simultaneously conducted if suspicious lesions are found during the procedure. Endoscopic removal of small polyps is also possible. However, for the colonoscopy, it is necessary to have bowel preparation for examination, which may cause discomfort. You may feel pain or discomfort as the endoscopic tube enters the colon while the gas is injected, but the pain can be reduced through the sedation. As complications of colonoscopy, perforations (3.8 per 100,000), bleeding (if biopsy is performed) and abdominal pain may occur. In addition, acute cardiovascular events (acute myocardial infarction) may occur during the test in elderly patients or high-risk patients with hypertension.

Q3. Questions below are about **perceived benefit** of colorectal cancer. Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) I can survive if I find CRC early	①	②	③	④	⑤
2) Colonoscopy will help early detection of CRC	①	②	③	④	⑤
3) If I find CRC early, treatment is not difficult	①	②	③	④	⑤
4) Colonoscopy will reduce concerns about CRC	①	②	③	④	⑤
5) Colonoscopy will reduce probability of CRC death	①	②	③	④	⑤

Q4. Questions below are about **perceived barriers** of colorectal cancer. Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) I am afraid of having colonoscopy in case of abnormal findings	①	②	③	④	⑤
2) Colonoscopy is embarrassing	①	②	③	④	⑤
3) I have no time to have colonoscopy	①	②	③	④	⑤
4) I can't receive colonoscopy because of high cost	①	②	③	④	⑤
5) I don't need colonoscopy because I have no problems	①	②	③	④	⑤
6) I am afraid of having colonoscopy because I don't know what it is	①	②	③	④	⑤
7) Colonoscopy is painful	①	②	③	④	⑤
8) It is too difficult to have bowel preparation and diet restriction before colonoscopy	①	②	③	④	⑤
9) I am afraid of complications of colonoscopy such as bleeding and perforation	①	②	③	④	⑤
10) I can't have colonoscopy because of transportation problems	①	②	③	④	⑤
11) I cannot trust colonoscopy	①	②	③	④	⑤

C. Colorectal cancer screening

Q5. Questions below are about **cues to action** for colorectal cancer screening. Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) If a doctor recommends colonoscopy, I will have it	①	②	③	④	⑤
2) If my friends or family recommend colonoscopy, I will have it	①	②	③	④	⑤
3) If mass media (Radio or TV) recommends colonoscopy, I would have it	①	②	③	④	⑤
4) If I have symptoms of CRC, I will have it	①	②	③	④	⑤
5) I will have colonoscopy as I concern about my health	①	②	③	④	⑤
6) If I had a family or acquaintance with CRC, I would have colonoscopy	①	②	③	④	⑤

Q6. Questions below are about your future chance of having colonoscopy. . Please read the sentences below, and **tick ✓ in appropriate answers.**

Questions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1) If colonoscopy is available as a national colorectal cancer screening program, I would have it	①	②	③	④	⑤

Section2. General information section

※ The questions below are for your general information. Please write or tick √ in appropriate answers

Q7-1. What is your age? _____

Q7-2. What is the highest degree or level of education that you have completed?

- ① Primary school ② Secondary school ③ High school
degree or equivalent
④ Bachelor's degree or Master's degree ⑤ Others ()

Q7-3. What is your marital status?

- ① Married ② Not married ③ Widowed/Divorced/Separated
④ Others ()

Q7-4. Are you employed?

- ① Yes ② No

Q7-5. What is your monthly household income?

- ① Less than \$99 ② \$1,000~\$1,499 ③ \$1,500~\$1,999
④ \$2,000~\$2,499 ⑤ \$2,500~\$2,999 ⑥ \$3,000~\$3,499
⑦ \$3,500~\$3,999 ⑧ \$4,000~\$4,499 ⑨ \$4,500~\$4,999
⑩ \$5,000~\$6,999 ⑪ \$7,000~\$9,999 ⑫ Over \$10,000
⑬ None

Q7-6. Are you currently holding a private insurance (cancer insurance and etc.)?

- ① Yes ② No ③ Don't know

Q7-7. What is your general interest in health?

- ① Highly interested ② Normal ③ Not interested in health

Q7-8. Do you exercise regularly?

- ① I regularly exercise
② Sometimes
③ I don't exercise

Q7-9. What is your current smoking status?

- ① I am currently smoking
- ② I used to smoke in the past, but I am not currently smoking
- ③ I have never smoked

Q7-10. Have you been diagnosed with any following diseases? (You may select multiple answers)

- ① Hypertension ② Diabetes ③ Chronic kidney disease
- ④ Cerebrovascular diseases (e.g. stroke) ⑤ Inflammatory bowel disease
- ⑥ None ⑦ Others ()

Section3. Cancer history and colorectal cancer screening section

※ The questions below are for your history of cancer and colorectal cancer screening.
Please write or tick ✓ in appropriate answers

Q8. Have you been diagnosed with cancer?

- ① Yes (✗ Move to Q8-1)
- ② No (✗ Move to Q9)

Q8-1. If you have been diagnosed with cancer, what is the type of cancer?

Q9. Have any of your family members or relatives been diagnosed with cancer or died of cancer?

- ① Yes (✗ Move to Q9-1)
- ② No (Move to ✗ Q10)

Q9-1. Who is your family members or relatives who have been diagnosed with cancer or died of cancer? (You may select multiple answers)

- ① Father ② Mother ③ Grand parents ④ Brothers/Sisters ⑤ Others ()

Q9-2. What is the cancer type that your family members or relatives who have been diagnosed with or died of ? (If you selected multiple answers in Q 9-1, Please answer by per person)

Q10. Are there any medical staff, family, or friends who recommended colonoscopy screening?

- ① Yes (~~☐~~ Move to Q10-1) ② No (~~☐~~ Move to Q11)

Q10-1. Who recommended screening colonoscopy? (You may select multiple answers)

- ① Medical staff ② Family ③ Friends ④ Others ()

Q11. Have you ever undergone colonoscopy for colorectal cancer screening in your lifetime?

- ① Yes ② No (~~☐~~ End of survey)

Q11-1. Have you received colonoscopy within 10 years for colorectal cancer screening?

- ① Yes ② No (~~☐~~ End of survey)

Q11-2. If you have received colonoscopy within 10 years, how often do you undergo colonoscopy?

- ① Regularly (every 5 to 10 years)
② Not regularly, but I receive it whenever I remember
③ Not regularly

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ACKNOWLEDGEMENT

Foremost, I would like to express my sincere and warmest gratitude to my advisor professor Kui Son Choi, who made this thesis possible. Her continuous support and insightful guidance have been invaluable throughout all stages of this master's thesis.

I would like to further extend my deepest gratitude to the committee members, professor Aesun Shin and Mina Suh, who have greatly contributed to the improvement of this thesis through valuable comments and suggestions.

Also, I would like to express special thanks to my GCSP friends, Miyoun Shin and Seongwon Byun for all the good memories and emotional supports throughout my study at GCSP. Moreover, I would like to thank to my lab colleague, Eunji Choi who helped me to make a first step to conduct a statistical analysis and provided continuous support.

Finally, I would like to sincerely thank to my family for providing me concrete support and being a great strength of my life whenever I became weak.

I would like to devote this thesis to my caring, precious and loving people.