Perceived Obstacles of Colorectal Cancer Screening and Their Associated Factors among 10,078 Chinese Participants

Martin C. S. Wong¹,², Jessica Y. L. Ching¹, Hoyee H. Hirai¹, Thomas Y. T. Lam¹, Sian M. Griffiths², Francis K. L. Chan¹, Joseph J. Y. Sung¹

¹Institute of Digestive Disease, Faculty of Medicine, Chinese University of Hong Kong, Hong Kong SAR, China, ²School of Public Health and Primary Care, Chinese University of Hong Kong, Hong Kong SAR, China

Abstract

Purpose: to evaluate the proportion of self-referred screening participants having various psychological barriers and the factors associated with these barriers.

Methods: A territory-wide bowel cancer screening centre sent an invitation via the media to all Hong Kong residents aged 50–70 years who were asymptomatic of CRC to join a free screening programme. Upon attendance they were requested to complete self-administered surveys on their perceived barriers of screening. Binary logistic regression analyses were used to evaluate the factors associated with these barriers.

Results: From 10,078 consecutive screening participants (mean age 57.5 years; female 56.4%) completed the surveys between May 2008 to September 2012. There were high proportions who agreed or strongly agreed with the following barriers: financial difficulty (86.0%), limited service accessibility (58.2%), screening-induced bodily discomfort (55.2%), physical harm (44.4%), embarrassment (40.1%), apprehension (38.8%) and time constraints (13.9%). From regression models, older participants (aged ≥56) were less likely to have these barriers (Adjusted odds ratio [AOR] ranged from 0.738 to 0.952) but they encountered more difficulties to access to screening services (AOR ranged from 1.141 to 1.371). Participants who were uncertain of the necessity of CRC screening for people aged ≥50 were more likely to report these barriers (AOR ranged from 1.151 to 1.671).

Conclusion: The proportions of perceptual barriers of CRC screening were high among these participants. Those with these associated factors should receive more thorough explanation of the screening test procedures.
recent territory-wide population-based survey conducted in Hong Kong showed that perceived access, health and psychological barriers to CRC screening were strongly associated with lower screening uptake rates [18]. Prominent psychological barriers of CRC screening included concerns about pain, discomfort, unpleasantness associated with CRC testing and fear of follow-up procedures. Lack of insurance coverage is also a significant barrier, as there is an absence of incentive to undertake screening when no symptoms exist. Financial cost and lack of time commitment are the major access barriers to the undertake CRC screening tests [18]. Other studies have reported that embarrassment associated with CRC screening has been a particularly important obstacle to undergo a screening test [19–21].

Nevertheless, most of the existing studies on barriers to CRC screening were conducted among the general public, family members of CRC patients and those who declined invitations to screening programmes. In primary care settings, subjects who

| Table 1. Participant Characteristics (N = 10,078). |
|--------------------------------------------------|
|                                                   |
| **No. of Participants**   | **Proportions** |
| Age (years)               |                 |
| 50–54                    | 3408            | 33.8 |
| 55–59                    | 3244            | 32.2 |
| 60–64                    | 2280            | 22.6 |
| 65–70                    | 1136            | 11.3 |
| Gender                   |                 |
| Male                     | 4384            | 43.5 |
| Female                   | 5689            | 56.4 |
| Educational level        |                 |
| Primary or below         | 2747            | 27.3 |
| Secondary                | 5739            | 56.9 |
| Tertiary or above        | 1576            | 15.6 |
| Marital status           |                 |
| Married/cohabit          | 8514            | 84.5 |
| Single/divorced/widowed/others | 1546 | 15.3 |
| Occupational status      |                 |
| Full time                | 3609            | 35.8 |
| Part time or retired     | 3424            | 34.0 |
| Housewife and others     | 3030            | 30.1 |
| Monthly household income ($US) |             |
| <1285$                   | 2932            | 29.1 |
| 1285$ – 2571$            | 2856            | 28.3 |
| 2571$ – 3856$            | 1428            | 14.2 |
| 3856$ – 5141$            | 665             | 6.6  |
| >5142$                   | 611             | 6.1  |
| Refused to answer        | 1572            | 15.6 |
| Self perceived risk of CRC |             |
| At risk                  | 6873            | 38.2 |
| Not at risk              | 2552            | 25.3 |
| Not sure                 | 608             | 6.0  |
| Family history of CRC    |                 |
| Nil                      | 5714            | 57.7 |
| First degree relatives   | 1313            | 13.0 |
| Second degree relatives  | 1242            | 12.3 |
| Others                   | 1709            | 17.0 |
| Necessity of CRC screening for people aged ≥50 |         |
| Very or quite necessary  | 8402            | 83.4 |
| Not very necessary or unnecessary | 344 | 3.4 |
| Not sure                 | 1315            | 13.0 |

*CRC: Colorectal Cancer. 
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Table 2. Attitudinal Barriers of colorectal cancer (CRC) screening (N = 10,078).

| Physical harm | Bodily discomfort | Embarrassment | Apprehension | Economic difficulties | Time constraint | Poor accessibility | Perceived benefit being minimal |
|---------------|------------------|---------------|--------------|----------------------|----------------|--------------------|-----------------------------|
| n  | %       | n  | %       | n  | %       | n  | %       | n  | %       | n  | %       | n  | %       |
| **Age (years)** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| 50–54       | 1512 | 44.4 | 1898 | 55.7 | 1512 | 44.4 | 1373 | 40.3 | 2951 | 86.6 | 522 | 15.3 | 2008 | 58.9 | 329 | 9.7 |
| 55–59       | 1473 | 45.4 | 1805 | 55.6 | 1351 | 41.6 | 1274 | 39.3 | 2762 | 85.1 | 482 | 14.9 | 2067 | 63.7 | 310 | 9.6 |
| 60–64       | 1020 | 44.7 | 1288 | 56.5 | 833  | 36.5 | 858  | 37.6 | 1973 | 86.5 | 277 | 12.1 | 1534 | 67.3 | 208 | 9.1 |
| 65–70       | 466  | 41.0 | 570  | 50.2 | 338  | 29.8 | 351  | 30.9 | 976  | 85.9 | 122 | 10.7 | 790  | 69.5 | 109 | 9.6 |
| **Gender**  |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| Male        | 1784 | 40.7 | 2151 | 49.1 | 1390 | 31.7 | 1224 | 27.9 | 3668 | 86.6 | 625 | 14.9 | 2716 | 62.0 | 380 | 8.7 |
| Female      | 2690 | 47.3 | 3414 | 50.0 | 2648 | 46.5 | 2686 | 46.5 | 4998 | 87.9 | 779 | 13.7 | 3688 | 64.8 | 576 | 10.1 |
| **Educational level** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| Primary or below | 1304 | 47.5 | 1696 | 61.7 | 1204 | 43.8 | 1245 | 45.3 | 2427 | 88.4 | 477 | 17.4 | 2034 | 74.0 | 346 | 12.6 |
| Secondary   | 2497 | 43.5 | 3043 | 53.0 | 2245 | 39.1 | 2101 | 36.6 | 5034 | 87.7 | 720 | 12.5 | 3512 | 61.2 | 499 | 8.7 |
| Tertiary or above | 670  | 42.5 | 823  | 52.2 | 585  | 37.1 | 560  | 35.5 | 1205 | 76.5 | 206 | 13.1 | 853  | 54.1 | 110 | 7.0 |
| **Marital status** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| Married/cohabit | 3804 | 44.7 | 4657 | 54.7 | 3343 | 39.3 | 3264 | 38.3 | 7316 | 85.9 | 1172 | 13.8 | 5396 | 63.4 | 788 | 9.3 |
| Single/divorced/widowed/others | 665  | 43.0 | 902  | 58.3 | 690  | 44.6 | 643  | 41.6 | 1347 | 87.1 | 230 | 14.9 | 1001 | 64.7 | 166 | 10.7 |
| **Occupational status** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| Full time   | 1516 | 42.0 | 1895 | 52.5 | 1393 | 38.6 | 1267 | 35.1 | 3014 | 83.5 | 760 | 21.1 | 2212 | 61.3 | 342 | 9.5 |
| Part time or retired | 1458 | 42.6 | 1827 | 53.4 | 1225 | 35.8 | 1182 | 34.5 | 2961 | 86.5 | 311 | 9.1 | 2183 | 63.8 | 300 | 8.8 |
| Housewife and others | 1498 | 49.4 | 1842 | 60.8 | 1418 | 46.8 | 1461 | 48.2 | 2690 | 88.8 | 332 | 11.0 | 2005 | 66.2 | 312 | 10.3 |
| **Monthly household income ($US)** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| <1285$      | 1270 | 43.3 | 1641 | 56.0 | 1121 | 38.2 | 1120 | 38.2 | 2685 | 91.6 | 389 | 13.3 | 2008 | 68.5 | 288 | 9.8 |
| 1285$ – 2571$ | 1261 | 44.2 | 1600 | 56.0 | 1110 | 38.9 | 1065 | 37.3 | 2573 | 90.1 | 423 | 14.8 | 1838 | 64.4 | 271 | 9.5 |
| 2571$ – 3856$ | 619  | 43.3 | 731  | 51.2 | 549  | 38.4 | 500  | 35.0 | 1193 | 83.5 | 206 | 14.4 | 834  | 58.4 | 110 | 7.7 |
| 3856$ – 5141$ | 283  | 42.6 | 331  | 49.8 | 256  | 38.5 | 235  | 35.3 | 505  | 75.9 | 79  | 11.9 | 370  | 55.6 | 51  | 7.7 |
| >5142$      | 259  | 42.4 | 293  | 48.0 | 251  | 41.1 | 238  | 40.1 | 363  | 94.2 | 92  | 15.1 | 296  | 48.4 | 49  | 8.0 |
| **Refused to answer** | 781  | 49.7 | 969  | 61.6 | 749  | 47.6 | 752  | 47.8 | 1348 | 85.8 | 214 | 13.6 | 1053 | 67.0 | 186 | 11.8 |
| **Self perceived risk of CRC** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| At risk     | 3095 | 45.0 | 38.9 | 40.5 | 2788 | 40.6 | 2654 | 38.6 | 5944 | 86.5 | 342 | 5.0 | 4330 | 63.0 | 611 | 8.9 |
| Not at risk | 1103 | 43.2 | 1390 | 54.5 | 996  | 39.0 | 994  | 38.9 | 2167 | 84.9 | 300 | 11.8 | 1616 | 63.3 | 261 | 10.2 |
| Not sure    | 261  | 42.9 | 342  | 56.3 | 237  | 39.0 | 250  | 41.1 | 524  | 86.2 | 312 | 51.3 | 431  | 70.9 | 79  | 13.0 |
| **Family history of CRC** |                |                |                |                      |                |                    |                |          |                |                |          |                |                |
| Nil         | 2497 | 43.7 | 3178 | 55.6 | 2347 | 41.1 | 2282 | 39.9 | 4992 | 87.4 | 886 | 15.5 | 3872 | 67.8 | 608 | 10.6 |
| First degree relatives | 590  | 44.9 | 722  | 55.0 | 532  | 40.5 | 495  | 37.7 | 1140 | 86.8 | 176 | 13.4 | 761  | 58.0 | 97  | 7.4 |
expressed an initial interest to CRC screening are arguably the most likely group who will eventually receive a CRC screening test, but there exists no studies conducted among these individuals. The objective of this study is to evaluate the proportion of self-referred CRC screening participants who perceived various psychological barriers, and the independent factors associated with perception of these barriers.

Materials and Methods

Ethics Statement

This study was approved by the Clinical Research Ethics Committee of the Chinese University of Hong Kong.

Setting

A CRC screening centre was established in Hong Kong in 2008, which invited free CRC screening via the media for all Hong Kong residents aged 50-70 years asymptomatic of CRC. A more detailed description of this invitation has been published previously [22,23]. Briefly, this study was conducted in a community-based centre which provides education and CRC screening to a large population of Hong Kong. Data were collected based on recruitment between 1st May 2008 and 31st July 2012.

Study Design

This study prospectively recruited a consecutive cohort of 10,078 participants aged 50 to 70 years who self-referred for CRC screening in the centre via telephone, fax, email, or walk-in.

Participant Recruitment

The eligibility criteria for this study was (i) age 50 to 70 years; (ii) absence of existing or previous symptoms suggestive of CRC such as haematochezia, malena, anorexia or change in bowel habit in the past 4 weeks, or weight loss greater than 5 kg in the past 6 months; and (iii) absence of screening test for CRC performed in the past 5 years. Exclusion criteria included personal history of CRC, colonic adenoma, diverticular disease, inflammatory bowel disease, prosthetic heart valve or vascular graft surgery. Participants with medical conditions which were contraindications for colonoscopy were also excluded [22]. The eligibility of each participant and the exclusion criteria were checked by trained staff.

Registered participants were invited to fill in a self-administered questionnaire. Meanwhile, centre staff checked for the completeness of questionnaires and trained volunteers assisted survey completion for illiterate participants by reading the questions word-by-word. Information on their age, gender, educational level, marital status, occupation, monthly household income, family history of CRC was collected. They were also enquired on their perception of various perceptual barriers to CRC screening. A four-point Likert scale was adopted to assess perceptions of eight barriers to CRC screening (strongly agree; agree; disagree; strongly disagree), developed based on published methodology using the Health Belief Model [22,24,25], and validated by a panel of epidemiologists, psychologists and gastroenterologists.

Outcome Variables and Covariates

The outcome variables include the proportions of screening participants who agreed or strongly agreed the presence of eight perceived barriers. These included screening-induced physical harm, bodily discomfort, embarrassment, apprehension, financial difficulties, time constraints for attending screening programmes, limited accessibility to screening service providers, and perceived

| Table 2. Cont. |
|----------------|
| **Perceived Benefit Being Minimal** | **Physical harm** | **Bodily discomfort** | **Embarassment** | **Apprehension** | **Economic difficulties** | **Time constraint** | **Poor accessibility** | **Not very necessary or unnecessary** |
| n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| Second degree relatives | 567 | 45.7 | 714 | 57.5 | 482 | 38.9 | 470 | 37.8 | 1085 | 87.4 | 137 | 11.0 | 754 | 60.7 | 105 | 8.5 |
| Others | 821 | 48.0 | 953 | 55.8 | 678 | 39.7 | 666 | 39.7 | 1454 | 85.1 | 205 | 12.0 | 1018 | 59.6 | 146 | 8.4 |
| Necessity of CRC screening for people aged ≥50 | 3692 | 43.8 | 4541 | 54.0 | 3301 | 39.3 | 3110 | 37.0 | 7249 | 86.3 | 1068 | 12.7 | 5172 | 61.6 | 707 | 8.4 |
| Very or quite necessary | 169 | 49.1 | 217 | 63.1 | 149 | 43.3 | 163 | 48.3 | 474 | 291 | 43.3 | 198 | 29.9 | 995 | 66.9 | 67 | 9.5 |
| Not very necessary or unnecessary | 620 | 47.1 | 803 | 61.1 | 586 | 44.6 | 586 | 44.6 | 67 | 48.4 | 1124 | 85.5 | 267 | 20.3 | 995 | 75.7 |

All n/% refer to responses of "strongly agree" or "agree".

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Obstacles of Colorectal Cancer Screening
Table 3. Factors associated with greater barriers of CRC screening (physical harm, bodily discomfort, embarrassment and apprehension).

|                      | Physical harm | Bodily discomfort | Embarrassment | Apprehension |
|----------------------|---------------|-------------------|---------------|--------------|
|                      | Adjusted odds ratio | Adjusted odds ratio | Adjusted odds ratio | Adjusted odds ratio |
|                      | (95% C.I.) | p | (95% C.I.) | p | (95% C.I.) | p | (95% C.I.) | p |
| Age (years)          |               |               |               |               |
| 50–54                | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| 55–59                | 1.016 (0.919–1.123) | 0.754 | 0.948 (0.858–1.049) | 0.305 | 0.879 (0.794–0.972) | 0.012 | 0.952 (0.858–1.056) | 0.352 |
| 60–64                | 0.982 (0.874–1.105) | 0.766 | 0.966 (0.858–1.087) | 0.561 | 0.702 (0.622–0.791) | <0.001 | 0.883 (0.782–0.998) | 0.046 |
| 65–70                | 0.866 (0.744–1.008) | 0.063 | 0.738 (0.634–0.859) | <0.001 | 0.520 (0.443–0.611) | <0.001 | 0.830 (0.709–0.972) | 0.021 |
| Gender               |               |               |               |               |
| Male                 | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| Female               | 1.188 (1.076–1.311) | 0.001 | 1.411 (1.278–1.558) | <0.001 | 1.708 (1.543–1.891) | <0.001 | 2.179 (1.965–2.417) | <0.001 |
| Educational level    |               |               |               |               |
| Primary or below     | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| Secondary            | 0.894 (0.812–0.985) | 0.024 | 0.761 (0.690–0.840) | <0.001 | 0.865 (0.783–0.955) | 0.004 | 0.812 (0.735–0.988) | <0.001 |
| Tertiary or above    | 0.905 (0.786–1.042) | 0.166 | 0.835 (0.725–0.963) | 0.013 | 0.854 (0.738–0.988) | 0.034 | 0.880 (0.759–1.020) | 0.089 |
| Marital status       |               |               |               |               |
| Married/cohabited    | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| Single/divorced/widowed/others | 0.892 (0.795–1.001) | 0.051 | 1.008 (0.897–1.132) | 0.893 | 1.095 (0.975–1.230) | 0.126 | 0.930 (0.826–1.047) | 0.228 |
| Occupational status  |               |               |               |               |
| Full time            | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| Part time or retired | 1.052 (0.944–1.173) | 0.360 | 1.009 (0.905–1.25) | 0.871 | 0.865 (0.783–0.955) | 0.004 | 0.975 (0.869–1.093) | 0.659 |
| Housewife and others | 1.217 (1.078–1.374) | 0.001 | 1.058 (0.936–1.196) | 0.365 | 0.854 (0.738–0.988) | 0.034 | 1.103 (0.975–1.248) | 0.121 |
| Monthly household income (US) |       |               |               |               |
| $<1285$              | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| $1285–2571$          | 1.061 (0.951–1.183) | 0.292 | 1.041 (0.932–1.162) | 0.475 | 1.024 (0.914–1.146) | 0.685 | 1.050 (0.937–1.177) | 0.400 |
| $2571–3856$          | 1.055 (0.922–1.208) | 0.435 | 0.880 (0.769–1.007) | 0.064 | 1.025 (0.891–1.178) | 0.733 | 0.986 (0.856–1.137) | 0.850 |
| $3856–5142$          | 1.052 (0.879–1.259) | 0.580 | 0.863 (0.722–1.033) | 0.108 | 1.104 (0.917–1.328) | 0.295 | 1.071 (0.887–1.293) | 0.478 |
| $>5142$              | 1.078 (0.886–1.311) | 0.455 | 0.827 (0.680–1.005) | 0.056 | 1.285 (1.052–1.569) | 0.014 | 1.385 (1.131–1.696) | 0.002 |
| Self perceived risk of CRC |       |               |               |               |
| At risk              | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| Not at risk          | 0.897 (0.817–0.985) | 0.023 | 0.917 (0.835–1.007) | 0.069 | 0.884 (0.805–0.972) | 0.011 | 0.920 (0.835–1.013) | 0.091 |
| Not sure             | 0.878 (0.739–1.042) | 0.136 | 0.950 (0.799–1.129) | 0.557 | 0.904 (0.757–1.078) | 0.260 | 0.976 (0.817–1.165) | 0.784 |
| Family history of CRC |       |               |               |               |
| Nil                  | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) | 1.00 (referent) |
| First degree relatives | 1.079 (0.954–1.229) | 0.224 | 1.010 (0.893–1.142) | 0.875 | 0.975 (0.860–1.106) | 0.696 | 0.943 (0.829–1.072) | 0.368 |
| Second degree relatives | 1.101 (0.972–1.247) | 0.131 | 1.103 (0.973–1.252) | 0.127 | 0.901 (0.792–1.025) | 0.114 | 0.895 (0.785–1.020) | 0.096 |
benefits of screening being minimal. The covariates tested for association with these barriers include participants’ age, gender, educational level, marital status, occupational status, monthly household income, self-perceived risks of CRC, family history, and the necessity of CRC screening for people aged ≥50 years.

Statistical Analyses

All data were entered into a predesigned database with logistic checking using Microsoft Access, and analyzed using SPSS software, version 16.0 (Chicago, Illinois). The proportions of participants who perceived the barriers were compared according to the covariates. Eight separate, unconditional logistic regression analyses were conducted with all covariates listed above entered into the models after checking for the absence of interactions. The adjusted Odds Ratios (AORs) and 95% CIs of the potential independent predictors of perceived barriers were estimated. All the variables selected in the multivariate regression analysis were detected for the presence of co-linearity (r > 0.80) [26]. P-values ≤0.05 were regarded as statistically significant.

Results

Participant Characteristics

A total of 10,078 screening participants were included in the analysis (Table 1). Their mean age was 57.5 years (SD 5.12 years), and 56.4% were female. The majority of them (56.9%) achieved an educational level at secondary or above, and were married or cohabiting (84.5%). 35.8% worked full-time and 34.0% worked in part-time jobs or were retired. Most of them (57.4%) had monthly household income at US$2,571 or below, and 68.2% perceived themselves as at risks for developing CRC. 13.1% and 12.3% reported their first and second degree relatives to have suffered from CRC, respectively. 83.4% of the participants regarded CRC screening for people aged 50 years or older as very or quite necessary.

Levels of Perceived Barriers among Screening Participants

Financial difficulty (86.0%), limited service accessibility (58.2%) and screening-induced bodily discomfort (55.2%) were the barriers where the greatest proportions of participants “agreed” or “strongly agreed” as barriers; these were followed by physical harm (44.4%), embarrassment (40.1%), apprehension (38.8%) and time constraints (13.9%) (Table 2). A minority perceived the benefit of CRC screening was minimal (9.5%).

Factors Associated with the Perception of Screening Barriers

From multivariate regression analysis, older age was significantly associated with lower likelihood of perceiving screening-induced bodily discomfort, embarrassment, apprehension, and financial difficulties (Table 3 and Table 4). Nevertheless, they were more likely than younger participants to have poorer access to service providers. Female participants were more likely to encounter perception of physical harm, bodily discomfort, embarrassment and apprehension related to the screening process, as well as time constraints to attend screening sessions (Adjusted odds ratios [AOR] ranged from 1.188 to 2.179). In general, participants with higher educational levels were less likely to encounter all of these barriers separately (AOR ranged from 0.531 to 0.894). Marital status was not associated with perception of any barriers. When compared with subjects with full-time jobs, those with part-time jobs, retired or housewives were less likely to
**Table 4.** Factors associated with greater barriers of CRC screening (economic difficulties, time constraints, poor accessibility, perceived benefit of screening being minimal).

|                       | Economic difficulties |                      | Time constraint |                      | Poor accessibility |                      | Perceived benefit being minimal |                      |
|------------------------|------------------------|-----------------------|-----------------|-----------------------|---------------------|-----------------|---------------------------------|-----------------------|
|                        | Adjusted odds ratio (95% C.I.) | p | Adjusted odds ratio (95% C.I.) | p | Adjusted odds ratio (95% C.I.) | p | Adjusted odds ratio (95% C.I.) | p |
| **Age (years)**        |                        |                |                |                        |                      |                |                                |                        |
| 50–54                  | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| 55–59                  | 0.738 (0.635–0.856)    | <0.001           | 1.094 (0.950–1.260) | 0.213 | 1.141 (1.029–1.266) | 0.012 | 0.953 (0.805–1.129) | 0.579 |
| 60–64                  | 0.738 (0.617–0.883)    | 0.001            | 1.051 (0.883–1.251) | 0.576 | 1.263 (1.117–1.429) | <0.001 | 0.857 (0.701–1.047) | 0.130 |
| 65–70                  | 0.660 (0.526–0.828)    | <0.001           | 1.039 (0.820–1.318) | 0.749 | 1.371 (1.166–1.611) | <0.001 | 0.885 (0.685–1.142) | 0.347 |
| **Gender**             |                        |                |                |                        |                      |                |                                |                        |
| Male                   | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| Female                 | 1.116 (0.963–1.292)    | 0.144            | 1.206 (1.048–1.388) | 0.009 | 1.021 (0.921–1.132) | 0.696 | 1.063 (0.897–1.259) | 0.481 |
| **Educational level**  |                        |                |                |                        |                      |                |                                |                        |
| Primary or below       | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| Secondary              | 1.064 (0.913–1.240)    | 0.429            | 0.638 (0.556–0.732) | <0.001 | 0.634 (0.570–0.705) | <0.001 | 0.730 (0.625–0.853) | <0.001 |
| Tertiary or above      | 0.749 (0.614–0.913)    | 0.004            | 0.668 (0.543–0.821) | <0.001 | 0.531 (0.458–0.616) | <0.001 | 0.586 (0.455–0.755) | <0.001 |
| **Marital status**     |                        |                |                |                        |                      |                |                                |                        |
| Married/cohabited      | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| Single/divorced/widowed/others | 0.873 (0.733–1.039) | 0.126          | 1.066 (0.904–1.257) | 0.446 | 0.977 (0.866–1.103) | 0.712 | 1.130 (0.937–1.362) | 0.203 |
| **Occupational status**|                        |                |                |                        |                      |                |                                |                        |
| Full time              | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| Part time or retired   | 1.007 (0.859–1.181)    | 0.932            | 0.317 (0.269–0.374) | <0.001 | 0.861 (0.768–0.964) | 0.009 | 0.867 (0.719–1.046) | 0.137 |
| Housewife and others   | 1.050 (0.872–1.265)    | 0.606            | 0.325 (0.273–0.387) | <0.001 | 0.876 (0.771–0.995) | 0.041 | 0.888 (0.725–1.087) | 0.248 |
| **Monthly household income ($US)** |    |                |                |                        |                      |                |                                |                        |
| <1285$                 | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| 1285$–2571$            | 0.782 (0.648–0.944)    | 0.010            | 0.903 (0.769–1.061) | 0.216 | 0.900 (0.802–1.011) | 0.076 | 1.008 (0.838–1.213) | 0.933 |
| 2571$–3856$            | 0.433 (0.353–0.532)    | <0.001           | 0.816 (0.669–0.996) | 0.046 | 0.720 (0.626–0.829) | <0.001 | 0.831 (0.652–1.058) | 0.133 |
| 3856$–5141$            | 0.267 (0.211–0.338)    | <0.001           | 0.661 (0.502–0.872) | 0.003 | 0.689 (0.574–0.828) | <0.001 | 0.882 (0.637–1.221) | 0.450 |
| >5142$                 | 0.137 (0.108–0.174)    | <0.001           | 0.828 (0.625–1.097) | 0.188 | 0.580 (0.476–0.707) | <0.001 | 1.021 (0.720–1.448) | 0.906 |
| **Self perceived risk of CRC** |                  |                |                |                        |                      |                |                                |                        |
| At risk                | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| Not at risk            | 0.853 (0.745–0.977)    | 0.021            | 0.956 (0.834–1.097) | 0.523 | 0.958 (0.869–1.056) | 0.386 | 1.089 (0.932–1.272) | 0.283 |
| Not sure               | 0.931 (0.723–1.199)    | 0.580            | 0.905 (0.708–1.156) | 0.424 | 1.120 (0.927–1.353) | 0.239 | 1.249 (0.964–1.619) | 0.092 |
| **Family history of CRC** |                        |                |                |                        |                      |                |                                |                        |
| Nil                    | 1.00 (referent)        | 1.00 (referent)   | 1.00 (referent) | 1.00 (referent)        |                      |                |                                |                        |
| First degree relatives | 1.032 (0.858–1.243)    | 0.735            | 0.880 (0.735–1.054) | 0.165 | 0.729 (0.643–0.827) | <0.001 | 0.740 (0.590–0.928) | 0.009 |
| Second degree relatives| 1.075 (0.888–1.301)    | 0.457            | 0.727 (0.597–0.884) | 0.001 | 0.799 (0.702–0.909) | 0.001 | 0.831 (0.667–1.035) | 0.098 |
encounter embarrassment (AOR 0.854 to 0.865), perceive time constraints (AOR 0.317 to 0.325) and experience accessibility problems (AOR 0.861 to 0.876). In addition, housewives were more likely to perceive physical harm induced by screening (AOR 1.205) and apprehensive (AOR 1.365) about screening, yet were in general less likely to encounter financial difficulties (AOR 0.137 to 0.702), time constraints (AOR 0.661 to 0.816), and accessibility to screening services (AOR 0.590 to 0.710). Those who did not perceived themselves at risks for CRC were less likely to experience physical harm (APR 0.897), embarrassment (AOR 0.884), apprehension (AOR 0.920) and financial difficulties (AR 0.853). Participants with their relatives having family history of CRC were less likely to encounter accessibility problems (AOR 0.729 to 0.799). Except financial difficulties, people who were uncertain about the necessity of CRC screening among subjects aged at $\geq 50$ years were more likely to encounter all the barriers under study (AOR 0.151 to 1.671). The covariates in the regression analysis did not show interactions nor multi-collinearity, implying the robustness of the regression models.

**Discussion**

At present CRC screening among asymptomatic patients in Hong Kong is not subsidized by the Government and citizens who wish to undergo screening should pay out of their own pocket. According to the Health Belief Model [27] one should address the major constructs in order to enhance the CRC screening uptake rate. These include perceived susceptibility, severity, barriers and benefits. In this study we found a high proportion of CRC screening participants having various barriers, especially financial difficulty, limited service accessibility, as well as screening-induced bodily discomfort, physical harm, embarrassment and apprehension. Notable patient groups having higher likelihood of encountering these barriers include younger subjects, female participants, people with lower educational level, subjects with full-time jobs, those who perceived themselves at risks for CRC, and people who were uncertain about the necessity of CRC screening among subjects aged at $\geq 50$ years.

A cross-sectional study of the barriers among a sample of persons at risk for CRC was conducted in the Mid-western metropolitan area of Omaha [28]. A significant proportion of people reported internal barriers like time constraints (49%), pain (44%), inconvenience (42%), fear of cancer diagnosis (42%) and embarrassment (35%), amongst others. Some external factors were also reported, including cost of the screening tests (44%) and lack of recommendation from a primary care physician (35%). This study presented even higher proportions of screening participants reporting these barriers. Further, a recent systematic review includes 83 studies on the most commonly found barriers to CRC screening and the associated factors. Some of them were compatible with the findings of the present survey. These consist of low education levels, female gender, low socioeconomic status, presence of chronic comorbid conditions, being married or living with partner, lack of awareness regarding CRC screening, absence of health insurance and lack of screening recommendation by a physician [29]. The last barrier has been consistently found from other studies [30,31], and also in our previous study [18]. However, we are unaware of any studies conducted among self-referred screening participants studying the independent factors associated with perception of the different barriers. The reasons why people with these associated factors were more likely to
perceive screening barriers remain speculative, and future studies are warranted to ascertain the underlying reasons.

To our knowledge, this is the largest study conducted among screening participants on their perceptions of screening barriers. The survey used was designed based on the well recognized health belief model, and the 100% completion rates of the questionnaires are amongst some of the strengths. Nevertheless, there are some limitations which should be addressed. Firstly, the study was conducted among consecutive screening participants, and their socio-demographic characteristics might be different from the general public. However, as our research question focused on self-referred screening participants, it is inevitable for this survey to include more health-conscious subjects who are not generalisable to the population. In addition, some participants might have already accessed to information on the CRC screening tests before attendance to the centre, and this might change their perception on the different barriers. Furthermore, there might exist some confounders where we could not control for in this study, like prior experience of health service utilization, peer influences and previous consultations with physicians. Furthermore, this is a cross sectional study which could not delineate cause-and-effect relationships - and one may only draw conclusions on associations between the barriers and the covariates. Some of the other well-recognized barriers have not been evaluated, including those related to healthcare providers and the Governmental policy.

This study bears several important implications. Firstly, the proportions of participants having various barriers of CRC screening were high despite the fact that they were self-referred. It could be speculated the general public may experience these barriers to an even greater extent. To improve CRC screening uptake, more educational seminars should be designed and implemented in the community and clinics to explain the screening procedures in a more thorough manner. These include the simplicity and safety nature of the screening process which very rarely induces significant bodily discomfort or physical harm. Peer educators who have undergone CRC screening procedures could be invited to share with prospective screening participants on their screening experience, which could potentially remove the perception of embarrassment and apprehension associated with screening. Secondly, this study has evaluated the factors associated with the perception of these barriers. It follows that people with these associated factors should be explored more for the possible presence of psychological barriers. Also, more comprehensive explanation of the screening procedures should be discussed with this group of prospective participants to facilitate screening uptake. In addition, it has been found that some health system-related barriers were also reported in a large proportion of participants. For instance, whereas the elderly were less likely to encounter the various psychological barriers and were at higher risks for CRC, they were however more likely to experience poor access to the service providers for screening. Also, those who perceived themselves at risks for CRC were more likely to experience psychological barriers, which might be due to their higher likelihood to encounter an adverse screening outcome. For implementation of population-based CRC screening programmes in the future, a better infrastructure for CRC screening should be constructed so as to improve accessibility to screening services, coupled with counseling services which could help remove the various barriers. Financial difficulties have also been reported in a large proportion of self-referred participants, and the Government should consider subsidizing screening services among eligible subjects as recommended by guidelines. In the long term, this will translate into reduction of CRC mortality. Future studies should explore effective interventional strategies to overcome these barriers.

Author Contributions

Conceived and designed the experiments: MCSW JYLC SMG FKLC JJYS. Performed the experiments: HHH TYTL. Analyzed the data: MCSW JYLC HHH TYTL. Contributed reagents/materials/analysis tools: MCSW JYLC HHH TYTL. SMG FKLC JJYS. Wrote the paper: MCSW JYLC HHH TYTL. Critically revised the manuscript: SMG FKLC JJYS.

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