ORIGINAL ARTICLE

Links between socio-demographic characteristics and body mass index to colorectal cancer in North Borneo, Malaysia: A case–control study

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ABSTRACT

Introduction: The fourth leading cause of cancer-related mortality and morbidity worldwide is colorectal cancer (CRC). Numerous reasons have contributed to the massive rise in CRC cases, for which Asian nations differ significantly in terms of risk incidence rates. The objectives of this study were to, first, identify the socio-demographic characteristics of those of North Borneo ethnicity and body mass index (BMI) and, second, determine the association of these factors with CRC. This research will contribute to preventing this form of cancer.

Materials and Methods: This study is an analysis of a matched case-control study with a ratio of 1:2. The case group contained 206 respondents, and the control group contained 412. All CRC cases were confirmed with the histological results. The control group was matched for links between age, sex and ethnicity with CRC. The Statistical Package for Social Sciences Statistics (SPSS) IBM version 28.0 was used to conduct descriptive analysis using chi-squared testing and simple logistic regression. The statistical significance was P < 0.05.

Result: Overall, 618 respondents took part in this survey, of which 256 (41.4%) were female and 362 (58.6%) were male. The maximum age was 76, with a mean age ± SD of 53.17 ± 11.4. Those of Bajau ethnicity comprised 24.6% (152) of the population, followed by Dusun with 22.8% (141), Kadazan with 17.6% (109%), other North Borneo ethnic groups with 15.5% (96), Bugis with 9.7% (60), Brunei with 4.4% (27) and other predominant races with 5.3% (33). Regression analyses revealed that the incidence of CRC in North Borneo, Malaysia, was substantially correlated with income, occupation, other linked diseases and BMI.

Conclusion: Various risk factors are linked to CRC, based on the findings related to socio-demographic characteristics and BMI. Therefore, to lower the nationwide prevalence of CRC, national public health campaigns should include collaboration with the regional authorities to highlight the incidence and risk factors of CRC based on ethnicity.

KEYWORDS:
Colorectal cancer; Ethnicity; Malaysia; Obese; Overweight; Sociodemographic

INTRODUCTION

Colorectal cancer (CRC), a leading cause of cancer-related morbidity and mortality, is the fourth leading cause of cancer deaths worldwide.[1] In 2018, 550,000 men and 470,000 women were affected by CRC, of which there are approximately one million new cases yearly. The number of new cases of CRC includes about 1,096,000 and 704,000 new cases of rectal cancer among men and women, respectively.[1] In Asian countries, incidence rates vary widely, and CRC cases have increased dramatically in certain economically mature parts of the continent.[2] This pattern can also be observed in Malaysia. CRC incidence rates are the highest among those of Chinese ethnicity, and CRC is the second most common cancer in both males and females, with an age-specific incidence of 10.2 per 100,000 females.[3]

Evidence from worldwide literature demonstrates that the CRC risk can be attributed to genetics, gender, ethnic origin, geographical region and environmental conditions.[4] In addition, meta-analysis research showed a considerably increased incidence of CRC associated with obesity.[5,6] The findings from 13 different meta-analysis cohort studies revealed weight gain or BMI were related to an elevated risk of colon cancer.[7,8] Compared to those of normal weight, obesity is associated with a 7%–60% higher risk of CRC; updated reviews suggest a 30%–70% higher risk and links to the population's lifestyle.[9,10] Therefore, the variety of cultures

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and technological changes mean that individual variations, age-related differences, body composition and ethnic factors must be considered when diagnosing CRC.[5]

In Asian countries, common risk factors are positively associated with CRC, such as positive family history, obesity and old age.[11–13] Understanding risk factors that compare various differences in demographics and resources would facilitate the prevention of CRC in Asia.[13] Studies in Malaysia have revealed the prevalence of CRC risk factors and their reduction in the Malaysian population as areas that should be investigated more extensively.[7] Thus far, most studies have represented only the three major ethnicities in Malaysia (Malay, Chinese and Indian) when exploring the risk factors of CRC.[14] To the best of the authors' knowledge, few studies have examined the socio-demographic characteristics of the indigenous population in North Borneo, Malaysia and their association with CRC incidence.

The population of North Borneo is approximately 3.59 million and comprises 32 ethnic groups, of which 28 are indigenous.[15] These multiple ethnic groups are characterised by diverse languages, cultures, and high genetic diversity, but they can communicate effectively in the Sabah Malay dialect.[16] Although the majority professed either Islam or Christianity, some retain ancient beliefs and practices. The latter group are not always genetically homogenous.[17] Therefore, understanding population-based differences concerning CRC will improve clinical practice and increase the resources available to facilitate the prevention of CRC in Malaysia. The objectives of this paper were to, first, identify links between socio-demographic characteristics—focusing on age, gender, ethnicity, religion, residential areas, marital status, education, income and occupation—and CRC incidence and, second, determine the association between BMI and CRC in those of North Borneo ethnicity.

MATERIALS AND METHODS

This is an analysis of a matched case–control study with a ratio of 1:2. CRC cases were taken from four district general hospitals (Queen Elizabeth Hospital, Duchess of Kent Hospital, Tawau Hospital, and Keningau Hospital) between 2019 and 2022. Using a multilevel research approach, the control group was matched for age, sex, ethnicity and place of residence to avoid potential bias.

The target population for the cases was all CRC patients (male and female) registered and reported in the Sabah Cancer Registry or the National Cancer Registry within three years of diagnosis (from 2019 to 2021). Participants in the control group were matched with cases in age (within five years), sex, and ethnicity in the same district and of the same ethnic group in Sabah. Based on the CRC risk, the sample size was determined (odds ratio [OR] = 1.78, 95% confidence interval [CI], P2 = 0.546). To identify odds ratios greater than 2.0 or lower than 0.6 with an 80% power, the sample size was matched to two controls (206:412) for age, sex and ethnicity. However, 2 years after the study began, new CRC cases were included to account for patients who had passed away.

Data collection commenced in March 2020 after obtaining research approval from the Malaysian Ministry of Health and Ethics Committee. Further support from the selected hospitals, clinics and Sabah State Health Departments was obtained to allow access to cancer registry lists, hospital records of diagnoses and patients' medical records. The investigator met selected respondents from the case group who visited one of four selected general hospitals in Sabah. Meanwhile, the control subjects met in the community and at their chosen health clinic. All the respondents were selected using purposive sampling. All the eligible respondents gave written informed consent to their participation before the interviews.

The subjects in the case groups were confirmed CRC patients diagnosed based on histopathological examination (HPE), registered in the Sabah State Cancer Register or the National Cancer Registry, and alive, regardless of their family history of cancer. These requirements helped to establish a comprehensive and reliable source for identifying cases. The control group was free of CRC participants with no family history of colorectal or any other form of cancer. Each respondent was matched by age, sex, gender and ethnicity to minimise potential confounding factors and enhance the comparability between groups. All the control subjects were screened for CRC using a faecal immunochemical blood test (iFOBT). The results needed to be negative, with no signs or symptoms of the disease. Respondents in both the case and control groups had to be indigenous to North Borneo and belong to one of the region's major ethnicities—such as Kadazan, Dusun, Bajau, Bugis, Brunei, Murut, Sungai, Bisaya, Jawa, Lundayeh, Rungus, Suluk, Irranun, Cocos, Kegayan or Tidung—or to another predominant race, such as Malay, Chinese or Indian. All the respondents had to be at least five years old to ensure their potential environmental exposure to the risk of CRC. To ensure the validity and reliability of data collection, participants were excluded if they could not provide written consent or had difficulties understanding or answering the questionnaire.

All the study respondents were interviewed face-to-face and given a standardised self-report questionnaire. These structured questionnaires were cross-culturally adapted to the research topic and valid for use in the local context. The questionnaire was divided into two sections. Section A (socio-demographic characteristics) covered the respondents' details, such as their age, gender (male or female), ethnicity (North Borneo ethnicity), religion (Muslim, Christian, Buddhist, Hindu or other), area or place of residence (by district), marital status (single, married, widow/widower/divorced), educational status (no formal education, primary, secondary, tertiary), household income (less than RM1000, RM1000-RM3000, RM3000 and above) and current employment (based on the International Labour Organisation criteria: self-employed, retired). Section B covered measurements of the respondent's anthropometric details.

A literature review of the studies, journals and books relevant to this topic validated the questionnaire's content. Face validity was used to assess the questionnaire. It was pre-tested with 30 respondents not included in the study sample to

ensure they understood the questions and statements. To gather more information, interviews were also conducted with the patients' family members and the medical professionals in charge of the patients. A document review was conducted of the patients' case notes, and hospital documents were reviewed to obtain the respondents' HPE results and notification reports. The North Borneo dialect uses the Malaysian national language, *Bahasa Melayu*, which was used when communicating with and interviewing the respondents.

Direct measurements of anthropometric data (weight, height and waist circumferences) were performed after the interview with each subject. Validated and calibrated instruments were utilised following Malaysian Health Ministry protocol standards. The participants wore light clothing and no shoes, and individual accessories were removed. According to standard procedures, body weight was measured to the nearest 0.1 kg using a digital SECA scale (model Seca Clara 803, Seca GmbH & Co. KG., Hamburg, Germany). The parameter used to determine underweight, normal weight, overweight, and obese was the BMI, which is calculated according to the formula BMI = weight (kg)/height (m^2). The BMI values were calculated as the ratio of weight in kilograms to the square of the height in metres (kg/m^2) and categorised based on the WHO 1998 guideline and the Asian BMI cutoff values. Every participant was divided into one of four categories based on the Asian BMI cutoff points: BMI 18.5 kg/m^2 (slim or underweight), BMI between 18.5 and 24.9 kg/m^2 (normal), BMI between 25 and 29.9 kg/m^2 (overweight) and BMI > 30 kg/m^2 (obesity).

According to standard procedures, waist circumference (WC) was measured with a non-elastic measuring tape Seca 201 (SECA, Vogel & Halke GmbH & Co. KG, Hamburg, Germany) and recorded to the closest 0.1 centimetres.[18] After the participant took several successive natural breaths, WC was measured at a level parallel to the floor, halfway between the top of the iliac crest and the lower edge of the last perceptible rib in the midaxillary line.[19] The waist circumferences were classified based on the cutoff established by the International Diabetes Federation (IDF)/Western Pacific World Health Organization/International Obesity Task (WHO/IASO/IOTF,2000) for Asians (90 cm in men and 80 cm in women).[20]

Patient privacy and confidentiality were maintained. Respondent selection was voluntary, so they were given the choice to participate, with no attention paid to any conflict of interest. They also had the right to withdraw from the study at any time. Informed consent was obtained from the respondents who wished to participate in the study, the confidentiality of which was assured. Ethical approval was obtained from the Medical Research Ethics Committee, Ministry of Health Malaysia NMRR: 19-3905-52394 and the University of Malaysia Sabah Research Ethics Committee (UMS/FPSK 6.9/100-6/1/95).

The Statistical Package for Social Sciences Statistics (SPSS) IBM version 28.0 was used to analyse the data. The data collected from the respondents were analysed according to their group. The normality tests showed that the data had a normal distribution. The socio-demographic data were analysed using the Pearson chi-squared test. Categorical data were expressed as frequencies, and percentages were presented descriptively and expressed as frequency (percentage, %) distribution. The current variables only used simple logistic regression on the effect size to determine the various socio-demographic factors associated with CRC. Simple regression was also used to determine the association between BMI and CRC. Hosmer and Lemeshow recommended this p-value as they found that using $p < 0.05$ might not enable certain significant variables to be identified.[21] No adjustments were made for confounding factors in the statistical analysis. The significance level was set as $p < 0.05$. The outcomes are presented as crude and odds ratios (OR) with a 95% confidence interval (CI) and the corresponding p values.

RESULTS

This case-control study involving 618 participants was conducted between March 2020 and December 2022. According to Table I, of the 206 cases and 412 controls, most participants were 61–65 years old, with 19.3% being 21.8% in the case group and 18.7% in the control group. The mean age of the participants was 53.17 (11.4) years old. Of the seven ethnic groups identified in this survey, Bajau comprised the greatest percentage (24.8%), followed by Dusun (22.3%), Kadazan (18.0%), other North Borneo groups (15.5%), Bugis (9.7%), other major races (5.3%) and Brunei (4.4%). Most participants (58.6%) were male, making up a majority of 59.2% in the case group and a majority of 58.3% in the control group. The participants were predominantly Muslim (59.4%) and married (78.3%). A total of 53.1% were secondary school graduates. Table II lists the socio-demographic characteristics with regard to CRC, including the respondents' incomes, occupations and BMI values.

The average monthly income of the wealthiest households was RM1000 (227.25 USD), and 38.2% earned between RM1000 and RM3000 (681.74 USD). The unemployment rate among the participants was 35.6%, while retirees comprised 15.0%. Following the International Labor Organization criteria, professionals made up 15.3% of the participants in the control group and 13.9% of those in the case group. Sales and service professionals comprised the next-largest group in both categories, accounting for 11.0% in each. Although the majority (61.7% of the respondents in the case and control groups) did not report receiving any treatment, 15.0% of the respondents from the case group and 41.0% of those from the control group did, receiving additional treatment for conditions such as hypertension, diabetes mellitus and cholesterol.

Table II also summarises the BMI values of the participants. It is statistically significant that CRC was associated with most respondents in the case group (48.5% vs. 63.1% in the control group), with a p-value of 0.001. Males with a waist circumference of less than 90 cm represented the majority of these, followed by men with a waist circumference beyond 90 cm. The mean (SD) of the case group is 3.62, whereas that of the control group is 3.42.

Table I: Frequency distribution of socio-demographic background of the participants

Variable	Case (206) n (%)	Control (412) n (%)
Age of respondent		
>25	4 (1.9)	8 (1.9)
26–30	5 (2.4)	10 (2.4)
31–35	10 (4.9)	22 (5.3)
36–40	14 (6.8)	26 (6.3)
41–45	13 (6.3)	31 (7.5)
46–50	23 (11.2)	39 (9.5)
51–55	34 (16.5)	72 (17.5)
56–60	37 (18.0)	82 (19.9)
61–65	45 (21.8)	77 (18.7)
>65	21 (10.2)	45 (10.9)
Mean age±SD (years) 53.17 ± 11.4		
Min–Max age 18–76 years		
Gender		
Male	122 (59.2)	240 (58.3)
Female	84 (40.8)	172 (41.7)
Ethnicity		
Bajau	51 (24.8)	101 (24.5)
Dusun	46 (22.3)	95 (23.1)
Kadazan	37 (18.0)	72 (17.5)
Bugis	20 (9.7)	40 (9.7)
Brunei	9 (4.4)	18 (4.4)
Other North Borneo ethnicity[a]	32 (15.5)	64 (15.5)
Other predominant race[b]	11 (5.3)	22 (5.3)
Religion		
Muslim	125 (60.7)	242 (58.7)
Christian	76 (36.9)	164 (39.8)
Buddha	5 (2.4)	5 (1.2)
Free thinker	0	1 (0.2)
Marital status		
Married	158 (76.7)	326 (79.1)
Divorce	14 (6.8)	19 (4.6)
widow	15 (7.3)	25 (6.1)
Single	19 (9.2)	42 (10.2)
Education		
None	16 (7.8)	16 (7.8)
Primary	45 (21.8)	87 (21.1)
Secondary	106 (51.5)	222 (53.9)
Higher education	39 (18.9)	87 (21.1)

[a](Murut, sungai, Bisaya, Jawa,Lundayeh, Rungus, Suluk, Irranun, Cocos, Kegayan, Tidung)
[b](Chinese, Malay)

DISCUSSION

Ethnicity age-adjusted incidence has often been interpreted to account for the differences in the prevalence of CRC worldwide. In addition, ethnicity, geographic variation, being younger, and gender have been linked to increased risk.[20–23] However, classification systems with four consensus molecular (CMS) subtypes of CRC are yet to be defined.[24] Some people in Asia, particularly the Chinese, Koreans and Japanese, live in similar environments and have similar lifestyles and dietary behaviours, unlike multi-ethnic populations like those of Singapore and Malaysia.[25,26] Cancer incidence and survival differences between indigenous and non-indigenous populations have been reported.[27,28] Surprisingly, the reported CRC prevalence was below the national norm. Malays, Chinese, Indians and others (including foreigners) are not representative of the indigenous communities in North Borneo, Malaysia (Sabah).[29,30]

The population of Sabah was projected to be 3,418.8 million in 2020. There are 36 officially recognised ethnic groups in North Borneo. The majority of the population (698,300) are of the Kadazan/Dusun ethnic group, followed by the Bajau (592,400) and Murut (112,900).[31] However, the study found that the highest incidence of CRC in selected districts was among the Bajau, with 24.8%, followed by the Dusun (22.3%), Kadazan (18.0%), and others in North Borneo (15.5%). These results may have been obtained due to these groups being the majority ethnicities in that area, and the findings do not represent the whole country. Following other research in Malaysia, the main ethnic groups reflected the increased risk factors for CRC.[32]

Most of those in the case group were found to be between the ages of 61 and 65, while 59.2% were male and 40.8% were female. In contrast, a global study in 2018 placed CRC risk third among men and second among women.[3] In Asian countries such as Korea and Japan, CRC is more significant in women than men, and it has surpassed all other cancer-

Table II: Univariate analysis of risk factors for colorectal cancer

Variable	Case (206) n (%)	Control (412) n (%)	OR	95% CI Lower	Upper	p value
Income						0.004
RM 1000–RM 3000	72 (35.0)	16 (39.8)	1.756	1.164	2.648	
> RM 3000	60 (29.1)	236 (38.2)	1.953	1.276	2.989	
< RM 1000	74 (35.9)	90 (23.3)	Ref			
Occupational						0.001
Manager	5 (2.4)	11 (2.7)	0.9	0.212	3.822	
Professional	23 (11.2)	63 (15.3)	2.073	0.678	6.339	
Technician and associate professional	4 (1.9)	9 (2.2)	1.05	0.277	3.985	
Clerical support workers	8 (3.9)	17 (4.1)	2.631	0.81	8.543	
Service and sales worker	13(6.3)	55 (13.3)	0.487	0.14	1.7	
Skilled agricultural, forestry and fishery worker	14 (6.8)	13 (3.2)	0.9	0.178	4.549	
Craft and related trades workers	5 (2.4)	7 (1.7)	0.15	0.013	1.676	
Plant and machine operators and assemblers	4(1.9)	2 (0.5)	3	0.786	11.445	
Elementary occupation	7 (3.4)	37 (9)	2.4	0.215	26.822	
Armed force	3 (1.5)	5 (1.2)	0.9	0.316	2.565	
Pensioner	32 (15.5)	61 (14.8)	1.125	0.375	3.377	
Not working	88 (42.7)	132 (32)	Ref			
Other related diseases						<0.001
HPT, DM, and cholesterol	31 (15)	169 (41)	3.25	2.09	5.055	
HPT, DM, and others	0	15 (3.6)	96322	0		
Others	5 (2.4)	15 (3.6)	1.789	0.635	5.039	
Chemotherapy	43 (20.9)	0	0	0		
Not on any treatment	127 (61.7)	213 (61.7)	Ref			
BMI						<0.001
Healthy weight	64 (31.1)	79 (19.2)	0.178	0.063	0.499	
Overweight	26 (12.6)	68 (16.5)	1.674	1.135	2.47	
Obesity	100 (48.5)	260 (63.1)	1.396	0.871	2.237	
Underweight	16 (7.8)	5 (1.2)	Ref			

OR = odds ratio, CI = confidence interval, BMI=Body mass index, and Ref = Reference

related causes as the second-most significant cause of death globally.[33,34] CRC has overtaken breast disease as the second-most frequent cancer in both men and women. The gender disparity may be partly due to lifestyle factors such as higher rates of smoking and drinking alcohol among men, as well as fewer doctor visits or cancer screenings.[32]

The earliest age at which diagnosis of CRC occurred was 18; however, between the ages of 41 and 50, the incidence rose by 17.5%. Between the ages of 61 and 65, it increased by 21.8% between notified cases.[23] These results agree with those of other studies in which indigenous people had a threefold higher risk of CRC than Chinese people.[3] It subsequently had CRC at age 50, climbs by 30% until age 55 and peaks at 70 years for both sexes.[3,23] In contrast, other studies have revealed a higher burden of prevalent CRC in people aged 45–49, based on observed incidence rates, and an increase among people younger than 40.[3]

Unique to this study, 66.5% of CRC cases were found to be diagnosed in patients between the ages of 51 and more than 65; however, most of these represent the majority of the primary ethnicity of North Borneo, Malaysia. These findings are in accordance with the Malaysian clinical practice guidelines for managing CRC. Recent studies have also shown that beginning screening at age 40 or 45 is cost-effective, and cancer screening models must be updated with the most current data regarding age and incidence of CRC.[33,34] In contrast to this study, by the ages of 41–50, 17.5% of the respondents in the control group were free from CRC because they attended CRC screening with the iFOBT (Immunological Faecal Blood Test).

Studies have also revealed that the country's population is divided between Muslims and Christians, with 60.7% of the respondents being Muslims and 36.9% being Christians.[29] Furthermore, only a small number of socio-demographic relationships were found not to be statistically significant. However, socioeconomic status was found to be a significant risk factor for CRC, with the majority of the respondents having a household income of less than RM1000 per month. The majority (51.5%) also had secondary-level schooling as their highest level of education. However, earlier research established a correlation between updated rates of CRC screening, income, and BMI category.[21,35]

The relationship between occupation and the onset of CRC has not been extensively studied. However, several studies have demonstrated that there are differences between the incidence of CRC in a variety of occupational groups. Some workers have more significant occupational exposure to particular agents, including those in the textile industry, automotive industry, petrochemical industry, beverage industry, iron and steel industry and railway industry, as well as dockyard workers and firefighters.[36] Our findings did not suggest exposure to any of these, but a connection between CRC and occupation was discovered. However, most respondents (220, or 35.6%) were unemployed, pensioners (15.0%) or professionals (13.9%), based on the International Standard Classification of Occupations (ISCO). Furthermore,

the results showed that 11.0% were sales and service workers, while 7.1% were employed at stalls, at markets or in elementary occupations. This association may be because North Borneo, Malaysia (Sabah) has the third-highest population working in the informal sector, with 165.5% of the population working in the unregistered sector (the informal sector establishment category includes establishments not registered with CCM and professional bodies, as well as establishments with fewer than ten workers and where all or at least one type of the goods produced are meant for sale or barter transactions).[29]

According to the findings shown in Table II, 51.7% of the respondents in the control group were healthy or not receiving any treatment, whereas 61.7% of those in the case group only received treatment for CRC. Additionally, respondents diagnosed with hypertension, diabetes mellitus, or hypercholesterolaemia were less common in the case group than the control group (15.0% vs. 41.0%). Co-morbid illnesses (diabetes, hypertension, dyslipidemia, coronary heart disease, gallbladder disease, arthritis and constipation) are more common in CRC patients with a Western lifestyle. As the data illustrate, CRC was significantly associated with the three morbid disorders of hypertension, hypercholesterolaemia, and diabetes mellitus, which were more prevalent in the control group than the case group. This aligned with the inverse relationship between blood cholesterol and the risk of CRC frequently noted in earlier research. In contrast, a small number of additional studies found a non-significant relationship between metformin use and decreased CRC risk in those with DM type II.[37] However, statins, antihypertensives and metformin use among patients and controls have not been fully documented. Although CRC risk factors vary from country to country, it is critical to investigate the disease further among healthy individuals.

Obesity is rapidly becoming a severe health problem because of lifestyle changes. Being overweight and being obese are two highly modifiable risk factors that significantly affect the incidence and mortality of CRC.[38] As shown in Table II, there is a substantial correlation between obesity and CRC, with 63.1% of the case group being obese and 31.1% being of normal weight. These results may be explained by the fact that obese people had a 33% higher risk of CRC than those of normal weight.[39] However, a study on CRC and obesity conducted in Malaysia in 2017 found that this country had a lower population attributable fraction (PAF) for overweight than Korea and Brazil. The PAF reflects the percentage of cases (both exposed and unexposed). Findings from 13 distinct meta-analysis cohort studies revealed that weight gain as determined by BMI or weight was marginally related to an elevated risk of colon cancer.[4] Further research is required to better understand the underlying biological mechanisms linking obesity to CRC.

Gender differences, the age of onset of metabolic syndrome, and BMI appear inconsistently associated with an increased risk of CRC. Consistent with the literature, the current findings show a significant correlation between all the anthropometric variables (weight, BMI and waist circumference) and CRC risk. Regardless of gender, the case group's average BMI was slightly higher than that of the control group, at 3.62 (1.054) and 3.42 (0.837), respectively. That is consistent with the findings of three further meta-analyses, which showed that both BMI and waist size were linked to the risk of CRC.[33,40] The strong correlation between the two sexes supports our findings on the association between BMI and CRC, as opposed to two studies from China that indicated a significant increase in colon cancer in men but not women.[40]

One limitation of the study is that the generalisability of these findings only represented a few specific ethnicities. The findings could only be generalised to some of the population of Sabah for reasons of ethnicity. Although all the socio-demographic factors were extensively discussed, it is unfortunate that not all the CRC cases registered in all the general hospitals in North Borneo could be included. Moreover, occupational exposure to the particular agent linked to CRC was not explored in this study. These areas require further research to determine whether an actual difference exists with regard to gender.

CONCLUSION

The authors concluded that there is a risk variance for CRC among the ethnic groups in North Borneo, Malaysia. The study showed various socio-demographic characteristics are linked to CRC based on socio-demographic characteristics and BMI. Therefore, national public health campaigns should include collaboration with the regional authorities to highlight the incidence and risk factors of CRC based on ethnicity to lower the nationwide prevalence of CRC.

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