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The relationship between health risk and consumption of confectioneries: An instrumental variable approach

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ABSTRACT

Introduction: Consumption of confectioneries is a determinant of health risk. However, how health risk determines the intake of confectioneries remains unclear. The objective is to examine how waist circumference (WC) as a measurement of health risk influences the consumption of confectioneries among adults. The research question is that do high-risk people consume more confectioneries than low-risk people? **Methods:** A quantitative research design with a focus on establishing a correlation between the measurement of health risk and consumption of confectioneries was adopted. Secondary analysis of a nationally representative cross-sectional data was used. The population of interest was the Malaysian population, regardless of being obese or non-obese. Analyses stratified by body mass index (BMI) or WC were not conducted. An instrumental variable (IV) approach was used to estimate the regression of consumption of confectioneries. BMI was used as an IV for WC. In the first stage, we regressed WC on all exogenous variables, including BMI. Then, we replaced the original values of WC with the fitted values of WC. **Results:** BMI was an appropriate IV for WC. An additional cm of WC was associated with a 0.022 unit of reduction in the serving of confectioneries per week. The negative relationship between WC and consumption of confectioneries indicated that adults who had high health risk consumed lesser confectioneries than adults who had low health risk. **Conclusion:** Drawing from the IV regression results, the present study highlighted that people with high health risk, rather than people with low health risk, were less likely to consume confectioneries.

Keywords: Body mass index, confectionery, health risk, obesity, waist circumference

INTRODUCTION

Waist circumference (WC) is considered a measurement of health risk. Health risk is defined as an individual's probability of developing a disease. Large WC is related to various non-communicable diseases

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(NCDs), most notably cardiovascular disease, stroke and diabetes, accounting for greater mortalities than small WC (WHO, 2018). Individuals who are in the upper quantile of WC have about 137-216% higher odds of developing hypercholesterolemia, hypertension and diabetes compared with individuals who are in the lower quantile of WC (Zhu *et al.*, 2002). An increase of 1 cm in WC raises the odds of being diagnosed with high triglycerides and metabolic syndrome by 6-7% (Janssen, Katzmarzyk & Ross, 2004). Men and women who have large WC are two times more likely to suffer from colon cancer than their counterparts having small WC (Moore *et al.*, 2004). It is apparent that large WC indicates higher health risk, while small WC denotes lower health risk.

The increase in the prevalence of NCDs has become a serious global public health concern, notably in developing countries, including Malaysia (Lum, 2018; WHO, 2018). From 2006 to 2015, the prevalences of obesity, diabetes and hypercholesterolemia in Malaysia increased from 14.0%, 11.5% and 20.7% to 17.7%, 17.5% and 47.7%, respectively (IPH, 2008; Wan Mohamud *et al.*, 2011; IPH, 2015). There are numerous factors that elevate health risk or increase WC. One of the factors is the excessive consumption of added sugar, including confectioneries (Hu, 2013; Stem *et al.*, 2017). Added sugar is sugar that is added to foods and beverages, whilst confectionery is a type of food that consists of added sugar. Therefore, the greater the consumption of confectioneries, the greater the intake of added sugar. There is evidence suggesting that an additional serving of added sugar per day increases WC by 1 cm (Stem *et al.*, 2017). On average, a Malaysian adult consumes about 5.2 servings of confectioneries per week (IPH, 2014). This amount is significantly high, especially given that carbohydrate-rich foods are the staples of the Malaysian people.

Although the effects of added sugar consumption on WC have been well-documented, how WC as a measurement of health risk determines confectioneries consumption behaviour is unclear. A research question arises: are high-risk people or people with large WC more likely to consume confectioneries than low-risk people or people with small WC? Having a better understanding of confectioneries consumption behaviour among people is important for policy makers if the goal is to lower the risk of disease via a reduction in the consumption of confectioneries. If high-risk people, rather than low-risk people, consume less confectioneries, then anti-confectioneries policy that focuses mainly on high-risk people may be less optimal.

In general, WC can influence confectioneries consumption in two different ways. Firstly, people with high risk of disease, i.e., those who have large WC, tend to have a higher rate of time preference, that is that they are more present oriented than people with low risk of disease, i.e., those who have small WC (Komlos, Smith & Bogin, 2004; Smith, Bogin & Bishai, 2005). Since consumption of confectioneries is an unhealthy behaviour, high-risk people are hypothesised to consume more confectioneries than low-risk people. This is our first hypothesis. Secondly, high-risk people are more aware of various diseases compared with low-risk people, and consequently are less likely to consume confectioneries (Lin *et al.*, 2016; Park *et al.*, 2016). Hence, a negative relationship between having a large WC and consumption of confectioneries is hypothesised. This is our second hypothesis. With that, the objective of the present study is to examine the influence of WC, i.e., a measurement of health risk, on the consumption of confectioneries.

The relationship between health risk and intake of added sugar has been

examined in previous studies (Rehm *et al.*, 2008; Bleich & Wang, 2011; Zytnick *et al.*, 2015; Park *et al.*, 2016; Pollard *et al.*, 2016; Xu, Park & Siegel, 2018). Although previous findings are interesting, they have some limitations. Firstly, body mass index (BMI) was used to measure health risk. This may result in measurement error as BMI cannot measure fat, body image and health condition accurately. As numerous studies have indicated, BMI is not a good measure for health risk because it does not differentiate between weight from fat and weight from muscle and bone (Burkhauser & Cawley, 2008; Kinge, 2017). This means that muscular people or people with a large bone structure, but having low body fat can be miscategorised as having high risk if their BMI is more than 29kg/m^2. For instance, O'Neill (2015) found that nearly 50% of high-risk women were misclassified as being low-risk, if BMI was used. In addition, Kragelund & Omland (2005), Yusuf *et al.* (2005) and Bozeman *et al.* (2012) pointed out that BMI was a weaker predictor of illnesses as compared with other measures, such as WC and waist-to-hip ratio. Secondly, even if BMI is a good measure for health risk, it causes simultaneity issue when it is included as an independent variable in the regression for added sugar intake. Since excessive consumption of added sugar can increase body weight, there is a two-way causation between added sugar consumption and BMI. Thus, it can be concluded that BMI is an endogenous variable, which can cause endogeneity problem, that is, a problem that leads to biased and inconsistent estimates if the regressions are not estimated using an instrumental variable (IV) approach.

Owing to these weaknesses, the present study attempts to contribute to the literature in several ways. Firstly, unlike previous studies, the interest of this study is in a rapidly-growing developing country like Malaysia, with a high prevalence of health risk and where empirical studies related to health risk and added sugar consumption are lacking. Moreover, the obesity rate in Malaysia is quite high (17.7%). Hence, it can be useful for policy makers to examine how food consumption behaviour is affected by health risk. Furthermore, as pointed out by Kleiman, Ng & Popkin (2012), the majority of the sales of sugary foods across the globe is in developing countries, making the prevalence of diseases worse-off. In this context, it justifies paying more attention to a developing country than a developed country.

Secondly, the present study replaces BMI with WC and examines how it affects confectioneries consumption. WC has been proven to be a better measure and predictor of health risk than BMI (Kragelund & Omland, 2005; Yusuf *et al.*, 2005; Bozeman *et al.*, 2012; Zhu *et al.*, 2014). By using WC, low-risk people are unlikely to be misclassified as high-risk people and vice versa (O'Neill, 2015). It is well-documented that where fat is located in a person's body is significant. Fat accumulated in the abdomen is more dangerous than in the hips or in other parts of the body (Burkhauser & Cawley, 2008). Hence, measurement error can be avoided if WC is used.

Thirdly, although WC is better than BMI, WC is also an endogenous variable due to simultaneity. Hence, in order to overcome the endogeneity issue, IV approach is used to estimate the regression. A quantitative research method with a focus on IV regression is the design of the present study and is considered as the uniqueness of this research. Our estimated results will be unbiased and consistent, thereby able to provide better statistical inferences. If our model is estimated using non-IV methods, such as ordinary least square (OLS), imprecise and biased estimates will be obtained because of the two-way causal relationship between confectioneries consumption and WC. Therefore, it will lead to wrong conclusions and provide policy

makers with inaccurate information. Using an appropriate IV regression can ensure that this problem will not occur, especially when IV is correctly identified.

MATERIALS AND METHODS

Data

Secondary data from the Malaysian Adult Nutrition Survey (MANS) 2014 were used in the present study (IPH, 2014). It was a nationwide survey conducted by the Ministry of Health Malaysia. A multi-stage random sampling was used. In the first stage, the entire country was divided into several enumeration blocks (EBs), i.e., geographical areas with boundaries. Overall, there were about 75,000 EBs. Approximately 49,000 were in urban areas and 26,000 in rural areas. EBs were selected in accordance with the population size of each state. A total of 187 urban EBs and 150 rural EBs were selected. In the second stage, living quarters (LQs) in each EB were randomly selected. Each EB consisted of 80-120 LQs, and each LQ comprised of 500-600 in population. A total of twelve LQs were selected from each EB. In the third stage, individuals aged 18-59 years and who resided in the selected LQs were randomly selected. The exclusion criteria were those who were pregnant or breastfeeding, as well as those who followed a special diet. Since the scope of the present study was the entire Malaysian population, regardless obese or non-obese, and analyses were not stratified by BMI or WC, MANS 2014 was appropriate. Additional information about the sampling are provided elsewhere (IPH, 2014).

Multilingual structured questionnaires were used by trained staffs to conduct face-to-face interviews. These were questions in the questionnaire of the MANS 2014. Signed consent forms were taken from every respondent. A total of 3,000 respondents completed the questionnaire. However, due to missing information, only 2,696 were used for analyses. Despite some observations being deleted, the sample was still nationally representative. Ethical approval of MANS 2014 was given by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-12-815-13100).

Measurements

The dependent variable was the consumption of confectioneries. The independent variables were WC, age, income, education, gender, marital status, ethnicity, employment status and household location. BMI was used as an IV. Confectioneries referred to sugar added foods such as cakes, ice-cream and snacks. Consumption of confectioneries is the total servings of confectioneries consumed by the respondents in a week. It was obtained by asking the respondents 'Normally, how many days in a week do you take confectionery?' and 'Usually on the day you eat confectionery, how many servings do you take?'. Since face-to-face interview was conducted, respondents were provided with detailed explanations. The interviewers ensured that the respondents fully understood the definition of confectionery. Consumption of sugar-sweetened beverages, such as soft drink, sports drink and energy drink was often examined in previous studies (Park *et al.*, 2016; Rehm *et al.*, 2008; Bleich & Wang, 2011; Zytnick *et al.*, 2015; Pollard *et al.*, 2016; Xu *et al.*, 2018). Different from past researches, consumption of confectioneries was analysed in this study because it had not been examined in great detail and is highly linked to obesity-related illnesses (Naughton, McCarthy & McCarthy, 2017).

Demographic variables were selected in light of the findings of previous studies (Park *et al.*, 2016; Rehm *et al.*, 2008; Bleich & Wang, 2011; Friis *et al.*, 2014; Zytnick *et al.*, 2015; Pollard *et al.*, 2016; Xu *et al.*, 2018; Cheah *et al.*, 2019a). Previous studies found

that older individuals were less likely to consume added sugar than younger individuals because older individuals were more concerned about their health (Rehm *et al.*, 2008; Park *et al.*, 2016; Xu *et al.*, 2018). Consumption of added sugar varied across income as high income people tended to have better health awareness (Rehm *et al.*, 2008; Bleich & Wang, 2011). Men were more likely to consume added sugar relative to women because they have a higher tendency to adopt an unhealthy lifestyle (Bleich & Wang, 2011; Friis *et al.*, 2014; Zytnick *et al.*, 2015; Pollard *et al.*, 2016; Xu *et al.*, 2018). Being married reduced the consumption of added sugar (Xu *et al.*, 2018) and this was because of an increase in household commitment. Owing to cultural and religious factors, there was an ethnic variation in health behaviour (Cheah *et al.*, 2019b; Cheah *et al.*, 2020). Relative to unemployed individuals, employed individuals consumed more added sugar as they had a better financial capability (Cheah *et al.*, 2019a). Given the geographical differences in the supply of foods, urban and rural dwellers displayed different odds of consuming added-sugar (Park *et al.*, 2016; Cheah *et al.*, 2019a). Given these findings, we expected that demographic factors could affect the consumption of confectioneries.

During the survey, the respondents' height [meter (m)] and weight [kilogram (kg)] were measured using SECA Stadiometer 217 and Tanita Personal Scale HD 319. These information were then used to calculate BMI (kg/m^2). In addition, SECA 201 tape was used to measure the respondents' WC in cm. BMI and WC were formatted as continuous variables, instead of categorical variables, to facilitate IV regression. Nevertheless, in an effort to understand how many percent of the respondents were obese or non-obese, we categorised BMI into obese (BMI $25kg/m^2$) and non-obese (BMI $<25kg/m^2$) categories for descriptive statistics purpose.

Research design

The present study used a quantitative research design, particularly the correlational research design, to understand the correlation between the measurement of health risk and consumption of confectioneries. Quantitative research is a method of collecting quantifiable data and carrying out statistical tests, whilst correlational research is a method of identifying the association between two variables. In the present study, secondary analysis of survey data was conducted. The survey gathered measurable information on health risk and confectioneries consumption. The quantitative research approach was suitable for the present study because it could establish a relationship between the measurement of health risk and consumption of confectioneries by using available survey data. In addition, the present study attempted to deal with statistical issue, thus quantitative method was considered appropriate.

WC was an endogenous variable resulted from simultaneity as it could be jointly determined with the consumption of confectioneries. While WC may affect the decisions of people in the amount of confectioneries to consume, indeed, consuming too much confectioneries may increase WC. As such, using OLS or other non-IV methods to estimate the regression of consumption of confectioneries, that included WC as an independent variable, was likely to generate biased and inconsistent results. This was the problem of endogeneity. In order to overcome this problem, IV approach must be adopted.

Kinge (2017) used family members' WC as an IV for WC. However, because of data limitation, we did not have information on this variable. Instead, we used BMI as an IV for WC given that it satisfied these two main criteria (Wooldridge, 2013; Mehta, 2015). Firstly, BMI was highly correlated with WC. The covariance between these two variables

was not zero. People with high BMI was likely to have large WC. As pointed out by Bozeman *et al.* (2012), BMI was able to predict WC. Secondly, we assumed that WC, instead of BMI, had a direct effect on the consumption of confectioneries, because WC was a better measurement of health risk. People who had high BMI did not necessarily have high body fat or poor health conditions. They may be muscular or have a larger bone structure and lean body mass.

Two stage least square (2SLS), i.e., a method of IV, was used to estimate the regression. Since BMI appeared in the regression of WC, but not the others, the regression of consumption of confectioneries could be identified. In the first stage, we regressed WC on all the exogenous variables and BMI. This regression was known as a reduced form equation. The fitted values of WC were then used in the second stage. They replaced the original values of WC. Moreover, we used gender as an additional IV for WC in an effort to compare whether BMI was a better IV than demographic variables. We expected that gender would be highly correlated with WC. In the second stage, we regressed the consumption of confectioneries on all independent variables and the fitted values of WC. This regression was a structural equation, which was the model of primary interest of the present study. For comparison purpose, we also estimated the main regression using OLS. Because the fitted values of WC had lesser variations and were highly correlated with other exogenous variables, the standard errors of the IV estimates tended to be larger than those of the OLS estimates. Hence, robust standard errors of the IV estimates were calculated.

In spite of the assumption stating that BMI was an appropriate IV, we conducted a statistical test to confirm if this was true. We used OLS to estimate a multiple regression of WC on BMI and other exogenous variables. If the estimate of BMI was significant, BMI was considered to be an appropriate IV and the equation for the consumption of confectioneries could be identified. IV approach had been previously used to study the relationship between obesity and medical costs (Cawley & Meyerhoefer, 2012), and demand for cigarettes (Kenkel, Schmeiser & Urban, 2014).

RESULTS

The majority of the respondents were aged 30-39 years (27.3%), followed by those aged ≤29 years (26.2%), 40-49 years (26.0%) and ≥50 years (20.6%). Approximately 52.3%, 21.3%, 9.9%, 7.1% and 9.6% of the respondents had a monthly income of ≤ Ringgit Malaysia (RM) 999, RM1000-1999, RM2000-2999, RM3000-3999 and ≥ RM4000, respectively. A large proportion of the respondents had secondary level education (64.3%), followed by those who had primary level (20.8%), tertiary level (10.1%) and no formal education (4.8%). Slightly more than half of the respondents were females (53.5%). Nearly two-third of the respondents were married (68.8%), while only 24.7% and 6.5% were single and widowed/divorced, respectively. The ethnic breakdown consisted of 72.4% Bumiputera, 17.1% Chinese, 4.5% Indians and 6.1% individuals from other ethnic backgrounds. Of the total respondents, the majority were employed (74.3%) and resided in urban areas (52.7%) (Table 1).

On average, the respondents consumed about 4.190 servings of confectioneries (e.g. cakes, ice-cream, snacks etc.) per week. This amount of serving was slightly lesser than the amount reported in MANS 2014, i.e., 5.2 servings, because of the different calculation formulas employed (IPH, 2014). Our calculation included the respondents who reported zero intake of confectioneries, thus the mean value of confectioneries intake (i.e.,

Table 1. Variables and correlates of BMI and other exogenous variables to WC (N=2696)

Variables	*Mean (standard deviation)*	*Frequency (percentage)*	*Estimates*	*Standard errors*	*p-value*
Constant	–	–	44.682	1.009	<0.001
Confectioneries	4.19 (5.84)	–	–	–	–
WC (cm)	84.58 (13.21)	–	–	–	–
BMI (kg/m^2)	25.99 (6.68)	–	1.470	0.025	<0.001
BMI					
Obese	–	1394 (51.7)	–	–	–
Non-obese	–	1302 (48.3)	–	–	–
Age					
≤ 29 years	–	707 (26.2)	–	–	–
30-39 years	–	737 (27.3)	0.029	0.519	0.956
40-49 years	–	700 (26.0)	-0.311	0.553	0.574
≥ 50 years	–	554 (20.6)	0.709	0.599	0.237
Income					
≤ RM999	–	1409 (52.3)	–	–	–
RM1000-1999	–	573 (21.3)	0.084	0.487	0.862
RM2000-2999	–	266 (9.9)	0.835	0.652	0.200
RM3000-3999	–	190 (7.1)	0.182	0.748	0.808
≥ RM4000	–	258 (9.6)	-0.008	0.742	0.991
Education					
Tertiary	–	272 (10.1)	–	–	–
Secondary	–	1734 (64.3)	-0.508	0.650	0.434
Primary	–	560 (20.8)	0.080	0.776	0.918
No formal	–	130 (4.8)	0.847	1.045	0.417
Gender					
Male	–	1255 (46.6)	1.833	0.376	<0.001
Female	–	1441 (53.5)	–	–	–
Marital status					
Married	–	1855 (68.8)	0.468	0.486	0.335
Single	–	665 (24.7)	–	–	–
Widow/divorce	–	176 (6.5)	1.235	0.825	0.134
Ethnicity					
Bumiputera	–	1953 (72.4)	–	–	–
Chinese	–	460 (17.1)	0.808	0.493	0.102
Indian	–	120 (4.5)	2.046	0.839	0.015
Others	–	163 (6.1)	0.153	0.738	0.836
Employment					
Employed	–	2003 (74.3)	-0.161	0.460	0.726
Unemployed	–	693 (25.7)	–	–	–
Location					
Urban	–	1420 (52.7)	0.789	0.375	0.035
Rural	–	1276 (47.3)	–	–	–

Source: MANS 2014 (IPH, 2014)

unconditional mean) was somewhat smaller. The average units for WC and BMI of the total respondents were 84.6 cm and 26.0kg/m^2, respectively. Of all the respondents, 51.7% were obese and 48.3% were non-obese. BMI seemed to be significantly associated with WC, and so was gender. Holding other factors constant, on average, an increase of one unit of BMI increased WC by 1.5 cm, and males' WC was 1.8 cm larger than females' WC.

Using BMI as an IV, the results of 2SLS regression showed that an additional cm of WC was associated with a 0.022 unit reduction in the serving of confectioneries per week, if the values of other variables were held fixed. This meant that for every 20 cm increase in WC, the weekly intake of confectioneries was lower by 0.500 serving. These results supported our second hypothesis that having a large WC was negatively related to the consumption of confectioneries. However, when gender was used as an IV, the relationship between WC and confectioneries consumption became insignificant, implying that demographic variables may not be a better IV for WC compared with BMI. Considering the OLS estimates, for every one unit increase in WC, the consumption of confectioneries reduced by only 0.018 serving (Table 2).

DISCUSSION

Considering the two-way causal relationship between health risk and confectioneries consumption, the present study examined the influence of WC, i.e., a measurement of health risk, on consumption of confectioneries among adults. Owing to the fact that WC was an endogenous variable, IV approach was utilised to estimate the regression of confectioneries consumption. BMI was used as an IV for WC. Our findings suggested that BMI was an appropriate IV for WC as there was a significant association between these two variables, although it may not be the best IV. In addition, our findings showed that WC was negatively associated with the consumption of confectioneries, which indicated that adults who had high risk of disease consumed lesser added sugar than adults who had low risk of disease. However, we were unable to identify whether high-risk people consumed more or lesser fat and energy-dense foods than low-risk people because of data limitation. Moreover, the IV estimate of WC was found to be larger and more statistically significant than the OLS estimate. This implied that if non-IV method was used, the effect of WC on confectioneries consumption would be underestimated and may consequently be neglected by researchers and policy makers. The outcome could result in an inappropriate conclusion with dire consequences on public policy development.

A similar relationship between BMI and WC was evidenced in previous studies (Chinedu *et al.*, 2013; Gierach *et al.*, 2014), particularly in studies that used various statistical approaches and found a strong positive correlation between BMI and WC. Given that the effect of WC on confectioneries consumption had not been examined in previous studies, our literature review was based on studies pertaining to the relationship between BMI and consumption of added sugar. Similar to WC, high-risk people referred to those with high BMI, while low-risk people referred to those with low BMI. The relationship between BMI and consumption of added sugar found in previous studies appeared to be mixed. Using data from the National Health Interview Survey, Park *et al.* (2016) found that high-risk men were less likely to consume added sugar compared to low-risk men. They claimed that people who had high risk had a higher tendency to reduce their sugar intake in an effort to reduce their risks of suffering from diseases than their low-risk counterparts. Similar findings were evidenced by Zytnick *et al.* (2015),

Table 2. Correlates of WC and demographic factors to consumption of confectioneries, N=2696

Variables	*OLS*	*2SLS*[a]	*2SLS*[b]
Constant	5.934*	6.313*	20.764*
	(0.861)	(0.909)	(10.013)
WC (cm)	-0.018*	-0.022*	-0.198
	(0.008)	(0.009)	(0.121)
Age			
≤ 29 years	–	–	–
30-39 years	0.094	0.095	0.158
	(0.341)	(0.378)	(0.403)
40-49 years	-0.146	-0.150	-0.327
	(0.363)	(0.429)	(0.457)
≥ 50 years	-0.368	-0.361	-0.206
	(0.394)	(0.405)	(0.449)
Income			
≤ RM999	–	–	–
RM1000-1999	0.371	0.377	0.418
	(0.319)	(0.336)	(0.366)
RM2000-2999	-0.442	-0.440	-0.336
	(0.428)	(0.402)	(0.440)
RM3000-3999	0.333	0.341	0.561
	(0.491)	(0.578)	(0.642)
≥ RM4000	0.555	0.557	0.644
	(0.487)	(0.478)	(0.523)
Education			
Tertiary	–	–	–
Secondary	0.464	0.461	0.425
	(0.426)	(0.398)	(0.429)
Primary	-0.492	-0.487	-0.392
	(0.509)	(0.449)	(0.498)
No formal	-1.118	-1.116	-0.991
	(0.686)	(0.583)	(0.648)
Gender			
Male	-0.393	-0.382	–
	(0.247)	(0.246)	
Female	–	–	–
Marital status			
Married	-0.127	-0.118	0.178
	(0.319)	(0.369)	(0.405)
Single	–	–	–
Widow/divorce	-0.083	-0.074	0.332
	(0.542)	(0.482)	(0.527)

Table 2. Correlates of WC and demographic factors to consumption of confectioneries, N=2696 *[cont'd]*

Variables	*OLS*	*2SLS*[a]	*2SLS*[b]
Ethnicity			
Bumiputera	–	–	–
Chinese	-2.372*	-2.372*	-2.299*
	(0.324)	(0.315)	(0.354)
Indian	-1.757*	-1.749*	-1.337*
	(0.551)	(0.423)	(0.594)
Others	-0.975*	-0.987	-1.315*
	(0.484)	(0.541)	(0.627)
Employment			
Employed	0.573	0.570	0.446
	(0.302)	(0.305)	(0.320)
Unemployed	–	–	–
Location			
Urban	-0.043	-0.036	0.083
	(0.246)	(0.241)	(0.271)
Rural	–	–	–

Note: [a]BMI is used as an IV. [b]gender is used as an IV. Standard errors in parentheses
*p<0.05
Source: MANS 2014 (IPH, 2014)

who used a different dataset. Their findings showed that high-risk adults consumed lesser sports drinks than low-risk adults. On the other hand, Pollard *et al.* (2016), who investigated the intake of added sugar among Australians, found that high-risk women consumed more added sugar than low-risk women. They argued that the reverse causation between health risk and added sugar consumption was the reason. Xu *et al.* (2018) in examining the consumption of added sugar among adults with and without diabetes, also found that high-risk adults were more likely to consume added sugar than low-risk adults. Our findings confirmed our second hypothesis that high-risk people were more likely to take care of their health by avoiding confectioneries, as well as the findings of Park *et al.* (2016) and Zytnick *et al.* (2015) that being high-risk was inversely related to added sugar intake. Since Park *et al.* (2016) and Zytnick *et al.* (2015) used logistic regressions, the magnitude of WC evidenced in the present study could not be directly compared with their estimates.

Because individuals who have an unhealthy body weight usually have a large WC, except those with high lean body mass, there exists a significant positive relationship between WC and BMI. Even though WC is a more accurate determinant of the consumption of confectioneries compared with BMI as it predicts obesity-related diseases and mortality better than BMI (Kragelund & Omland, 2005; Yusuf *et al.*, 2005; Bozeman *et al.*, 2012; Zhu *et al.*, 2014), WC and BMI are closely related. It appears, therefore, that BMI is an appropriate IV for WC. Given that consumption of confectioneries is an unhealthy behaviour, people often believe that high-risk people are associated with high consumption of confectioneries. However, findings of the present study

indicated that this was not necessarily the case. In fact, high-risk people are more aware of their health than low-risk people, and thus have a lower likelihood of consuming confectioneries (Lin *et al.*, 2016; Park *et al.*, 2016).

Given the findings of the present study, we suggest that an intervention measure directed towards reducing the consumption of confectioneries among low-risk people or people with small WC should be adopted and emphasised in order to prevent further increases in the prevalence of diseases. More attention should be paid to this group of population than high-risk people or people with large WC. Unfortunately, analysis stratified by WC was not conducted in the present study, therefore we were unable to identify factors other than risk that determined confectioneries consumption among high- and low-risk people. This could be a direction for future research. Also, the cost-effectiveness of policies was not analysed in our study, thus we avoided providing any unverified extrapolations to possible anti-confectioneries policies.

While the present study had significantly illustrated the effect of WC on consumption of confectioneries, it had some limitations. For instance, all the information, except for BMI and WC, were self-reported by the respondents. Hence, minor reporting errors may have existed as high-risk people may have underestimated or underreported their consumption of confectioneries. However, this error was not as serious as what had been found by Ali Zainuddin *et al.* (2019). The authors calculated the respondents' energy intake-basal metabolic rate ratio and found high prevalence of underreporting of energy intake in MANS 2014. This should not be an issue in the present study because in MANS 2014, the questions used to obtain data on confectioneries intake were not related to the questions used to calculate energy intake. This meant that even though the information on energy intake lacked reliability, the data on confectioneries consumption were still reliable and useful for research.

Another limitation was that the data on confectioneries consumption were not obtained from very thorough dietary assessment techniques, such as 24-hour diet recall, and there was no information on total sugar intake per respondent. Next, given that cross-sectional data were used, the causality between WC and confectioneries intake could not be well identified. Finally, some people consumed confectioneries infrequently, therefore, asking if a respondent consumed confectioneries weekly may have caused a lack of variation in the data. Notwithstanding, future research with data availability would facilitate in a better IV for WC, such as WC of the respondents' siblings or parents. In addition, other types of measurement of health risk, such as waist-to-hip ratio and body fat percentage could be considered in the analysis. Moreover, data with a larger sample size, if available, should be utilised in order to generate more efficient estimates.

CONCLUSION

The present study found that BMI was positively associated with WC, indicating that obese people were likely to have large WC. In addition, there was a strong evidence suggesting that individuals who had large WC were less likely to consume confectioneries compared to individuals who had small WC. This implied that high-risk people were more aware of their health than low-risk people, and consequently had a lower tendency to consume confectioneries. In terms of policy implications, an intervention strategy directed towards reducing the intake of confectioneries among low-risk people or people who have small WC may yield promising results. Policy makers are suggested to make a concerted effort to improve health awareness among this group of population by providing

them with adequate knowledge about the negative consequences of excessive consumption of confectioneries.

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Authors' contributions

CYK, conceptualised the study, contributed in the funding acquisition, methodology, validation, formal analysis, investigation, drafting of original manuscript, reviewing and editing of the manuscript, visualisation and supervision of the study; MA, contributed in the methodology and validation of the study; NSMN, contributed in the methodology and validation of the study; PSN, contributed in the drafting, reviewing and editing of the manuscript; NHAM, contributed in the reviewing and editing of the manuscript.

Conflict of interest

The authors have no competing interests to declare.

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