Institutions and Economies
Vol. 16, No. 1, January 2024, pp. 53-78 https://doi.org/10.22452/IJIE.vol16no1.3

Cross-Sectional Analysis of Expenditure on Fruits and Vegetables: A Comparison Between Low-Income and High-Income Households

Yong Kang Cheah[a], Tin Tin Su[b] and Azira Abdul Adzis[c]

Abstract: *The present study is the first to our knowledge to use quantile regressions to explore the effects of sociodemographic and household factors on consumption expenditure on fruits and vegetables (FV) among households of different income groups. Data from the Malaysian Household Expenditure Surveys 2014 and 2016 were used for pooled cross-sectional analyses. Quantile regressions were utilised to examine factors affecting household expenditure on FV at different ranges of the expenditure. Results showed that low-, medium- and high-income households headed by younger adults (< 60 years), females, less-educated individuals, Bumiputera and unemployed individuals spent less on FV compared with those headed by older adults (≥ 60 years), males, well-educated individuals, non-Bumiputera and employed individuals. Furthermore, there were positive relationships between quantiles of FV expenditure and household income, rural households, tobacco consumption, and health insurance spending. In conclusion, household heads' sociodemographic characteristics and household profiles play an important role in influencing household expenditure on FV. Findings obtained in the present study can assist policymakers in formulating better intervention measures and assistance directed toward improving FV intake. Policymakers could consider subsidising FV purchases and promoting FV consumption among female-headed households. Additionally, health awareness programmes could target urban households with single and less-educated heads.*

Keywords: Expenditure; Fruit; Household; Income; Vegetable
JEL Classification: D0, D1, I1

[a] Corresponding author. School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah, Malaysia. *Email: yong@uum.edu.my*
[b] School of Medicine and Health Sciences, Monash University, Bandar Sunway, Selangor, Malaysia. *Email: tintin.su@monash.edu*
[c] School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah, Malaysia. *Email: azira@uum.edu.my*

1. Introduction

A high intake of fruits and vegetables (FV) is an important component of a healthy diet. The World Health Organization (WHO) recommends a minimum of five servings of FV per day (Hall et al., 2009). Low consumption of FV is a risk factor for the rise in the burden of chronic diseases across the globe (Hall et al., 2009; Yip et al., 2019). In 2017, about 3.9 million deaths were related to inadequate consumption of FV (WHO, 2019). There is evidence suggesting that high consumption of FV reduces the burden of heart disease, stroke, oesophageal cancer and lung cancer by 12% to 31% (Lock et al., 2005). He et al. (2006) find that individuals who consumed more than five servings of FV per day were 26% less likely to develop strokes compared with those who did not consume FV. Furthermore, Dauchet et al. (2006) and Carter et al. (2010) suggest that an additional serving of FV per day reduced the risk of coronary heart disease and type 2 diabetes by 7% to 14%.

Despite its importance, many people still do not consume adequate FV. In 2019, 94.9% of Malaysian adults consumed less than the recommended amount of FV (less than five servings per day) (IKU, 2020). Furthermore, Yen and Tan (2012) point out that 73% of people in Malaysia do not consume any FV daily. This could be one of the factors contributing to the high prevalence of non-communicable diseases (NCDs) in the country. As highlighted by Chandran et al. (2021), approximately 60% to 70% of premature deaths and disease burden in Malaysia are related to NCDs. In Southeast Asia, Malaysia has the highest burden of NCDs (Castillo-Carandang et al., 2020).

Consumption of FV could be influenced by various sociodemographic factors. For instance, FV intake was found to be higher among people with higher incomes than those with lower incomes (Kamphuis et al., 2006; Satheannoppakao et al., 2009; Azagba & Sharaf, 2011; Li, 2017; Karim et al., 2017; Yaya & Bishwajit, 2018). Furthermore, numerous studies show that older people are more likely to consume FV relative to their younger counterparts (Jaime et al., 2009; Dehghan et al., 2011), and that well-educated people consume more FV (Jaime et al., 2009; Satheannoppakao et al., 2009; Azagba & Sharaf, 2011; Dehghan et al., 2011; Peltzer & Phaswana-Mafuya, 2012; Li et al., 2017; Karim et al., 2017; Pengpid et al., 2019). Moreover, previous findings show that married people have a higher

tendency to consume FV compared to unmarried people (Kamphuis et al., 2006; Jaime et al., 2009; Azagba & Sharaf, 2011; Li et al., 2017).

There are several studies exploring FV consumption in Malaysia, but only three use nationally representative data to shed light on the effects of sociodemographic factors on FV consumption (Yen & Tan, 2012; Yen et al., 2015; Abd Aziz et al., 2019). These studies consistently find that low-income people are less likely to consume FV because they allocate their money for other necessities, such as rice, housing and clothing. This raises serious public health concerns, especially given that a large proportion of households in Malaysia are low-income. According to the Department of Statistics Malaysia (DOSM, 2017), households with a monthly income below RM4,360 are classified as low-income. Such households are commonly referred to as bottom 40% (B40). Between 2016 and 2020, about 2.7 million households in Malaysia were classified as B40 (Shahar et al., 2019).

In spite of the fact that many Malaysians do not have adequate intake of FV, there is still a lack of studies examining factors affecting the decisions of people to consume FV. While previous studies often focus on this topic in developed countries, only a handful pay attention to developing countries, such as Malaysia. Studies by Yen and Tan (2012), Yen et al. (2015) and Abd Aziz et al. (2019) are among the few Malaysian studies related to FV consumption. Although these studies offer significant findings on FV consumption, they do not investigate sociodemographic variations in household expenditure on FV across income groups. It is expected that households of different income levels may have different expenditure on FV. Moreover, these studies also did not estimate the results based on quantiles. As such, important insights into FV expenditure are not provided.

The objective of the present study is to investigate the influence of sociodemographic and household factors on consumption expenditure on FV among Malaysian households of different income groups. In Malaysia, the approximately 7.1 million years of healthy life lost in 2017 were caused by burden of disease (Muhamad Noor et al., 2020). This was equivalent to a loss of 2.7 months per year for every Malaysian. NCDs were the biggest contributor to the burden of disease in Malaysia. They were responsible for 63.9%, 85.2% and 72.4% years of life lost, years lived with disability, and disability-adjusted life years, respectively (Muhamad Noor et al., 2020). It is apparent that the country of interest in the present study, Malaysia, is a fast-growing developing country with high burden of disease.

2. Literature Review

Using data from the Thailand National Health Examination Survey and logistic regression, Satheannoppakao et al. (2009) find that the odds of consuming FV are higher among better-educated and higher-income individuals. The authors also found females to be more likely to consume FV than males because they had better health awareness. Another important finding highlighted by Satheannoppakao et al. (2009) is that older individuals tend to face more difficulties in accessing FV sources, and thus were less likely to consume FV than younger individuals. Similar findings were evidenced by Azagba and Sharaf (2011) in the Canadian context. Using the ordinary least squares (OLS) regression, the authors found that FV consumption was positively correlated with income and education levels, but negatively associated with age and male gender. The authors also stressed that married adults consumed more FV than their single counterparts because eating meals with others could encourage FV consumption. The findings of Li et al. (2017), derived from the China Chronic Disease Surveillance survey and logistic regression, seem to be consistent with those of Satheannoppakao et al. (2009) and Azagba and Sharaf (2011) that income, age, gender, education and marital status were associated with FV intake. The authors explained that a better understanding of the benefits of FV is the reason why better-educated individuals consumed more FV.

In Brazil, Jaime et al. (2009) use logistic regression and find that older individuals had higher odds of consuming FV compared with their younger peers because they had better health awareness. This finding was, however, in contrast to the evidence observed in Thailand, Canada and China (Satheannoppakao et al., 2009; Azagba & Sharaf, 2011; Li et al., 2017). In addition to age, Jaime et al. (2009) find positive relationships between consumption of FV and female gender, education level, and being married. These findings are supported by Dehghan et al. (2011), who devoted their attention to the Canadian population. The authors, using logistic regression, estimated the odds of consuming FV and found that older adults, females and well-educated individuals were more likely to consume FV than their younger, male and less-educated counterparts. Surprisingly, however, the finding on gender evidenced in a South African study contradicted those observed in other countries, even though the statistical methods used in the studies were identical (Peltzer & Phaswana-Mafuya, 2012). The authors

found that in general, males were less likely to have insufficient FV intake than females.

Based on nationwide data of Namibia and logistic regressions, Yaya and Bishwajit (2018) find higher-income and better-educated adults to be more likely to consume adequate amounts of FV than lower-income and less-educated adults. These findings lend support to those of other studies (Satheannoppakao et al., 2009; Azagba & Sharaf, 2011; Li et al., 2017). The results of Karim et al. (2017), estimated using Bangladeshi data and mixed-effect logistic regressions, likewise show that income and education levels are associated with increased odds of consuming FV. Additionally, the authors find that being female increased the consumption of FV because women were more concerned about their health and had a higher tendency to adopt a healthy diet lifestyle than men. An identical scenario was identified in Iran (Esteghamati et al., 2012). The authors find that older people and men consumed less FV than younger people and women. Furthermore, urban dwellers in Iran were found to consume more FV compared to rural dwellers. These urban-rural differences in FV consumption were also evidenced in Laos (Pengpid et al., 2019). Utilising logistic regressions, the findings suggested urban dwellers to be more likely to consume FV than rural dwellers.

The present study attempts to contribute to the existing literature in several ways. First, the study takes a different approach, i.e., quantile regressions, to examine factors associated with household expenditure on FV at different ranges of the expenditure. Second, the use of pooled cross-sectional data has two main advantages: (1) a large increase in sample size; and (2) year of data can be used as an explanatory variable, and this offers an opportunity to explore temporal variations in FV consumption expenditure. The findings of the study could be generalised to other low- and middle-income countries, especially those in Asia, which have similar population characteristics to Malaysia.

Third, a unique feature of the present study is that regressions are stratified by income groups—bottom 40% (B40) (below RM4,360), middle 40% (M40) (RM4,360–RM9,619) and top 20% (T20) (above RM9,619) (DOSM, 2017). M40 and T20 refer to middle- and high-income groups, respectively. Any differences or similarities in factors predicting FV expenditure among these three income groups could provide policymakers with a better understanding of which categories of the low-, middle- and high-income population to be focused on.

Fourth, a health insurance variable is added to the analyses. Health insurance is not mandatory in Malaysia, but is an important source of funding for medical care, even though public health facilities in Malaysia are financed by the government (Cheah, 2018). It is believed, however, that health insurance may cause a moral hazard (Dave & Kaestner, 2009). People who own health insurance could be less likely to make an effort to prevent illnesses. Therefore, it is imperative to understand whether people with health insurance consume more or less FV than those without health insurance.

3. Methodology

3.1 Theoretical basis

The demand for health model developed by Grossman (2000) serves as a theoretical basis for household consumption expenditure on FV. According to Grossman, utility is a function of health status and other commodities, such as food and shelter. Since having good health can improve individuals' well-being, health is like a commodity that can be consumed to increase individuals' utility. This is especially true given that illnesses can hamper an individual's quality of life and generate disutility.

Rational individuals are assumed to make an effort to maximise their utility throughout their lifetime, but this utility maximisation is subject to resource constraints, such as time and income. Health can also be treated as a capital good because it depreciates over time. Thus, the future health status of individuals depends on their current stock of health. In order to increase the stock of health, individuals need to make health investments. These include the use of medical check-ups, participation in physical activity, and adoption of a healthy eating lifestyle, such as consumption of FV, which is the scope of the present study.

Both market and time inputs play an important role in health production. For example, individuals could use their income to purchase medical care, such as visiting medical doctors and consumption of drugs, in order to lower their blood sugar level. Alternatively, they can spend more time preparing healthy food, such as adding more FV to their meals in an attempt to improve their health. Therefore, medical care and healthy food do not have direct impacts on utility. It is health that directly affects utility. Put simply,

people consume medical care and healthy food for the sake of their health. Based on these arguments, Grossman (2000) claims that people consume and produce their health at the same time.

Grossman (2000) also argues that income, education and age can affect health investment in several ways. First, health capital can yield returns over time given that a health improvement increases productive time and reduces absenteeism due to illnesses. As a result, healthy individuals can allocate more time to work and consequently earn higher incomes compared to those who are not. Based on these phenomena, higher-income individuals tend to invest more in health because they encounter a higher opportunity cost of being ill. As such, it is expected that higher-income households spend more money on FV than lower-income households.

Second, education improves productive efficiency. Better educated individuals have better health awareness and interpreting skills than less-educated individuals. In addition, education can reduce rate of time preference. This means that better-educated people are more future oriented. Taken together, better-educated individuals tend to make more health investments than their less-educated counterparts. Therefore, households with better-educated heads are hypothesised to spend more money on FV.

Third, owing to the biological process of ageing, rate of depreciation of health increases with age. In other words, older individuals are more prone to illnesses. As such, the health of older individuals deteriorates faster than that of younger individuals, and this motivates them to invest more in health. Considering this situation, the present study anticipates that households with older heads spend more money on FV than households with younger heads.

Recent empirical studies find that income is positively associated with FV consumption (Yen & Tan, 2012; Yen et al., 2015; Li et al., 2017; Yaya & Bishwajit, 2018; Abd Aziz et al., 2019). Yen and Tan (2012) state that higher earners had better financial capability than their lower-income counterparts, and thus were more likely to consume FV. Yen et al (2015) add that low earners tended to allocate their income to necessities, such as rice and housing, rather than FV. The high prices of FV may also be an explanatory factor (Abd Aziz et al., 2019).

The positive relationship between education level and FV consumption is evidenced in several empirical studies (Yen & Tan, 2012; Yen et al., 2015; Karim et al., 2017; Pengpid et al., 2019). In particular, these studies find that more educated individuals consumed more FV compared with less-

educated individuals. The explanation provided by these studies was that education improved knowledge of a healthy diet. In other words, better-educated individuals are more aware of the benefits of FV than less-educated individuals.

Previous studies' findings on age were mixed. On one hand, Satheannoppakao et al. (2009), Azagba and Sharaf (2011), Esteghamati et al. (2012), Li et al. (2017) and Karim et al. (2017) find older individuals to be less likely to consume FV as they may have poorer access to FV. On the other hand, Jaime et al. (2009), Dehghan et al. (2011) and Yen and Tan (2012) observe that older people consumed more FV than their younger peers. This was simply because health awareness increased with age.

3.2 Data

Data from the Malaysian Household Expenditure Surveys (HES) 2014 and 2016 was used for pooled cross-sectional analyses. The HES is a nationwide survey conducted by the Department of Statistics Malaysia (DOSM) twice every five years. Although the HES 2019 is the latest survey, it was unavailable for public use at the time of study. The sample sizes for HES 2014 and 2016 were 49,862 and 48,491 households, respectively. These amounted to a total sample size of 98,353 households. However, only 30% of the total sample were allowed by the DOSM for public use. Therefore, the final sample size of the present study is 29,389 households (14,838 from HES 2014, and 14,551 from HES 2016). Nevertheless, DOSM ensured that this randomly selected subsample was still nationally representative. In both HES 2014 and 2016, similar pre-tested structured questionnaires were used by trained interviewers to interview household heads (face-to-face). Every respondent was requested to fill in the consent form prior to the interview. Those who did not give consent were not eligible for participation in the surveys. More details about the HES can be found elsewhere (DOSM, 2015; 2017).

3.3 Selected variables

The dependent variable used in the present study is monthly household expenditure on FV (in RM). This includes expenditure on tropical and non-tropical fruits, and fresh vegetables. Consumption expenditure is the

multiplication of quantity consumed and price. Changes in consumption expenditure on FV were mainly driven by changes in quantity consumed because the price of FV is partly controlled by the government and did not vary substantially across respondents. Therefore, consumption expenditure can be seen as a proxy for quantity consumed. Two published articles using similar datasets explored household consumption expenditure on sugar-sweetened foods and alcohol (Cheah et al., 2019; 2020).

The independent variables used in the present study were selected in light of the theories, findings of previous studies related to the consumption of FV and the availability of data (Satheannoppakao et al., 2009; Jaime et al., 2009; Esteghamati et al., 2012; Peltzer & Phaswana-Mafuya, 2012; Yen et al., 2015; Li et al., 2017; Karim et al., 2017; Yaya & Bishwajit, 2018; Pengpid et al., 2019). The independent variables comprise three main categories: i) household heads' sociodemographic characteristics; ii) household profiles; and iii) year of survey. Given that household heads played the main role in decision-making, their sociodemographic characteristics were the main influencing factors of patterns of household consumption expenditure (Cheah et al., 2019; 2020).

Household heads' age, gender, education level, ethnicity, marital status and employment status were sociodemographic variables. Age was divided into five categories (≤ 29, 30–39, 40–49, 50–59 and ≥ 60 years). Education levels were categorised into three levels (primary, secondary and tertiary). The ethnic variable consisted of Bumiputera and non-Bumiputera. Bumiputera is a Malaysian of indigenous Malay origin. Marital status is categorised into three categories (married, divorced/widowed and single). Household variables consist of monthly household income (in RM) and household location (urban versus rural). In addition, monthly household expenditure on tobacco and health insurance variables (in RM) were included. Households having no tobacco users or health insurance owners reported zero values for these two variables. To determine whether consumption expenditure on FV increased or decreased over time, a year variable was used (2016 versus 2014).

3.4 Statistical analyses

Analyses stratified by household income were conducted to compare factors predicting FV consumption expenditure in the three main income groups:

B40 (low income), M40 (middle income) and T20 (high income) (DOSM, 2017). We utilised quantile regressions to examine factors correlated with household expenditure on FV. Only households that spent on FV (n = 29,178) were used for analyses. We estimated the results for five quantiles, i.e., 0.1, 0.25, 0.5, 0.75 and 0.9. The estimates for the 0.1 quantile measured the association between FV expenditure and the selected factors for the 10% of households with the lowest expenditure on FV, whereas the estimates for the 0.9 quantile were for the top 10% household FV consumers. The 0.5 quantile referred to median. In addition, variance inflation factors (VIFs) of all the independent variables were computed. VIFs of less than 10 indicated that the regression did not have multicollinearity (Wooldridge, 2010). The significance level for inferences was fixed at 0.05. All the statistical analyses were performed using the Stata statistical software (StataCorp, 2019).

4. Results and Discussion

Table 1 shows the summary statistics of all the variables. On average, a household spent about RM94.89–RM116.58, RM52.76–RM77.29 and RM9.80–RM40.32 on FV, tobacco and health insurance per month, respectively. The average monthly household income of a B40, M40 and T20 household is RM2,687.61, RM6,417.94 and RM16,057.06, respectively. Among all the income groups, the majority of household heads were 40 to 49 years old, male, secondary-educated, Bumiputera, married, employed and resided in urban areas. The majority of the B40 households were reported in 2014, whereas a large proportion of the M40 and T20 households were reported in 2016.

Table 1: Summary Statistics of Variables, by Income Groups

Variables	B40 (n = 14,212)		M40 (n = 10,374)		T20 (n = 4,592)	
	Mean/%	SD/Freq.	Mean/%	SD/Freq.	Mean/%	SD/Freq.
Continuous (RM)						
FV	94.89	61.89	107.69	74.89	116.58	82.89
Income	2687.61	962.38	6417.94	1447.23	16057.06	9555.78
Tobacco	52.79	99.61	71.38	123.79	77.29	152.67
Insurance	9.80	84.86	15.10	77.48	40.32	180.62
Categorical						
Age (years)						
≤29	10.04	1427	9.76	1012	7.38	332
30–39	21.57	3065	24.12	2502	23.41	1073
40–49	26.18	3720	26.18	2716	30.07	1381
50–59	22.40	3183	25.16	2610	26.63	1223
≥60	19.82	2817	14.79	1534	12.70	583
Gender						
Male	82.63	11743	84.56	8772	87.28	4008
Female	17.37	2469	15.44	1602	12.72	584
Education						
Primary	28.71	4080	17.82	1849	13.35	613
Secondary	56.71	8060	57.15	5929	44.62	2049
Tertiary	14.58	2072	25.02	2596	42.03	1930
Ethnicity						
Bumiputera	70.62	10036	66.97	6947	61.72	2834
Non-Bumiputera	29.38	4176	33.03	3427	38.28	1758
Marital status						
Married	79.14	11248	77.68	8059	78.35	3598
Divorced/ widowed	8.84	1257	9.50	986	8.67	398
Single	12.01	1707	12.81	1329	12.98	596
Employment						
Employed	91.36	12989	91.48	9490	91.64	4208
Unemployed	8.61	1223	8.52	884	8.36	384
Location						
Urban	62.12	8828	73.72	7648	79.05	3630
Rural	37.88	5384	26.28	2726	20.95	962
Year						
2016	46.97	6675	52.53	5449	51.28	2355
2014	53.03	7537	47.47	4925	48.72	2237

Notes: For continuous variables, the values refer to mean and standard deviation (SD). For categorical variables, the values refer to percentage (%) and frequency.

Sources: HES 2014 and 2016.

State representation of the total sample is illustrated in Table 2. The majority of households were from Sarawak (14.7%), followed by Sabah (12.8%), Selangor (10.9%), Johor (8.6%) and Perak (7.3%). Only a very small proportion were from Perlis (2.2%), Labuan (1.1%) and Putrajaya (0.6%). This state characteristics represented the recent household population in Malaysia (DOSM, 2020).

Table 2: State Representation of Total Sample (n = 29,178)

States	Percent	Frequency
Johor	8.57	2502
Kedah	6.32	1845
Kelantan	6.21	1811
Melaka	3.15	920
Negeri Sembilan	3.79	1105
Pahang	5.14	1501
Pulau Pinang	5.96	1740
Perak	7.29	2128
Perlis	2.17	632
Selangor	10.92	3185
Terengganu	4.76	1389
Sabah	12.79	3731
Sarawak	14.67	4281
Kuala Lumpur	6.56	1915
Labuan	1.07	312
Putrajaya	0.62	181

Sources: HES 2014 & 2016.

Tables 3, 4 and 5 present the quantiles of monthly household expenditure on FV among the B40, M40 and T20 households, respectively. In all the income groups, an increase of RM100 in household income increased household expenditure on FV by RM0.05–RM1.03, which supports our hypothesis. The effects of household income on FV were small, even though they increased as FV expenditure became larger. This may be due to the fact that FV is a necessity and its consumption does not increase substantially with income. Similar findings were evidenced in previous studies, which showed income to be positively associated with FV consumption (Satheannoppakao et al., 2009; Azagba & Sharaf, 2011; Yen &

Tan, 2012; Yen et al., 2015; Karim et al., 2017; Yaya & Bishwajit, 2018; Abd Aziz et al., 2019). This is simply because households that make more money are able to spend more on FV, whereas households that make less money tend to spend more on cheap energy-dense foods (Azagba & Sharaf, 2011; Dehghan et al., 2011; Karim et al., 2017; Abd Aziz et al., 2019).

Table 3: Quantiles of Monthly Household Expenditure on Fruits and Vegetables Among B40 Households (n = 14,212)

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Constant	20.673*	40.689*	79.766*	133.780*	191.939*
	(3.003)	(3.359)	(3.778)	(5.162)	(8.902)
Income/100	0.413*	0.606*	0.720*	0.886*	1.032*
	(0.045)	(0.050)	(0.056)	(0.077)	(0.133)
Age					
≤29	-15.541*	-17.799*	-22.869*	-30.699*	-32.591*
	(1.780)	(1.992)	(2.240)	(3.061)	(5.278)
30–39	-8.364*	-11.308*	-16.313*	-23.579*	-25.574*
	(1.447)	(1.618)	(1.820)	(2.487)	(4.289)
40–49	-3.285*	-4.660*	-6.806*	-9.938*	-9.264*
	(1.367)	(1.529)	(1.720)	(2.350)	(4.052)
50–59	-0.766	-0.365	1.963	0.301	2.403
	(1.357)	(1.518)	(1.707)	(2.333)	(4.023)
≥60	Ref.	Ref.	Ref.	Ref.	Ref.
Gender					
Male	2.022	3.003*	5.009*	5.314*	9.989*
	(1.182)	(1.323)	(1.488)	(2.033)	(3.505)
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Education					
Primary	-0.205	-5.088*	-14.577*	-26.396*	-35.332*
	(1.553)	(1.737)	(1.954)	(2.670)	(4.604)
Secondary	1.186	-0.465	-7.462*	-14.686*	-22.778*
	(1.291)	(1.444)	(1.624)	(2.219)	(3.826)
Tertiary	Ref.	Ref.	Ref.	Ref.	Ref.
Ethnicity					
Bumiputera	-0.439	-4.657*	-9.890*	-15.716*	-27.189*
	(0.980)	(1.096)	(1.233)	(1.685)	(2.906)
Non-Bumiputera	Ref.	Ref.	Ref.	Ref.	Ref.

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Married	4.978*	4.395*	2.980	1.130	0.152
	(1.350)	(1.510)	(1.699)	(2.321)	(4.003)
Divorced/widowed	-3.626	-3.656	-1.468	-2.869	0.579
	(1.959)	(2.192)	(2.465)	(3.368)	(5.808)
Single	Ref.	Ref.	Ref.	Ref.	Ref.
Employment					
Employed	1.218	3.174	3.503	3.977	2.789
	(1.581)	(1.769)	(1.989)	(2.718)	(4.687)
Unemployed	Ref.	Ref.	Ref.	Ref.	Ref.
Location					
Urban	-1.269	-1.352	-1.036	-1.154	2.080
	(0.955)	(1.069)	(1.202)	(1.642)	(2.832)
Rural	Ref.	Ref.	Ref.	Ref.	Ref.
Year					
2016	-0.563	-1.569	-6.062*	-12.548*	-23.634*
	(0.890)	(0.996)	(1.120)	(1.530)	(2.639)
2014	Ref.	Ref.	Ref.	Ref.	Ref.
Tobacco/10	-0.013	0.031	0.163*	0.202*	0.240
	(0.043)	(0.048)	(0.055)	(0.075)	(0.129)
Insurance/10	0.067	0.238*	0.169*	0.183*	0.391*
	(0.050)	(0.056)	(0.063)	(0.087)	(0.149)
Pseudo R^2	0.021	0.023	0.030	0.038	0.055

Notes: Standard errors in parentheses. Ref. refers to reference category. *$p < 0.05$. VIF refers to variance inflation factors.

Sources: HES 2014 & 2016.

Table 4: Quantiles of Monthly Household Expenditure on Fruits and Vegetables Among M40 Households (n = 10,374)

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Constant	31.893*	67.151*	107.727*	145.774*	201.443*
	(4.542)	(4.616)	(5.761)	(8.185)	(12.978)
Income/100	0.024	-0.027	-0.001	0.172*	0.249*
	(0.039)	(0.040)	(0.050)	(0.071)	(0.113)
Age					
≤29	-14.076*	-22.669*	-26.168*	-27.944*	-22.397*
	(2.525)	(2.567)	(3.203)	(4.551)	(7.215)
30–39	-10.103*	-17.291*	-20.673*	-25.848*	-27.910*
	(2.040)	(2.073)	(2.587)	(3.676)	(5.828)
40–49	-4.577*	-10.368*	-12.585*	-14.956*	-15.215*
	(1.973)	(2.005)	(2.502)	(3.555)	(5.637)
50–59	0.915	-2.257	-1.151	0.146	2.023
	(1.925)	(1.956)	(2.442)	(3.469)	(5.500)
≥60	Ref.	Ref.	Ref.	Ref.	Ref.
Gender					
Male	1.705	2.080	3.883	4.774	9.559*
	(1.651)	(1.678)	(2.094)	(2.975)	(4.716)
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Education					
Primary	-2.666	-6.613*	-10.286*	-13.539*	-11.445*
	(1.977)	(2.010)	(2.508)	(3.563)	(5.650)
Secondary	0.776	-0.612	-3.414	-6.701*	-12.016*
	(1.406)	(1.429)	(1.784)	(2.534)	(4.017)
Tertiary	Ref.	Ref.	Ref.	Ref.	Ref.
Ethnicity					
Bumiputera	-2.096	-5.896*	-12.863*	-18.991*	-34.085*
	(1.254)	(1.275)	(1.591)	(2.260)	(3.584)
Non-Bumiputera	Ref.	Ref.	Ref.	Ref.	Ref.
Marital status					
Married	2.135	0.465	-3.153	-4.275	-4.263
	(1.756)	(1.785)	(2.228)	(3.165)	(5.018)
Divorced/widowed	-2.368	-5.697*	-10.914*	-8.286	-9.339
	(2.531)	(2.573)	(3.211)	(4.562)	(7.233)
Single	Ref.	Ref.	Ref.	Ref.	Ref.

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Employment					
Employed	4.736*	4.900*	5.028	6.507	4.167
	(2.120)	(2.155)	(2.689)	(3.821)	(6.058)
Unemployed	Ref.	Ref.	Ref.	Ref.	Ref.
Location					
Urban	-4.128*	-3.940*	-5.552*	-8.418*	-9.010*
	(1.375)	(1.397)	(1.744)	(2.478)	(3.928)
Rural	Ref.	Ref.	Ref.	Ref.	Ref.
Year					
2016	13.099*	15.604*	17.471*	20.131*	24.138*
	(1.150)	(1.169)	(1.459)	(2.073)	(3.287)
2014	Ref.	Ref.	Ref.	Ref.	Ref.
Tobacco/10	-0.001	0.060	0.125*	0.353*	0.305*
	(0.047)	(0.047)	(0.059)	(0.084)	(0.133)
Insurance/10	0.040	0.002	0.098	0.188	0.394
	(0.074)	(0.075)	(0.094)	(0.133)	(0.211)
Pseudo R2	0.023	0.029	0.030	0.031	0.038
Maximum VIF			2.380		

Notes: Standard errors in parentheses. Ref. refers to reference category. *$p < 0.05$. VIF refers to variance inflation factors.

Sources: HES 2014 & 2016.

Table 5: Quantiles of Monthly Household Expenditure on Fruits and Vegetables Among T20 Households (n = 4,592)

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Constant	26.484*	63.907*	96.400*	142.973*	166.502*
	(6.470)	(7.024)	(8.352)	(12.244)	(20.299)
Income/100	-0.012	-0.008	0.012	0.047*	0.138*
	(0.010)	(0.011)	(0.013)	(0.018)	(0.031)
Age					
≤29	-13.240*	-24.164*	-29.799*	-31.590*	-37.773*
	(4.532)	(4.920)	(5.850)	(8.576)	(14.217)
30–39	-9.300*	-10.574*	-18.727*	-29.651*	-39.716*
	(3.497)	(3.796)	(4.514)	(6.617)	(10.970)
40–49	-3.898	-9.247*	-18.302*	-24.417*	-28.073*
	(3.328)	(3.613)	(4.296)	(6.298)	(10.441)
50–59	-0.247	-2.282	-8.425*	-17.314*	-17.216
	(3.282)	(3.562)	(4.236)	(6.210)	(10.295)
≥60	Ref.	Ref.	Ref.	Ref.	Ref.
Gender					
Male	4.439	4.345	11.065*	3.671	-0.171
	(2.897)	(3.145)	(3.740)	(5.483)	(9.090)
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Education					
Primary	3.452	-9.370*	-11.850*	-13.520*	-14.999
	(3.458)	(3.754)	(4.464)	(6.544)	(10.849)
Secondary	5.736*	0.677	0.628	-3.916	-7.916
	(2.186)	(2.374)	(2.822)	(4.137)	(6.859)
Tertiary	Ref.	Ref.	Ref.	Ref.	Ref.
Ethnicity					
Bumiputera	-4.007*	-6.102*	-12.007*	-23.511*	-26.034*
	(1.982)	(2.151)	(2.558)	(3.750)	(6.217)
Non-Bumiputera	Ref.	Ref.	Ref.	Ref.	Ref.
Marital status					
Married	6.057*	3.616	-0.006	2.436	2.366
	(2.834)	(3.077)	(3.658)	(5.363)	(8.891)
Divorced/widowed	1.728	2.050	-3.896	-5.401	-22.169
	(4.215)	(4.576)	(5.441)	(7.976)	(13.223)
Single	Ref.	Ref.	Ref.	Ref.	Ref.

Variables	Quantiles				
	0.1	**0.25**	**0.5**	**0.75**	**0.9**
Employment					
Employed	0.975	-1.236	2.422	15.095*	31.351*
	(3.476)	(3.774)	(4.487)	(6.578)	(10.905)
Unemployed	Ref.	Ref.	Ref.	Ref.	Ref.
Location					
Urban	-0.775	-5.313*	-7.081*	-7.461	0.531
	(2.478)	(2.690)	(3.199)	(4.689)	(7.774)
Rural	Ref.	Ref.	Ref.	Ref.	Ref.
Year					
2016	17.708*	21.063*	34.057*	49.315*	69.945*
	(2.130)	(2.313)	(2.750)	(4.031)	(6.683)
2014	Ref.	Ref.	Ref.	Ref.	Ref.
Tobacco/10	-0.112	-0.029	0.106	0.284*	0.590*
	(0.061)	(0.067)	(0.079)	(0.116)	(0.193)
Insurance/10	0.078	0.123*	0.077	0.012	-0.019
	(0.052)	(0.069)	(0.067)	(0.098)	(0.163)
Pseudo R^2	0.028	0.034	0.048	0.062	0.074
Maximum VIF			2.380		

Notes: Standard errors in parentheses. Ref. refers to reference category. *p <0 .05. VIF refers to variance inflation factors.
Sources: HES 2014 & 2016.

The B40, M40 and T20 households with younger heads (≤ 29, 30–39 and 40–49 years) spent RM3.29–39.72 less on FV than their counterparts with older heads (≥ 60 years). Comparing between the lowest and highest quantiles, the effects of age on FV increased about twofold. These findings were consistent with our expectation, as well as the evidence of previous studies (Jaime et al., 2009; Dehghan et al., 2011; Yen & Tan, 2012). Given that older people are prone to chronic diseases, they are more likely to adopt a healthy diet lifestyle (Jaime et al., 2009).

In the B40 household sample, FV expenditure differences due to gender occurred for all levels of expenditure, except the lowest quantile. In particular, households headed by males spent about RM3–RM9.99 more on FV compared with households headed by females. However, previous studies conducted in Thailand and Canada suggested otherwise that women consumed more FV than men (Satheannoppakao et al., 2009; Dehghan et al.,

2011). A plausible but unverified explanation for our findings could be that men carry more responsibilities for their households than women and thus put more efforts into improving their family health (Cheah, 2018).

The effect of education on FV expenditure was found to be significant in all the income groups of households that spent a moderate or large amount of money on FV. Compared to households with well-educated heads, those having heads with primary- or secondary-level education spent RM5.09–RM35.33 less on FV. Our findings were as per anticipation and in agreement with the evidence of previous studies (Jaime et al., 2009; Satheannoppakao et al., 2009; Dehghan et al., 2011; Azagba & Sharaf, 2011; Peltzer & Phaswana-Mafuya, 2012; Yen & Tan, 2012; Yen et al., 2015; Karim et al., 2017; Yaya & Bishwajit, 2018; Pengpid et al., 2019). This could be because better-educated individuals have better nutritional knowledge and are consequently more aware of the benefits of FV (Azagba & Sharaf, 2011; Li et al., 2017; Pengpid et al., 2019).

In all the income groups, Bumiputera households spent approximately RM4.66–RM34.09 less at all the quantiles of FV than non-Bumiputera households, and these differentials were large at the high quantiles. The relationship between ethnicity and FV expenditure could be explained by cultural factors. It is possible that ethnicity affects FV intake through mediation of culture. For instance, meals consumed by Bumiputera may consist of less FV than meals consumed by non-Bumiputera.

The B40 and T20 households with married heads spent RM4.40–RM6.06 more on FV than those with single heads. However, marital status did not play a significant role in influencing expenditure on FV among households that spent a lot on FV. Kamphuis et al. (2006) also find that being married increased consumption of FV. They claim that the presence of a spouse in a family could influence an individual's eating pattern through social behaviour. Findings of other studies related to marital status show likewise (Jaime et al., 2009; Azagba & Sharaf, 2011; Yen et al., 2015; Li et al., 2017). The given explanation is that eating with others could encourage one to consume more FV. Moreover, households with married heads also have more family members, and households that have a larger family size tend to spend more money on FV.

Employment status was significantly associated with FV expenditure among the M40 households that spent very little on FV and T20 households that spent a lot on FV. Specifically, households with employed heads

spent RM4.74–RM31.35 more on FV than those headed by unemployed individuals. Perhaps this is because employed people have a better financial capability to purchase FV than the unemployed.

The present study finds that the urban M40 and T20 households spent RM3.94–RM9.01 less on FV compared with their rural counterparts, which is consistent with the findings of previous studies (Yen & Tan, 2012; Yen et al., 2015). These urban-rural differentials increased with the levels of expenditure. Busy and hectic lifestyles could be a contributing factor for the low intake of FV among urbanites (Yen & Tan, 2012).

The findings of the present study show that the B40 households in 2016 spent about RM6.06–RM23.63 less on FV compared with those in 2014. These temporal differentials increased as FV expenditure became larger. The reduction in expenditure on FV among low-income households across time is a serious public health issue because it could lead to poor health outcomes in low-income populations (Gundersen & Ziliak, 2015). As pointed out by Nasir (2019), food insecurity remains a common problem in low-income countries, which should be resolved urgently.

It was surprising to find that the B40, M40 and T20 households with high expenditure on tobacco spent more on FV than those with low expenditure. Specifically, an increase of RM10 in tobacco expenditure increased FV expenditure by RM0.13–RM0.59. This finding contradicted the evidence from previous studies, which showed that non-smokers consumed more FV than smokers (Azagba & Sharaf, 2011; Yen & Tan, 2012; Yen et al., 2015). The impacts of tobacco use on FV expenditure were only significant among households that had moderate and large FV expenses. Although there is no clear explanation for these findings, we postulate that smokers tend to use FV, which is the main source of antioxidants, to reduce oxidative damages induced by smoking (Dehghan et al., 2011).

The results on health insurance were interesting but contradicted our hypothesis. We found that among B40 households, an increase of RM10 in health insurance expenditure elevated FV expenditure by RM0.17–RM0.39. Although the impacts of insurance on FV were small, they were significant at almost all the quantiles. Health insurance may reflect financial means to purchase it, thus its correlation with expenditure on FV may be confounded by purchasing power. Since stratification of income groups was performed and household income was used as an independent variable, the effect of this confounding variable had been controlled for. It can thus be concluded

that having health insurance leads to a better intake of FV. A study focused on the use of diagnostic tests also found people with health insurance to be more likely to take preventive measures compared to those without health insurance (Cheah, 2018). A plausible reason could be that people who purchase health insurance are more concerned about their health compared with those who do not.

5. Conclusion

Sociodemographic and household factors play an important role in influencing consumption expenditure on FV among Malaysian households of different income levels. In general, households are less likely to spend on FV if they are headed by lower-income, younger, female, less-educated, Bumiputera, single and unemployed heads. The positive relationship between income and FV expenditure seems to support the demand for health theory by Grossman (2000), which claims that income is correlated with increased health investments because return of health capital rises with income. Another major finding of the study is that education has a positive effect on FV expenditure. This finding is in agreement with Grossman's (2000) argument that the productive efficiency of health can be improved by education. In addition, the positive impact of age on FV expenditure evidenced in the present study is also consistent with Grossman's (2000) theory, indicating that health depreciation promotes consumption of FV.

Several policies are suggested in light of the findings of the study. First, an intervention measure directed towards promoting consumption of FV among low-income households could take gender factor and the level of expenditure on FV into account. Concentrations could be given to households headed by females. Second, policymakers could devote their attention to households of all income levels with younger heads ($\leq$ 49 years). Third, there is a need to promote consumption of FV among households that are headed by less-educated individuals, especially given that a large proportion of the B40 and M40 households in Malaysia are headed by adults with low education levels. Fourth, it is noteworthy for policymakers to promote FV consumption among middle- and high-income urban households with unemployed and single heads, taking FV expenditure level into consideration. It is suggested to have FV mobile trucks around housing areas in urban settings. Fifth, a strategy directed towards improving FV intake

among households of all income groups is suggested to be designed based on tobacco consumption pattern and the level of FV expenditure. Sixth, in order to promote consumption of FV among low-income households, policymakers could take an initiative to subsidise FV purchases through any nationwide health promotion programme with a focus on B40 households. This strategy has been found to be effective in the United States (Choi et al., 2017). Finally, households that spend less on health insurance could be the focus of nutritional interventions if the objective of improving FV consumption among low-income households is to be met.

One of the limitations of the present study is that the causal effects of sociodemographic factors on FV consumption are not well-identified. This is because of the use of cross-sectional data. Furthermore, the data are self-reported by respondents, thus minor reporting errors are unavoidable. Moreover, the effect of price of FV on FV expenditure could not be explored. With availability of data, a future study could explore how ethnicity is related to FV consumption, and the plausible mediational role of culture.

Acknowledgements

This research was supported by Universiti Utara Malaysia through Research Generation University Grant (SO Code: 21359). The authors would like to thank the DOSM for sharing the data from the Malaysian HES.

References

Abd Aziz, N. S., Yoep, N., Rodzlan Hasani, W. S., & Paiwai, F. (2019). Predictive factors of fruits and vegetables intake among Malaysian adults: Findings from Malaysian Adults Nutrition Survey 2014. *Southeast Asian Journal of Tropical Medicine and Public Health*, *50*(2), 392-400. https://www.tm.mahidol.ac.th/seameo/2019-50-2/19-7501-16-392.pdf

Azagba, S., & Sharaf, M. F. (2011). Disparities in the frequency of fruit and vegetable consumption by socio-demographic and lifestyle characteristics in Canada. Nutrition Journal, *10*, 118. https://doi.org/10.1186/1475-2891-10-118

Carter, P., Gray, L. J., Troughton, J., Khunti, K., & Davies, M. J. (2010). Fruit and vegetable intake and incidence of type 2 diabetes mellitus:

Systematic review and meta-analysis. *BMJ*, *341*, 229. https://doi.org/10.1136/bmj.c4229

Castillo-Carandang, N. T., Buenaventura, R. D., Chia, Y. C., Van, D. D., Lee, C., Duong, N. L., Ng, C. H., Robles, Y. R., Santoso, A., Sigua, H. S., Sukonthasarn, A., Tan, R., Viora, E., Zakaria, H., Brizuela, G. E., Ratnasingham, P., Thomas, M., & Majumdar, A. (2020). Moving towards optimized noncommunicable disease management in the ASEAN region: Recommendations from a review and multidisciplinary expert panel. *Risk Management and Healthcare Policy*, *13*, 803-819. https://doi.org/10.2147/RMHP.S256165

Chandran, A., Selva Kumar, S., Hairi, N. N., Low, W. Y., & Mustapha, F. I. (2021). Non-communicable disease surveillance in Malaysia: An overview of existing systems and priorities going forward. *Frontiers in Public Health*, *9*, 698741. https://doi.org/10.3389/fpubh.2021.698741

Cheah, Y. K. (2018). The utilization of diagnostic tests among the elderly: Evidence from Malaysia. *Socio-Economic Planning Sciences*, *62*, 121-128. https://doi.org/10.1016/j.seps.2017.10.002

Cheah, Y. K., Abdul Adzis, A., Abu Bakar, J., & Applanaidu, S. D. (2019). Factors associated with consumption of sugar-sweetened foods and beverages in Malaysia: An ethnic comparison. *International Journal of Diabetes in Developing Countries*, *39*(3), 568-578. https://doi.org/10.1007/s13410-018-0673-7

Cheah, Y. K., Abdul Adzis, A., Abu Bakar, J., & Applanaidu, S. D. (2020). Sociodemographic determinants of Malaysian household's use of and expenditure on alcohol: A regional comparison. *Drugs: Education, Prevention and Policy*, *27*(2), 165-172. https://doi.org/10.1080/09687637.2019.1587387

Choi, S. E., Seligman, H., & Basu, S. (2017). Cost effectiveness of subsidizing fruit and vegetable purchases through the supplemental nutrition assistance program. *American Journal of Preventive Medicine*, *52*(5), e147-e155. https://doi.org/10.1016/j.amepre.2016.12.013

Dauchet, L., Amouyel, P., Hercberg, S., & Dallongeville, J. (2006). Fruit and vegetable consumption and risk of coronary heart disease: A meta-analysis of cohort studies. *Journal of Nutrition*, *136*(10), 2588-2593. https://doi.org/10.1093/jn/136.10.2588

Dave, D., & Kaestner, R. (2009). Health insurance and ex ante moral hazard: Evidence from Medicare. *International Journal of Health Care Finance*

and Economics, *9*(4), 367-390. https://doi.org/10.1007/s10754-009-9056-4

Dehghan, M., Akhtar-Danesh, N., & Merchant, A. T. (2011). Factors associated with fruit and vegetable consumption among adults. *Journal of Human Nutrition and Dietetics*, *24*, 128-134. https://doi.org/10.1111/j.1365-277X.2010.01142.x

Department of Statistics Malaysia (DOSM) (2015). *Household Expenditure Survey 2014*. https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=323&bul_id=cGpPdWw3REhucFZPdXRpek1Jd3FZUT09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09

DOSM (2017). *Household Expenditure Survey 2016*. https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=323&bul_id=WnZvZWNVeDYxKzJjZ3RlUVVYU2s2Zz09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09

DOSM (2020). *Household Expenditure Survey 2019*. https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=323&bul_id=c3JpRzRqeTNPamMxL1FpTkNBNUVBQT09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09

Esteghamati, A., Noshad, S., Nazeri, A., Khalilzadeh, O., Khalili, M., & Nakhjavani, M. (2012). Patterns of fruit and vegetable consumption among Iranian adults: A SuRFNCD-2007 study. *British Journal of Nutrition*, *108*, 177-181. https://doi.org/10.1017/S0007114511005393

Grossman, M. (2000). The human capital model. In A. J. Culyer and J. P. Newhouse (Eds.), *Handbook of Health Economics, Volume IA* (347-408). Amsterdam: Elsevier. https://doi.org/10.1016/S1574-0064(00)80166-3

Gundersen, C., & Ziliak, J. P. (2015). Food insecurity and health outcomes. *Health Affairs*, *34*(11), 1830-1839. https://doi.org/10.1377/hlthaff.2015.0645

Hall, J. N., Moore, S., Harper, S. B., & Lynch, J. W. (2009). Global variability in fruit and vegetable consumption. *American Journal of Preventive Medicine*, *36*(5), 402-409. https://doi.org/10.1016/j.amepre.2009.01.029

He, F. J., Nowson, C. A., & MacGregor, G. A. (2006). Fruit and vegetable consumption and stroke: Meta-analysis of cohort studies. *Lancet*, *367*, 320-326. https://doi.org/10.1016/S0140-6736(06)68069-0

Institute for Public Health (IKU) (2020). *National Health and Morbidity Survey 2019*. https://iku.gov.my/nhms-2019

Jaime, P. C., Figueiredo, I. C. R., Moura, E. C., & Malta, D. C. (2009). Factors associated with fruit and vegetable consumption in Brazil, 2006. *Revista de Saude Publica*, *43*(S2), 57-64. https://doi.org/10.1590/s0034-89102009000900008

Kamphuis, C. B. M., Giskes, K., Bruijn, G. J., Wendel-Vos, W., Brug, J., & Lenthe, F. J. (2006). Environmental determinants of fruit and vegetable consumption among adults: A systematic review. *British Journal of Nutrition*, *96*, 620-635. https://doi.org/10.1079/BJN20061896

Karim, M. N., Zaman, M. M., Rahman, M. M., Chowdhury, M. A. J., Ahsan, H. A. M. N., Hassan, M. M., Karim, S. R., Hossain, M. Z., & Billah, B. (2017). Sociodemographic determinants of low fruit and vegetable consumption among Bangladeshi adults: Results from WHO-STEPS survey 2010. *Asia Pacific Journal of Public Health*, *29*(3), 189-198. https://doi.org/10.1177/1010539517699059

Li, Y. C., Jiang, B., Zhang, M., Huang, Z. J., Deng, Q., Zhou, M. G., Zhao, Z. P., Wang, Y. F., & Wang, L. M. (2017). Vegetable and fruit consumption among Chinese adults and associated factors: A nationally representative study of 170,847 adults. Biomedical and Environmental Sciences, *30*(12), 863-874. https://doi.org/10.3967/bes2017.117

Lock, K., Pomerleau, J., Causer, L., Altmann, D. R., & McKee, M. (2005). The global burden of disease attributable to low consumption of fruit and vegetables: Implications for the global strategy on diet. *Bulletin of the World Health Organization*, *83*(2), 100-108. Retrived from https://apps.who.int/iris/handle/10665/269344

Muhamad Noor, N., Megat Muzafar, P. M., & Khalidi, J. R. (2020). *Health of the nation: Measuring burden of disease*. KRI Working Paper No. 3/20. Kuala Lumpur: Khazanah Research Institute. https://www.krinstitute.org/assets/contentMS/img/template/editor/Working%20Paper_%20Health%20of%20the%20Nation;%20Measuring%20Burden%20of%20Disease%2003042020.pdf

Nasir S.M. (2019). Food insecurity: Coping strategies and policy responses. *New Straits Times*, September 8. https://www.nst.com.my/opinion/columnists/2019/09/519782/food-insecurity-strategies-and-policy-responses

Peltzer, K., & Phaswana-Mafuya, N. (2012). Fruit and vegetable intake and associated factors in older adults in South Africa. *Global Health Action*, *5*, 1. https://doi.org/10.3402/gha.v5i0.18668

Pengpid, S., Vonglokham, M., Kounnavong, S., Sychareun, V., & Peltzer, K. (2019). The prevalence and social determinants of fruit and vegetable consumption and its association with noncommunicable diseases risk factors among adults in Laos. *Asia Pacific Journal of Public Health*, *31*(2), 157-166. https://doi.org/10.1177/1010539519830824

Satheannoppakao, W., Aekplakorn, W., & Pradipasen, M. (2009). Fruit and vegetable consumption and its recommended intake associated with sociodemographic factors: Thailand National Health Examination Survey III. *Public Health Nutrition*, *12*(11), 2192-2198. https://doi.org/10.1017/S1368980009005837

Shahar, S., Lau, H., Wan Puteh, S. E., Amara, S., & Abdul Razak, N. (2019). Health, access and nutritional issues among low-income population in Malaysia: Introductory note. *BMC Public Health*, *19*(S4), 552. https://doi.org/10.1186/s12889-019-6852-8

StataCorp. (2019). *Stata Statistics/Data Analysis*, *16.1*. StataCorp, College Station, Texas.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). Cambridge: MIT Press.

World Health Organization (WHO) (2019). Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases. WHO. https://www.who.int/elena/titles/fruit_vegetables_ncds/en/

Yaya, S., & Bishwajit, G. (2018). Fruit and vegetable consumption among adults in Namibia: Analysis of a nationally representative population. *Health Promotion Perspectives*, *8*(4), 283-289. https://doi.org/10.15171/hpp.2018.40

Yen, S. T., & Tan, A. K. G. (2012). Who is eating and not eating fruits and vegetables in Malaysia? *International Journal of Public Health*, *57*, 945-951. https://doi.org/10.1007/s00038-012-0343-3

Yen, S. T., Tan, A. K. G., & Feisul, M. I. (2015). Consumption of fruits and vegetables in Malaysia: Profiling the daily and nondaily consumers. *Asia Pacific Journal of Public Health*, *27*(2), NP2635-NP2650. https://doi.org/10.1177/1010539512458523

Yip, C. S. C., Chan, W., & Fielding, R. (2019). The association of fruit and vegetable intakes with burden of diseases: A systematic review of meta-analyses. *Journal of Academy of Nutrition and Dietetics*, *119*(3), P464-P481. https://doi.org/10.1016/j.jand.2018.11.007