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Trends in fruit and vegetables consumption among Malaysian adults, 2006-2019

Kee CHEE CHEONG[1*], Tan LAY KIM[1], Sumarni MOHD GHAZALI[2], Yong Kang CHEAH[3], Lim HUI LI[4], Mohd Azahadi OMAR[1]

[1]Department of Biostatistics and Data Repository, National Institutes of Health, Ministry of Health Malaysia, Shah Alam, Selangor, Malaysia
[2]Department of Biomedical Epidemiology , Institute for Medical Research, National Institutes of Health, Ministry of Health Malaysia, Shah Alam, Selangor, Malaysia
[3]School of Economics, Finance and Banking, College of Business, Universiti Utara Malaysia, Sintok, Kedah, Malaysia
[4]Clinical Research Centre, Hospital Sultan Ismail, Ministry of Health Malaysia, Johor Baru, Johor, Malaysia

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ABSTRACT

Introduction: Inadequate fruit and vegetables consumption is linked to cardiovascular diseases, type 2 diabetes, and certain types of cancers, obesity and all-cause mortality. Although the Malaysian Dietary Guidelines 2020 recommended the consumption of at least two servings of fruit and three servings of vegetables daily in the adults, data from several National Health and Morbidity Survey among the Malaysian adults showed remarkedly low prevalence of adequate fruit and vegetables consumption.

Objective: We aimed to determine the trend in fruit and vegetables consumption among the Malaysian adults between 2006 and 2019.

Methodology: We analysed data from five nationally representative, cross-sectional national surveys, namely the Malaysian Non-Communicable Disease Surveillance 2006 (MyNCDS-1), the National Health and Morbidity Survey (NHMS) 2011, the NHMS 2014, NHMS 2015 and NHMS 2019 in this study. We assessed time and sociodemographic (age, sex, ethnicity and household income) trends in prevalence of adequate fruit and vegetables consumption between 2006 and 2019 among Malaysian adults.

Results: We observed a significant downward trend in the prevalence of adequate fruit and vegetables consumption among the Malaysian adults between 2006 and 2019 with each successive survey (3.9%, 4.1%, 1.1%, 2.9% and 2.3%, respectively) (P_{trend}<0.001). The prevalence of adequate fruit and vegetables consumption increased significantly with household income and age.

Conclusion: Our data showed a declining trend in fruit and vegetables consumption among Malaysian adults over the 13-year period, suggesting a need for a continuous effort to strengthen the existing healthy eating campaigns. This will not only increase the public awareness about the importance of adequate fruit and vegetables consumption to maintain an optimal health, but also aid in the effort to reverse the declining trend.

Keywords: Fruit and vegetables, Trend, Adults, Malaysia.

Abbreviations: FV: Fruit and Vegetables; NHMS: National Health and Morbidity Survey; NCDs: Non-Communicable Diseases.

INTRODUCTION

Fruits and vegetables are excellent sources of potassium, fibre, folate (folic acid), vitamin A, E, and C, as well as other minerals and vitamins. These nutrients are essential for good health, body function, and disease prevention [1]. Inadequate Fruit and Vegetables (FV) consumption is linked to increased risk of cardiovascular diseases, type 2 diabetes, certain types of cancers, obesity and all-

Correspondence to:
Kee CHEE CHEONG, E-mail: kee@moh.gov.my

cause mortality [2-7]. However, many Malaysian adults do not consume enough FV despite the well-known health benefits. The National Health and Morbidity Survey of 2019 reported a low percentage of Malaysians (5.1%) consumed enough fruits and/or vegetables [8].

The World Health Organization (WHO) recommends a minimum consumption of 400 grams or 5 servings of FV per day, however, countries may set their own recommendations for FV intake [9]. For instance, the 2020-2025 Dietary Guidelines for Americans recommend an intake of 1.5-2 cup-equivalents of fruits and 2-3 cup-equivalents of vegetables daily [10]. The Dietary Guidelines of Chinese Residents 2016 recommend a daily intake of 300-500 grams of vegetables and 200-350 grams of fruit (equivalent to 4-5 servings of FV), whereas the 2000 Dietary Guidelines for Japanese recommend 5-6 servings of vegetables and 2 servings of fruit and the Malaysian Dietary Guideline (MDG) 2010 recommended daily consumption of at least 5 servings of a variety of FV and (at least 3 servings of vegetables and 2 servings of fruit) for healthy adults [11-13].

In Malaysia, the consumption of adequate FV has been promoted in many health awareness campaigns. In MDG 2010, FV occupied the second tier of the Malaysian food pyramid. As a response to increases in diet-related, non-communicable diseases in Malaysia, the guidelines underwent a revision. In the new guidelines, MDG 2020, FV has swapped places with carbohydrates and is now positioned at the base of the pyramid, while the serving size of at least 5 servings per day recommendation has been maintained, further emphasize the importance of adequate daily intake of FV [13]. In addition to the revised MDG in 2017 the Malaysian Healthy Plate campaign was initiated, which aimed to emphasise the importance of increasing FV intake in a healthy diet. The Malaysian Healthy Plate promoted with the tagline *Suku-Suku-Separuh* (literal translation "Quarter-Quarter-Half"), illustrates the proportions of the food groups that should be consumed at each meal. The plate is divided into 3 portions, a quarter portion of grains, a quarter of protein (e.g., meat, fish, eggs), and the remaining half of the plate of FV [14]. Despite the various dietary campaigns conducted by government health agencies, data from several national surveys among Malaysian adults have shown low prevalence of adequate FV consumption [15-18]. In this study, we aimed to examine the trends in FV consumption among within large samples of Malaysian adults between 2006 and 2019. Our findings may assist the government in formulating better health policies aimed at promoting adequate FV intake in the Malaysian population.

METHODOLOGY

We analysed data from five nationally representative, population-based, health surveys, i.e. the Malaysian Non-Communicable Disease Surveillance 2006 (My-NCDS-1), the National Health and Morbidity Survey (NHMS) 2011, the NHMS 2014, NHMS 2015 and NHMS 2019 [8,15-18]. These five national surveys included assessments of Fruit and Vegetable (FV) intake among adults in Malaysia over the past two decades. We assessed the prevalence of adequate FV consumption and stratified by sociodemographic subgroups in each survey. The present study was approved by the Malaysian Ministry of Health Medical Research Ethics Committee (MREC).

Malaysian Non-Communicable Disease Surveillance 2006 (MyNCDS-1)

MyNCDS-1 was a cross-sectional, population-based survey, which was conducted between 2005 and 2006 to monitor the prevalence of NCD risk factors (diabetes mellitus, hypertension, dyslipidaemia, overweight/obesity, physical inactivity, smoking habits, alcohol intake and unhealthy dietary behaviours) in the Malaysian adult population. Two-stage stratified cluster random sampling was used to select a sample of Malaysian adults aged 25 to 64 years old. The total sample size was 2,572, all of which were included in this study [15].

National Health and Morbidity Survey 2011 (NHMS 2011)

NHMS 2011 was a population-based survey conducted between April and July 2011 aimed to provide community-based data on the prevalence of Non-Communicable Diseases (NCDs) such as diabetes, hypertension, hypercholesterolemia, and other health-related problems along with its risk factors in the Malaysian population. The target population was comprised of individuals residing in non-institutional living quarters [17]. Using a two-stage stratified random sampling method to select respondents, the target population was non-institutionalized residents of Malaysia with a total sample size of 28,498 respondents. However, only data from 18,191 adult respondents (aged above 18 years old) were included in this analysis.

National Health and Morbidity Survey 2014 (NHMS 2014)

The NHMS 2014 study was a population-based survey

which assessed the eating habits, dietary intake, vitamins and minerals intake, food supplement usage, food security, nutritional status, and physical activity patterns among adults aged 18 to 59 years in Malaysia. Data collection for the survey took place between March and June 2014. A multi-stage stratified cluster sampling method was employed to select the respondents. This survey recruited a total of 3,000 respondents [16].

National Health and Morbidity Survey 2015 (NHMS 2015)

NHMS 2015 replicated the methodology and included most of the modules covered in the previous NHMS (NHMS 2011), but with a particular focus on healthcare demand and non-communicable diseases and their risk factors. A total of 29,490 respondents participated in this survey, but only data from 19,881 adult respondents were analysed [18].

National Health and Morbidity Survey 2019 (NHMS 2019)

The NHMS 2019 was the fourth NHMS with the similar methodology as the previous NMHSs. The risk factors of NCDs included physical inactivity, tobacco use, substance abuse, alcohol consumption, nutritional status, dietary practices, and health literacy. Additionally, health screenings were performed during the survey to detect breast, cervical, and colorectal cancers; erectile dysfunction; anaemia; children's mental health issues; epilepsy; depression; and disability [8]. The NHMS 2019 was carried out between July and October 2019, which was a cross-sectional, population-based survey, that applied a multi-stage stratified cluster sampling technique. The survey recruited a total of 14,965 respondents. But for this study, only data from 8,428 adult respondents (age 18 and above) were extracted and analysed.

Sociodemographic information

All of the surveys collected sociodemographic data using interviewer-administered questionnaires. For this study, we extracted data on selected variables, which were comprised of residential areas (urban or rural), sex, age, ethnicity (Malay, Chinese, Indians, Other Bumiputra (Indigenous groups in Sabah and Sarawak), and household income. Age was categorised into 6 groups: 18-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, and ≥ 60 years. Monthly household income was divided into the following categories: less than MYR 1,000 (~USD 213), MYR 1,000-1,999 (~USD 213-426), MYR 2,000-2,999 (~USD 427-640), MYR 3,000-3,999 (~USD 641-853), MYR 4,000-4,999 (~USD 854-1067), and MYR 5,000 (~USD 1068) and above.

Fruit and vegetables intake measurements

Daily FV intake was assessed using four questions: 1) "In a typical week, how many days do you eat fruit?"; 2) "On the day that you usually eat fruit, how much did you eat?" or "How many servings of fruit do you eat on one of those days?"; 3) "In a typical week, on how many days do you eat vegetables?"; and 4) "On the day that you usually eat vegetables, how much did you eat on that day?" or "How many servings of vegetables do you eat on one of those days?". Pictures of food serving sizes were used to aid participants in recalling the serving sizes of the fruits and vegetables consumed. These photographs depicted a single serving of commonly consumed fruits and vegetables. For example, one medium slice of papaya, watermelon, pineapple, or honeydew is considered a single serving of fruit. A cup of chopped raw leafy green vegetables, such as 'ulam' (local vegetables salad), or a half cup of cooked vegetables with edible stems (e.g., water spinach, choy sum, Chinese spinach), or a half cup of minced vegetables (e.g., carrot, ladyfingers, brinjal, tomato), is considered a single serving of vegetables. Adequate intake of vegetables was defined as ≥ 3 servings per day; adequate fruit intake was defined as ≥ 2 servings per day. Definition of adequate intake of FV according to MDG 2020, is ≥ 5 servings per day (*i.e.,* at least 2 servings of fruit and at least 3 servings of vegetables) [13].

Statistical analysis

All statistical analyses were performed using SPSS software version 28 (IBM SPSS, Chicago). The analyses took account of unequal selection probability due to complex survey sampling. The sociodemographic characteristics of the respondents (*i.e.,* residential area, sex, age groups and household income) were described in percentages with 95% confidence intervals (95% CI). The 95% CI were used to assess the significance of differences in the sociodemographic distribution of respondents between surveys. Pearson's chi-square tests were performed to examine associations between sociodemographic factors and adequacy of FV consumption. The extended Mantel-Haenszel chi-square for linear trend was applied to investigate whether any linear trends were observed between age and household income and adequacy of FV intake. For all analyses, p values less than 0.05 were considered significant.

RESULTS

The total number of participants in each survey was as follows: MyNCD-1 (n=2,572); NHMS 2011 (n=18,191); NHMS 2014 (n=2,993); NHMS 2015 (n=19,881); and NHMS 2019 (n=8,428). The prevalence of adequate FV consumption was 3.9%, 4.1%, 1.1%, 2.9% and 2.3% in MyNCD-1 2006, NHMS 2011, NHMS 2014, NHMS 2015, and NHMS 2019 respectively. In all the surveys, more than two-thirds of the respondents resided in rural areas. The gender distribution was approximately equal, the majority of respondents (approximately 50%) were between 20 and 39 years old and Malays (Table 1).

Adequate FV intake varied across sociodemographic characteristics. The univariable analysis showed significant differences in the prevalence of adequate FV intake between urban and rural areas in two surveys, that is, NHMS 2011 and NHMS 2019. Specifically, urban residents had significantly higher FV intake than rural residents. Comparing adequate FV intake between genders, there was a significant difference in FV intake between men and women in NHMS 2015, wherein the prevalence of adequate FV intake was significantly higher among women than men. A significant association was observed between ethnic groups and adequacy of FV intake, in all the surveys except NHMS 2014 (Table 2). Linear trend analysis showed a significant downward trend in the prevalence of adequate FV consumption among Malaysian adults between 2006 and 2015 with each successive survey (P_{trend}<0.001) (Figure 1).

The prevalence of adequate fruit and vegetables consumption significantly increased with age and household income in all of the surveys except NHMS 2019. A significantly higher proportion of those aged ≥ 60 years met the recommended FV intake compared to younger adults aged <30 years. Furthermore, a significantly higher proportion of adults with monthly household incomes MYR 5,000 and above had adequate FV intake than those with household incomes less than MYR 2,000 (Figure 2 and Figure 3).

Table 1. Sociodemographic characteristics of participants by survey

Sociodemographic Characteristic		MyNCD-1 2006 (n=2,572)			NHMS 2011 (n=18,191)			NHMS 2014 (n=2,993)			NHMS 2015 (n=19,881)			NHMS 2019 (n=8,428)		
		Estimated population	n	% (95% CI)	Estimated population	n	% (95% CI)	Estimated population	n	% (95% CI)	Estimated population	n	% (95% CI)	Estimated population	n	% (95% CI)
Residential area	Rural	40,99,400	1,277	34.2 (32.3, 36.1)	1,30,05,590	7,607	73.2 (71.9, 74.4)	1,35,87,391	1,408	69.3 (67.7, 70.9)	1,53,48,505	8,407	76.2 (75.2, 77.2)	1,27,84,597	5,143	79.1 (77.6, 80.6)
	Urban	78,99,400	1,295	65.8 (63.9, 67.7)	47,70,869	10,584	26.8 (25.6, 28.1)	60,13,035	1,585	30.7 (29.1, 32.3)	47,91,917	11,474	23.8 (22.8, 24.8)	33,71,569	3,285	20.9 (19.4, 22.4)
Sex	Male	62,17,599	1,044	51.8 (49.1, 54.6)	90,70,451	8,512	51.0 (50.1, 51.9)	1,02,26,855	1,384	52.2 (49.5, 54.8)	1,03,96,458	9,455	51.6 (50.7, 52.5)	78,97,201	3,739	48.9 (47.6, 50.2)
	Female	57,81,200	1,528	48.2 (45.4, 50.9)	87,06,009	9,679	49.0 (48.1, 49.9)	93,73,571	1,609	47.8 (45.2, 50.5)	97,43,964	10,426	48.4 (47.5, 49.3)	82,58,965	4,689	51.1 (49.8, 52.4)

Ethnicity	Malay	66,57,065	1,425	55.5 (52.4, 58.5)	88,34,872	10,358	49.7 (46.9, 52.5)	1,05,73,364	1,474	53.9 (49.5, 58.4)	98,93,121	1,20,402	49.1 (46.4, 51.8)	91,82,490	5,759	56.8 (52.5, 61.1)
	Chinese	20,49,144	461	17.1 (14.8, 19.6)	45,29,338	3,521	25.5 (23.1, 28.0)	37,99,064	516	19.4 (16.2, 23.0)	47,18,263	3,173	23.4 (21.1, 26.0)	39,22,732	1,147	24.3 (20.3, 28.7)
	Indian	11,34,272	231	9.5 (7.7, 11.6)	12,53,028	1,457	7.0 (5.9, 8.4)	13,61,965	133	6.9 (5.3, 9.1)	13,70,032	1,408	6.8 (5.9, 7.9)	10,31,787	568	6.4 (5.1, 8.0)
	Non-malay bumiputra	17,92,379	378	14.9 (13.4, 16.6)	19,08,407	1,722	10.7 (9.2, 12.4)	26,71,552	688	13.6 (12.0, 15.4)	21,50,666	1,741	10.7 (9.3, 12.3)	18,88,411	903	11.7 (9.7, 14.0)
	Others	3,65,938	77	3.0 (2.2, 4.1)	12,50,816	1,133	7.0 (5.8, 8.5)	11,94,482	182	6.1 (4.8, 7.8)	20,08,340	1,237	10.0 (8.4, 11.8)	1,30,745	51	0.8 (0.4, 1.5)
Age groups	18-19	NA	NA	NA	8,87,222	782	5.0 (4.6, 5.5)	11,14,241	130	5.7 (4.5, 7.1)	9,47,242	798	4.7 (4.3, 5.2)	6,02,798	235	3.7 (3.1, 4.4)
	20-29	19,82,109	269	16.5 (14.2, 19.2)	53,05,493	4,197	29.8 (28.6, 31.2)	53,68,392	688	27.4 (25.3, 29.6)	56,16,288	4,086	27.9 (26.8, 29.0)	40,64,349	1,443	25.2 (23.4, 27.0)
	30-39	38,69,979	672	32.3 (29.5, 35.1)	38,98,325	3,674	21.9 (20.9, 23.0)	48,61,866	831	24.8 (22.8, 26.9)	46,93,467	3,996	23.3 (22.3, 24.4)	35,82,873	1,577	22.2 (20.4, 24.1)
	40-49	33,53,413	797	27.9 (25.5, 30.6)	32,83,490	3,634	18.5 (17.6, 19.4)	46,02,902	755	23.5 (21.4, 25.7)	35,19,617	3,651	17.5 (16.7, 18.3)	27,54,738	1,441	17.1 (15.8, 18.4)
	50-59	22,72,859	639	18.9 (16.9, 21.2)	23,37,418	3,141	13.1 (12.4, 13.9)	36,53,025	589	18.6 (16.9, 20.5)	27,69,390	3,571	13.8 (13.1, 14.5)	24,71,536	1,634	15.3 (14.2, 16.5)
	60+	5,20,440	195	4.3 (3.6, 5.3)	20,64,511	2,763	11.6 (10.8, 12.4)	NA	NA	NA	25,94,418	3,779	12.9 (12.2, 13.6)	26,79,872	2,098	16.6 (15.3, 18.0)

Household income (RM)	<1,000	50,57,589	1,206	43.7 (40.7, 46.7)	30,35,194	3,451	17.1 (15.9, 18.3)	51,86,902	983	26.8 (24.3, 29.4)	27,23,737	3,225	13.5 (12.6, 14.5)	13,39,225	852	8.8 (7.7, 10.2)
	1000-1999	33,47,692	659	28.9 (26.1, 31.9)	32,31,661	3,670	18.2 (17.0, 19.4)	42,15,668	625	21.8 (19.6, 24.1)	33,12,643	3,624	16.4 (15.4, 17.6)	26,26,759	1,555	17.3 (15.5, 19.3)
	2,000-2,999	16,51,123	301	14.3 (11.9, 16.9)	29,91,811	3,084	16.8 (15.6, 18.1)	31,08,667	450	16.0 (14.3, 18.0)	32,60,634	3,362	16.2 (15.0, 17.4)	25,08,218	1,360	16.5 (14.8, 18.5)
	3,000-3,999	7,00,319	125	6.0 (4.6, 7.9)	24,17,102	2,405	13.6 (12.5, 14.8)	21,36,189	291	11.0 (9.5, 12.8)	25,91,914	2,520	12.9 (11.9, 14.0)	22,41,379	1,086	14.8 (13.1, 16.6)
	4,000-4,999	3,98,159	82	3.4 (2.5, 4.7)	18,52,012	1,660	10.4 (9.3, 11.6)	12,10,733	167	6.3 (5.2, 7.5)	19,82,176	1,788	9.8 (8.9, 10.8)	15,22,742	756	10.0 (8.6, 11.7)
	>5000	4,28,397	98	3.7 (2.8, 4.9)	42,48,680	3,921	23.9 (22.0, 25.9)	35,11,385	448	18.1 (15.4, 21.2)	62,69,319	5,362	31.1 (29.3, 33.0)	49,25,041	2,284	32.5 (29.7, 35.4)
Fruit and vege-tables intake	Inadequate	1,15,31,516	2451	96.1 (95.1, 96.9)	1,70,55,524	17,464	95.9 (95.5, 96.4)	1,93,85,675	2,949	98.9 (98.4, 99.2)	1,95,64,597	19,281	97.1 (96.7, 97.5)	3,68,364	164	97.7 (97.2, 98.1)
	Adequate	4,67,284	121	3.9 (3.1, 4.9)	7,20,936	727	4.1 (3.6, 4.5)	2,14,751	44	1.1 (0.8, 1.6)	5,75,826	600	2.9 (2.5, 3.3)	1,57,87,802	8,264	2.3 (1.9, 2.8)

Table 2. Associations between sociodemographic characteristics and adequacy of fruit and vegetables intake by survey

Sociodemographic Characteristics		MyNCD-1 2006 (n=2572)				NHMS 2011 (n=18,191)				NHMS 2014 (n=2,993)				NHMS 2015 (n=19,881)				NHMS 2019 (n=8,428)			
		Inadequate		Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate		Adequate		Inade-quate		Adequate	
Overall (P_{trend}<0.001)		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
		2451	96.1 (95.1, 96.9)	121	3.9 (3.1, 4.9)	17,464	95.9 (95.5, 96.4)	727	4.1 (3.6, 4.5)	2,949	98.9 (98.4, 99.2)	44	1.1 (0.8, 1.6)	19,281	97.1 (96.7, 97.5)	600	2.9 (2.5, 3.3)	164	97.7 (97.2, 98.1)	8,264	2.3 (1.9, 2.8)
Residential area	Rural	1225	96.2 (94.7, 97.3)	52	3.8 (2.7, 5.3)	7,352	96.6 (96.0, 97.2)	255	3.4 (2.8, 4.0)	1,388	98.7 (97.9, 99.2)	20	1.3 (0.8, 2.1)	8,172	97.2 (96.5, 97.8)	235	2.8 (2.2, 3.5)	3234	98.2 (97.3, 98.8)	51	1.8 (1.2, 2.7)
	Urban	1226	96.1 (94.7, 97.3)	69	3.9 (2.9, 5.3)	10,112	95.7 (95.1, 96.2)	472	4.3 (3.8, 4.9)	1,561	99.0 (98.4, 99.4)	24	1.0 (0.6, 1.6)	11,109	97.1 (96.6, 97.5)	365	2.9 (2.5, 3.4)	5030	97.6 (97.0, 98.1)	113	2.4 (1.9, 3.0)
					(p=0.132)				(p=0.025)				(p=0.433)				(p=0.790)				p=0.037
Sex	Male	994	96.3 (94.9, 97.3)	50	3.7 (2.7, 5.1)	8,187	96.2 (95.6, 96.7)	325	3.8 (3.3, 4.4)	1,367	99.1 (98.4, 99.4)	17	0.9 (0.6, 1.6)	9,227	97.6 (97.2, 98.0)	228	2.4 (2.0, 2.8)	3669	98.0 (97.3, 98.5)	70	2.0 (1.5, 2.7)
	Female	1457	95.9 (94.5, 97.0)	71	4.1 (3.0, 5.5)	9,277	95.7 (95.0, 96.2)	402	4.3 (3.8, 5.0)	1,582	98.7 (98.0, 99.2)	27	1.3 (0.8, 2.0)	10,054	96.6 (96.1, 97.1)	372	3.4 (2.9, 3.9)	4595	97.5 (96.6, 98.1)	94	2.5 (1.9, 3.4)
		2451			(p=0.705)				(p=0.121)				(p=0.438)				p=0.001				p=0.662

Ethnicity	Malays	1376	97.0 (95.6, 98.0)	49	3.0 (2.0, 4.4)	9,961	95.9 (95.3, 96.4)	397	4.1 (3.6, 4.7)	1,459	99.3 (98.6, 99.6)	15	0.7 (0.4, 1.4)	1,20,088	97.7 (97.2, 98.1)	314	2.3 (1.9, 2.8)	5669	98.1 (97.5, 98.5)	90	1.9 (1.5, 2.5)
	Chinese	428	94.8 (92.1, 96.6)	33	5.2 (3.4, 7.9)	3,318	94.6 (93.4, 95.6)	203	5.4 (4.4, 6.6)	505	98.6 (97.2, 99.3)	11	1.4 (0.7, 2.8)	3,016	95.8 (94.6, 96.7)	157	4.2 (3.3, 5.4)	1106	96.7 (95.4, 97.6)	41	3.3 (2.4, 4.6)
	Indians	222	97.5 (94.5, 98.9)	9	2.5 (1.1, 5.5)	1,425	98.3 (97.3, 98.8)	32	1.7 (1.1, 2.7)	131	98.9 (94.9, 99.7)	2	1.1 (0.3, 5.1)	1,367	96.8 (94.9, 98.0)	41	3.2 (2.0, 5.1)	556	97.7 (95.4, 98.9)	12	2.3 (1.1, 4.6)
	Other Bumiputras	359	95.5 (92.6, 97.3)	19	4.5 (2.7, 7.4)	1,675	97.8 (96.9, 98.4)	47	2.2 (1.6, 3.1)	674	98.0 (96.4, 98.9)	14	2.0 (1.1, 3.6)	1,676	96.6 (95.3, 97.6)	65	3.4 (2.4, 4.7)	883	98.0 (96.3, 99.0)	20	2.0 (1.0, 3.7)
	Others	66	84.7 (73.1, 91.9)	11	15.3 (8.1, 26.9)	1,085	96.1 (93.9, 97.5)	48	3.9 (2.5, 6.1)	180	98.7 (94.8, 99.7)	2	1.3 (0.3, 5.2)	1,214	98.4 (97.4, 99.0)	23	1.6 (1.0, 2.6)	50	99.9 (99.4, 100.0)	1	0.1 (0, 0.6)
					(p<0.001)				(p<0.001)				(p=0.276)				(p<0.001)				(p=0.031)
Age groups	18-19	NA	NA	NA	NA	770	98.8 (97.9, 99.4)	12	1.2 (0.6, 2.1)	129	99.4 (96.1, 99.9)	1	0.6 (0.1, 3.9)	783	98.3 (96.9, 99.1)	15	1.7 (0.9, 3.1)	233	99.4 (97.0, 99.9)	2	0.6 (0.1, 3.0)
	20-29	263	98.1 (95.6, 99.2)	6	1.9 (0.8, 4.4)	4,088	97.4 (96.7, 97.9)	109	2.6 (2.1, 3.3)	682	99.5 (98.8, 99.8)	6	0.5 (0.2, 1.2)	3,989	97.8 (97.2, 98.3)	97	2.2 (1.7, 2.8)	1412	97.6 (96.2, 98.5)	31	2.4 (1.5, 3.8)
	30-39	650	97.6 (96.2, 98.5)	22	2.4 (1.5, 3.8)	3,523	95.4 (94.4, 96.2)	151	4.6 (3.8, 5.6)	820	98.9 (97.9, 99.5)	11	1.1 (0.5, 2.1)	3,887	97.7 (97.1, 98.2)	109	2.3 (1.8, 2.9)	1543	97.2 (95.8, 98.2)	34	2.8 (1.8, 4.2)
	40-49	756	95.7 (93.9, 96.9)	41	4.3 (3.1, 6.1)	3,471	95.1 (93.9, 96.1)	163	4.9 (3.9, 6.1)	745	98.7 (97.2, 99.5)	10	1.3 (0.5, 2.8)	3,533	96.3 (95.3, 97.1)	118	3.7 (2.9, 4.7)	1420	98.2 (97.0, 98.9)	21	1.8 (1.1, 3.0)
	50-59	595	93.2 (89.8, 95.6)	44	6.8 (4.4, 10.2)	2,979	94.4 (93.2, 95.4)	162	5.6 (4.6, 6.8)	573	98.0 (96.7, 98.9)	16	2.0 (1.1, 3.3)	3,434	96.1 (95.1, 96.9)	137	3.9 (3.1, 4.9)	1604	97.9 (96.6, 98.7)	30	2.1 (1.3, 34)
	60+	187	93.1 (82.2, 97.5)	8	6.9 (2.5, 17.8)	2,633	95.1 (96.9, 96.1)	130	4.9 (3.9, 6.1)	NA	NA			3,655	96.5 (95.5, 97.3)	124	3.5 (2.7, 4.5)	2052	97.5 (96.3, 98.3)	46	2.5 (1.7, 3.7)
					(P_{trend}=0.004)				(P_{trend}<0.001)				(P_{trend}=0.01)				(P_{trend}<0.001)				(P_{trend}=0.692)

Household income (MYR)	<1,000	1160	96.6 (95.1, 97.7)	46	3.4 (2.3, 4.9)	3,333	96.7 (95.8, 97.4)	118	3.3 (2.6, 4.2)	973	99.1 (98.1, 99.6)	10	0.9 (0.4, 1.9)	3,131	97.2 (96.3, 97.9)	94	2.8 (2.1, 3.7)	1370	98.6 (97.6, 99.2)	17	1.4 (0.8, 2.4)
	1000-1999	636	96.8 (94.3, 98.3)	23	3.2 (1.7, 5.7)	3,542	96.7 (95.9, 97.4)	128	3.3 (2.6, 4.1)	619	99.3 (98.3, 99.7)	6	0.7 (0.3, 1.7)	3,538	97.8 (96.9, 98.4)	86	2.2 (1.6, 3.1)	1530	97.8 (96.2, 98.7)	25	2.2 (1.3, 3.8)
	2,000-2,999	280	94.7 (91.7, 96.6)	21	5.3 (3.4, 8.3)	2,970	95.7 (94.6, 96.6)	114	4.3 (3.4, 5.4)	443	99.0 (97.7, 99.5)	7	1.0 (0.5, 2.3)	3,271	97.8 (97.2, 98.3)	91	2.2 (1.7, 2.8)	1340	98.4 (97.3, 99.1)	20	1.6 (0.9, 2.7)
	3,000-3,999	113	94.6 (89.9, 97.2)	12	5.4 (2.8, 10.1)	2,301	95.7 (94.6, 96.6)	104	4.3 (3.3, 5.6)	285	98.3 (95.0, 99.4)	6	1.7 (0.6, 5.0)	2,448	97.2 (96.2, 98.0)	72	2.8 (2.0, 3.8)	1058	97.2 (95.6, 98.3)	28	2.8 (1.7, 4.4)
	4,000-4,999	75	94.7 (88.2, 97.7)	7	5.3 (2.3, 11.8)	1,595	95.8 (94.4, 96.9)	65	4.2 (3.1, 5.6)	165	99.5 (97.6, 99.9)	2	0.5(0.1, 2.4)	1,735	96.8 (95.5, 97.8)	53	3.2 (2.2, 4.5)	744	98.5 (97.1, 99.2)	12	1.5 (0.8, 2.9)
	>5,000	89	92.1 (82.1, 96.7)	9	7.9 (3.3, 17.9)	3,723	95.2 (94.1, 96.1)	198	4.8 (3.9, 5.9)	437	98.4 (96.9, 99.2)	11	1.6 (0.8, 3.1)	5,158	96.5 (95.6, 97.2)	204	3.5 (2.8, 4.4)	1699	96.5 (95.0, 97.6)	53	3.5 (2.4, 5.0)
					(P_{trend}<0.001)				(P_{trend}<0.001)				(P_{trend}=0.024)				(P_{trend}<0.001)				(P_{trend}<0.001)

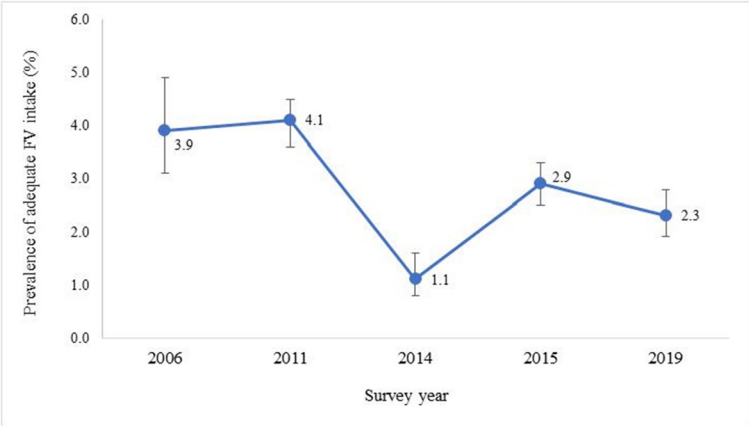


Figure 1. Prevalence of adequate fruit and vegetables intake among Malaysians in 2006, 2011, 2014, 2015 and 2019.
Note: Mantel-Haenszel chi-square test for linear trend, P<0.001. Vertical bars=95%CI.

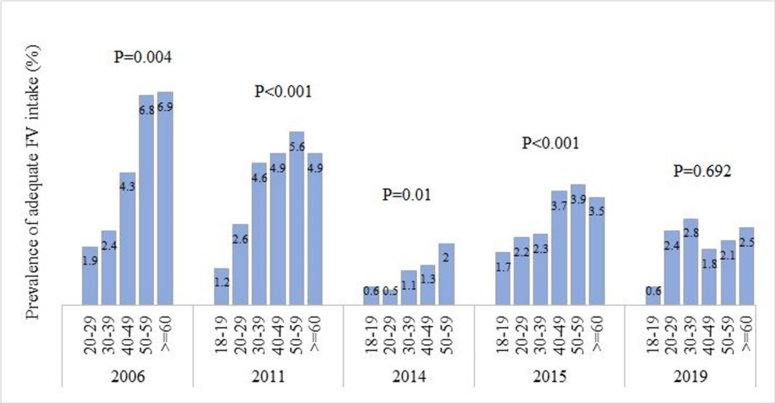


Figure 2. Prevalence of adequate daily FV intake among Malaysian adults according to age group in 2006, 2011, 2014 and 2015. P values calculated using Mantel-Haenszel chi-square test for linear trend.

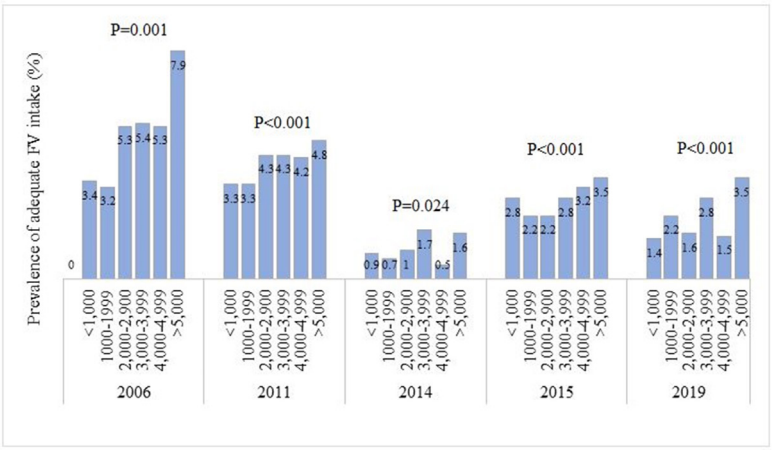


Figure 3. Prevalence of adequate daily FV intake among Malaysian adults according to monthly household income (in MYR) in 2006, 2011, 2014 and 2015. P values calculated using Mantel-Haenszel chi-square test for linear trend.

DISCUSSION

Our findings showed that the prevalence of adequate FV intake had not changed substantially from 2006 to 2019. In fact, there was a downward trend in FV consumption during these periods. Over 95% of Malaysian adults did not consume adequate FV. Similar observations have been reported by other Malaysian studies. An earlier study of 242 adults aged 18 and above in the state of Selangor reported an average consumption of FV of 173 grams per day, which was significantly lower than the recommended amount of 400 grams [19]. A more recent study by Ahmad et al., in a group of 279 young female students from a local public university revealed that approximately 87.8% of the respondents consumed fewer than 2 servings of fruits per day, while 93.6% consumed fewer than 3 servings of vegetables per day [20]. Another study by Eng and colleagues among 2,983 low-income adults residing in six low-cost flats in the Federal Territory of Kuala Lumpur also showed that 89.5% of the respondents did not meet the recommended daily intake of FV [21].

Regardless of the definition of adequate FV intake (whether ≥ 5 servings per day of FV, or 2 servings of fruit and 3 servings of vegetables) and the dietary assessment method used, the consumption of FV among Malaysian adults was still very low as compared to other countries. Two national surveys conducted in Thailand in 2004 and 2018 revealed that 26.6% and 34.4% of Thai adults aged >15 years, respectively, consumed at least 5 servings of FV daily [22,23]. According to the third wave of the European Health Interview Survey, approximately 12% of the population in the European Union (EU) consumed five or more portions of FV daily in 2019. Among the EU countries, the highest rates of daily intake of five portions or more of FV were in Ireland (33% of the population), the Netherlands (30%), Denmark (23%), and France

(20%); while the lowest was in Romania, where only 2% of the population consumed at least five portions of FV. Bulgaria and Slovenia followed closely, Bulgaria reported 5%, and Austria reported 6% of prevalence of adequate FV intake [24]. There are several possible explanations as to why Malaysian adults consume insufficient FV. Health consciousness and knowledge about healthy eating have a significant positive effect on consumption of healthy food [25]. In other words, the low intake of daily FV could be attributed to inadequate knowledge surrounding the importance of consuming FV in achieving a balanced diet and improving overall health. A report from NHMS 2019 showed that about 83% of rural adults were unaware of the Malaysian Healthy Plate concept even after three years of its inception [14]. With rapid economic growth, coupled with urbanization and modernization over the past 30 years, Malaysian dietary habits have shifted to the consumption of more refined carbohydrates, high-fat foods, processed or convenience foods, and animal products, and this may have led to decreased intake of FV [26-28]. The cost of fresh FV can sometimes be higher than other food options, making them less affordable to the lower income group [21]. Putting all together, these pose more challenges to promoting greater FV consumption among Malaysian adults. Therefore, more efforts must be made to promote higher FV intake. This includes, modifying the food environment by increasing accessibility to healthier foods, including FV, in supermarkets, grocery stores and convenience stores, can influence health behaviours and promote healthier food choices. Such modifications may involve changing the store layout in order to make healthy foods more visually appealing, grouping healthier food items to showcase healthy options, and providing shelf labels with the nutritional value information of the healthier foodsn [29]. Promotion of FV intake should also be expanded to the electronic, print and social Medias through health talks or cooking demonstrations that emphasize the benefits of adequate FV intake in the prevention of NCD and nutrition-related health problems. There should also be a focus on improving understanding of food serving sizes, the food pyramid and the healthy eating plate [30].

This study demonstrated that FV consumption tended to increase with advancing age. Our finding mirrors the United States' 2019 Behavioural Risk Factor Surveillance system report, which had a representative sample of 249,566 American adults aged ≥ 18 years in the United States as well as the 2011–12 National Nutrition and Physical Activity Survey of 2,337 young Australian aged 18–34 years [31,32]. However, other reports of FV intake in relation to age have shown otherwise. Two national surveys conducted in Thailand showed that the older age groups were more likely to consume insufficient amounts of fruits and vegetables compared to younger age groups. The Thailand National Health Examination Survey III which collected data from 39,290 individuals aged 15 years and above, reported that Thais aged ≥ 45 years had significantly lower intake of FV than those aged <30 years [23]. A similar study on a smaller scale, involving 6,991 participants from the four geographic regions of Thailand and Bangkok within the same age group, revealed that individuals aged ≥ 60 years were associated with insufficient FV intake compared to those aged 30-44 years [22]. However, a pooled analysis of data collected from 193,606 individuals aged ≥ 15 years in 28 low and medium-income countries between 2005 and 2016 revealed no association between FV consumption and age [33]. We offer the following explanations for the association between increasing age and FV consumption. Firstly, as people age, they tend to become more health-conscious and aware of the importance of a balanced diet. They may also seek to improve their overall health and well-being, leading to a greater consumption of nutritious foods like FV. Secondly, age-related health conditions and chronic ailments may motivate older individuals to learn about it, and adopt healthier eating habits, including higher FV intake. Furthermore, due to changing nutritional demands and health concerns, older persons may receive particular medical advice or recommendations from healthcare professionals to increase their FV intake [34]. Also as people age, with greater financial stability, they may settle in areas with better access to fresh produce, thus making it easier for them to incorporate FV into their diet, and also allowing them to afford a more diverse and nutritious diet, that includes an increased proportion of FV [35]. Besides, with the experience of being raised or exposed to rural/agricultural environments, in which FV is more, readily and cheaply, available, they may incorporate this concept into their diet and have more FV than the younger generation.

Our findings are consistent with the literature suggesting higher household income to be associated with increased consumption of FV. In a survey conducted among 1,200 adults who had visited shopping malls in seven cities in Malaysia, higher income was associated with more frequent purchase of FV and a tendency to spend more on FV in a week [36]. A study by Eng et al., also showed that low-income households tend to consume insufficient

FV, and more than two-thirds of the respondents perceived FV as being moderately priced [21]. Low consumption of FV may be attributed to affordability concerns, as low-income households often prioritize purchasing meat products over FV due to their limited income [35]. This concurred with the US National Health and Nutrition Examination Survey (2015-2018) reported that the percentage of US adults aged 20 years and above who consumed any FV on a given day increased with family income levels [37]. Also, the Prospective Urban Rural Epidemiology (PURE) study, which assessed data related to FV consumption from 18 countries with different gross national income levels between 2003 and 2013, reported that per-person gross national income was positively associated with FV intake. Furthermore, the cost of one serving of vegetables or fruit relative to household income was more than 19 times higher in low-income countries than in high-income countries. The relative cost of one serving of fruit was 50 times higher in low-income countries than in high-income countries [38]. These factors are likely to explain the low consumption of FV among Malaysian adults with economic backgrounds. Therefore, to increase consumption of FV among those from low-income families, we advocate policies that support affordable access to FV. This can be done by providing financial assistance in the form of food vouchers to lower income families to purchase FV, besides encouraging community and urban farming initiatives [39,40]. Furthermore, authorities could engage with farmers to organize events such as farmers' markets and provide incentives to support them in increasing their productivity and selling their products directly to consumers. These approaches aim to make FV more affordable, thereby promoting accessibility to a wider population [41].

CONCLUSION

In conclusion, our analysis of data spanning from 2006 to 2019 reveals a disconcerting decline in adequate fruit and vegetable consumption among Malaysian adults, despite dietary guidelines recommending daily servings. Adequate fruit and vegetable consumption was closely associated with higher household income and age; however, the overall consumption of fruits and vegetables among Malaysian adults remained unsatisfactory. The observed downward trend signals a critical public health challenge, given the well-established links between insufficient fruit and vegetable intake and various health risks. To address this issue, there is an urgent need for intensified and targeted interventions, encompassing robust public health campaigns, community engagement, and tailored strategies considering sociodemographic factors. Collaboration between government agencies, non-governmental organizations, and the private sector is crucial, supported by policy measures such as subsidies for fresh produce and incentives for healthier food retail practices. Continuous monitoring through national surveys is essential for assessing the effectiveness of interventions. By fostering a comprehensive and collaborative approach, Malaysia can strive to reverse this concerning trend, promoting a healthier population.

Limitations

Our study has several limitations. Firstly, FV intake was self-reported and thus susceptible to recall and social desirability biases, potentially leading to overestimation or underestimation of FV consumption across sociodemographic groups. Secondly, the data obtained from the national surveys involved non-institutionalized individuals only, thereby preventing the generalization of our findings to the entire adult population of Malaysia. Thirdly, all the surveys utilized a cross-sectional design, meaning that data was collected at a single point in time, thus limiting our ability to establish causal relationships. Despite these limitations, it is important to note that all the surveys employed a rigorous stratified multistage cluster probability sampling method. This approach ensured that the inclusion of a diverse range of participants representing different sociodemographic groups, resulting in a large and representative sample that allowed for the generalizability of the findings to the Malaysian adult population.

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AUTHOR'S CONTRIBUTIONS

KCC, TLK, and SMG were involved in the conceptualization and study design. KCC, TLK, SMG, LHL, and CYK performed data extraction, data analysis, and interpretation. KCC drafted the manuscript, and TLK, SMG, LHL, CYK, and MAO subsequently reviewed and edited the manuscript. All authors participated in manuscript revision and approved the final version.

Availability of data and materials

The data for this study are not publicly available, but they can be obtained upon reasonable request and with permission from the Director General of Health Malaysia.

DECLARATIONS

Ethics approval and consent to participate

This study was conducted in accordance with the guidelines and regulations of the Institutional Review Board of the National Institutes of Health, Ministry of Health Malaysia. All the data extracted from the surveys, which was approved by the Malaysian Ministry of Health Medical Research Ethics Committee (MREC). The requirement for informed consent was waived by MREC because of the retrospective nature of the study.

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