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Inadequate fruits and vegetables consumption among Malaysian adults during the COVID-19 pandemic

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Abstract

Background: The COVID-19 pandemic has negatively impacted the eating behaviours of people especially fruits and vegetable intake. No study has addressed the fruits and vegetables intake during the COVID-19 in Malaysia. **Aim:** to assess the daily intake of fruits and vegetables among Malaysian adults during the COVID-19 outbreak, perceived changes in intake, as well as factors associated with the changes in intake. **Methods:** A cross-sectional study was conducted through online platforms and a total of 506 participants were recruited. Semi food-frequency questionnaires were used to assess participants' fruit and vegetable intake. Socio-demographics information, knowledge, attitude and practices (KAP) of fruits and vegetables were collected. All statistical analyses were performed using SPSS. **Results:** The majority of participants (99.8%) did not achieve the recommended five servings per day, in which they consumed an average of 0.84 servings of fruits and vegetables per day. 46.4% of participants reported no changes in intake compared to before the outbreak. Fruits and vegetables intake was associated with physical activity level, knowledge, and beliefs of foods that may prevent/cure COVID-19. Binary logistic regression identified two significant risk factors of daily fruits and vegetables intake namely, being a non-Chinese (AOR = 1.905, 95% CI = 1.114–3.257) and having good practices scores (AOR = 2.543, 95% CI = 1.611–4.015). **Conclusion:** The study found a low daily intake of fruits and vegetables. The findings suggested that nutritional interventions are necessary to improve awareness on consuming more fruits and vegetables to improve overall health.

Keywords

COVID-19, vegetable intake, fruit intake, malaysian adults, eating pattern, MCO, inadequate intake

Introduction

The novel coronavirus SARS-CoV-2 disease (also known as 2019-nCoV or COVID-19) is an infectious virus strain that was first known to transmit its first infection to humans on the Huanan seafood market located in Wuhan, Hubei province in China (Fauci et al., 2020). The World Health Organisation (WHO) has declared the outbreak of COVID-19 to be classified as a global pandemic on March 11, 2020 (WHO, 2020). On 29 April 2021, there were more than 150 million confirmed COVID-19 cases worldwide, with total death cases reaching over 3.1 million and more than 127 million cases recovered (Worldometer, 2021). On the same given date, there were 401,593 confirmed COVID-19 cases in Malaysia, with total death cases at 1477 and 373,397 cases recovered (Worldometer, 2021). Due to the arising cases worldwide as well as the existence of mutated variants of the COVID-19 virus, several preventive measures have been implemented which were proven effective to minimize the spread of infection among individuals. According to the Centers for Disease Control and Prevention (CDC), such measures include physical distancing 2 metres apart in various interactions, wearing face masks properly, avoiding crowds and washing your hands often using soap or hand sanitizers (CDC, 2021).

The COVID-19 pandemic has caused many negative impacts across the globe including economic recessions and poor diet associations (Litton and Beavers, 2021). For instance, the rising number of infected cases accompanying lockdown commencements was seen to affect several countries by spikes in panic buying cases on food and household supplies. In addition, limited access to daily grocery shopping might reduce the consumption of fresh foods such as

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fruits, vegetables and fish due to their shorter shelf-lives, while processed foods with longer shelf-lives such as snacks and ready-to-eat foods were more favoured during the pandemic [6]. Quarantine measures could also result in boredom and stress as well as psychological and emotional responses to the COVID-19 outbreak (Di Renzo et al., 2020). These negative emotional responses might alter meal patterns and eating behaviours, which lead to overeating, or so-called "emotional eating" and "food craving". Therefore, the changes in meal patterns and eating behaviour might compromise a healthy and balanced diet, resulting in a decrease in the consumption of fruits and vegetables (Di Renzo et al., 2020).

Previous epidemiological studies have consistently demonstrated that a healthy dietary pattern plays a crucial role in the prevention of non-communicable diseases (NCDs) such as coronary heart disease (CHD) and cancers based on the principles of oxidative stress (Temple, 2000; Liu, 2003). Fruits and vegetables are well known to be an excellent source of fibre and are rich in minerals and vitamins (Slavin and Lloyd, 2012). In particular, vitamin C, E and β-carotene, play important roles as immune boosters. In addition, fruits and vegetables contain phytonutrients/phytochemicals that act as the main contributor of providing immune-boosting effects after consumption (Slavin and Lloyd, 2012). Examples of commonly known phytonutrients include polyphenols, anthocyanins, flavonoids and carotenoids (Slavin and Lloyd, 2012; Harasym and Oledzki, 2014). Phytonutrients help give fruits and vegetables their distinctive colours, smells and taste whilst act as antioxidants against oxidative stress (Leitzmann, 2016). Therefore, increased consumption of fruits and vegetables can reduce the risk of oxidative stress-related diseases, including infectious respiratory diseases, cardiovascular disease, neurodegenerative disease, musculoskeletal disorder and others age-related functional declines (Temple, 2000; Liu, 2003).

In Malaysia, it is recommended that adults, in general, should consume at least five servings of fruits and vegetables per day, specifically three servings of vegetables and two servings of fruits, with a standard portion weighing approximately 80 g (Aziz et al., 2019; Ahmad et al., 2020). However, the majority of Malaysian do not consume near enough the given intake level based on Malaysia Dietary Guidelines. Previous studies have reported that fruits and vegetables consumption in Malaysia accounts to only less than three servings (228 g) of fruits and vegetables per capita per day according to recorded statistics from the Food and Agriculture Organization (FAO) between 1980 and 2003 (Yen and Tan, 2011).

In addition to physical distancing and movement control measures, it is important to consume a balanced diet containing high amounts of fruits and vegetables to improve our immunity to tackle against the COVID-19 virus. Even with the beneficial effects they provide, no study has addressed the fruits and vegetables intake during the COVID-19 in Malaysia. Therefore, the aims of this study are to determine the daily fruit and vegetable intake among Malaysians during the COVID-19 outbreak, perceived changes in the intakes and the factors associated with fruits and vegetables intake during the COVID-19.

Materials and methods

Study design

This was a cross-sectional study conducted to assess the daily fruit and vegetable intake among Malaysian adults. This study was approved by the Science and Engineering Research Ethics Committee of the University of Nottingham Malaysia (Ethics approval ID: LYL231020).

Subjects and recruitment procedures

This cross-sectional study was conducted from 28th November 2020 to 20th February 2021 through the Google Forms platform. The sample size was calculated using the formula by Taherdoost (2017) $n = \frac{p\,(1-p)z^2}{e^2}$, where n = required sample size, p = prevalence, e = precision, z = level of confidence. Using an estimated prevalence of 50% (Ng et al., 2010), precision of 5% with a 95% confidence interval and 30% of non-response rate, the sample size was 500 participants.

All participants were recruited through snowball sampling. Malaysian adults aged 18 and above were invited to participate by sending the study link online via several platforms. This included the university's email, instant messaging (WhatsApp, Telegram), social media and networking applications (Facebook, Twitter, Instagram and LinkedIn). Adults who were infected with COVID-19 or having any terminal illnesses such as final stage cancer, diabetes, or cardiovascular diseases were excluded from this study.

Instrument and measures

The questionnaire consisted of three sections: (1) sociodemographics, which data collected included gender, age, highest education, state and area of residence, ethnicity, household monthly income, occupation, smoking status, and physical activity levels; (2) fruit and vegetable intake, and perceived changes in intake of participants before and during the COVID-19 outbreak; and (3) knowledge, attitudes and practices (KAP) towards fruits and vegetables and COVID-19. A copy of the KAP questionnaire used is available in the appendix.

The daily fruit and vegetable intake among participants was assessed using a semi-quantitative food frequency questionnaire (FFQ), adapted from a validated FFQ, which was previously developed and validated for assessing habitual dietary intake among Malaysian adults (Institute for Public health, 2011; Ali et al., 2014). Participants were asked to recall the frequency intake of fruits and vegetables over the past one month which the participants indicated whether they had fruits and vegetables

"2-3 times per day", "Once a day", "5-6 times per week", "3-4 times per week", "Once a week", "1-3 times per month", or "Never". The participants were required to provide information regarding the serving size of each fruit/vegetable eaten for each time/meal which was used to indicate the participants' usual serving size for each intake of fruit/vegetable for each meal. The "Malaysian Food Album" was used to guide the participants on the serving size (Institute for Public health, 2011).

Frequency intakes were then converted from per month to per day according to the conversion factors (Table 1) by Norimah et al. (2008).

Daily intake of fruits and vegetables were calculated using the formula below: Fruit/vegetable serving per day = frequency of intake (conversion factor) × serving size × total number of servings (Norimah et al., 2008).

Participants were asked about their perceived change in fruits and vegetables intake before and during the COVID-19 outbreak. The responses to the question were *decreased a lot*, *decreased somewhat*, *no changes*, *increased somewhat*, *increased a lot* and *don't know*. Both increase and decrease groups were respectively combined with "*increased a lot* + *increased somewhat*" and "*decreased a lot* + *decreased somewhat*", considering the small proportions of participants who responded their changes in fruit and vegetable intake *decreased a lot* (2% in full sample) or *increased a lot* (5.9% in full sample). Participants were also asked about their beliefs if there were some foods that may effectively cure/prevent COVID-19, with given responses of *yes*, *no,* or *maybe*. Those who answered *yes* to the statement were asked to list the foods which may prevent/cure the disease.

To measure knowledge about fruits and vegetables and COVID-19, 15 items were adapted from previous studies (Aung et al., 2012; Zhong et al., 2020). These items included the participant's knowledge about the benefits and daily recommended intake, preservation, myths about fruits and vegetables, transmission route, and prevention and control of COVID-19. Participants were given "true" or "false" response options to these items. A correct response to an item was assigned 1 point, while an incorrect response was assigned 0 points. The maximum total score ranged from 0-15, with a higher score indicating better knowledge about fruits and vegetables and COVID-19.

Table 1. The conversion factor used to estimate food intake based on frequency of intake.

Frequency of intake	Frequency	Conversion factor
Per day	1×	1
	2×	2
	3×	3
Per week	1×	0.14 (1/7)
	2×	0.29 (2/7)
	3×	0.43 (3/7)
Per month	1×	0.03 (1/30)
	2×	0.07 (2/30)
	3×	0.10 (3/30)

To measure attitudes towards fruits and vegetables, participants were asked whether they were on the scale of: "*strongly disagree*, *disagree*, *neutral*, *agree*, *strongly agree*" based on their perspectives towards fruits and vegetables. They were also asked about their confidence and influence on taking fruits and vegetables throughout various challenges including COVID-19 as well as their behaviours involving fruits and vegetables. To measure practices, participants were asked *yes*/*no* questions regarding their current habits and their willingness to expose themselves more on new habits around fruits and vegetables. A total of 20 items and 16 items were asked in attitudes and practices sections respectively.

All items in the practices and attitudes sections were also given scores to assist in studying its associations on daily fruit and vegetable intake. For practices, all items were assigned 1 point for participants answering *yes*, and 0 points for those answering *no*. Attitudes were given a scoring system for every item via the given answers: "*Strongly disagree* = 0 marks; *Disagree* = 1 mark; *Neutral* = 2 marks; *Agree* = 3 marks; *Strongly agree* = 4 marks". This scoring system was created so for attitudes and practices, considering all items were capable of positively affecting and may increase fruit and vegetable intake among participants for those who agreed on the statement of each item. Scores of KAP were categorised into two groups: good (≥ 80% marks) and moderate (< 80% marks), to compare and study its association on fruit and vegetable intake.

Statistical analyses

All data analyses were performed using the Statistical Package for Social Sciences (SPSS), version 26 (SPSS Inc., Chicago, IL USA). Kolmogorov-Smirnov test was used to assess the normality of the continuous variables. Continuous variables were described as means and standard deviations (SD); Categorical variables were described as frequencies percentages. Daily fruit and vegetable intake was categorised into "Less than 1 serving per day" and "1 serving and above per day". Comparisons between variables between fruit and vegetable intake per day were performed using independent t-tests and Chi-square (χ^2) tests. Variables that had $p < 0.25$ in univariate analyses were included in multivariate analyses to determine factors associated with daily fruit and vegetable intake. The statistical significance level for all tests was set at $p < 0.05$.

Results

Characteristics of participants

The sociodemographic characteristics of the participants by daily fruit and vegetable intake are shown in Table 2.

Among the 506 participants, 62% of the participants were females and the mean age of all participants was

Table 2. Associations between daily fruit and vegetable intake and socio-demographics.

Variable	Total (n = 506) n (%)	< 1 serving (n = 365) n (%)	≥ 1 serving (n = 141) n (%)	*P*-value[a]
Age (years) (Mean ± SD)	25.3 ± 10.1	25.6 ± 10.5	24.5 ± 8.9	0.298
***Gender**				
Male	193 (38.3)	145 (39.8)	48 (34.3)	0.251
Female	311 (61.7)	219 (60.2)	92 (65.7)	
Age (years)				
18-29	436 (86.2)	310 (84.9)	126 (89.4)	0.408
30-49	39 (7.7)	30 (8.3)	9 (6.3)	
50 and above	31 (6.1)	25 (6.8)	6 (4.3)	
Highest education level				
Secondary or lower	67 (13.2)	47 (12.9)	20 (14.2)	0.455
A-levels/Diploma	105 (20.8)	79 (21.6)	26 (18.4)	
Undergraduate	288 (56.9)	210 (57.6)	78 (55.3)	
Postgraduate	46 (9.1)	29 (7.9)	17 (12.1)	
Region				
Northern	129 (25.5)	96 (26.3)	33 (23.4)	0.923
Central	281 (55.5)	203 (55.6)	78 (55.3)	
Southern	48 (9.5)	33 (9.1)	15 (10.6)	
East coast Peninsular	20 (4)	14 (3.8)	6 (4.3)	
East Malaysia	28 (5.5)	19 (5.2)	9 (6.4)	
Area of residency				
Urban	285 (56.3)	203 (55.6)	82 (58.2)	0.875
Suburban	202 (39.9)	148 (40.6)	54 (38.3)	
Rural	19 (3.8)	14 (3.8)	5 (3.5)	
***Ethnicity**				
Malay	40 (8)	26 (7.2)	14 (10.1)	0.234
Chinese	423 (84.4)	312 (86.2)	111 (79.8)	
Indian	16 (3.2)	11 (3)	5 (3.6)	
Bumiputera	11 (2.2)	5 (1.4)	6 (4.3)	
Others	11 (2.2)	8 (2.2)	3 (2.2)	
***Monthly household monthly**				
Below than RM2500	93 (20)	61 (18.2)	32 (24.6)	0.295
RM2500-RM4999	114 (24.4)	80 (23.8)	34 (26.2)	
RM5000-RM9999	151 (32.4)	112 (33.7)	39 (30)	
RM10000 and above	108 (23.2)	83 (24.7)	25 (19.2)	
***Employment status**				
Student	354 (70.7)	250 (69.3)	104 (74.3)	0.257
Public/Government Sector	3 (0.6)	3 (0.8)	0 (0)	
Private Sector	81 (16.1)	65 (18)	16 (11.4)	
Self-employed	21 (4.2)	13 (3.6)	8 (5.7)	
Unemployed + Retiree + Others (such as part-time jobs and freelancers)	42 (8.4)	30 (8.3)	12 (8.6)	
***Smoking status**				
Smoker	23 (4.6)	15 (4.2)	8 (5.7)	0.469
Non-smoker	478 (95.4)	345 (95.8)	133 (94.3)	
Dietary preference				
Omnivore	463 (91.5)	339 (92.9)	124 (87.9)	0.203
Lacto-ovo-vegetarian + Vegan	23 (4.6)	14 (3.8)	9 (6.4)	
Pescatarian	20 (3.9)	12 (3.3)	8 (5.7)	
***Physical activity level**				
<2 times per week	286 (56.9)	223 (61.6)	63 (44.7)	**<0.001**
3-4 times per week	145 (28.8)	93 (25.7)	52 (36.9)	
5-6 times per week	60 (11.9)	42 (11.6)	18 (12.7)	
7 times and above per week	12 (2.4)	4 (1.1)	8 (5.7)	

RM, Malaysian Ringgit (RM1 = 0.24 USD$). * missing data.

Missing data: Gender (n = 2), Ethnicity (n = 5), Household monthly income (n = 40), Employment status (n = 5), Smoking status (n = 5), Physical activity level (n = 3).

[a] Independent t-test was performed to compare continuous variables among <1 serving per day and ≥ 1 serving per day. Chi-square test was performed to compare categorical variables.

Table 3. Daily fruit and vegetable intake of participants during the COVID-19 outbreak.

Daily intake variables	Mean	Standard Error (SE)	% Rec. [a]
Fruit intake	0.1937	0.0108	0
Vegetable intake	0.6422	0.0275	0.8
Total fruit and vegetable intake	0.8359	0.0343	0.2

Abbreviation: [a] Percentage of adults achieving fruit and vegetable intake recommendations (rec.): 2 servings of fruits and 3 servings of vegetables daily, summing up to a total of 5 servings of fruits and vegetables per day.

25.3 ± 10.1 years. The majority of the participants were students (70.7%), with more than half of the total participation (56.9%) having a bachelor's degree as their highest education level. Most of the participants (55.5%) were from the central region of Malaysia, followed by Northern (25.5%) Malaysia and more than half of the participants lived in urban areas (56.3%). For ethnicity, 84.4% were Chinese, 8% were Malay, 3.2% were Indian, 2.2% were Bumiputera Sabah/Sarawak and 2.2% were from other minor ethnicities like Eurasians. Monthly household income levels were rather evenly distributed, with almost one-third of the participants were from the middle class of RM5000-RM9999 (approximately USD1185–2371) (32.4%). The majority of the respondents were non-smokers (95.4%) and consumed an omnivorous diet (91.5%). 41.9% of participants had a family history of NCDs, while 58.1% did not. Participants were also mainly engaged in physical activities less than 2 times per week (56.9%) to 3-4 times per week (28.8%).

There was a significant association between physical activity level and daily fruit and vegetable intake ($p < 0.001$). Participants who exercised less than 2 times per week were likely to consume less than 1 serving of fruits and vegetables (less than 1 serving: 61.6%; 1 serving and above: 44.7%).

Daily intake of fruits and vegetables

Table 3 presents the daily intake of fruits and vegetables of the participants. The mean and standard deviation for daily fruits and vegetables intake was 0.84 ± 0.03 servings. Only 0.2% of participants achieved the recommended five servings per day. The mean daily intake for fruits was 0.19 ± 0.01 servings/day with no participants achieved the recommended two servings per day. The mean daily intake for vegetables was 0.64 ± 0.03 servings/day, and 0.8% of participants reportedly achieved the recommended three servings per day.

Associations between daily fruit and vegetable intake and knowledge, attitude and practices (KAP) towards fruits and vegetables and COVID-19

Table 4 shows the associations between daily fruit and vegetable intake and KAP scores. In general, the majority of the participants were found to have good knowledge scores (66.8%) but moderate attitude (83.8%) and practices scores (72.3%). Significant differences were observed between knowledge ($p = 0.032$) and practices ($p < 0.001$) scores with fruits and vegetables intake. Participants who had a good knowledge score tended to eat less than 1 serving (less than 1 serving: 69.6%; 1 serving and above: 59.6%) while those with good practices scores were likely to eat more than 1 serving (less than 1 serving: 21.6%; 1 serving and above: 43.3%).

Table 4. Associations between daily fruit and vegetable intake and KAP scores towards fruits and vegetables and COVID-19.

		Daily fruit and vegetable intake			
Variables	Total (n = 506) n (%)	< 1 serving (n = 365) n (%)	≥ 1 serving (n = 141) n (%)	χ^2	*P*-value
Knowledge levels					
Moderate (<80%)	168 (33.2)	111 (30.4)	57 (40.4)	4.599	**0.032**
Good (≥80%)	338 (66.8)	254 (69.6)	84 (59.6)		
Attitude levels					
Moderate (<80%)	424 (83.8)	311 (85.2)	113 (80.1)	1.920	0.166
Good (≥80%)	82 (16.2)	54 (14.8)	28 (19.9)		
Practices levels					
Moderate (<80%)	366 (72.3)	286 (78.4)	80 (56.7)	23.752	**<0.001**
Good (≥80%)	140 (27.7)	79 (21.6)	61 (43.3)		

Chi-square test was performed with a significant difference at $p < 0.05$.

Associations between daily fruit and vegetable intake and perceived changes in fruit and vegetable intake before and during the COVID-19 outbreak

About half of the participants (46.4%) reported that they did not change in their fruits and vegetables consumption. Approximately one-third of participants (32.6%) claimed that they increased their fruits and vegetables consumption during the COVID-19 pandemic while 14.5% claimed they decreased their intake. There was no association ($p = 0.649$) between daily fruit and vegetable intake and perceived changes in fruit and vegetable intake before and during the COVID-19 outbreak (Table 5).

Associations between daily fruit and vegetable intake and participants' beliefs of foods that may prevent/cure COVID-19

Nearly half of the participants (47%) believed that there are foods that can prevent or cure COVID-19. There was a significant association ($p = 0.018$) between daily fruit and vegetable intake and the beliefs of foods that may

prevent/cure COVID-19 (Table 5). Participants who answered "no" and "maybe" were more likely to consume less than 1 serving (for "no", less than 1 serving: 40.3%; 1 serving and above: 34.7%) (for "maybe", less than 1 serving: 48.2%; 1 serving and above: 44%), and those who answered "yes" were likely to consume 1 serving and above (less than 1 serving: 11.5%; 1 serving and above: 21.3%).

Among participants who believed food can prevent or cure COVID-19, a total of 66 known responses were recorded for the foods that they think can prevent or cure COVID-19. More than half of the participants (69.4%) believed that antioxidants like vitamin C can effectively prevent or cure COVID-19 (Table 6). About one in ten participants (10.2%) reported that protein sources, herbs and spices can prevent or cure COVID, while only a small proportion (4.1%) of the participants mentioned vitamin D and resveratrol.

Odds ratios for socio-demographics, KAP scores and beliefs of foods that may prevent/cure COVID-19 towards daily fruit and vegetable intake

As shown in Table 7, non-Chinese participants were 1.9 times as likely to consume 1 serving or more fruits and vegetables than Chinese participants (AOR = 1.9, 95% CI = 1.1–3.2, p = 0.019). Also, participants with good practices scores were 2.5 times as likely to consume 1 serving or more fruits and vegetables than participants with moderate practices scores (AOR = 2.543, 95% CI = 1.611–4.015, p < 0.001). The model explained 9.9% (Nagelkerke R^2) of the variance in daily fruit and vegetable intake of Malaysian adults, with 73.7% of cases correctly classified.

Table 5. Associations between daily fruit and vegetable intake, perceived changes and participants' beliefs of foods that may prevent/cure COVID-19.

	Daily fruit and vegetable intake derived from semi-FFQ				
Question	Total (n = 506) n (%)	< 1 serving (n = 365) n (%)	≥ 1 serving (n = 141) n (%)	χ^2	*P*-value
Were your dietary habits affected and caused any changes on your fruits and vegetables consumption?					
Decreased	73 (14.5)	57 (15.6)	16 (11.3)	1.644	0.649
No changes	235 (46.4)	166 (45.5)	69 (49)		
Increased	165 (32.6)	119 (32.6)	46 (32.6)		
Don't know	33 (6.5)	23 (6.3)	10 (7.1)		
Do you believe there are some foods that can effectively cure or prevent COVID-19?					
Yes	72 (14.2)	42 (11.5)	30 (21.3)	8.013	**0.018**
No	196 (38.8)	147 (40.3)	49 (34.7)		
Maybe	238 (47)	176 (48.2)	62 (44)		

Chi-square test was performed with a significant difference at p < 0.05.

Discussion

To the best of knowledge, this study was one of the first to assess the fruits and vegetables consumption during the COVID-19 pandemic among Malaysian adults. This study showed the daily intake of fruits and vegetables during the COVID-19 pandemic and factors associated with the intake, which include sociodemographic and lifestyle factors, KAP towards fruits and vegetables and COVID-19, and the beliefs of food remedies that may prevent/cure COVID-19 among Malaysian adults.

The average daily intake of fruits and vegetables of 0.84 servings found in this study was alarming. It was observed that the daily fruit and vegetable intake during the COVID-19 outbreak was less than 1 serving per day for majority of the participants. However, the fruit and vegetable consumption reported in this study was much lower compared to those reported in previous studies among Malaysian communities (Nurul Izzah et al., 2012; Ismail et al., 2016). In the study by Shahida et al. (2015) among Malaysian adults, they found that adults consumed about 1.46 servings of fruits and 1.6 servings of vegetables per day in 2014. Latest reports from the Malaysian National Health and Morbidity Survey (NHMS) 2019 also stated that 95% of Malaysian adults did not fulfil the recommended daily amount of fruits and vegetables (Institute for Public Health, 2020). According to the NHMS 2015, the average daily fruit intake was 0.7 ± 1.0 servings per

Table 6. List of foods that may prevent/cure COVID-19 from participants who believed on the statement.

List of foods	Total (n = 49) n (%)
1. Foods which are high in antioxidants, mainly vitamin C (including citrus fruits like orange, lemon; cruciferous vegetables like broccoli.)	34 (69.4)
2. Protein sources (including legumes like lentils, beans and soy; meat)	5 (10.2)
3. Herbs and spices (including turmeric, garlic, ginger, neem)	5 (10.2)
4. Foods which are high in vitamin D	2 (4.1)
5. Foods containing resveratrol (including red wine, grapes)	2 (4.1)
6. Onions	1 (2)

49 valid responses were selected and arranged from the total responses of 66.

Table 7. Odds ratios for socio-demographics, KAP scores and beliefs of foods that may prevent/cure COVID-19 towards daily fruit and vegetable intake.

Variables	Adjusted Odds Ratio (95% CI)	*P*-value
Ethnicity		
Chinese	1	0.019
Non-Chinese	1.905 (1.114–3.257)	
Dietary Preference		
Omnivore	1	0.052
Non-omnivore	1.959 (0.994–3.864)	
Physical Activity Level		
≤ 4 times of exercise per week	1	0.131
≥ 5 times of exercise per week	1.531 (0.881–2.662)	
Knowledge Score Levels		
Moderate (<80%)	1	0.300
Good (≥80%)	0.797 (0.518–1.225)	
Attitudes Score Levels		
Moderate (<80%)	1	0.837
Good (≥80%)	0.943 (0.542–1.644)	
Practices Score Levels		
Moderate (<80%)	1	**<0.001**
Good (≥80%)	2.543 (1.611–4.015)	
Beliefs of food that may prevent/cure COVID-19		
Yes	1	0.085
No/Maybe	0.618 (0.358–1.068)	

Abbreviation: CI, Confidence interval.
Binary logistic regression test was performed with all confounding variables of $p < 0.25$ during the previous chi-square tests. Significant difference was set at $p < 0.05$.

day and vegetable intake was 1.3 ± 1.0 servings per day (Abu Bakar et al., 2015).

Although most participants reported no changes (46.4%) or increase (32.6%) in their perceived changes in fruits and vegetables intake, the daily intake may have decreased significantly due to the COVID-19 impact. Reports from the US in the state of Michigan mentioned that the impact of COVID-19 has caused a substantial change in food purchasing behaviours, leading to an increase in food insecurity due to the global economic recession. The rise of food insecurity was found to be associated with negative health impacts due to the association of poor diet, especially low consumption of fruits and vegetables (Litton and Beavers, 2021). In the same study, it was also found that food-insecure individuals during the pandemic consumed fewer fruits and vegetables than food-secure individuals compared to before the pandemic (Litton and Beavers, 2021). Other study in Qatar however, reported similar results as observed in this study, with 32.4% of individuals increased and 60% of individuals had their fruits and vegetables consumption unchanged during the pandemic (Ben Hassen et al., 2020). Despite the possible decrease in fruits and vegetables intake due to the COVID-19 impact, the reasoning behind this speculation cannot be confirmed as there are other confounding factors in this study that may cause this change. For instance, the change in intake according to the number of servings found in this study has made it difficult to determine due to differences in population characteristics between previous research, such as socio-economic characteristics which participants were mainly students (70.7%), and ethnicity distribution since most participants were Chinese (84.4%) in this study.

The present study found that physical activity level was associated with fruits and vegetables intakes. More than half of the Malaysian adults had less than 2 times of exercise per week and were consuming less than 1 serving per day. This finding was consistent with a previous 2-year longitudinal study on correlations between fruit and vegetable intake and physical activity among adults in Hawaii, stated that adults with higher physical activity durations tend to eat more fruits and vegetables ($r = 0.3$, $p < 0.0001$) (Woolcott et al., 2013). This association can be explained based on certain reasons in relation to the COVID-19 impact. The occurrence of lockdowns [Movement Control Order (MCO)] (including MCO, CMCO, RMCO) in Malaysia throughout the COVID-19 pandemic may have resulted a reduction in physical activity levels due to the lack of access to facilities such as gyms and swimming pools. As a result, individuals are forced to stay at home and engaged in sedentary behaviours such as watching television or playing computers during the lockdowns, which may stimulate the consumption of unhealthy foods (Di Renzo et al., 2020). It has also been suggested that physical activity could be a gateway behaviour, and that the increased in physical activity could lead to a healthier dietary behaviour. It was also reasonable to assume that individuals who increased their physical activity are more

health-conscious and tend to consume a higher fruits and vegetable intake (Woolcott et al., 2013).

It was observed that there was correlation between daily fruit and vegetable intake and ethnicity, with non-Chinese participants were about twice more likely to consume 1 serving or more than Chinese participants according to odds ratio results. Similarly, it was shown that there was an association between the two variables, with Malays consumed significantly more than Chinese and Indians from a study in Selangor (Nurul Izzah et al., 2012). Studies from Chong *et al*. however, explained that Malays showed significantly lower vegetable intake compared to non-Malay ethnic groups (Chong et al., 2017). Another research in 2016 also reported that Chinese had higher intakes of fruits and vegetables than Malay adolescents in Kelantan, Malaysia (Abdullah et al., 2016). The differences in fruit and vegetable intake between races may be due to the variations in socio-cultural aspects or religious beliefs across the diverse ethnic groups in Malaysia (Kumanyika, 2008). However, further investigations are required to discover its true underlying reasons between its relationship.

This study revealed that a high knowledge score towards fruits and vegetables and COVID-19 was associated with a consumption of less than 1 serving of fruits and vegetables, while higher practices scores on fruits and vegetables were associated with a consumption of 1 serving or more fruits and vegetables, and were more than 2.5 times likely to consume more than 1 serving. Our findings reflected the lack of ability to apply fruit and vegetable knowledge to practical dietary choices, which explains the high number of participants having good knowledge scores, yet obtaining moderate practices scores towards fruits and vegetables (Gibson et al., 1998). Besides, nutrition information obtained from multiple unofficial sources may have the tendency to be unreliable and mistrusted, which discourage motivation to change in dietary intake (De Almeida et al., 1997). Other barriers such as economic constraints may affect the fruit and vegetables intakes. Restrictions in grocery shopping may also lead to reduction in fresh food consumption, which include fruits and vegetables, in favour of processed foods with longer shelf-lives like convenience or ready-to-eat foods (including snacks, junk foods and microwaveable meals) throughout the pandemic (Di Renzo et al., 2020).

It was discovered that Malaysian adults were more likely to consume more fruits and vegetables ($\geq$1 serving of fruits and vegetables) for those who believed in the existence of foods that may prevent/cure COVID-19 than those who did not or were uncertain of it. Since fruits and vegetables are mainly rich in micronutrients and phytonutrients, they serve as an essential source for maintaining and strengthening the immune system in both innate and adaptive immune responses. Not only are they able to protect against free radical damage which can arise various chronic diseases (Slavin and Lloyd, 2012; Harasym and Oledzki, 2014; Leitzmann, 2016), but also contain antimicrobial effects against bacterial or viral infections causing respiratory diseases (Fernández-Quintela et al., 2020). Due to these health effects, several studies have proposed nutritional therapy as a potential health remedy for preventing/curing the COVID-19 virus (Fernández-Quintela et al., 2020; Iddir et al., 2020). As a result of the importance of fruits and vegetables in regulating metabolism and overall health, it is therefore important to achieve a daily intake of at least 5 servings of fruits and vegetables (Ahmad et al., 2020).

Several limitations were found in this study. Firstly, the snowball sampling method was conducted via a convenience sample through the networks of the researcher and supervisors and distributed only through online platforms (including emails, WhatsApp and Facebook). As a result, the sample of this study may not represent the whole Malaysian adult population and the findings may not be generalised to other populations like underprivileged populations. Nevertheless, this study provided a useful insight into fruits and vegetables intake among the Malaysian adult population during the COVID-19 outbreak. Secondly, the fruit and vegetable intake was assessed by self-reporting which depend on personal recall and honesty. This posed a risk of inaccuracy and unreliability, especially when it came to remembering the number of times consuming a certain food choice in a month. However, pictures of different fruits and vegetables were used to assist participants to recall and estimate the serving size of each fruit or vegetable class.

Conclusion

The daily intake of fruits and vegetables among Malaysian adults found in this study is discouraging, with a total average intake of less than 1 serving compared to the recommended intake of five servings. One of the possible reason for low intake could be due to the COVID-19 pandemic, despite most Malaysians perceived that their daily intake has increased or remained unchanged during the pandemic. Fruit and vegetable intake was associated with physical activity levels, ethnicity, knowledge and practices towards fruits and vegetables and COVID-19, and the beliefs of foods that may prevent or cure COVID-19. These findings can provide a useful insight to future nutritional interventions (such as online campaigns and educational seminars) to promote awareness and the importance of increasing fruit and vegetable intake for enhancing overall health. Further longitudinal research is required to determine the effectiveness of nutrition education in improving healthy eating habits, especially fruits and vegetables intake among Malaysian adults.

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Data will be made available upon request

Authors' contributions

YYL administered the project, performed statistical analysis, and wrote the first draft of manuscript. SSL and SHC conceptualized this study, developed methods and supervised the project. SHC and SSL aided in interpretation, critically reviewed and revised the manuscript.

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The authors give permission for the journal to publish this work.

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Supplemental Material

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