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...
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) \( n = \frac{e^2 \cdot p(1-p)}{\epsilon^2} \), 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...
Those who answered list the foods which may prevent/cure the disease. COVID-19, with given responses of were some foods that may effectively cure/prevent. 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 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 ($\chi^2$) 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 1. The conversion factor used to estimate food intake based on frequency of intake. |
|--------------------------------------|-----------------|---------------------|
| Frequency of intake                  | Frequency | Conversion factor   |
|--------------------------------------|-----------|---------------------|
| Per day                              | 1 x       | 1                   |
|                                      | 2 x       | 2                   |
|                                      | 3 x       | 3                   |
| Per week                             | 1 x       | 0.14 (1/7)          |
|                                      | 2 x       | 0.29 (2/7)          |
|                                      | 3 x       | 0.43 (3/7)          |
| Per month                            | 1 x       | 0.03 (1/30)         |
|                                      | 2 x       | 0.07 (2/30)         |
|                                      | 3 x       | 0.10 (3/30)         |

ranged from 0-15, with a higher score indicating better knowledge about fruits and vegetables and COVID-19.

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

| Variable                                      | Total (n = 506) | < 1 serving (n = 365) | ≥ 1 serving (n = 141) | P-value<sup>a</sup> |
|-----------------------------------------------|-----------------|-----------------------|-----------------------|---------------------|
| **Age (years) (Mean ± SD)**                   |                 |                       |                       |                     |
| *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).

<sup>a</sup> 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.
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 US$1185–2371) (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%).

### 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 (Table 6). About one in ten participants (10.2%) reported that protein sources, herbs and spices can prevent or cure COVID-19, 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.

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

| Question                                                                 | Total (n = 506) | < 1 serving (n = 365) | ≥ 1 serving (n = 141) | χ² | P-value |
|-------------------------------------------------------------------------|----------------|-----------------------|-----------------------|-----|---------|
| **Were your dietary habits affected and caused any changes on your fruits and vegetables consumption?** |                |                       |                       |     |         |
| Decreased                                                               | 235 (46.4)     | 166 (45.5)            | 69 (49)               | 1.644 | 0.469 |
| Increased                                                               | 165 (32.6)     | 119 (32.6)            | 46 (32.6)             |     |         |
| Don’t know                                                              | 33 (6.5)       | 23 (6.3)              | 10 (7.1)              |     |         |

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

| List of foods                                                                 | Total (n = 49) |
|-----------------------------------------------------------------------------|----------------|
| 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.
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). 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).

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

| 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                   | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |
| Non-Chinese               | 1.905 (1.114–3.257)          | 0.019 |
| Dietary Preference        |                              |       |
| Omnivore                  | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |
| Non-omnivore              | 1.959 (0.994–3.864)          | 0.052 |
| Physical Activity Level   |                              |       |
| ≤ 4 times of exercise per week | 1.000 (1.000–1.000)    | 1.000 (1.000–1.000) |
| ≥ 5 times of exercise per week | 1.531 (0.881–2.662)    | 0.131 |
| Knowledge Score Levels    |                              |       |
| Moderate (<80%)           | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |
| Good (≥80%)               | 0.797 (0.518–1.225)          | 0.300 |
| Attitudes Score Levels    |                              |       |
| Moderate (<80%)           | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |
| Good (≥80%)               | 0.943 (0.542–1.644)          | 0.837 |
| Practices Score Levels    |                              |       |
| Moderate (<80%)           | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |
| Good (≥80%)               | 2.543 (1.611–4.015)          | <0.001 |
| Beliefs of food that may prevent/cure COVID-19 | 0.618 (0.358–1.068) |
| Yes                        | 1.000 (1.000–1.000)          | 0.085 |
| No/ Maybe                 | 1.000 (1.000–1.000)          | 1.000 (1.000–1.000) |

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.
It was observed that there was correlation between daily fruit and vegetable intake and ethnicity, with non-Chinese participants being 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 consuming 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 vegetable intakes. Restrictions in grocery shopping may also lead to reduction in fresh food consumption, which includes 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 (≥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 reasons 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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