Association of food habit with the COVID-19 severity and hospitalization: A cross-sectional study among the recovered individuals in Bangladesh

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Abstract
Background: It was assumed that dietary habits might influence the status of COVID-19 patients. Aim: We aimed at the identification of association of dietary habits with the COVID-19 severity and hospitalization. Methods: It was a retrospective cross-sectional study (n = 1025). We used bivariate and multivariate analyses to correlate the association between self-reported dietary patterns and COVID-19 severity and hospitalization. Results: Dietary habits (black tea, milked tea, pickles, black caraway seeds, honey, fish, fruits, vegetables, garlic, onion and turmeric) were identified with lower risk of COVID-19 severity and hospitalization. Interestingly, the consumption frequency (one-, two- or three-times/day) of rice - the staple food in Bangladesh - was not associated with COVID-19 severity and hospitalization for comorbid patients. In contrast, a moderate rice-eating habit (two times/day) was strongly associated with the lower risk of severity and hospitalization for non-comorbid patients. However, for both comorbid and non-comorbid patients, consumption of black tea, milked tea, pickles and honey were associated with a lower likelihood of severity and hospitalization. Overall, a high consumption (three-times/day) of fish, fruits and vegetables, a moderate consumption of garlic, onion and turmeric spices and a daily intake of black/milked tea, and honey were associated with reduced risk of COVID-19 severity and hospitalization. Conclusions: To reduce the severity of COVID-19, a habitual practice of intaking black tea, milked tea, black caraway seeds and honey along with dietary habit (rice, fish and vegetables) and with a moderate consumption of ginger, garlic, onion, mixed aromatic spices (cinnamon + cardamom + cloves) and turmeric might be suggested.

Keywords
COVID-19, severity, hospitalization, dietary habits, foods, spices

Introduction
COVID-19 – a disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) - has been a buzzing word across the world posing a severe stress to the global healthcare system. Since the first report in December 2019 in Wuhan, China, COVID-19 has caused over 265 million cases and over 5.24 million deaths globally as of 4th December 2021 (Andersen et al., 2020; WHO, 2021). On the other hand, an unprecedented speed in developing COVID-19 vaccines around the world resulted in a handful of successful vaccine candidates; however, some big concerns still remain such as lasting of vaccine-imparted immunity, vaccine effectiveness against new variant or even facing more infectious variant and new pandemic (Dodd et al., 2021; Forni et al., 2021;
Lai et al., 2021; Li et al., 2021). Additionally, the solid evidence of vaccine in terms of longer-term effectiveness, safety, and protection against severe COVID-19 is still missing (Krause et al., 2020). Of note, Delta variant is the most common variants available recently infected people in Bangladesh (Ghosh et al., 2021; Moona et al., 2021). Recently, a new variant designated as Omicron has surged over the world while Bangladesh is experiencing a rapid spreading of third wave from January 2022 (TBS, 2022).

So far, scientists and physicians have noticed that people exposed to SARS-CoV-2 are not equally infected with COVID-19 disease (asymptomatic to mild to severe to death) (Kim et al., 2020; Shi et al., 2020). Notable that, several factors have been found to be associated with the severity and mortality rate which may increase the risk in COVID-19 patients, including aged person (>60 years) and having comorbidities (Akbar and Gilroy, 2020; Martins-Filho et al., 2020; Richardson et al., 2020). However, elderly-aged and comorbidities are not enough to explain the vulnerability to this severe infection. Additionally, pre-existing dietary habits of people appear to be linked to variability in COVID-19 symptoms (Butler and Barrientos, 2020; Hull et al., 2020; Whittemore, 2020; Zbinden-Foncea et al., 2020). Nevertheless, it is poorly known exactly why some people are more vulnerable whilst others less.

It is obvious that balanced nutritional status of the individuals can fight against any disease. Recently, Alam et al. (2021) has carried out a comprehensive review where strong nutritional interventions serve as a therapeutic tool against COVID-19 (Alam et al., 2021). Abdulah and Hassan (2020) explored the relation between dietary factors and infection/mortality rates globally; briefly, higher intake of fruits/sugar-sweetened products and lower intake of legumes/beans had a positive and negative effect on infection and mortality rates (Abdulah and Hassan, 2020). Several other review and original articles forecasted that nutritional management/supplement/interventions could be considered as a therapeutic gun against pandemic (Brugliera et al., 2020; Cobre et al., 2021; Grant et al., 2020; Iddir et al., 2020; Lidoriki et al., 2020; Liu et al., 2020; Moscatelli et al., 2021; Singh et al., 2020). Particularly, very recently, Kim et al. (2021), Salazar-Robles et al. (2021), Tavakol et al. (2021), and Merino et al. (2021) reported that increased level of physical activity and some dietary patterns such as consuming plant-based diets, fruits and poultry were associated with less severity of COVID-19 and disease duration (Kim et al., 2021; Merino et al., 2021; Salazar-Robles et al., 2021; Tavakol et al., 2021). However, dietary habit considerably varies across cultures as well as within culture among people. All the reports mentioned earlier mainly focused on the Western and Mediterranean diets which are typically less spicy, though various spices are regarded as hidden treasures of numerous therapeutic components and related health benefits (Peter, 2006; Sharif et al., 2018).

Consequently, it is critical to decipher the impact of dietary habits including spices consumption on the susceptibility to COVID-19, hospitalization risk and recovery. In this scenario, various predictors such as pre-existing food habits of infected people, symptoms ranging from asymptomatic, mild to moderate to severe can be considered for the study. No doubt, the eating habit of Bangladeshi people is a very complex issue. Keeping this in mind, we aimed to focus on the specific food habits such as various spices and drinks, dietary carbohydrates, proteins and fats. Furthermore, biological attribution of variation in age and gender were considered to find out their association with COVID-19 severity and hospitalization (Hu et al., 2021; Kushwaha et al., 2021). The various benefitting predictors, of course will not terminate COVID-19 infection rate, but may help to reduce the pain and mortality rate of the patients. Therefore, this study will help to examine this association (beneficiary or worsening) so that a new combo approach can be developed to relieve patients from COVID-19 sufferings and saves as many lives as possible via reducing severity and prompting recovery during this deadly contagious disease. Though a few investigations have been done around the world (Bousquet et al., 2020; Ingram et al., 2020; Jayawardena and Misra, 2020; Maiorino et al., 2020; Martinez-Ferran et al., 2020), to our knowledge, this is the first survey-based findings in Bangladesh which deals with the investigation on the association between pre-existing food habits with COVID-19 severity and hospitalization.

Methods

Study design, participants, sites and data collection

The study included laboratory-confirmed COVID-19 patients who were diagnosed positive and later found to be negative at the COVID-19 test laboratory by RT-PCR assay. The risk factors such as age, sex, dwelling and comorbidities were considered to quantify the association between COVID-19 severity and hospitalization status of the recovered individuals. By following the guidelines from Directorate General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW), Bangladesh and World Health Organization other than clinical data, the symptoms of recovered patients were divided into three categories (we did not find any moderate case among the respondents): asymptomatic, mild and severe (DGHS, MOHFW, 2020). One might raise a valid question about why the COVID-19 patients enrolled for the study were not clinically assessed to ascertain mild, moderate, and severe cases. Inclusion of clinical examination of cases could have been more ideal for this study, but was impracticable for recruiting a fairly large number of cases from a South Asian country like Bangladesh where access to quality health services (proper documentation, electronic medical data archive etc.) for the common people is insufficient. To overcome the limitation, we compared the patients self-described reports, as received during the telephonic interviews, with the guidelines provided by the
DGHS (Bangladesh) aligned with the COVID-19 categorizations described by WHO (DGHS, MOHFW, 2020), to discriminate among the severity of the cases enrolled. In our previous study, we followed the similar way to ascertain the epidemiological and symptom data (Ganguli et al., 2022). Of note, it was confirmed that the attending doctors had already diagnosed the patients during their infection period and the same was reported by the respondents (patients) through telephonic interviews. Additionally, physicians directed the patient’s severity (asymptomatic, mild, severe) of COVID-19 disease upon examination of laboratory reports based on the guidelines of DGHS, MOHFW and WHO in order to avoid unnecessary hospital admission load caused by the COVID-19. Huang C. (2020) and his group also directly communicated with patients or their relatives to ascertain the epidemiological and symptom data which were not available from electronic medical records (Huang et al., 2020). For asymptomatic, mild, and moderate cases, interviews were conducted over telephone following the list collected from city corporation booths in Dhaka, Bangladesh by Hawlader M. D. H. and his group (Mohsin et al., 2021). COVID-19 severities and hospitalization were compared between the recovered patients with or without comorbidity status. We randomly included 1025 recovered individuals who provided completed data (See Supplementary Information for details). The study sites were two districts (Dhaka and Jhenaidah) of Bangladesh. All data were collected through telephone interviews and the same were recorded in an electronic form. The data collection period was November 2020 to March 2021.

**Statistical analysis**

Bivariate and multivariate analyses were done to identify the association of the selected parameters with COVID-19 status. We used graphical presentation and tabular format to display the distribution of age, sex and dwelling for identifying the pattern of the patients who suffered from COVID-19. We performed the bivariate analysis to compare age, hospitalization, and comorbidities between male and female. Chi-square test was performed to test the association between the categorical variables (sex, dwelling, consumption habits, dietary foods and spices) while Student’s t-test was used to explore the significance of the mean difference of the continuous variables (age). In multivariate analysis, we performed three regression models to assess the influencing factors of two outcome variables such as hospitalization status (model 1) and degree of severity (model 2). The binary logistic regression model was used to estimate each model of interest. It is noted that the outcome variable “degree of severity” was defined as “severe” if the patients reported the severity level of the symptoms as “severe” and as “not severe” if the patients reported the severity level as “mild” or they were asymptomatic. The explanatory variables were age (in years), sex (male vs. female), dwelling status (urban vs. village), consumption habits (black tea, milked tea, coffee, betel leaf, honey, black caraway seeds and pickles; consumption vs non-consumption), dietary foods (rice, fish, meat, vegetables and fruits; consumption-once/twice/thrice per day vs non-consumption) and spices (ginger, garlic, onion, turmeric, bay leaf and mixed aromatic spices (cinnamon + cardamom + cloves); consumption vs non-consumption). To identify consumption vs non-consumption habits, at least 3 months period prior to COVID-19 infection was considered for analyzing risk association of dietary habits to hospitalization and severity. We considered the odds ratios (ORs), 95% confidence intervals (CI), and p values for the variables in the models. In the case of all statistical analyses, we assumed significance only if p<0.05 (two-tailed). We performed the statistical analysis using SPSS (version 25).

**Results**

**Demographic data**

Demographic data suggested that the non-comorbid patients differed from the comorbid patients. Of the patients enrolled for the study, 45.6% (n = 467) had at least one comorbidity (Supplementary Information (SI) Figure 1). Overall, comorbid patients required more hospitalization (12.6%) (SI Figure 2).

In addition, comorbidity might have influenced the severity of the diseases. Though mild symptoms prevailed mostly for both types of patients, severe symptoms were found comparatively higher in the case of comorbid patients (Figure 1). Median age of the non-comorbid patients was 31±10.7 year which was much less than that of comorbid patients (45±12.8 year) (SI Figure 3). It is worth noting that male and urban patients outnumbered their counterparts in terms of numbers (SI Figure 4). On the other hand, regardless of gender and comorbidity status, a higher percentage of urban patients suffered from severe symptoms and required a greater rate of hospitalization compared to those of dwelling in villages (Figure 1). For instance, comorbid urban dwellers experienced a greater degree of disease severity (urban 38.6% vs village 32.1%) as well as a higher rate of hospitalization (urban 13.2% vs village 9.9%) than the villagers. A similar trend also was observed for non-comorbid patients (severity: urban 20.7% vs village 14.0% and hospitalization: urban 7.2% vs village 4.4%). The results of chi-square test showed that significant association between severity and socio-demographic characteristics (sex, dwelling). Alike severity, similar results were obtained in case of hospitalization as well (Supplementary Table 1).

**Comparison among the consumption habits of tea, honey, black caraway seeds, pickles and betel leaf**

Consumption of black tea was found as most popular habit in comparison to milked tea and coffee for both types of
Of the patients with comorbidity, 88.4% consumed black tea (SI Figure 5(a)). Betel leaf was the least consumed of all the regular habits (28.8% for non-comorbid and 40.1% for comorbid), while honey, black caraway seeds, and pickles were consumed by more than 70% of non-comorbid patients (SI Figure 5(b)). Their corresponding consumption rates were a little lower among the comorbid patients (68–82%). As rice is the staple food of Bangladesh, a large number of patients consumed rice twice or thrice a day (SI Figure 5(c) and 5(d)). Fish are found adequately and cheaply compared with another source of animal protein in Bangladesh. Consequently, two times consumption of fish were the frequent phenomenon because of the traditional habit where they mostly consumed meat once a day. Vegetables (leafy or fleshy; fiber and vitamin-rich) were evenly popular for both types of the patients. Surprisingly, fruits were consumed thrice per day by non-comorbid patients (55.9%) but much less by comorbid patients (22.9%). The percentages of patients with moderate consumption of spices (70–79%) were higher than those of low and high consumption of spices for both types of the patients (SI Figure 5(e) and 5(f)).

**Impact of dietary habits towards hospitalization and severity**

Table 1 shows the correlation among food habits, severity and hospitalization for comorbid and non-comorbid patients. The trend of degree of severity and the hospitalization rate for non-comorbid patients were found decreasing.
with consumption of black and milked tea, honey, black caraway seeds and pickles. Hospitalization rates were less than 7%. Besides, severity decreased along with regular consumption of these habitual foods. However, mixed results were observed for the comorbid patients. Less hospitalization was observed for comorbid patients who had consumed pickles (12.1%), black tea (11.9%), milked tea (11.3%) and honey (11.3%). However, opposite trends for hospitalization of comorbid patients were found for coffee, betel leaf and black caraway seeds. The least severity was found in case of comorbid black tea consumers (29.7%) where the severity was increased up to 35.6% for black caraway seeds consumers. On the other hand, severity did not exceed 20% for non-comorbid patients when they consumed these foods (Table 1).

In case of non-comorbid patients, moderate (twice) to high (thrice) consumption of rice, fish, meat, vegetables, and fruits were associated with mild form of disease and lower rate of hospitalization. For instance, three times consumption of fish per day reduced severity from 26.7% (once/day) to 14.8%. Whereas two times consumption of fish per day reduced the rate of hospitalization from 8.4% (once/day) to 5.0%. Overall, a similar trend was observed for the patients with comorbidity. Interestingly, no hospitalization was observed in case of the non-comorbid consumers of vegetables and fish (thrice/day) where rice, fish and meat were associated with 5–10% hospitalization for the non-comorbid patients. On the contrary, hospitalization percentages (10–13%) for comorbid patients did not differ much along with the frequency of the consumption of these food.

In case of ginger, garlic, onion, turmeric and mixed aromatic spices (MAS) (cinnamon + cardamom + cloves), reduced degree of severity and hospitalization were observed in case of the moderate consumers of these spices for both types of patients (Table 1). For example, moderate consumption of ginger reduced the hospitalization rate to 10.1% from 21.7% (low consumption) and 17.3% (high consumption) for the comorbid patients, whereas to 5.5% from 12.8% (low consumption) and 9.9% (high consumption) for the non-comorbid patients. Overall, moderate consumption of spices was associated with least hospitalization for comorbid patients (<10%) which were quite similar to the trend for non-comorbid patients.

Risk association of dietary habits to hospitalization and severity

The results of chi-square test indicated the significant association between severity and food habits (consumption habits, dietary foods, or spices) and similar results were obtained in cases of hospitalization as well (Supplementary Table 1). Table 2 displays the odds ratio of the dominating factors of hospitalization and severity of symptoms due to COVID-19. It is manifest from a cursory glance at the habitual consumption of the respondents, those who did not consume any kinds of hot drinks such as black or milk tea or coffee, natural remedies such as honey or black caraway seeds had more likelihood of being hospitalized due to COVID-19 compared to the counterpart. Similar evidence has been observed for both non-comorbid and comorbid conditions.

COVID-19 patients without comorbidity had 57% (OR 1.57; p < 0.05) and 30% (OR 1.30; p < 0.05) higher risk of admitting hospital when they did not consume honey and black caraway seeds respectively than those patients who consumed these items. While these figures were 75% (OR 1.75; p < 0.05) and 124% (OR 2.24; p < 0.05) for COVID-19 patients with comorbid condition. The risk of hospitalization was surprisingly 232% (OR 3.32; p < 0.01) and 60% (OR 1.60; p < 0.01) higher respectively in case of non-comorbid and comorbid milked tea consumer. However, habit of milked tea consumption has less benefit compared to black tea. These figures were 13% and 19% respectively for non-comorbid and comorbid patients in developing the risk of severe symptoms. Honey (OR 1.028; p < 0.05) and black caraway seeds (OR 1.038; p < 0.05) also had a significant effect on the occurrence of severe symptoms in COVID-19 patients without comorbidity; however, surprisingly, they had no significant effect (p > 0.05) on comorbid patients.

There was less likelihood of hospitalization for the non-comorbid patients who had consumed rice, vegetables, and fruits two or three times daily. The likelihood of being hospitalized for the non-comorbid patients decreased by 61 percent (OR 0.39; p < 0.01) with increased (twice daily) consumption of rice. For comorbid patients, there was no significant effect (p > 0.05) of rice consumption on their hospitalization and degree of severity.

Moreover, patients without comorbidity who ingested more (2 times/day) vegetables and fruits were 61% and 11% respectively less likely to be hospitalized compared to those who did not take such foods once a day. If these patients increased their daily consumption level of such foods, i.e., three times/day, the corresponding figures also increased to 82% and 65%, respectively. Vegetables and fruits consumption also reduced the likelihood of hospitalization and severity of the patients with comorbidity. Interestingly, the comorbid patients who took meat two times daily had 400% more likelihood of being hospitalized due to COVID-19 compared to the counterpart though the likelihoods for developing severe symptoms were slightly decreased for both two- and three-time consumption (OR 0.995 and 0.917 respectively). The likelihood of having severe symptoms decreased with an increased intake of vegetables. Specially, three-time consumption per day was associated with the least likelihood (with respect to one-and two-time consumers) of hospitalization and severe symptoms both for comorbid and non-comorbid patients.

According to the amount of spices intake, more consumption of ginger, garlic, and onion reduced the
hospitalization risk for both comorbid and non-comorbid patients. The likelihood of being hospitalized due to COVID-19 for the non-comorbid patients decreased by 23% (OR 0.77; p < 0.01) and 67% (OR 0.33; p < 0.01) with the increased (high) levels of ginger and garlic intake, respectively. In addition to these spices, other spices such as turmeric and bay leaf also played a significant role in reducing the risk of hospitalization for patients with comorbidity. The comorbid patients who consumed a medium and high levels of turmeric had 72% (OR 0.28; p <

| Table 1. Correlation between food habit, severity and hospitalization. |
|-----------------------------|------------------|------------------|-------------------------------|------------------|------------------|-----------------------------|
|                          | Comorbid Hospitalization | Non-comorbid Hospitalization |                          | Comorbid Severity | Non-comorbid Severity |                          |
|                          | No   | Yes | Asymptomatic | Mild | Severe | No   | Yes | Asymptomatic | Mild | Severe |
| Black tea                | Not Consumed | 82.8% | 17.2% | 6.0% | 55.3% | 38.7% | 92.6% | 7.4% | 11.3% | 69.2% | 19.5% |
|                          | Consumed | 88.1% | 11.9% | 9.4% | 60.9% | 29.7% | 93.5% | 6.5% | 12.3% | 69.1% | 18.5% |
| Milk tea                 | Not consumed | 83.7% | 16.3% | 6.1% | 54.9% | 39.0% | 84.6% | 15.4% | 11.4% | 67.5% | 21.1% |
|                          | Consumed | 88.7% | 11.3% | 7.3% | 59.3% | 33.3% | 95.9% | 4.1% | 11.5% | 69.7% | 18.9% |
| Coffee                   | Not consumed | 88.1% | 11.9% | 4.9% | 55.3% | 39.8% | 91.8% | 8.2% | 10.7% | 69.5% | 19.8% |
|                          | Consumed | 86.8% | 13.2% | 8.5% | 57.2% | 34.3% | 94.2% | 5.8% | 12.9% | 68.6% | 18.6% |
| Betel leaf               | Not consumed | 88.7% | 11.3% | 5.1% | 55.1% | 39.8% | 92.5% | 7.5% | 13.4% | 68.8% | 17.8% |
|                          | Consumed | 85.2% | 14.8% | 7.2% | 56.7% | 36.1% | 95.5% | 4.5% | 10.7% | 69.3% | 20.0% |
| Honey                    | Not consumed | 84.5% | 15.5% | 5.0% | 56.1% | 38.9% | 89.5% | 10.1% | 11.6% | 67.4% | 21.0% |
|                          | Consumed | 88.7% | 11.3% | 9.5% | 56.1% | 34.5% | 94.5% | 5.5% | 11.4% | 60.7% | 18.3% |
| Black caraway seeds      | Not consumed | 88.9% | 10.1% | 5.0% | 57.6% | 37.4% | 92.1% | 7.9% | 15.9% | 63.4% | 20.7% |
|                          | Consumed | 86.3% | 13.7% | 7.0% | 55.5% | 37.5% | 93.9% | 6.1% | 9.6% | 71.6% | 18.8% |
| Pickles                  | Not consumed | 85.4% | 14.6% | 6.5% | 54.4% | 39.1% | 91.2% | 8.8% | 10.3% | 69.4% | 20.3% |
|                          | Consumed | 87.5% | 12.1% | 6.3% | 62.5% | 31.3% | 93.8% | 6.2% | 12.9% | 68.1% | 14.3% |
| Rice                      | Not consumed | 87.1% | 12.9% | 4.3% | 58.6% | 37.1% | 89.2% | 10.8% | 2.7% | 59.5% | 37.8% |
|                          | Consumed | 86.7% | 13.3% | 7.6% | 54.3% | 38.1% | 97.3% | 2.7% | 13.3% | 70.1% | 16.7% |
| Fish                      | Not consumed | 89.3% | 10.7% | 7.1% | 54.6% | 46.4% | 91.6% | 8.4% | 13.7% | 59.5% | 26.7% |
|                          | Consumed | 86.7% | 13.3% | 6.8% | 59.0% | 34.1% | 95.0% | 5.0% | 12.2% | 69.4% | 18.3% |
| Meat                      | Not consumed | 85.8% | 14.2% | 7.1% | 50.0% | 42.9% | 92.6% | 7.4% | 14.8% | 59.3% | 25.9% |
|                          | Consumed | 87.8% | 12.2% | 6.8% | 63.3% | 29.9% | 93.7% | 6.3% | 9.4% | 75.4% | 15.2% |
| Vegetables                | Not consumed | 89.9% | 10.1% | 9.0% | 32.6% | 58.4% | 88.4% | 11.6% | 11.2% | 62.9% | 25.8% |
|                          | Consumed | 87.4% | 12.6% | 5.7% | 58.3% | 36.0% | 96.1% | 3.9% | 13.2% | 68.0% | 18.9% |
| Fruits                    | Not consumed | 86.2% | 13.8% | 5.9% | 64.5% | 29.6% | 100.0% | 0.0% | 10.0% | 72.6% | 17.4% |
|                          | Consumed | 86.8% | 13.2% | 4.7% | 59.4% | 35.8% | 91.9% | 8.1% | 8.1% | 77.2% | 14.8% |
| Mixed Aromatic Spices     | Not consumed | 85.4% | 14.6% | 6.5% | 54.4% | 39.1% | 91.2% | 8.8% | 10.3% | 69.4% | 20.3% |
|                          | Consumed | 87.5% | 12.1% | 6.3% | 62.5% | 31.3% | 93.8% | 6.2% | 17.6% | 68.1% | 14.3% |

*Per day.
56% (OR 0.44; p < 0.01) respectively less likelihood of hospitalization. Medium and high levels of consumption of all the aforementioned spices had a significant effect on reducing the risk of severe symptoms among the patients with comorbidities. In the case of comorbid patients, only high-level intake of garlic (OR 0.86; p < 0.05), turmeric (OR 0.95; p < 0.05), and mixed aromatic spices (OR 0.65; p < 0.05) had a significant effect on developing the severity symptom, however, surprisingly, those patients who consumed medium level of turmeric (OR 2.22; p < 0.05), and mixed aromatic spices (OR 1.41; p < 0.05) had the opposite effect.

**Discussion**

Hospitalization requirements were relatively higher in case of comorbid patients which might be due to less immunity (Callender et al., 2020; Castle et al., 2005). In this study, comorbid patients experienced higher severity and had the fewest asymptomatic cases which are coherent with prior investigations (Davies et al., 2020). According to our data, males prevailed over females in number of cases where most of the patients were urban dwellers which also reflected the previous reports (Bwire, 2020; Girdhar et al., 2021; Peckham et al., 2020). Of note, hospitalization and severe symptoms were observed in higher percentages for comorbid and non-comorbid female patients than their male counterparts which might be observed for the first time in the South-Asian country. Females, specially, aged ones usually suffer from different post-menopausal difficulties which might trigger worse COVID-19 outcomes (Colditz et al., 2010; Costeira et al., 2021). In addition, Delta variant of coronavirus (SARS COV-2) were predominant during our investigation, therefore, possibly females were vulnerable against Delta variant (Chen et al., 2021; Rangchaikal and Venketaraman, 2021). However, villagers required less hospitalization and suffered mostly from mild symptoms. This phenomenon can be explained by the fact that they were accustomed to more physical activities, greener abode and contamination-free foods than the urban peoples (Chen et al., 2017; Riva et al., 2009). However, easy access to hospital for urban peoples cannot be ruled out at this moment (Bain et al., 2014; Chatterjee and Sarkar, 2021; Lee et al., 2015). We found that consumption of black tea, milked tea, honey and pickles were responsible for decreasing the degree of severity and hospitalization requirement due to COVID-19 (Table 1). Particularly, consumption of black tea appeared to be liked with lesser severity (non-consumer 38.7% vs consumer 29.7%) and lower hospitalization (non-consumer 17.2% vs consumer 11.9%) for comorbid patients. It is worthwhile to mention that the role of natural products for defending against infectious disease is a widespread practice from the earlier days. Because of their preventative properties against different microbial infection, they are being suggested to use in case of COVID-19 as well, somewhere, they have been proved to be effective (Aman and Masood, 2020; Ayivi et al., 2021; Gasmii et al., 2021). It is well known that tea and coffee contain antioxidants which are regarded as the immune promoters (Acikalin and Sanlier, 2021; Bhattacharyya et al., 2003; Hamer, 2007; Turkmen et al., 2007). Even tea has been reported as a bioactive modulator of innate immunity in cases of COVID-19 (Chowdhury and Barooah, 2020). Though coffee is considered as an effective beverage against different diseases, its impact on the recovery from COVID-19 is yet to be concluded (Belaroussi et al., 2020; Kennedy et al., 2021; Wierzejksa, 2017). Black caraway seeds and pickles were also reported for their high medicinal values as they are well known for their anti-microbial actions (Chakraborty and Roy, 2018; Forouzanfar et al., 2014). Taken collectively, it can be recalled that due to antimicrobial, antiviral, antioxidant properties and having vitamins/minerals into tea, honey and pickles might play a role against COVID-19.

On the other hand, increased consumption of rice, fish, meat, fruits and vegetables were found to be associated with less severity and hospitalization (Table 1). Though direct relationship between rice consumption and COVID-19 severity and hospitalization is not evident, but, rice consumption might be beneficiary for avoiding massive damage by this disease. As carbohydrates are closely associated with immune components at molecular level, carbohydrate rich food is suggested for COVID-19 patients in different studies (Kumbhar et al., 2021). Fish and meat both contain protein which might be the factor for less hospitalization and severity among the consumers. This result is coherent with previous studies (Batiha et al., 2021; Fan et al., 2020). Fruits and vegetables contain different vitamins and minerals including vitamin-C which assist the immune system (Carr and Maggini, 2017). For this reason, most of the dietary guidelines recommended for taking vegetables and fruits to prevent COVID-19 (Jayawardena and Misra, 2020).

Besides, moderate consumption of spices (ginger, garlic, turmeric, onion, mixed aromatic spices and bay leaf) was linked with less hospitalization and severity comorbid and non-comorbid patients. Ginger was reported to modulate oxidative stress and prostaglandins as harmful factors in COVID-19 (Mashhadi et al., 2013; Mohamed et al., 2015). In addition, it is capable of modulating improper effect or T cell responses in COVID-19 (Jafarzadeh et al., 2021). Garlic is a potential therapeutic as it contains organosulfur and flavonoid compounds which can be used to fight with COVID-19 (Khubeber et al., 2020). Turmeric contains curcumin which is regarded as a treatment for COVID-19 infection (Babaei et al., 2020). Meanwhile, onion and bay leaf have also high medicinal values which might be the reason for less damage among the users. High and low consumption of these spices were observed with higher hospitalization and severity, moderate consumption of these spices were mostly favorable.

Significant correlation between food habits with severity and hospitalization for comorbid and non-comorbid
### Table 2. Risk association for hospitalization and severity.

| Category                      | Hospitalization |             | Comorbid |             | Severity |             | Comorbid |             |
|-------------------------------|-----------------|-------------|----------|-------------|----------|-------------|----------|-------------|
|                               | Non-comorbid OR (95%CI) p-value | Comorbid OR (95%CI) p-value | Non-comorbid OR (95%CI) p-value | Comorbid OR (95%CI) p-value |
| **Consumption Habits**        |                 |             |          |             |          |             |          |             |
| Black tea                     | Not consumed    | 1.167 (3.48–3.915) .061 | 1.146 (4.88–2.687) .045 | .602 (2.70–1.340) .014 | 1.271 (6.44–2.511) .049 |
| Milked tea                    | Not consumed    | 3.317 (1.28–8.556) <.001 | 1.597 (7.77–3.280) .003 | 1.129 (6.19–2.060) .032 | 1.191 (6.89–2.031) .022 |
| Coffee                        | Not consumed    | 2.153 (7.98–5.805) .063 | 1.357 (6.77–2.720) .039 | 1.054 (6.22–1.787) .045 | 1.267 (7.94–2.022) .044 |
| Betel leaf                    | Not consumed    | 2.407 (7.86–7.371) .197 | .715 (3.80–2.279) .300 | 1.247 (7.18–2.166) .433 | 1.544 (9.84–2.83) |
| Honey                         | Not consumed    | 1.569 (5.83–4.221) .046 | 1.750 (8.69–3.527) .17 | 1.028 (5.58–1.894) .030 | 1.265 (7.46–2.126) .022 |
| Black caraway seeds           | Not consumed    | 1.295 (4.69–4.221) .027 | 2.238 (9.58–5.227) .043 | 1.031 (4.88–1.95) .028 | 1.029 (3.83–1.814) .085 |
| Pickles                       | Not consumed    | 1.583 (5.58–4.489) .065 | 1.016 (4.53–2.729) .269 | 1.605 (7.83–3.292) .197 | 1.232 (6.80–2.232) .047 |
| **Dietary Foods**             |                 |             |          |             |          |             |          |             |
| Rice                          | Once            | .836 (0.07–2.046) <.001 | 1.242 (4.57–3.738) .671 | .242 (1.03–1.50) .071 | .785 (4.11–1.08) |
|                              | Twice           | .980 (2.07–4.641) .002 | 1.522 (6.72–3.448) .314 | .465 (1.93–1.123) .089 | 1.157 (5.71–2.344) .086 |
|                              | Thrice          | .311 (0.09–1.230) .131 | 3.42 (0.95–1.383) .10 | 1.344 (6.54–2.764) .421 | 1.326 (7.00–2.514) .387 |
| Fish                          | Once            | .602 (1.49–4.233) .415 | 5.47 (1.83–1.639) .282 | 1.090 (3.39–3.507) .884 | 1.920 (6.85–5.383) .215 |
|                              | Twice           | .3508 (8.47–14.526) .517 | 5.003 (1.82–19.529) .20 | 9.95 (8.55–8.010) .017 | 5.66 (3.08–1.103) .066 |
|                              | Thrice          | .4590 (9.19–22.910) .812 | 2.532 (1.67–9.537) .170 | .917 (2.82–3.506) .013 | .569 (2.05–1.578) .279 |
| Vegetable                     | Once            | <.001 <.001 | .017 | .008 | <.001 |
|                              | Twice           | .394 (1.28–3.524) .006 | .751 (2.49–2.721) .012 | .927 (4.23–11.72) .045 | .444 (2.25–8.78) .020 |
|                              | Thrice          | .182 (0.20–1.690) .034 | .798 (3.64–1.752) <.001 | .867 (9.11–5.642) .039 | .201 (0.09–4.42) <.001 |
| Fruit                         | Once            | .006 .049 | .186 | .080 |
|                              | Twice           | .893 (3.24–1.723) .044 | .785 (3.25–1.95) .004 | 1.028 (2.33–5.427) .064 | .813 (4.35–1.17) |
|                              | Thrice          | .346 (1.28–3.695) .004 | .755 (2.93–1.945) .036 | 2.081 (4.28–10.130) .064 | 1.520 (8.60–2.126) .047 |

(continued)
COVID-19 patients were observed. Among the pre-existing habits, consumption of black tea, milked tea, pickles, honey, and black caraway seeds were identified as positive factors of reducing the degree of severity and hospitalization for COVID-19 patients. Two- or three-times/day consumption of fish, fruits and vegetables may reduce severity and hospitalization requirements. On the other hand, comorbid patients with a daily meat intake (twice daily) were at a very high risk of hospitalization. Moderate consumption of ginger, garlic, onion, turmeric and MAS was found as favorable and hence recommended. Therefore, we hypothesized that a combo approach of nutritional management with the necessary medical diagnose and treatment might be suggested against COVID-19. However, cautions should be considered as it is first time survey-based reports among the recovered individuals in Bangladesh and sixth report in world.

**Limitations**

This study included recovered patients from only two selected cities in Bangladesh. No specific community population involvement in the present study. Therefore, the diversity of the sample size is questionable. We do not have clinical data such as oxygen level during infection, CBC, SGPT, blood glucose, ferritin, D-dimer, ESR, Creatinine, HbA1C, etc. Moreover, we could not record the duration of the underlying conditions. In addition, we collected data through a telephone call; there could be misinformation or biased information from the interviewer and participants. However, this study reconfirms the global findings that preexisting nutritional habits associated with low severity and hospitalization.

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**Availability of data and materials**

Available upon request.
Consent for publication
Yes.

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The protocol was approved by the ethics committee, Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh (CVASU/DIR/(R & E)/EC/2020.191/1).

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Supplemental material
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References
Abdul DM and Hassan AB (2020) Relation of dietary factors with infection and mortality rates of COVID-19 across the world. The Journal of Nutrition, Health & Aging 24(9): 1011–1018.
Açkalın B and Sanlier N (2021) Coffee and its effects on the immune system. Trends in Food Science & Technology 114: 625–632.
Akbar AN and Gilroy DW (2020) Aging immunity may exacerbate COVID-19. Science (New York, N.Y.) 369(6501): 256–257.
Alam S, Bhuiyan FR, Emon TH, et al. (2021) Prospects of nutritional interventions in the care of COVID-19 patients. Heliyon 7(2): e06285.
Aman F and Masood S (2020) How nutrition can help to fight against COVID-19 pandemic. Pakistan Journal of Medical Sciences 36(COVID19-S4): S121.
Andersen KG, Rambaut A, Lipkin WI, et al. (2020) The proximal origin of SARS-CoV-2. Nature Medicine 26(4): 450–452.
Ayivi R, Ibrahim SA, Collerer H, et al. (2021) COVID-19: Human immune response and the influence of food ingredients and active compounds. Bioactive Compounds in Health and Disease 4(6): 100–148.
Babaei F, Nassiri-Asl M and Hosseinizadeh H (2020) Curcumin (a constituent of turmeric): New treatment option against COVID-19. Food Science & Nutrition 8(10): 5215–5227.
Bain RES, Wright JA, Christenson E, et al. (2014) Rural:Urban inequalities in post 2015 targets and indicators for drinking-water. Science of The Total Environment 490: 509–513.
Batiha GE-S, Alqarni M, Awad DAB, et al. (2021) Dairy-Derived and egg white proteins in enhancing immune system against COVID-19. Frontiers in Nutrition 8: 629440.
Belaroussi Y, Roblot P, Peiffer-Smaja N, et al. (2020) Why methodology is important: Coffee as a candidate treatment for COVID-19? Journal of Clinical Medicine 9(11): 3691.
Bhattacharyya A, Sà G, Das T, et al. (2003) Black tea-induced cellular survival: Evidence for reduced toxicity and enhanced immunity in mice under stress. International Journal of Tea Science 2(2). https://doi.org/10.20425/ijts.v2i1and2.4587.
Bousquet J, Anto JM, Iaccarino G, et al. (2020) Is diet partly responsible for differences in COVID-19 death rates between and within countries? Clinical and Translational Allergy 10(1): 16.
Bruglera L, Spina A, Castellazzi P, et al. (2020) Nutritional management of COVID-19 patients in a rehabilitation unit. European Journal of Clinical Nutrition 74(6): 860–863.
Butler MJ and Barrientos RM (2020) The impact of nutrition on COVID-19 susceptibility and long-term consequences. Brain, Behavior, and Immunity 87: 53–54.
Bwire GM (2020) Coronavirus: Why men are more vulnerable to COVID-19 than women? Sn Comprehensive Clinical Medicine 2: 7.
Callender LA, Curran M, Bates SM, et al. (2020) The impact of pre-existing comorbidities and therapeutic interventions on COVID-19. Frontiers in Immunology 11: 1991.
Carr AC and Maggini S (2017) Vitamin C and Immune Function. Nutrients 9(11): 1211.
Castle SC, Uyemura K, Ratnayake JL, et al. (2021) Comorbidity and Nutrition: Reducing COVID-19 Risk And Mortality. Clinical and Translational Allergy 11: 16.
Chakraborty R and Roy S (2018) Exploration of the diversity and associated health benefits of traditional pickles from the Himalayan and adjacent hilly regions of Indian subcontinent. Journal of Food Science and Technology 55(5): 1599–1613.
Chatterjee S and Sarkar K (2021) Appraisal of urban–rural disparities in access to health care facilities and exposure to health risk factors: A case study of Durgapur Industrial region, India.2021: 1–18.
Chen H, Liu Y, Zhu Z, et al. (2017) Does where you live matter to your health? Investigating factors that influence the self-rated health of urban and rural Chinese residents: Evidence drawn from Chinese general social survey data. Health and Quality of Life Outcomes 15(1): 1–11.
Chen S, Liu T, Li X, et al. (2021) Health QR code application in the novel containment strategy and healthcare plan for pregnant women and children under quarantine during the summer outbreak of SARS-CoV-2 delta variant in Chengdu, China: An observational study. Risk Management and Healthcare Policy 14: 4499.
Chowdhury P and Barooah AK (2020) Tea bioactive modulate innate immunity: In perception to COVID-19 pandemic. Frontiers in Immunology 11(1): 590716.
Cobre AF, Surek M, Vilhena RO, et al. (2021) Influence of foods and nutrients on COVID-19 recovery: A multivariate analysis of data from 170 countries using a generalized linear model. Clinical Nutrition S0261-5614(21): 00157–6.
Colditz GA, Willett WC, Stampfer MJ, et al. (2010) Menopause and the risk of coronary heart disease in women. The New England Journal of Medicine 316(18): 1105–1110.
Costeira R, Lee KA, Murray B, et al. (2021) Estrogen and COVID-19 symptoms: Associations in women from the COVID symptom study. PLOS ONE 16(9): e0257051.

Davies NG, Klepac P, Liu Y, et al. (2020) Age-dependent effects in the transmission and control of COVID-19 epidemics. Nature Medicine 26(8): 1205–1211.

DGHS, MOHFW (2020) Novel Coronavirus (COVID-19) Guidelines. Available at: https://dghs.gov.bd/index.php/en/home/5376-novel-coronavirus-covid-19-guidelines (accessed 21 January 2022).

Dodd RH, Pickles K, Nickel B, et al. (2021) Concerns and motivations about COVID-19 vaccination. The Lancet Infectious Diseases 21(2): 161–163.

Fan H, Hong B, Luo Y, et al. (2020) The effect of whey protein on viral infection and replication of SARS-CoV-2 and pangolin coronavirus in vitro. Signal Transduction and Targeted Therapy 5(1): 1–3.

Forni G, Mantovani A, Forni G, et al. (2021) COVID-19 vaccines: Where we stand and challenges ahead. Cell Death & Differentiation 28(2): 626–639.

Forouzanfar F, Fazly Bazzaz BS and Hosseinzadeh H (2014) Black cumin (Nigella sativa) and its constituent (thymoquinone): A review on antimicrobial effects. Iranian Journal of Basic Medical Sciences 17(12): 929.

Ganguli S, Howlader S, Dey K, et al. (2022) Association of comorbidities with the COVID-19 severity and hospitalization: A study among the recovered individuals in Bangladesh. International Journal of Health Sciences 16(4): 30–38.

Gasmi A, Chiurumbolo S, Peana M, et al. (2021) The role of diet and supplementation of natural products in COVID-19 prevention. Biological Trace Element Research 200: 27–30.

Ghosh AK, Kaiser M, Molla MMA, et al. (2021) Molecular and serological characterization of the SARS-CoV-2 delta variant in Bangladesh in 2021. Viruses 13(11): 2310.

Girdhar A, Kapur H, Kumar V, et al. (2021) Effect of COVID-19 outbreak on urban health and environment. Air Quality, Atmosphere and Health 14(3): 389–397.

Grant WB, Lahore H, McDonnell SL, et al. (2020) Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients 12(4): 988.

Hamer M (2007) The beneficial effects of tea on immune function and inflammation: A review of evidence from in vitro, animal, and human research. Nutrition Research 27(7): 373–379.

Hu D, Lou X, Meng N, et al. (2021) Influence of age and gender on the epidemic of COVID-19: Evidence from 177 countries and territories—an exploratory, ecological study. Wiener Klinische Wochenschrift 133: 321–330.

Huang C, Wang Y, Li X, et al. (2020) Clinical features of patients infected with 2019 novel coronavirus in Wuhan. China. The Lancet 395(10223): 497–506.

Hull JH, Loosemore M and Schwellnus M (2020) Respiratory health in athletes: Facing the COVID-19 challenge. The Lancet Respiratory Medicine 8(6): 557–558.

Iddir M, Brito A, Dingeo G, et al. (2020) Strengthening the immune system and reducing inflammation and oxidative stress through diet and nutrition: Considerations during the COVID-19 crisis. Nutrients 12(6): 1562.

Ingram J, Maciejewski G and Hand CJ (2020) Changes in diet, sleep, and physical activity are associated with differences in negative mood during COVID-19 lockdown. Frontiers in Psychology 11: 2328.

Jafarzadeh A, Jafarzadeh S and Nemati M (2021) Therapeutic potential of ginger against COVID-19: Is there enough evidence? Journal of Traditional Chinese Medical Sciences 8(4): 267–279.

Jayawardena R and Misra A (2020) Balanced diet is a major casualty in COVID-19. Diabetes & Metabolic Syndrome 14(5): 1085–1086.

Kennedy OJ, Fallowfield JA, Poole R, et al. (2021) All coffee types decrease the risk of adverse clinical outcomes in chronic liver disease: A UK biobank study. BMC Public Health 21(1): 970.

Khüber S, Hashemifesharaki R, Mohammadi M, et al. (2020) Garlic (Allium sativum L.): A potential unique therapeutic food rich in organosulfur and flavonoid compounds to fight with COVID-19. Nutrition Journal 19(1): 124.

Kim GU, Kim MJ, Ra SH, et al. (2020) Clinical characteristics of asymptomatic and symptomatic patients with mild COVID-19. Clinical Microbiology and Infection 26(7): 948.e1–948.e3.

Kim H, Rebholz CM, Hegde S, et al. (2021) Plant-based diets, pescatarian diets and COVID-19 severity: A population-based case–control study in six countries. BMJ Nutrition, Prevention & Health 4(1). doi: 10.1136/bmjnph-2021-000272.

Krause P, Fleming Thomas R, Longini I, et al. (2020) COVID-19 vaccine trials should seek worthwhile efficacy. The Lancet 396(10253): 741–743.

Kumbhar PS, Pandya AK, Manjappa AS, et al. (2021) Carbohydrate-based diagnosis, prophylaxis and treatment of infectious diseases: Special emphasis on COVID-19. Carbohydrate Polymer Technologies and Applications 2: 100052.

Kushwaha S, Khanna P, Rajagopal V, et al. (2021) Biological attributes of age and gender variations in Indian COVID-19 cases: A retrospective data analysis. Clinical Epidemiology and Global Health 11: 100788.

Lai CC, Chen IT, Chao CM, et al. (2021) COVID-19 vaccines: Concerns beyond protective efficacy and safety. Expert Review of Vaccines 20(8): 1013–1025.

Lee JA, Park JH and Kim M (2015) Social and physical environments and self-rated health in urban and rural communities in Korea. International Journal of Environmental Research and Public Health 12(11): 14329–14341.

Li Y, Tenchov R, Smoot J, et al. (2021) A comprehensive review of the global efforts on COVID-19 vaccine development. ACS Central Science 7(4): 512–533.

Lidoriki I, Froutzas M and Schizas D (2020) Could nutritional and functional status serve as prognostic factors for COVID-19 in the elderly? Medical Hypotheses 144: 109946.

Liu G, Zhang S, Mao Z, et al. (2020) Clinical significance of nutritional risk screening for older adult patients with COVID-19. European Journal of Clinical Nutrition 74(6): 876–883.

Maiorino MI, Bellastella G, Longo M, et al. (2020) Mediterranean Diet and COVID-19: Hypothesizing potential benefits in people with diabetes. Frontiers in Endocrinology 11: 574315.

Martinez-Ferran M, de la Guía-Galipienso F, Sanchis-Gomar F, et al. (2020) Metabolic impacts of consumption of different calorie and macronutrient diets in asymptomatic and symptomatic patients with mild COVID-19. Cell Death & Disease 11: 1639.

Martins-Filho PR, Tavares CSS and Santos VS (2020) Factors affecting sleep, and physical activity are associated with differences in negative mood during COVID-19 lockdown. Frontiers in Psychology 11: 2328.

Mashhadi NS, Ghiasvand R, Askari G, et al. (2013) Anti-oxidative and anti-inflammatory effects of ginger in health and physical
activity: Review of current evidence. International Journal of Preventive Medicine 4(Suppl 1): S36.
Merino J, Joshi AD, Nguyen LH, et al. (2021) Diet quality and risk and severity of COVID-19: A prospective cohort study. Gut 70(11): 2096–2104.
Mohamed OI, El-Nahas AF, El-Sayed YS, et al. (2015) Ginger extract modulates Pb-induced hepatic oxidative stress and expression of antioxidant gene transcripts in rat liver. Pharmaceutical Biology 54(7): 1164–1172.
Mohsin FM, Tonmon TT, Nahrin R, et al. (2021) Association between smoking and COVID-19 severity: Evidence from Bangladesh. Journal of Multidisciplinary Healthcare 14: 1923–1933.
Moona AA, Daria S, Asaduzzaman M, et al. (2021) Bangladesh reported delta variant of coronavirus among its citizen: Actionable items to tackle the potential massive third wave. Infection prevention in practice 3(3): 60159.
Moscatelli F, Sessa F, Valenzano A, et al. (2021) COVID-19: Role of nutrition and supplementation. Nutrients 13(3): 976.
Peckham H, de Gruijter NM, Raine C, et al. (2020) Male sex identified by global COVID-19 meta-analysis as a risk factor for death and ITU admission. Nature Communications 11(1): 6317.
Peter KV (2006) Handbook of Herbs and Spices, 1st ed. Swaston: Woodhead Publishing.
Rangehaikul P and Venketaraman V (2021) SARS-CoV-2 and the immune response in pregnancy with delta variant considerations. Infectious Disease Reports 13(4): 993–1008.
Richardson S, Hirsch JS, Narasimhan M, et al. (2020) Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York city area. Journal of American Medical Association 323(20): 2052–2059.
Riva M, Curtis S, Gauvin L, et al. (2009) Unravelling the extent of inequalities in health across urban and rural areas: Evidence from a national sample in England. Social Science & Medicine 68(4): 654–663.
Salazar-Robles E, Kalantar-Zadeh K, Badillo H, et al. (2021) Association between severity of COVID-19 symptoms and habitual food intake in adult outpatients. BMJ Nutrition 4: e000348.
Sharif MK, Rebia E and Imran P (2018) Nutritional and therapeutic potential of spices. In: Therapeutic, Probiotic, and Unconventional Foods. Cambridge, MA: Academic Press, pp. 181–199.
Shi Y, Wang Y, Shao C, et al. (2020) COVID-19 infection: The perspectives on immune responses. Cell Death & Differentiation 27(5): 1451–1454.
Singh P, Tripathi MK, Yasir M, et al. (2020) Potential inhibitors for SARS-CoV-2 and functional food components as nutritional supplement for COVID-19: A review. Plant Foods for Human Nutrition 75(4): 458–446.
Tavakol Z, Ghannadi S, Tabesh MR, et al. (2021) Relationship between physical activity, healthy lifestyle and COVID-19 disease severity; a cross-sectional study. Journal of Public Health: From Theory to Practice. https://doi.org/10.1007/s10389-020-01468-9.
TBS (2022) Bangladesh braces for third wave as Omicron spreads. Available at https://www.tbsnews.net/coronavirus-chronicle/covid-19-bangladesh/bangladesh-braces-third-wave-omicron-spreads-354526 (accessed 3 February 2022).
Turkmen N, Velioglu YS, Sari F, et al. (2007) Effect of extraction conditions on measured total polyphenol contents and antioxidant and antibacterial activities of black tea. Molecules 12(3): 484–496.
Whittemore PB (2020) COVID-19 fatalities, latitude, sunlight, and vitamin D. American Journal of Infection Control 48(9): 1042–1044.
WHO (2021) Coronavirus Disease (COVID-19) Situation Reports. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports (accessed 11 December 2021).
Wierzejska R (2017) Can coffee consumption lower the risk of Alzheimer’s disease and Parkinson’s disease? A literature review. Archives of Medical Science: AMS 13(3): 507–514.
Zhinden-Foncea H, Francaux M, Deldicque L, et al. (2020) Does high cardiopulmonary fitness confer some protection against proinflammatory responses after infection by SARS-CoV-2? Obesity 28(8): 1378–1381.