**Prevalence of overweight and obesity among COVID-19 hospitalized patients in Southern Region Noakhali & Laksmipur, Bangladesh**

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**Abstract**

To minimize the harshness of this COVID-19 pandemic, it is crucial to point out the potential cofactors and their roles in disease severity. Obesity is one of the most important cofactors which correlate with many other human disorders. In this research perspective, the yields of excessive weight and obesity in SARS-CoV-2 disease were analyzed from 301 hospitalized positive COVID-19 patient samples. In order to examine any relationship, COVID-19 hospitalized positive patient samples were collected from two districts selected hospitals of Noakhali and Lakshmipur which were confirmed previously by the Bangladesh Government Laboratory (NSTU COVID-19 Diagnostic Lab). The nasopharyngeal and oropharyngeal samples used for the detection of COVID-19 positive samples and genome concentration were identified using RT-qPCR techniques where SARS-CoV-2 ORF1ab (nonstructural) and N (structural-nucleocapsid) biomarkers were applied. Multiple statistical tests, including data exploration, a chi-square assessment for consistency, an independent t-test, and binary logistic regression were carried out to carry out this cross-prospective cohort study. This current study indicated that there is no association between SARS-CoV-2 infection with hand washing with soup (p-value = 0.639) where age (p-value = 0.008), travel history (p-value = 0.035), fruits (p-value = 0.018), exercise (p-value = 0.012), and symptoms (p-value = 0.033) showed a significant association among the respondents BMI status. However, it was found that the respondents from the 18-29 years age group were 1.03 times more likely (OR= 1.03, 95%; CI: 1.01-1.26) to be overweight/obese than the respondents from greater than 44 years old. Regression data analysis indicated a positive correlation between BMI and viral load. Moreover, this research-based study screened the SARS-CoV-2 variants using a published primer and confirmed that 62% of patients were affected by the SARS-CoV-2 Delta subtype.

**Keywords:** COVID-19; Overweight; Obesity;Infection;Disease, Severity, Hand washing; Hospitalized patients

**1. Introduction**

The ongoing COVID-19 pandemic, a fatal infectious disease caused by the SARS-CoV-2 virus, has confirmed a total of 665 million positive cases with 6.7 million deaths in 230 countries as of January 02, 2023 (Ahmed et al., 2020; M. A. Islam, Sangkham, et al., 2022; Jakariya et al., 2021 ; WHO, 2022). Flu-like anomaly SARS-CoV-2 infection was discovered for the first time in late December 2019 in the Chinese city of Wuhan (C. Chakraborty et al., 2022; Rakib et al., 2021). This pathogen, which is a member of the coronavirus family and also has strong mutagenicity, is single-stranded, enclosed, high polarity, and non-segmented RNA (Hossain et al., 2021; Rakib, 2022). At least 11 important SARS-CoV-2 variants (Alpha, Beta, Gamma, Epsilon, Eta, Mu, Zeta, Iota, Kappa, Delta, Omicron, neo-Omicron), and almost 23 lineages have been identified already (Haider et al., 2020; Islam et al.;2021, n.d.; Kushal et al., 2020; Sakib et al., 2021). The COVID-19 pandemic has been going on for three years, and despite immunization efforts, its termination cannot be foreseen (Auler et al., 2020; Bashir et al., 2020; Rakib et al., 2021). More recently, again China and a few countrie’s COVID-19 situations is worsening drastically, and it is also presumed that the situation might be more worse rather than in previous years as no vaccines work properly (S. Chakraborty et al., 2022; Tiwari et al., 2023 ; WHO, 2022).

To manage the ongoing pandemic conditions, it is important to assess the parameters associated to the intensity of COVID-19. There are various risk factors linked with the severity of COVID-19 patients e.g. diabetes mellitus (Morgan et al., 2010), hypertension (Shibata et al., 2022), host immunity (Xia et al., 2022), COVID-19 vaccination, heat diseases, autoimmune diseases, and others ( Fitero et al., 2022). According to Wu Z et al., 2020, the highest 10.5% fatality rate was observed in persons who had cardiovascular disease from 72314 positive cases, 7.3% with diabetes mellitus, 6.0% hypertension, and 5.6% COVID-19 confirmed cases with cancer in China (Wu et al., 2020). The immunity system of COVID-19-positive patients plays a significant role in the recovery of this infectious disease whereas obese patients could not tackle this for adipose tissue inflammation (The Lancet Infectious Diseases, 2022). There are many factors behind increasing the number of obese patients, however, it is also pointed out that adult groups are affected mostly by obesity for a lack of insufficient physical activities (Knapp et al., 2022). A previously published study observed a significant association between obese patients and side effects of viral infections; influenza, MERS, and SARS (M. A. Islam, Hemo, et al., 2022; Ohno & Dzúrová, 2022). Many of these articles claimed that over weight gain ≥18 kg can provoke the risk of various infectious diseases (Louie et al., 2011; Morgan et al., 2010; Sawadogo et al., 2022). Obesity related complications like diabetes, hypertension been determined to be potential risk factors for escalating the degree of COVID-19 (Shi et al., 2020).

Obesity and associated complications are major public health concern worldwide, and there is no study in Bangladesh about hospitalized obese patients with COVID-19. In this multi-stational study, hospitalized COVID-19 positive patients samples collectd and observed the relationship with resk factor BMI including SARS-CoV-2 variants detection using published primers. This study will be helpful for researchers and others to handle hospitalized COVID-19 patients with overweight persons and conscious others to take proper actions against obesity for reducing COVID-19 severity.

**2. Methodology**

**2.1 Study area**

This multihospital research project was conducted in the Southern region of Bangladesh (Noakhali and Lakhmipur Distritricts-7 Upazilla Hospitals) from November 12, 2021, to November 12, 2022. Bangladesh Government acknowledged the NSTU COVID-19 diagnostic lab at the Department of Microbiology, Noakhali Science and Technology University for detecting COVID-19 from the districts of Noakhali and Lakshmipur. Directorate of Health, Bangladesh (DGSH) supporting IEDCR-qualified, WHO-certified NSTU lab has been engaged in detecting COVID-19 patient’s samples from these study areas. To conduct this study, COVID-19 hospitalized admitted patients data were gathered. Properly trained selective nurses filled up a questionnaire from the laboratory to confirm COVID-19 positive records (Supplementary Table ST1, Supplementary Data SD1). Patient's early history before COVID-19 identification, clinical manifestations, date of COVID-19 identification, and other information were collected. The Review Panel for the Protection Strategy of Human Subjects of the Noakhali Science and Technology University, Sonapur, Noakahli (NSTU) looked over the work and has been permitted by DGSH (Ref. 50/2021). The patients' consent form is also attached in the accessory file 1.

**Figure 1.** a) Study area in the district of Lakshmipur b) The Bangladesh map depicts the district boundary and all divisions where the red and blue boxes in this figure is indicating two selected study regions c) Noakhali district is one location in this study with hospital sign indicated by the places from where samples were collected

**2.2 COVID-19 specimen collection, processing, and RT-qPCR testing**

CDC COVID-19 specimen collection protocol was followed in this study. Nasopharyngeal and oropharyngeal swab samples were taken in VTM (Viral Transport Media) from preselected hospitalized admitted patients. During sample collection, PPE also can be referred as; Personal Protective Equipment such as masks (N-95), head cover, foot covers, gloves, goggles, and face shields were used for sample collection which recruited Medical Officer monitored. All samples collected from patients' with COVID-19 which were transported in the laboratorrry within 1-2 hours using a cold box under 40C temperature. The sample recipient laboratory staff properly checked all the specimens for labeling and proper sample condition, and samples were analyzed using standard protocol **Figure 2**.

**Figure 2.**COVID-19 detection using validated RT-PCR protocol.

From the SARS-CoV-2 confirmed hospitalized individuals, viral RNA was isolated using the QIAamp Viral RNA Mini Kit. For quality control in this study, two RT-PCR kit were applied where one originated from China (Sansure SARS-CoV-2 RT-PCR Kit) and another from Bangladesh (AFC SARS-COV-2 RT-PCR Kit). It is mentioned that Bio-Rad CFX96 was used for COVID-19 diagnosis following ORF1ab and N genes.

## 2.3 cDNA & variants detection

To convert RNA into complementary DNA of SARS-CoV-2, cDNAs were synthesized from extracted COVID-19 positive viral RNA following the kit protocol (SuperScript TM III First-Strand Synthesis System). Using published primer, SARS-CoV-2 variants were identified using the New England Biolab 2X master mix (**Table 1**). A total 50µL reaction mixture is used for PCR which was performed Bio-Rad PCR (Supplementary Table ST2) and the PCR product was confirmed by 2% gel electrophoresis (Hossain et al., 2021).

## 2.4 Quality control

This study was confirmed by several quality control strategies where positive, negative, and no-template controls were confirmed before RT-PCR result analysis. To check the cross-contamination in the collected COVID-19 samples, one VTM vial was checked without any sample. A standard curve was used to quantify viral load where a known concentration synthetic virus was supplied with kit (Supplementary Figure SF1). One previously positive COVID-19 sample and one negative sample were used during viral RNA extraction.

**2.5.1 Outcome variable**

This study evaluated overweight/obesity from BMI score. The BMI score was determined using the respondent’s height (meters) and weight (kilograms). Then, the BMI is categorized as the binary outcome variable, if the BMI score is greater than 25 kg/m2, the respondents’ are categorized as overweight/obese.

**2.5.2 Explanatory variables**

Close-ended questions are the mostly available in this study. Hence, a plot of pre-organized responses were collected by our respondents. Further, a screening process took place to code and sort the responses following the analysis's convenience. First, we categorized respondents' ages as <18, 18-29, 30-43, and 44+ years. Then the blood group was taken from the medical records of the respondents. Data on respondents' “Occupation” were collected in open ended then it categorized as “Business”, “Government”, “Health worker”, “Housewife”, and “Unemployed/None”. Information on respondents’ education was collected into four categories (Below SSC, SSC, HSC, and Bachelor or Higher). We also considered travel history, medical records related to COVID-19, hand-washing practices, eating habits, and other risk factors.

**2.5.3 Statistical analyses**

Different statistical and data analysis models have been structured and interpreted to justify our research findings; few of the models are noteworthy, like chi-square model, t-test model, exploratory data analysis model, and further logistic regression model, were designed and interpreted with 95% level of significance (M. A. Islam, Sangkham, et al., 2022).

Summarization of the dataset was crucial and to deal this we chose the data model based on exploratory analysis. The next step was to investigate the factors correlated with the mark of overweight or obesity condtion of the participants (p-value ≤ 0.20) from chi-squae test as suggested by (Hasan et al., 2020). At the end, to bring out the precise variales that are solely responsible for the obesity or overweight status we conducted the logistic regression model. R- statistical package were introduced to predict the outcomes of the study (M. A. Islam, Ahammed, et al., 2022; M. A. Islam, Hasan, et al., 2022).

**2.6 Model evaluation**

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Multivariable logistic regression were carried out independently for each of the selected variables. A cutoff value of 4.00 was used as the variance inflation factor (VIF) value to analyze multicollinearity in the final model (Table 1). The area under the curve (AUC) of the receiver operating characteristic curve is used to verify the prediction accuracy of the final model. We also utilized the Hosmer and Lemeshow goodness-of-fit test to examine the overall fit of the final model (Table 2).

**3. Results**

**3.1 Identification of COVID-19 positive samples**

According to the Bangladesh government dashboard as of January 02, 2023, the total COVID-19 instances that have been formally confirmed reported in Bangladesh was 2,037,156 (13% of total COVID-19 test) with corresponding 29,440 (1.4 % of total positive cases) confirmed death cases, and 1,987,923 (14% of total positive cases) recoveries (Worldometers.info (2022)) (IEDCR, 2022) ([https://dghs-dashboard.com/pages/covid19](https://dghs-dashboard.com/pages/covid19.ph)). The five highly-affected districts are Dhaka (n=728556), Chattogram (n=129121), Cumilla (n=47, 330), Sylhet (n=38,285), Narayanganj district (n=36,831) (Supplementary figure SF-2) (WHO, 2022) http://covid19tracker.gov.bd/. In the year of 2022, the highest number of daily death cases (n=06) was observed on October18, 2022, while the highest number of positive cases diagnosed was 491 on October 07, 2022 (WHO, 2022). The government of Bangladesh continues to observe COVID-19 as during the trial period, 49% of the population was immunized, and 72% of the population had gotten one dose of the COVID-19 vaccine.

The RT-PCR result of 301 COVID-19 specimens confirmed both ORF1ab and N SARS-CoV-2 genes from 32% of the total specimen using China-origin SANSURE diagnosis test kit, and 47% of those identified using AFC kit. Only the SARS-CoV-2 ORF1ab gene was identified in 21% of samples and merely the N gene of COVID-19 was confirmed in 79% of samples (Figure 4).

**Figure 4.**ORF1ab and N gene of SARS-CoV-2 using two commercial RT-PCR kits (a) SANSURE (b) AFC

According to kit result interpretation, CT (Cycle of threshold) 29.37 for the ORF1ab gene, 30.00 for the N gene, and 32.48 human RNase-P were counted as the highest, on the other hand, 21.14, 16.28, and 2.45 were the lowest value of these genes, respectively using SANSURE kit 27.4 and 29.65, with 31.7 found as the highest CT values for ORF1ab, N, human RNase-P gene while the lowest CT values were 22.11, 11.00, and 20.20 using AFC RT-PCR kit. Supplementary Figure SF1 is used for showing the quality control of this study.

## 3.2 Analysis of clinical data

The findings of the study revealed that about 7.27% of respondents were overweight/obese and less than 18 years old. Most of the respondents were 18-29 years old (39.09%) and overweight/obese. About 36.36% of the overweight/obese respondents were from blood group “B” and it was followed by “O” (28.18%), “A” (26.36%), and “AB” (9.09%). The majority of the overweight/obese respondents were bachelor students or higher degree holders (32.73%). Maximum respondents (48.18%) reported that they traveled to local markets before COVID-19 and they were also overweight/obese. More than half of the respondents (73.64%) frequently ate fruits and they were overweight/obese. About 52% of respondents were obese who exercise occasionally. Less than 50% of the respondents haven’t any COVID-19 symptoms who were overweight/obese. 23.56% of overweight/obese patients were exposed to positive patients (Figure 5a,b). An overview of various factors associated with the respondent's BMI status is demonstrated in Table 3. No association was found between COVID-19 treatment, occupation, hand washing with soap, hand washing with hand washing solution, hand washing with hand sanitizer, hand washing with just water, protein food taking, Vitamin supplement taking, water taking, and other risk factors with of the respondents BMI status (p > 0.20). Respondents’age group, blood group, education, travel history, fruits, exercise, and symptoms showed a significant association among the respondent's BMI status (Table 3).

Table 3: Summary of questionaries based data analysis (Chi-square Test).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristics** | **Overweight/Obese** | | | **P-value** |
| **Yes**  **n (%)** | **No**  **n (%)** | **Total**  **n (%)** |
| **Sex** |  |  |  |  |
| Male | 82 (74.55) | 148 (77.49) | 230 (76.41) | 0.062 |
| Female | 28 (25.45) | 43 (22.51) | 71 (23.59) |  |
| **Age group** |  |  |  |  |
| <18 | 8 (7.27) | 18 (9.42) | 26 (8.64) | 0.008 |
| 18-29 | 43 (39.09) | 40 (20.94) | 83 (27.57) |  |
| 30-43 | 40 (36.36) | 84 (43.98) | 124 (41.20) |  |
| 44+ | 19 (17.27) | 49 (25.65) | 68 (22.59) |  |
| **Blood group** |  |  |  |  |
| A | 29 (26.36) | 54 (28.27) | 83 (27.57) | 0.077 |
| AB | 10 (9.09) | 33 (17.28) | 43 (14.29) |  |
| B | 40 (36.36) | 70 (36.65) | 110 (36.54) |  |
| O | 31 (28.18) | 34 (17.80) | 65 (21.59) |  |
| **Education** |  |  |  |  |
| Bachelor or Higher | 36 (32.73) | 84 (43.98) | 120 (39.87) | 0.114 |
| Below SSC | 32 (29.09) | 35 (18.32) | 67 (22.26) |  |
| HSC | 31 (28.18) | 55 (28.80) | 86 (28.57) |  |
| SSC | 11 (10.00) | 17 (8.90) | 28 (9.30) |  |
| **Coronavirus treatment** |  |  |  |  |
| No | 101 (91.82) | 174 (91.10) | 275 (91.36) | 0.994 |
| Yes | 9 (8.18) | 17 (8.90) | 26 (8.64) |  |
| **Occupation** |  |  |  |  |
| Business | 26 (23.64) | 44 (23.04) | 70 (23.26) | 0.118 |
| Government | 18 (16.36) | 25 (13.09) | 43 (14.29) |  |
| Health worker | 5 (4.55) | 17 (8.90) | 22 (7.31) |  |
| Housewife | 20 (18.18) | 22 (11.52) | 42 (13.95) |  |
| None | 17 (15.45) | 41 (21.47) | 58 (19.27) |  |
| Private | 24 (21.82) | 42 (21.99) | 66 (21.93) |  |
| **Travel history** |  |  |  |  |
| Bank | 8 (7.27) | 5 (2.62) | 13 (4.32) | 0.035 |
| Health care facility | 11 (10.00) | 30 (15.71) | 41 (13.62) |  |
| None/Home | 3 (2.73) | 1 (0.52) | 4 (1.33) |  |
| Local market | 53 (48.18) | 98 (51.31) | 151 (50.17) |  |
| Relative’s house | 17 (15.45) | 16 (8.38) | 33 (10.96) |  |
| Workplace | 18 (21.47) | 41 (21.47) | 59 (19.60) |  |
| **Hand wash with soup (/day)** |  |  |  |  |
| 11-15 times | 29 (26.36) | 58 (30.37) | 87 (28.90) | 0.639 |
| 16-20 times | 2 (1.82) | 5 (2.62) | 7 (2.33) |  |
| 5-10 times | 64 (58.18) | 110 (57.59) | 174 (57.81) |  |
| Less than 5 | 14 (12.73) | 15 (7.85) | 29 (9.63) |  |
| More than 20 times | 1 (0.91) | 3 (1.57) | 4 (1.33) |  |
| **Hand wash with handwashing solution (/day)** |  |  |  |  |
| 11-15 times | 5 (4.55) | 3 (1.57) | 8 (2.66) | 0.488 |
| 16-20 times | 13 (11.82) | 18 (9.42) | 31 (10.30) |  |
| 5-10 times | 17 (15.45) | 29 (15.18) | 46 (15.28) |  |
| Less than 5 | 73 (66.36) | 139 (72.77) | 212 (70.43) |  |
| More than 20 times | 2 (1.82) | 2 (1.05) | 4 (1.33) |  |
| **Hand wash with hand sanitizer (/day)** |  |  |  |  |
| 11-15 times | 21 (19.09) | 44 (23.04) | 65 (21.59) | 0.476 |
| 16-20 times | 0 (0.00) | 3 ( 1.57) | 3 (1.00) |  |
| 5-10 times | 34 (30.91) | 46 (24.08) | 80 (26.58) |  |
| Less than 5 | 53 (48.18) | 95 (49.74) | 148 (49.17) |  |
| More than 20 times | 2 (1.82) | 3 (1.82) | 5 (1.66) |  |
| **Hand wash with just water (/day)** |  |  |  |  |
| 11-15 times | 22 (20.00) | 39 (20.42) | 61 (20.27) | 0.649 |
| 16-20 times | 5 (4.55) | 7 ( 3.66) | 12 (3.99) |  |
| 5-10 times | 41 (37.27) | 69 (36.13) | 110 (36.54) |  |
| Less than 5 | 42 (38.18) | 72 (37.70) | 114 (37.87) |  |
| More than 20 times | 0 (0.00) | 4 (2.09) | 4 (1.33) |  |
| **Fruits** |  |  |  |  |
| Frequently | 81 (73.64) | 147 (76.96) | 228 (75.75) | 0.018 |
| Occasionally | 24 (21.82) | 30 (15.71) | 54 (17.94) |  |
| Rarely | 4 (3.64) | 5 (2.62) | 9 (2.99) |  |
| Very frequently | 1 (0.91) | 9 (4.71) | 10 (3.32) |  |
| **Protein food** |  |  |  |  |
| Frequently | 75 (68.18) | 130 (68.06) | 205 (68.11) | 0.161 |
| Occasionally | 10 (9.09) | 14 (7.33) | 24 (7.97) |  |
| Rarely | 4 (3.64) | 3 (1.57) | 7 (2.33) |  |
| Very frequently | 21 (19.09) | 44 (23.04) | 65 (21.59) |  |
| **Vitamin Supplement** |  |  |  |  |
| Frequently | 9 (8.18) | 12 (6.28) | 21 (6.98) | 0.890 |
| Occasionally | 31 (28.18) | 58 (30.37) | 89 (29.57) |  |
| Rarely | 69 (62.73) | 120 (62.83) | 189 (62.79) |  |
| Very frequently | 1 (0.91) | 1 (0.52) | 2 (0.66) |  |
| **Water** |  |  |  |  |
| Frequently | 70 (63.64) | 131 (68.59) | 201 (66.78) | 0.346 |
| Occasionally | 5 (4.55) | 3 (1.57) | 8 (2.66) |  |
| Rarely | 2 (1.82) | 6 (3.14) | 8 (2.66) |  |
| Very frequently | 33 (30.00) | 51 (26.70) | 84 (27.91) |  |
| **Exercise** |  |  |  |  |
| Always/Very F | 20 (18.18) | 51 (26.70) | 71 (23.59) | 0.012 |
| Frequently | 4 (3.64) | 4 (2.09) | 8 (2.66) |  |
| Rarely | 29 (26.36) | 34 (17.80) | 63 (20.93) |  |
| Occasionally | 57 (51.82) | 102 (53.40) | 159 (52.82) |  |
| **Symptoms** |  |  |  |  |
| No | 49 (44.55) | 67 (35.08) | 116 (38.54) | 0.033 |
| Yes | 61 (55.45) | 124 (64.92) | 185 (61.46) |  |
| **Exposed by positive patients** |  |  |  |  |
| No | 75 (76.44) | 146 (68.18) | 221 (73.42) | 0.154 |
| Yes | 35 (23.56) | 45 (31.82) | 80 (26.58) |  |
| **Others risk factors** |  |  |  |  |
| No | 73 (66.36) | 140 (66.36) | 213 (70.76) | 0.253 |
| Yes | 37 (33.64) | 51 (33.64) | 88 (29.24) |  |

**Figure 5**: Percentage of COVID-19 hospitalized patients' travel history and age group.

**Table 4:** Result of logistic regression from various parameters

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| **Characteristics** | **OR (95% CI)** | **P-value** |
| **Sex** |  |  |
| Male | 0.88 (0.78 - 1.12) | 0.173 |
| Female | Reference | - |
| **Age group** |  |  |
| <18 | 0.97 (0.78 - 1.21) | 0.788 |
| 18-29 | 1.03 (1.01 - 1.26) | 0.009 |
| 30-43 | 1.24 (1.01 - 1.53) | 0.047 |
| 44+ | Reference | - |
| **Blood group** |  |  |
| A | Reference | - |
| AB | 0.84 (0.70 - 0.97) | 0.045 |
| B | 0.96 (0.84 - 1.10) | 0.542 |
| O | 1.07 (1.03 - 1.25) | 0.003 |
| **Education** |  |  |
| Bachelor or Higher | Reference | - |
| HSC | 1.09 (1.01 - 1.13) | <0.001 |
| SSC | 1.11 (1.02 - 1.29) | 0.006 |
| Below SSC | 1.14 (1.09 - 1.21) | <0.001 |
| **Occupation** |  |  |
| None | 1.73 (1.27 - 2.01) | <0.001 |
| Government | 1.54 (1.21 – 1.98) | <0.001 |
| Housewife | 1.25 (1.01 - 1.59) | 0.039 |
| Business | 1.11 (1.02 - 1.14) | 0.045 |
| Health worker | 1.09 (0.95 – 1.44) | <0.001 |
| Private | Reference | - |
| **Travel history** |  |  |
| Bank | 1.50 (1.12 - 1.99) | 0.006 |
| Health care facility | 1.39 (1.15 - 2.27) | 0.004 |
| Relative’s house | 1.16 (0.94 - 1.43) | 0.166 |
| Local market | 1.07 (0.92 - 1.24) | 0.371 |
| None/Home | 0.97 (0.80 – 0.99) | <0.001 |
| Workplace | Reference | - |
| **Fruits** |  |  |
| Rarely | 1.40 (0.90- 2.18) | 0.134 |
| Occasionally | 1.30 (1.01- 1.93) | 0.046 |
| Frequently | 1.04 (0.99 - 1.81) | 0.058 |
| Very frequently | Reference |  |
| **Protein food** |  |  |
| Frequently | 2.10 (1.90- 2.21) | <0.001 |
| Very frequently | 1.86 (1.41- 1.99) | 0.007 |
| Occasionally | 1.44 (0.95 - 2.51) | 0.233 |
| Rarely | Reference |  |
| **Exercise** |  |  |
| Rarely | 1.17 (1.02 1.66) | 0.005 |
| Occasionally | 1.05 (1.04 - 1.26) | <0.001 |
| Frequently | 1.02 (0.89 - 1.17) | 0.761 |
| Very frequently | Reference | - |
| **Symptoms** |  |  |
| No | 0.92 (0.82- 1.04) | 0.188 |
| Yes | Reference | - |
| **Exposed by positive patients** |  |  |
| No | 0.94 (0.83-0.97) | 0.002 |
| Yes | Reference | - |

In this overall scenario (Table 4), the age group of respondents, blood group, education, occupation, travel history, and fruits and protein intake were found to be statistically crucial variables. However, it was found that the respondents from 18-29 years’ age group were 1.03 times more likely [OR= 1.03, 95% confidence interval (CI): 1.01-1.26)] to be overweight/obese than the respondents from greater than 44 years old. Travel history of the **bank** showed a significant positive relationship with the BMI status [OR= 1.50, CI: 1.12-1.99]. The results indicated that for travel history of the bank was more overweight/obese than the people who traveled to workplace before COVID-19 infections. The respondents ate fruits rarely were 1.40 times more likely to overweight/obese [OR= 1.40, CI: 0.90-2.18].

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Cycle of threshold (CT) value of patients are positively correlated with BMI. This study finds CT values in certain BMI maximum (Figure-6). All of three genes ORF1ab (FAM), N (ROX), IC(CY5) were found to be interlinked with BMI 20-30 value.

**Figure 6:** Correlation of Cycle of threshold and BMI of COVID-19 positive patients (A) FAM/ORF1ab gene vs BMI (B) ROX/ N gene vs BMI (C) CY5/ Internal contro gene vs BMI

**Figure 6 (D):** Correlation of COVID-19 patient's viral load and BMI

The r-squared values of Fig 6A-C revealed that 21%, 29%, and 24% of the variability observed in the target variable BMI is explained by the regression models, respectively. In addition, this study results also indicated a positive correlation of viral load with BMI of COVID-19 positive patients.

Using previously published primers for detecting SARS-COV-2 primers it was confirmed that the maximum hospitalized patients were affected by SARS-CoV-2 Delta variants that are responsible for maximum death cases.

**4. Discussion**

It is almost three years since COVID-19 pandemic is going on, and nobody knows about the ending of this devastating disease. Although the rate of confirmed and death cases are lessening day after vaccination and following proper prevention and control guidelines, few countries of the world are still recording daily positive cases especially in different parts of China (Yu et al., 2021; WHO, 2022). Currently, Bangladesh is at the edge of the tertiary wave of this disease and Dhaka is found as mostly affected part of this country (Hossain et al., 2021). There are many reasons behind these scenarios, Bangladesh's capital has the densest population, slum areas, air pollution, lack of public health rules, etc. (Rakib, 2022).

The lab-based genetic count result of SRAS-CoV-2 of this study support that structural proteins (S) were detected in the maximum COVID-19 patients rather than non-structural proteins (ORF1ab). In addition, it was also confirmed that 100% internal control gene (RNase-p) which was designed focusing human cells. One of the previous studies published from the same lab also showed the same types of results when analyzed wastewater samples (A. Islam, Rahman, et al., 2022; Jakariya et al., 2022). In combination, both of these two studies proved that ORF1ab or other structural genes cannot be detected easily and prominently (S. Chakraborty et al., 2022; A. Islam, Hossen, et al., 2022). Two commercial COVID-19 RT-PCR kits indicated the same results where SANSURE showed the maximum percentage of this genetic material of SARS-CoV-2 (Ahmed et al., 2021; Dey et al., 2022). It is mentioned here that, before all result analysis, all quality controls such as no template, positive-negative and internal controls were cheeked. Any sample that fails to fill up all of these control is deleted from the analysis.

Questionnaire-based data analysis performed by STATA indicated that almost 40% of hospitalized COVID-19 obese patients came from the young generation (18-29) (Roy, Bhowmik, et al., 2022; Roy, Ripon, et al., 2022). Obesity is an important concern, and adolescents are more affected by the lack of proper physical activity (Hussain et al., 2020). Using social media like Facebook, Instagram, Skype, and other platform is also rapidly used by teenagers where during the pandemic online games, classes, and shopping also assist this cohort (Guglielmi et al., 2022). It is also found in other published articles that older people are less obese than young people (Arbel et al., 2022; Paravidino et al., 2022). It is high time to take the necessary steps against these following regular physical exercise, proper daily routine, early morning rising, and social activities (Belchior‐Bezerra et al., 2022). School, college, and university teachers can inspire students for taking part in indoor and outdoor games where one can keep himself / herself physically fit (Dhama et al., 2022; M. A. Islam, Hasan, et al., 2022; M. A. Islam, Sangkham, et al., 2022). The findings of this study also demonstrated that a lion portion of these young obese patients completed bachelor's or higher degree (Belchior‐Bezerra et al., 2022). These COVID-19 patients were maximum affected by marketplaces and social gatherings as half of the confirmed cases were from previous history (Belchior‐Bezerra et al., 2022; Houvèssou et al., 2022). Interestingly, it was found that few cofactors like occupation, hand washing agents, times, and food habits were not associated with COVID-19 with BMI status (Yang et al., 2021).

CT value of the COVID-19 hospitalized positive patients showed a statistical correlation with BMI (Houvèssou et al., 2022). The same result was observed in the case of viral load and BMI (Stavridou et al., 2021). This research indicates that the maximum hospitalized obese patients were affected by Delta variants and Beta variants of SAR-COV-2 were the prevalence of death cases observed from beta variants. Fever is the most common symptom in all of the variants.

**5. Conclusion**

This is the first study from Bangladesh to explore the correlation of obesity and SAR-COV-2 infection during COVID-19 pandemic. This developing country is also affected by 2022 flood, and currently Dengue is increasing with COVID-19. In order to control COVID-19 it is crucial to find out the risk factors like obesity and take care these patients with high care. COVID-19 is an organ-damaging disease, particularly in the lungs including the acute cardiovascular events also occur due to high cytokine storm in the obese patients. This study's results indicate that maximum COVID-19 hospitalized obese patients were affected by delta variants with various symptoms. The substantial relationship between obesity and COVID-19 reported in this study suggests that obesity may be a risk factor for this disease. These data will enable physicians to more accurately pinpoint populations at higher chance of experiencing severe COVID-19 infection and will encourage the adoption of the required preventative measures for obese patients.

**6. Ethical Statement**

The Noakhali Science and Technology University's Ethical Monitoring panel authorized and assessed the study's survey. Clinical survey was authorized by Bangladesh's Directorate General of Health Sciences (DGHS) depending on certain requirements (BMRCAIREC/2021/ I 708).

**7. Declaration of competing interest**

The authors declare that they were unaware of any personal or financial conflicts that could have impacted the research reported in this article.

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**10. Authors Contribution**

MAI degined, performed lab work, drafted first manuscript. All coauthors potentially edited and reviewed this manuscript.

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