Association of comorbidities with the COVID-19 severity and hospitalization: A study among the recovered individuals in Bangladesh

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ABSTRACT

Objectives: We aimed at the identification of the association of comorbidities with the COVID-19 severity and hospitalization.

Methods: It is a retrospective cross-sectional study to investigate the variation in age, sex, dwelling, comorbidities, and medication with the COVID-19 severity and hospitalization by enrolling 1025 recovered individuals while comparing their time of recovery with or without comorbidities.

Results: COVID-19 patients mostly suffered from fever. The predominant underlying medical conditions in them were hypertension (HTN) followed by diabetes mellitus (DM). Patients with cardiovascular disease (CVD) (54.3%) and hepatic disorders (HD) (43.6%) experienced higher severity. The risk of symptomatic cases was higher in aged (odds ratio, OR = 1.04, 95% CI = 1.02–1.06) and comorbid (OR = 1.87, 95% CI = 1.34–2.60) patients. T-test confirmed the differences between the comorbid and non-comorbid patients’ recovery duration. The presence of multiple comorbidities increased the time of recovery (15–27 days) and hospitalization (20–40%). Increased symptomatic cases were found for patients having DM+HTN whereas CVD+Asthma patients were found with higher percentage of severity. Besides, DM+CKD (chronic kidney disease) was associated with higher hospitalization rate. Higher odds of severity were found for DM+CVD (OR = 4.42, 95% CI = 1.81–10.78) patients. Hospitalization risk was also increased for them (OR = 5.14, 95% CI = 2.02–13.07). Moreover, if they had HTN along with DM+CVD, they were found with even higher odds (OR = 6.82, 95% CI = 2.37–19.58) for hospitalization.

Conclusion: Our study indicates that people who are aged, females, living in urban area and have comorbid conditions are at a higher risk for developing COVID-19 severity. Clinicians and health management authorities should prioritize these high-risk groups to reduce mortality attributed to the disease.

Keywords: COVID-19, comorbidities, severity, hospitalization

Introduction

The outbreak of coronavirus disease (COVID-19), a disease caused by the infection of a novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was first detected in Wuhan, China, at the end of December 2019.21 Assessing the alarming levels of spread and severity, the World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020.22 Alongside, the WHO recommended a handful of simple precautionary measures.23 As the toughest action, many countries imposed nationwide COVID-19 lockdown – softer or harder restriction on the movement of people outside the home, except for the emergency personnel – to slow down the spread of the virus.24 Fortunately, an unprecedented speed, there are some good vaccines already developed and the WHO approved their...
emergency use to control the pandemic. Despite the COVAX initiative, led by CEPI, Gavi, and WHO, alongside key delivery partner UNICEF for global equitable access to COVID-19 vaccines, least developed and lower-middle-income countries such as Bangladesh are still struggling to get sufficient vaccine to vaccinate at-risk people unlike the developed world. Intermittently, country-wide lockdown measures are imposed when the hospitals are overwhelmed with COVID-19 patients. Bangladesh is among the countries affected badly with COVID-19. The country has already reported more than 1.5 million laboratory confirmed cases with over 27 thousand deaths (as reported till November 24, 2021), and so far, the percentages of population fully vaccinated are only 20.6%. Prioritization of COVID-19 patients who would require hospitalization in Bangladesh can be made by assessing the risk factors within the local socioeconomic status and demographic characteristics, although some risk factors on COVID-19 are already available in published literature, such as male gender, aged people, and people having other comorbidities.

Despite multiple studies referred to above on association of comorbidity with severe COVID-19 illness, this subject still needs more investigations, particularly from resource-poor countries. This is also poorly understood from Bangladesh. Realizing the low vaccination rate and ongoing COVID-19 pandemic progression and comorbidities driven aggressive consequences of patients, a good understanding on the association of risk factors with COVID-19 severity would be helpful for timely hospitalization of COVID-19 patients and to support those who need the most when resources are limited. Here, we describe the impact of comorbidities on COVID-19 severity and hospitalization by assessing the recovered patients in Bangladesh from the disease.

Methods

Study design, sites, participants, and data collection

The study included laboratory-confirmed COVID-19 patients who were diagnosed positive and later found to be negative at the Bangladesh Government Health Ministry designated COVID-19 test laboratory in Dhaka, Kushtia, Khulna, and Jessore 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. The recovery duration (days) was determined as the median days required for individuals tested negative from positive through RT-PCR assay. By following the guidelines from Directorate General of Health Services (DGHS), Ministry of Health and Family Welfare (MOHFW), Bangladesh, and the World Health Organization, the symptoms of recovered patients were divided into four categories: Asymptomatic, mild, moderate to severe, and critical. COVID-19 severities were compared between the recovered patients with or without preexisting comorbidity. We randomly included 1025 recovered individuals who provided completed data (November 2020–March 2021). 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).

Statistical analysis

We used univariate, bivariate, and multivariate analyses. 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, and comorbidities) while Student’s t-test was used to explore the significance of the mean difference of the continuous variables (age and recovery duration). In multivariate analysis, we performed three regression models to assess the influencing factors of three outcome variables such as symptomatic cases (Model 1), severity of the symptoms (Model 2), and hospitalization status (Model 3). The binary logistic regression model was used to estimate each model of interest. It is noted that the outcome variable “severity of the symptoms” was defined as “severe” if the patients reported the severity level of the symptoms as “moderate to severe” or “critical” 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), habitation status (urban vs. village), having any comorbidity, having DM (diabetes mellitus), HTN (hypertension), CVD (cardiovascular disease), HC (hypercholesterolemia), RA (rheumatoid arthritis), HD (hepatic disorder), CKD (chronic kidney disease), and having allergic condition. We considered the odds ratios (ORs), 95% confidence interval (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. We performed the statistical analysis using SPSS (version 25).

Results

An overview on the demography of the patients enrolled

According to demographic data, 31.4% of patients were aged 31–40 years old represented in the supplementary information (SI), Figure 1A. Eventually, more than 70% of total patients were in the 21–50 years age range. The present study also revealed that the degree of severity of COVID-19 increased with increasing age and the incidence of asymptomatic cases decreased with increasing age [SI Figure 1B]. The percentages of male and female patients were 58.8% and 30.4%. However,
severities of the symptoms were found to be almost equal regardless of sex [SI Figure 1B]. About 90.0% of patients were urban dwellers likewise around the world [SI Figure 1A].[17] Among villagers and urban dwellers, there were a significant difference in case severity ($P = 0.035$).

**Prevalent symptoms**

There were about 9.2% ($n = 94$) of patients who were asymptomatic whereas $1, 2, 3, 4, 5, \text{ and } 6$ symptoms were predominant in 7.3%, 14.4%, 18.5%, 15.6%, 13.3%, and 8.8% of the patients, respectively [SI Figure 2]. Those with $3+$ symptoms were on average 38.5 years old. The most prevalent clinical symptom was fever (82.8%) [Figure 1] which is in line with the observations reported earlier.[14,18] The order of the symptoms were observed as fever (82.8%) > no taste (ageusia)/smell (anosmia) (55.1%) > cough (51.0%) > fatigue > (39.3%) > sore throat (31.2%) > pain in body (30.9%) > diarrhea (24.6%) > dyspnea (23.0%) > sneezing (17.2%) > vomiting (11.9%) > headache (6.0%) > conjunctivitis (5.8%) > reduction in oxygen level (ROL) (5.3%) > body pain with fever (BPF) (4.9%) > chest pain (1.0%). In addition, some other rare symptoms were also observed like memory loss (0.017%), hair fall (0.01%), and excessive sweating (0.006%). Fever was the most prevalent symptom for both males (83.4%), females (78.2%), and among all age groups [SI Table 1].

**Distribution of comorbidities**

Specific comorbidities – HTN was the most common preexisting comorbidities among the patients [Table 1]. The least common comorbidity was CKD (2%). In terms of comorbidities and COVID-19 severity, patients with CKD, asthma, and HTN suffered from critical conditions, proportionately 6.3%, 7.1%, and 5.1%, respectively. Patients with DM, CVD, HTN, and HC were found with variable degree (30–35%) of moderate-to-severe cases. About 50.9% of the female patients had comorbidity which was higher than that of the male patients (43.4%) [SI Table 2].

**Preexisting comorbidities and recovery period**

The recovery period of the patients with four or more comorbidities was longer (18 ± 6.6 days) compared to those with no or less than 2 comorbidities [Figure 2a]. Patients with no comorbidity had faster recovery (15.5 ± 6.1 days) where patients having 1, 2, and 3 comorbidities required 16 ± 9.7, 16 ± 10.2, and 17 ± 5.7 days, respectively [Figure 2a]. Comorbidities were identified as independent risk factors when analyzing the recovery period. Moderate-to-severe patients required more
time to recover than that of mild and asymptomatic patients who had comorbidities [Figure 2b]. Asymptomatic patients who had DM, HTN, CVD, asthma, and RA required <17 days to recover where other patients required higher duration (20 ± 6.0, 21.5 ± 3.9, and 21.5 ± 2.1 days for HC, HD, and allergy). Moderate-to-severe patients with HD (21.5 ± 5.7 days), HC (20.5 ± 8.2 days), HTN (18 ± 12.4 days), DM (18 ± 12.3 days), and CVD (18 ± 9.5 days) required at least 18 median days to recover. Moreover, patients with multiple comorbidities such as DM, HTN, HC, and CVD required 27 days compared with 15.5 days in patients without those comorbidities [Figure 2c].

Preexisting comorbidities and hospitalization

We found that the likelihood of hospitalization was 28.5% in patients with preexisting CVD, 27.6% in patients with DM, and 24% in patients with RA [Figure 3a]. The hospitalization proportion ranged from 15% to 18% in the patients with asthma, CKD, HTN, and HC [Figure 3a]. Significant association of hospitalization with DM ($P < 0.001$), CKD ($P < 0.001$), CVD ($P < 0.001$), and HTN ($P = 0.002$) was found [SI Table 3]. When patients suffered from DM combined with CVD and HTN, 40% of them required hospitalization [Figure 3b]. About 33% of patients who suffered from HTN and HC plus CVD with DM required hospitalization. The proportion of patients with CVD plus HTN required hospitalization was 40%, the highest percentage. Individually, the presence of DM and CVD was associated with a higher rate of hospitalization (35.2% and 28.5%, respectively).

Medication history

Of the patients’ information analyzed, 94.0% ($P < 0.001$) took medicines, and majority of them took multiple drugs. For instance, around 92.7% of the patients took both antipyretics and antibiotics [SI Table 4]. The used drugs could be ordered as antipyretic (93.9%) > antibiotic (92.7%) > antihistamine (84.9%) > antiviral (83.0%) > steroid (82.3%).

Hospitalization history with age, sex, and dwelling

In the present study, the proportion of hospitalization was higher in patients of >40 years of age compared with the younger

### Table 1: Distribution of comorbidities in COVID-19 patients, Bangladesh, 2020–2021

| Comorbidities | Population | Asymptomatic (%) | Mild (%) | Moderate to severe (%) | Critical (%) | Remarks (%) |
|---------------|------------|------------------|----------|------------------------|-------------|-------------|
| No            | 558        | 64 (11.5)        | 386 (69.2) | 101 (18.1)            | 7 (1.3)     | HTN (22.0%), DM (19.3%), HC (10.7%), asthma (8.2%), RA (8.1%), HD (5.0%), CVD (4.5%), allergy (3.0%), and CKD (1.8%). |
| Yes           | 467        | 30 (6.4)         | 262 (56.1) | 163 (34.9)            | 12 (2.6)    | * |

| No. of comorbidities | Population | Asymptomatic (%) | Mild (%) | Moderate to severe (%) | Critical (%) | Remarks (%) |
|----------------------|------------|------------------|----------|------------------------|-------------|-------------|
| 1                    | 238        | 20 (8.4)         | 147 (61.8) | 67 (28.2)            | 4 (1.7)     | * |
| 2                    | 122        | 3 (2.5)          | 70 (57.4)  | 47 (38.5)             | 2 (1.6)     | * |
| 3                    | 69         | 5 (7.2)          | 28 (40.6)  | 33 (47.8)             | 3 (4.3)     | * |
| 4                    | 24         | 0 (0.0)          | 9 (37.5)   | 13 (54.2)             | 2 (8.3)     | * |
| >4+                  | 14         | 2 (14.3)         | 8 (57.1)   | 3 (21.4)              | 1 (7.1)     | * |

| Specific comorbidities | Population | Asymptomatic (%) | Mild (%) | Moderate to severe (%) | Critical (%) | Remarks (%) |
|------------------------|------------|------------------|----------|------------------------|-------------|-------------|
| HTN                    | 171        | 5 (2.9)          | 107 (62.6) | 54 (31.6)            | 5 (2.9)     | $P<0.001$ (0.14–0.19) |
| DM                     | 149        | 4 (2.7)          | 82 (55.0)  | 61 (40.9)             | 2 (1.3)     | $P<0.001$ (0.12–0.17) |
| HC                     | 83         | 5 (6.0)          | 39 (47.0)  | 37 (44.6)             | 2 (2.4)     | $P<0.001$ (0.06–0.10) |
| Asthma                 | 64         | 8 (12.5)         | 28 (43.8)  | 24 (37.5)             | 4 (6.3)     | $P<0.001$ (0.05–0.08) |
| RA                     | 63         | 6 (9.5)          | 33 (52.4)  | 23 (36.5)             | 1 (1.6)     | $P<0.001$ (0.05–0.12) |
| HD                     | 39         | 4 (10.3)         | 16 (41.0)  | 17 (43.6)             | 2 (5.1)     | $P<0.001$ (0.03–0.05) |
| CVD                    | 35         | 3 (8.6)          | 12 (34.3)  | 19 (54.3)             | 1 (2.9)     | $P<0.001$ (0.02–0.05) |
| Allergy                | 23         | 2 (8.7)          | 15 (65.2)  | 6 (26.1)              | 0 (0.0)     | $P<0.001$ (0.02–0.04) |
| CKD                    | 14         | 0 (0.0)          | 8 (57.1)   | 5 (35.7)              | 1 (7.1)     | $P<0.001$ (0.01–0.02) |

DM: Diabetes mellitus, HTN: Hypertension, CVD: Cardiovascular disease, HC: Hypercholesterolemia, RA: Rheumatoid arthritis, HD: Hepatic disorder, CKD: Chronic kidney disease

Severity order for comorbidities

| Asthma, allergy, DM, HC | Mild>Moderate to severe>Asymptomatic>Critical |
| HD, CVD                  | Moderate to severe>Mild>Asymptomatic>Critical |
| CKD                      | Mild>Moderate to severe>Critical>Asymptomatic |
| HTN                      | Mild>Moderate to severe>Asymptomatic>Critical |
| No comorbidity           | Mild>Moderate to severe>Asymptomatic>Critical |

DM: Diabetes mellitus, HTN: Hypertension, CVD: Cardiovascular disease, HC: Hypercholesterolemia, RA: Rheumatoid arthritis, HD: Hepatic disorder, CKD: Chronic kidney disease
Binary logistic regression was performed to assess the impact of several factors on the likelihood that respondents would report for degree of severity and hospital admission [SI Table 7, 8(a) and 8(b)]. To perform binary logistic regression, we considered multiple predictor variables (sex, age, habitation, and comorbidities) and one response variable (degree of severity or hospital admission) using the following formula to estimate the relationship between the variables:

\[
\log \frac{p(x)}{1-p(x)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k
\]

Multiple logistic regression uses the following null and alternative hypotheses:

- Null hypothesis: \( H_0 : \beta_1 = \beta_2 = \ldots = \beta_k = 0 \)
- Alternative hypothesis: \( H_1 : \beta_1 = \beta_2 = \ldots = \beta_k \neq 0 \)

The null hypothesis states that all coefficients in the model are equal to zero. In other words, none of the predictor variables have a statistically significant relationship with the response variable, \( y \). Forward regression model was found to be the best fit for obtaining the optimal model [SI Table 7]. The model contained four independent variables (sex, age, habitation, and comorbidity status). The full model containing all predictors was statistically significant for degree of severity (\( \chi^2 = 53.673, P < 0.001 \)) with \(-2\log \text{likelihood ratio} = 1154.248\). However, 79% of the variance of the dependent variable being studied was explained by the variance of the independent variable \( R^2 = 0.79 \). Similar observation was found for hospital admission (\( \chi^2 = 125.520, P < 0.001 \)) with \(-2\log \text{likelihood ratio} = 511.869\) and \( R^2 = 0.82 \).

Chi-square test, t-test, and optimum regression model

A Chi-square test for independence with \( \alpha = 0.05 \) was used to assess whether sex, habitation, and comorbidity were related to the degree of severity and hospitalization [SI Table 5]. While tested for degree of severity, the Chi-square tests were found statistically significant for sex, \( \chi^2 = 9.306, P < 0.05, \phi = 0.010 \), habitant, \( \chi^2 = 5.223, P < 0.05, \phi = 0.202 \), and comorbidity, \( \chi^2 = 41.756, P < 0.05, \phi = 0.202 \). However, hospital admission was related to sex \( \chi^2 = 11.239, P < 0.05, \phi = 0.105 \) and comorbidity \( \chi^2 = 10.793, P < 0.05, \phi = 0.103 \). Thus, the null hypotheses were rejected and the relation of these indicators with severity and hospitalization was established.

An independent samples t-test was used to compare the mean recovery duration of comorbid and non-comorbid patients [SI Table 6(a) and 6(b)]. It was assumed that there is no significant difference among the comorbid and non-comorbid patients’ recovery duration. We found this null hypothesis to be rejected. Neither Shapiro–Wilk statistic was significant, indicating that the assumption of normality was not violated. Levene’s test was also insignificant; thus, an equal variance can be assumed for both groups. The t-test was statistically significant, with mean recovery duration of comorbid patients (\( M = 19.52, SD = 9.06 \)) was significantly higher (mean difference –2.01778, 95% CI [−3.01165, −1.02390]) than the non-comorbid patients (\( M = 17.51, SD = 6.10 \)), \( t = -3.984, P < 0.001 \), two tailed.

Association of the risk factors

After the univariable analysis, the variable aged COVID-19 patient was found to be positively associated with
symptomatic cases (OR = 1.04, 95% CI = 1.02–1.06, P = 0.001), development of severity (OR = 1.02, 95% CI = 1.00–1.04, P = 0.025), and higher hospital admission rate (OR = 1.05, 95% CI = 1.02–1.07, P < 0.001) [Table 2]. Male patients were negatively associated with the development clinical symptoms (OR = 0.66, 95% CI = 0.49–0.90, P = 0.008), severity (OR = 0.64, 95% CI = 0.47–0.88, P = 0.006), and need for hospitalization (OR = 0.58, 95% CI = 0.34–0.97, P = 0.039) compared with female. Patients with comorbid conditions had a higher risk of developing symptoms (OR = 1.87, 95% CI = 1.34–2.61, P < 0.001) and severity (OR = 1.85, 95% CI = 1.32–2.60, P < 0.001). The results of multivariable logistic regression analysis revealed that the risk of developing clinical symptoms was higher in patients with DM (OR = 3.54, 95% CI = 1.24–10.15, P = 0.019), HTN (OR = 3.45, 95% CI = 1.35–8.83, P = 0.010), CVD (OR = 2.55, 95% CI = 1.17–5.58, P = 0.019), HD (OR = 2.36, 95% CI = 1.17–4.75, P = 0.016), and asthma (OR = 1.94, 95% CI = 1.09–3.45, P = 0.025). The variable urban population was positively associated with the development of clinical symptoms (OR = 1.20, 95% CI = 1.05–2.51, P = 0.038). The comorbidity variable CVD had the highest impact in developing clinical severity (OR = 2.67, 95% CI = 1.29–5.53, P = 0.008), followed by asthma (OR = 2.28, 95% CI = 1.34–3.86, P = 0.002), HD (OR = 2.14, 95% CI = 1.09–4.20, P = 0.028), and DM (OR = 1.68, 95% CI = 1.13–2.48, P = 0.011).

However, comorbidity variable CVD and DM mellitus had positive but almost a similar impact on the requirement for hospitalization (OR = 2.40, 95% CI = 1.03–5.62, P = 0.043 vs. OR = 2.54, 95% CI = 1.49–4.35, P = 0.001). On the contrary, the risk for the need for hospitalization was found lower in COVID-19 patients with HC (OR = 0.28, 95% CI = 0.8–0.99, P = 0.047). Furthermore, multiple comorbidities were found to be associated with severity and hospitalization. Patients with preexisting DM plus CVD had higher risk for severe symptoms (OR = 4.42, 95% CI = 1.81–10.78, P = 0.001) or hospitalization (OR = 5.14, 95% CI = 2.02–13.07, P = 0.001). Similarly, preexisting DM plus HTN increased risk for severity (OR = 2.25, 95% CI = 1.31–3.84, P = 0.003) and hospitalization (OR = 3.43, 95% CI = 1.81–6.53, P < 0.001). In addition, patients having DM and CVD plus HTN conjointly had 4.03-times odds for severe symptoms (OR = 4.03, 95% CI = 1.42–11.43, P = 0.009) where risk for hospitalization was also very high (OR = 6.82, 95% CI = 2.37–19.58, P < 0.001) than the patients without those comorbidities.

### Discussion

COVID-19 is still causing health stress around the world. Health conditions and comorbid diseases have been studied in developed countries for their impact on severity of disease and the necessity for hospitalization.[19,20] However, a developing country like Bangladesh has not fully grasped this issue.[15] We, therefore, conducted a study to investigate the impact of comorbidities on COVID-19 severity and hospitalization.

**Table 2:** Association of the risk factors with COVID-19 symptomatic cases, severity, and hospitalization*

| Variables | Categories | OR (95% CI) | P     |
|-----------|------------|-------------|-------|
| **Model 1:** Symptomatic case (1=Yes, 0=Otherwise) | | | |
| Age (in years) | - | 1.04 (1.02–1.06) | 0.001 |
| Sex | Male | 0.66 (0.49–0.90) | 0.008 |
| Habitation | Urban | 1.61 (1.03–2.52) | 0.038 |
| Comorbidity | Yes | 1.87 (1.34–2.61) | 0.000 |
| DM | Yes | 3.54 (1.24–10.15) | 0.019 |
| HC | Yes | 1.68 (0.96–2.95) | 0.072 |
| Asthma | Yes | 1.94 (1.09–3.45) | 0.025 |
| HD | Yes | 2.36 (1.17–4.75) | 0.016 |
| CKD | Yes | 0.69 (0.19–2.48) | 0.569 |
| CVD | Yes | 2.55 (1.17–5.58) | 0.019 |
| Allergy | Yes | 0.89 (0.35–2.25) | 0.800 |
| HTN | Yes | 3.45 (1.35–8.83) | 0.010 |
| DM+CVD | Yes | 2.04 (0.75–5.37) | 0.489 |
| DM+HTN | Yes | 2.94 (0.71–12.62) | 0.138 |
| DM+HTN+CVD | Yes | 1.42 (0.19–10.92) | 0.736 |
| **Model 2:** Severity of the symptoms (1=Severe, 0=Not severe) | | | |
| Age (in years) | - | 1.02 (1.00–1.04) | 0.025 |
| Sex | Male | 0.64 (0.47–0.88) | 0.006 |
| Habitation | Urban | 1.20 (1.05–2.51) | 0.038 |
| Comorbidity | Yes | 1.85 (1.32–2.60) | <0.001 |
| DM | Yes | 1.68 (1.13–2.48) | 0.011 |
| HC | Yes | 2.00 (1.22–3.28) | 0.006 |
| Asthma | Yes | 2.28 (1.34–3.86) | 0.002 |
| HD | Yes | 2.14 (1.09–4.20) | 0.028 |
| CVD | Yes | 2.67 (1.29–5.53) | 0.008 |
| Allergy | Yes | 0.89 (0.35–2.22) | 0.808 |
| HTN | Yes | 0.75 (0.50–1.13) | 0.169 |
| DM+CVD | Yes | 4.42 (1.81–10.78) | 0.001 |
| DM+HTN | Yes | 2.25 (1.31–3.84) | 0.003 |
| DM+HTN+CVD | Yes | 4.03 (1.42–11.43) | 0.009 |
| **Model 3:** Hospitalization status (1=Hospitalized, 0=Otherwise) | | | |
| Age (in years) | – | 1.05 (1.02–1.07) | <0.001 |
| Sex | Male | 0.58 (0.34–0.97) | 0.039 |
| Habitation | Urban | 1.15 (0.56–2.39) | 0.705 |
| DM | Yes | 2.54 (1.49–4.35) | 0.001 |
| HC | Yes | 0.28 (0.08–0.99) | 0.047 |
| Asthma | Yes | 1.80 (0.73–4.48) | 0.204 |
| HD | Yes | 0.51 (0.10–2.51) | 0.407 |
| CKD | Yes | 2.99 (0.70–12.70) | 0.138 |
| CVD | Yes | 2.40 (1.03–5.62) | 0.043 |
| Allergy | Yes | 0.61 (0.08–4.84) | 0.641 |
| HTN | Yes | 1.70 (0.84–3.42) | 0.138 |
| DM+CVD | Yes | 5.14 (2.02–13.07) | 0.001 |
| DM+HTN | Yes | 3.43 (1.81–6.53) | <0.001 |
| DM + HTN + CVD | Yes | 6.82 (2.37–19.58) | <0.001 |

*DM: Diabetes mellitus, HTN: Hypertension, CVD: Cardiovascular disease, HC: Hypercholesterolemia, RA: Rheumatoid arthritis, HD: Hepatic disorder, CKD: Chronic kidney disease. P<0.05 is statistically significant at two-tailed test.
the association between comorbid diseases and COVID-19 severity. In this cohort, the majority of patients were in the 21–50 years old range, signifying that larger numbers of working-age people exposed to outside with greater possibilities of infection due to COVID-19 which was seen across the globe including Bangladesh.[21-24] This finding further reflected that young patients are more prevalent in Bangladesh. This study also confirmed that serious COVID-19 complications are closely associated with the eldest patients due to their weak immune responses. Zimmermann et al. reported that serious COVID-19 complications are closely associated with the eldest patients due to their weak immune responses.[25] The previous studies have also reported an increased infection rate among males.[26,27] Globally, most of the patients were urban dwellers which could be due to living in the dense area as well as using public transport, etc.[28] In our study, we detected that male and urban patients were dominant in similarity with the previous report.[16,27,29] The most prevalent clinical symptoms were fever and no taste (ageusia)/smell (anosmia) which is in line with the observations reported earlier.[14,18]

Numerous reports revealed that people with multiple preexisting comorbidities were at an increased risk for COVID-19 severity.[29-32] Notable that, H7N9, SARS-CoV, and MERS-CoV caused severe illness mostly in patients with preexisting comorbidities.[33] As presented in this report, it was observed that higher numbers of comorbidities could lead to the development of critical conditions. Patients with a single comorbidity were less likely to develop critical symptoms (1.7%) compared with patients having 4 comorbidities (8.3%). Moreover, the proportions of asymptomatic patients decreased as the number of comorbidities increased (8.4% and 0.0% asymptomatic cases for 1 and 4 comorbidities, respectively) whereas it was 11.5% without comorbidities [Table 1], in conformity with previous reports, suggesting that comorbidities substantially exacerbate COVID-19 complexity.[14,35] We found that preexisting DM, HTN, CVD, HD, and asthma were associated with an increased risk of symptomatic cases in COVID-19 patients, similar to reports from some other previous studies conducted elsewhere.[29,31] Moreover, on the severity scale, CVD, asthma, HD, HC, and DM ranked highest in line with the previous studies.[29,30] In addition, the results of our study confirmed the findings of the previous studies demonstrating severe clinical consequences when multiple comorbidities exist.[13-15] Of note, patients with comorbidity had median age 45 (min. 6–max. 80, SD ± 12.8) years, and the median age of the patients without comorbidity was 31 years (min. 2–max. 70, SD ± 10.7). This further signified a higher possibility of having comorbidity with the increased age which ultimately could lead to a higher severity of COVID-19. A substantial impact of preexisting comorbidities was found on the recovery period (median days to recover) according to t-test. Similar results were also observed globally.[14,35] Moderate-to-severe patients with HD, HC, HTN, DM, and CVD required higher duration to recover in contrast to other comorbidities. Moreover, patients having multiple comorbidities required even more times. This is consistent with previous reports that HTN, DM, CVD, liver, and CKD directly affected the disease severity and recovery.[31,36] Although the mechanism of the phenomenon was unclear, variation of the innate immune system and medication history associated with specific comorbidities could play a role.[37] In general, aged peoples were more likely to be affected with different comorbidities, which, in turn, could weaken their innate immune system.[38]

On the other hand, the proportion of hospitalization was higher in patients >40 years of age. We observed that the rate of infection in women was significantly lower compared with men in agreement with other reports.[14,15] However, surprisingly, once infected, the rate of hospitalization in female patients was higher compared with male. This was perhaps never reported before from any South Asian countries. This needs to be verified further by employing a broader sample size and to find out the cause behind the reported aggravation of physical conditions in female patients in Bangladesh after becoming infected. Our findings indicating that the average age of the female patients hospitalized was 42.5 ± 12.9 years which was higher than the average age of the patients enrolled (36.1 ± 13.4 years). However, weaker immune status due to malnourishment, age, and sex plus comorbidity could be the plausible reasons.[39] The proportion of hospitalization in the patients living in the urban areas (10%) was higher compared with the patients from rural areas (6.7%) in similarity with the previous studies.[14,15] Possibility of higher innate immune response in village people against SARS-CoV-2 was a debating issue until the mass spread of the delta variant of the virus in South Asian countries, but the difference in the rate of hospitalization could also be related to available and better health care facilities in the urban areas.[39] Hospitalization trend of the patients who were underlying health conditions can be ordered as CKD > DM > CVD > asthma > HTN whereas having multiple comorbidities put most at risk for hospitalization. Particularly, patients with DM along with CVD and HTN were found to be hospitalized most. These findings of the association of demographic factors, symptoms and comorbidities with the symptomatic case, severity, and hospitalization of COVID-19 patients reflect previous published findings.[20,31,34,39] It is imperative to examine underlying medical conditions of patients with COVID-19 to identify the risk group quickly. One of the conclusions from this study emphasizes the importance of providing immediate medical treatment to aged patients regardless of sex in Bangladesh who possess COVID-19 and comorbidities.

Conclusion

The occurrence of clinical symptoms, development of severity, and hospital admissions are higher among the older, female, and urban COVID-19 patients. Fever is the prevalent symptoms in both males and females of all ages. The commonly encountered comorbidities among COVID-19 patients in Bangladesh are HTN, DM, HC, and asthma. However, patients with CVD, asthma, CKD, and DM could have a
higher probability toward the development of severity that would require hospitalization. The presence of multiple comorbidities is associated with longer recovery time, severity, and hospitalization. The study recommends rapid response for older, female, and comorbid patients regardless of sex. In future, studies including more population and different center with the clinical data should be performed to power up the statistical analysis and to explore the association between comorbidities with the clinical data coupled with severity and hospitalization due to COVID-19.

Authors’ Declaration Statements

Ethics approval and consent to participate

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials. Participants gave their consent to participate willingly.

Consent for Publication

Participants gave their consent for publication of analyzed data provided that their identity will not be disclosed publicly.

Availability of Data Material

The data used in this study are available and will be provided by the corresponding author on a reasonable request.

Competing Interests

The authors declare no conflicts of interest.

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Authors’ Contributions

(I) Conception and design: S. Ganguli, S. Howlader, S. Barua, K. Dey, M.N. Islam, and P.K. Biswas; (II) Administrative support: S. Ganguli, S. Barua, and K. Dey; (III) Provision of study materials or patients: K. Dey and P.B. Partho, and R.R. Chakraborty; (IV) Collection and assembly of data: S. Howlader, M.D.H. Haulader, B. Barua, T.H. Aquib, and P.B. Partho; (V) Data analysis and interpretation: S. Ganguli, M.D.H. Haulader, P.K. Biswas, R.R. Chakraborty, and B. Barua; (VI) Manuscript writing: All authors; and (VII) final approval of manuscript: All authors.

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**SI Figure 1:** Age distribution (%) for the symptomatic status of the COVID-19 patients, (A) Percentages of symptomatic status, (B) Percentages of total cases

**SI Table 1:** Prevalent symptoms for age groups

| Age ranges | N  | Fever | Cough | Fatigue | No taste/smell | Sneezing | Sore throat | BPF | ROL | Most prevalent symptoms |
|------------|----|-------|-------|---------|----------------|----------|-------------|-----|-----|-------------------------|
| 01-10      | 12 | 58.3% | 16.7% | 33.3%   | 8.3%           | 16.7%    | 8.3%        | 8.3%| 0.0%| Fever>Fatigue>Sneezing |
| 11-20      | 70 | 77.1% | 58.6% | 25.7%   | 48.6%          | 10.0%    | 27.1%       | 25.7%| 7.1%| Fever>Cough>No taste/smell>Sore throat |
| 21-30      | 260| 80.4% | 54.2% | 38.5%   | 58.1%          | 16.2%    | 30.8%       | 33.1%| 1.9%| Fever>Cough>No taste/smell>Fatigue |
| 31-40      | 322| 82.6% | 59.3% | 39.4%   | 57.1%          | 20.8%    | 29.8%       | 38.8%| 5.0%| Fever>Cough>No test/smell>Fatigue |
| 41-50      | 190| 91.1% | 57.9% | 40.5%   | 50.0%          | 12.1%    | 30.5%       | 33.2%| 6.3%| Fever>Cough>No test/smell>Fatigue |
| 51-60      | 118| 88.1% | 65.3% | 44.9%   | 60.2%          | 13.6%    | 37.3%       | 44.9%| 9.3%| Fever>Cough>No test/smell>Fatigue |
| 61-70      | 46 | 87.0% | 82.6% | 45.7%   | 65.2%          | 17.4%    | 43.5%       | 43.5%| 17.4%| Fever>Fatigue>Sore throat |
| 70+        | 5  | 80.0% | 40.0% | 60.0%   | 0.0%           | 40.0%    | 40.0%       | 20.0%| 0.0%| Fever>Fatigue>Cough>Sore throat |
| Male       | 603| 83.4% | 55.7% | 34.8%   | 52.1%          | 20.1%    | 27.2%       | 35.2%| 6.1%| Fever>Cough>No test/smell>BPF |
| Female     | 312| 78.2% | 53.5% | 47.4%   | 50.3%          | 12.5%    | 33.7%       | 41.0%| 4.5%| Fever>Cough>No test/smell>Fatigue |
| NM         | 110| 100.0%| 90.9% | 40.9%   | 88.2%          | 7.3%     | 46.4%       | 24.5%| 2.7%| Fever>Cough>No test/smell>Sore throat |

Abbreviations: BPF=Body pain with fever, ROL=Reduction in oxygen level, NM=Not mentioned
**SI Table 2:** Comorbidity distribution against sex

| Comorbid patient | Total | Comorbid | Non-comorbid |
|------------------|-------|----------|--------------|
| Male             | 603   | 262 (43.4%) | 341 (56.5%)  |
| Female           | 312   | 159 (51%)  | 153 (49%)    |
| Not mentioned    | 110   | 46 (41.8%)  | 64 (58.2%)   |
| Total            | 1025  | 467 (45.6%) | 558 (54.4%)  |

| Hospitalization of comorbid patients against sex | Hospitalized | Comorbid | Non-comorbid |
|--------------------------------------------------|-------------|---------|--------------|
| Male                                             | 50          | 32 (64%) | 18 (36%)     |
| Female                                          | 42          | 23 (54.8%) | 19 (45.2%) |

**SI Figure 2:** Symptoms experienced by patients

**SI Figure 3:** Hospitalization history with respect to age, sex associated with comorbidity status (a) With comorbidity, (b) Without comorbidity
### SI Table 3: Test of significant dependence of symptomatic case and duration of recovery

|                          | Levene’s Test for Equality of Variances | t-test for Equality of Means |
|--------------------------|----------------------------------------|-----------------------------|
|                          | F          | Sig.  | t    | df | Sig. (2-tailed) | MD  | SE  |
| **Test for symptomatic case** |            |       |      |    |                |     |     |
| Sex                      | 0.018      | 0.894 | -0.067 | 913 | 0.947          | -0.001 | 0.021 |
| Comorbidity              | 32.480     | <.001 | -2.860 | 1016.069 | 0.004 | -0.050 | 0.018 |
| Habitation               | 0.239      | 0.625 | 0.243  | 1023 | 0.808          | 0.006  | 0.023 |
| DM                       | 41.752     | <.001 | -2.977 | 1023 | 0.003          | -0.076 | 0.025 |
| HC                       | 4.615      | 0.032 | -1.036 | 1023 | 0.301          | -0.034 | 0.033 |
| Asthma                   | 3.368      | 0.067 | 0.832  | 69.300 | 0.408          | 0.036  | 0.043 |
| HD                       | 0.223      | 0.637 | 0.225  | 40.686 | 0.823          | 0.011  | 0.050 |
| CKD                      | 7.113      | 0.008 | -1.197 | 1023 | 0.232          | -0.093 | 0.078 |
| CVD                      | 0.063      | 0.801 | -0.127 | 36.534 | 0.900          | -0.006 | 0.049 |
| HTN                      | 45.356     | <.001 | -3.112 | 1023 | 0.002          | -0.075 | 0.024 |
| Allergy                  | 0.289      | 0.591 | -0.281 | 26.496 | 0.781          | -0.015 | 0.054 |
| Medicines                | 0.288      | 0.591 | -10.863 | 1023 | <.001         | -0.83402 | 0.07678 |
| Antipyretics             | 1.081      | 0.299 | -10.576 | 1023 | <.001         | -0.80815 | 0.07641 |
| Antivirals               | 2.825      | 0.093 | -5.218 | 1023 | <.001         | -0.26518 | 0.05082 |
| Antimalarials            | 1.015      | 0.314 | -4.509 | 1023 | <.001         | -0.22632 | 0.05020 |
| Antihistaminic           | 0.944      | 0.331 | -6.237 | 1023 | <.001         | -0.33029 | 0.05296 |
| Antibiotics              | 0.677      | 0.411 | -10.669 | 1023 | <.001         | -0.75123 | 0.07041 |
| Steroids                 | 1.015      | 0.314 | -4.509 | 1023 | <.001         | -0.22632 | 0.05020 |
| **Test for hospitalization** |            |       |      |    |                |     |     |
| Sex                      | 23.943     | <.001 | 2.471  | 913  | 0.014          | 0.052  | 0.021 |
| Comorbidity              | 44.608     | <.001 | -3.299 | 1023 | 0.001          | -0.060 | 0.018 |
| Habitation               | 8.759      | 0.003 | -1.438 | 1023 | 0.151          | -0.033 | 0.023 |
| DM                       | 72.766     | <.001 | -4.619 | 1023 | <.001         | -0.118  | 0.026 |
| HC                       | 0.377      | 0.539 | 0.316  | 98.517 | 0.753          | 0.010  | 0.032 |
| Asthma                   | 10.966     | 0.001 | -1.776 | 1023 | 0.076          | -0.067 | 0.038 |
| **Levene’s Test for Equality of Variances** | F          | Sig.  | t    | df | Sig. (2-tailed) | MD  | SE  |
| HD                       | 3.791      | 0.052 | 1.191  | 43.367 | 0.240          | 0.044  | 0.037 |
| CKD                      | 27.336     | <.001 | -4.367 | 1023 | <.001         | -0.340 | 0.078 |
| CVD                      | 39.201     | <.001 | -3.995 | 1023 | <.001         | -0.199 | 0.050 |
| HTN                      | 36.369     | <.001 | -3.171 | 1023 | 0.002         | -0.077 | 0.024 |
| Allergy                  | 4.365      | 0.037 | 0.978  | 1023 | 0.328          | 0.057  | 0.058 |
| **Test for severity**    |            |       |      |    |                |     |     |
| Sex                      | 32.222     | <.001 | 3.046  | 913  | 0.002          | 0.094  | 0.031 |
| Comorbidity              | 160.791    | <.001 | -6.591 | 1023 | <.001         | -0.181 | 0.027 |
| Habitation               | 21.779     | <.001 | -2.110 | 1023 | 0.035          | -0.075 | 0.036 |
| DM                       | 39.170     | <.001 | -4.369 | 1023 | <.001         | -0.172 | 0.039 |
| HC                       | 24.243     | <.001 | -4.150 | 1023 | <.001         | -0.211 | 0.051 |
| Asthma                   | 15.480     | <.001 | -2.993 | 1023 | 0.003         | -0.172 | 0.058 |
| HD                       | 10.642     | 0.001 | -3.017 | 1023 | 0.003         | -0.219 | 0.073 |
| CKD                      | 2.902      | 0.089 | -1.120 | 13.273 | 0.282          | -0.155 | 0.138 |
| CVD                      | 8.058      | 0.005 | -4.004 | 1023 | <.001         | -0.306 | 0.076 |
| HTN                      | 14.986     | <.001 | -2.212 | 1023 | 0.027         | -0.083 | 0.037 |
| Allergy                  | 0.026      | 0.872 | 0.078  | 26.289 | 0.938          | 0.007  | 0.090 |
| **Test for duration of recovery** |            |       |      |    |                |     |     |

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Allergy, et al.: Impact of comorbidities on COVID-19 severity and hospitalization

*International Journal of Health Sciences*  
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### SI Table 4: Different medicine used during the recovery of Covid-19 patients

| Medicine | Antipyretics | Antivirals | Antimalarials | Antihistaminics | Antibiotics | Steroids |
|----------|--------------|------------|---------------|----------------|--------------|-----------|
| Antipyretics | 851 (83.0%) | 844 | 870 | 949 | 844 |
| Antivirals | 851 (83.0%) | 844 | 847 | 850 | 844 |
| Antimalarials | 844 | 844 | 844 | 844 | 844 |
| Antihistaminics | 870 | 847 | 844 | 849 | 844 |
| Antibiotics | 949 | 850 | 844 | 869 | 844 |
| Steroids | 844 | 844 | 844 | 844 | 844 |

**Remarks:**
- 844 patients used all the medicines.
- 962 patients took antipyretic medicine along with other medicines where 11 of them took only it.
- Combination of antipyretic, antibiotic, antiviral was highly used (850 cases).
- 77 patients taken only the combination of antipyretic and antibiotic medicines. Those who used steroid, antimalarial and antiviral medicine also took other medicines.
- Not surprising that only the symptomatic cases had the medication history (p<0.001).
- Briefly symptomatic cases had the history of taking antipyretic (p<0.001), antiviral (p<0.001), antimalarial (p<0.001), antibiotic (p<0.001), antihistaminic (p<0.001) and steroid (p<0.001) drugs.
- The use of antiviral (p=0.019), antimalarial (p=0.023), antihistaminic (p=0.003) and steroid (p=0.023) drugs was found to have positive impact in reducing the time of recovery.
### SI Table 5: Pearson Chi-Square tests for degree of severity

| Degree of severity | Value       | df | Asymptotic Significance (2-sided) | Approximate Significance |
|--------------------|-------------|----|-----------------------------------|-------------------------|
| Sex                |             |    |                                   |                         |
| Pearson Chi-Square | 9.306\(^a\) | 2  | 0.010                             |                         |
| Likelihood Ratio   | 9.174       | 2  | 0.010                             |                         |
| Phi                | 0.095       |    | 0.010                             |                         |
| Habitation         |             |    |                                   |                         |
| Pearson Chi-Square | 5.223\(^b\) | 1  | 0.022                             |                         |
| Likelihood Ratio   | 5.456       | 1  | 0.020                             |                         |
| Phi                | 0.071       |    | 0.022                             |                         |
| Comorbidity        |             |    |                                   |                         |
| Pearson Chi-Square | 41.756\(^c\) | 1  | <.001                             |                         |
| Likelihood Ratio   | 41.827      | 1  | <.001                             |                         |
| Phi                | 0.202       |    | <.001                             |                         |
| Hospitalization admission | |    |                                   |                         |
| Sex                |             |    |                                   |                         |
| Pearson Chi-Square | 11.239\(^d\) | 2  | 0.004                             |                         |
| Likelihood Ratio   | 11.777      | 2  | 0.003                             |                         |
| Phi                | 0.105       |    | 0.004                             |                         |
| Habitation         |             |    |                                   |                         |
| Pearson Chi-Square | 2.927\(^e\) | 1  | .087                              |                         |
| Likelihood Ratio   | 3.210       | 1  | .073                              |                         |
| Phi                | 053         |    |                                   |                         |
| Comorbidity        |             |    |                                   |                         |
| Pearson Chi-Square | 10.793\(^f\) | 1  | 0.001                             |                         |
| Likelihood Ratio   | 10.776      | 1  | 0.001                             |                         |
| Phi                | 0.103       |    | 0.001                             |                         |

* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 30.57
* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 53.84
* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 128.94
* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.30
* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.26
* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 43.74

### SI Table 6: (a). t-test statistics for comorbid and non-comorbid patients recovery duration

| Comorbidity | N  | Mean  | Std. Deviation | Std. Error Mean |
|-------------|----|-------|----------------|-----------------|
| Recovery    |    |       |                |                 |
| No          | 488| 17.51 | 6.10           | 0.275           |
| Yes         | 418| 19.52 | 9.06           | 0.44            |

### SI Table 6: (b). t-test for the difference in comorbid and non-comorbid patients recovery duration

| Recovery | Levene’s Test for Equality of Variances | t-test for Equality of Means |
|----------|----------------------------------------|-------------------------------|
|          | .  F        | Sig   | t      | df | Sig.  (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|          |            |       |       |    |                   |                |                       | Lower         | Upper         |
|          | Equal variances assumed | 18.961 | 0.075 | -3.984 | 904 | <.001 | -2.01778 | 0.50641 | -3.01165 | -1.02390 |
|          | Equal variances not assumed | -3.869 | 709.023 | <.001 | -2.01778 | 0.52157 | -3.04178 | -0.99377 |
### SI Table 7: Forward regression models for identifying best fit

|                   | Chi-square | df | Sig. | -2 log likelyhood |
|-------------------|------------|----|------|-------------------|
| **Degree of severity (R²=0.79)** |            |    |      |                   |
| Step 1            |            |    |      |                   |
| Step              | 41.827     | 1  | <.001| 1166.094          |
| Block             | 41.827     | 1  | <.001|                   |
| Model             | 41.827     | 1  | <.001|                   |
| Step 2            |            |    |      |                   |
| Step              | 7.195      | 2  | 0.027| 1158.899          |
| Block             | 49.022     | 3  | <.001|                   |
| Model             | 49.022     | 3  | <.001|                   |
| Step 3            |            |    |      |                   |
| Step              | 4.650      | 1  | 0.031| 1154.248          |
| Block             | 53.673     | 4  | <.001|                   |
| Model             | 53.673     | 4  | <.001|                   |
| **Hospital admission (R²=0.82)** |            |    |      |                   |
| Step 1            |            |    |      |                   |
| Step              | 102.822    | 69 | 0.005| 534.567           |
| Block             | 102.822    | 69 | 0.005|                   |
| Model             | 102.822    | 69 | 0.005|                   |
| Step 2            |            |    |      |                   |
| Step              | 22.698     | 2  | <.001| 511.869           |
| Block             | 125.520    | 71 | <.001|                   |
| Model             | 125.520    | 71 | <.001|                   |

### SI Table 8: (a). Influence of indicators from forward binary logistic regression analysis for degree of severity

|                   | B     | S.E.  | Wald  | df | Sig.  | Exp (B) | 95% C.I.for EXP (B) |
|-------------------|-------|-------|-------|----|-------|---------|---------------------|
|                   |       |       |       |    |       |         | Lower               |
|                   |       |       |       |    |       |         | Upper               |
| **Step 1**        |       |       |       |    |       |         |                    |
| Comorbidity       | 0.915 | 0.144 | 40.615| 1  | <.001 | 2.497   | 1.885               |
| Constant          | -2.342| 0.235 | 99.632| 1  | <.001 | 0.096   |                     |
| **Step 2**        |       |       |       |    |       |         |                    |
| Sex               |       |       |       |    |       |         |                    |
| Sex (1)           | 0.412 | 0.156 | 6.962 | 1  | 0.008 | 1.510   | 1.112               |
| Sex (2)           | 0.275 | 0.235 | 1.371 | 1  | 0.242 | 1.317   | 0.831               |
| Comorbidity       | 0.898 | 0.144 | 38.767| 1  | <.001 | 2.456   | 1.851               |
| Constant          | -2.481| 0.243 | 103.863| 1  | <.001 | 0.084   |                     |
| **Step 3**        |       |       |       |    |       |         |                    |
| Sex               |       |       |       |    |       |         |                    |
| Sex (1)           | 0.389 | 0.157 | 6.140 | 1  | 0.013 | 1.475   | 1.085               |
| Sex (2)           | 0.397 | 0.243 | 2.664 | 1  | 0.103 | 1.488   | 0.923               |
| Habitation (1)    | 0.427 | 0.203 | 4.444 | 1  | 0.035 | 1.533   | 1.030               |
| Comorbidity       | 0.892 | 0.145 | 38.079| 1  | <.001 | 2.441   | 1.838               |
| Constant          | -2.829| 0.298 | 90.258| 1  | <.001 | 0.059   |                     |

a. Variable(s) entered on step 1: Comorbidity.
b. Variable(s) entered on step 2: Sex.
c. Variable(s) entered on step 3: Habitation.
### SI Table 8: (b). Influence of indicators from forward binary logistic regression analysis for hospital admission

|                | B     | S.E.   | Wald  | df  | Sig.  | Exp (B) | 95% C.I. for EXP (B) | Lower | Upper |
|----------------|-------|--------|-------|-----|-------|---------|----------------------|-------|-------|
| **Step 1**     |       |        |       |     |       |         |                      |       |       |
| Comorbidity (1)| 0.711 | 0.220  | 10.459| 1   | <.001 | 2.036   | 1.323                | 3.133 |       |
| Constant       | -2.645| 0.170  | 241.658| 1   | <.001 | 0.071   |                      |       |       |
| **Step 2**     |       |        |       |     |       |         |                      |       |       |
| Sex            |       |        |       |     |       |         |                      |       |       |
| Sex (1)        | 0.498 | 0.224  | 4.956 | 1   | 0.026 | 1.645   | 1.061                | 2.550 |       |
| Sex (2)        | -0.868| 0.531  | 2.667 | 1   | 0.102 | 0.420   | 0.148                | 1.190 |       |
| Comorbidity (1)| 0.672 | 0.221  | 9.217 | 1   | 0.002 | 1.958   | 1.269                | 3.021 |       |
| Constant       | -2.742| 0.195  | 197.358| 1   | <.001 | 0.064   |                      |       |       |

*a. Variable (s) entered on step 1: Comorbidity.

b. Variable (s) entered on step 2: Sex.*