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COVID-19 among staff and their family members of a healthcare research institution in Bangladesh: a test negative case-control study

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Abstract

Objective: To identify factors associated with COVID-19 positivity among staff and their family members of icddr,b, a health research institute located in Bangladesh.

Setting: Dhaka, Bangladesh

Participants: A total of 4,295 symptomatic people tested for SARS-CoV-2 by RT-PCR between March 19, 2020 to April 15, 2021. Multivariable logistic regression was done to identify the factors associated with COVID-19 positivity by contrasting test-positives with test-negatives.

Result: Forty-three percent of the participants were tested positive for SARS-CoV-2. The median age was high in positive cases (37 years vs. 34 years). Among the positive cases, 97% were recovered, 2.1% had re-infections, 24 died, and 41 were active cases as of April 15, 2021. Multivariable regression analysis showed that age more than 60 years (AOR=2.1, 95% CI=1.3 to 3.3; p<0.05), blood group AB (AOR=1.5, 95% CI=1.1 to 2; p<0.05), fever (AOR=3.1, 95% CI=2.6 to 3.7; p<0.05), cough (AOR=1.3, 95% CI=1.1 to 1.6; p<0.05) and anosmia (AOR=2.7, 95% CI=1.3 to 5.7; p<0.05) were significantly associated with higher odds of being COVID-19 positive when compared to participants who were tested negative.

Conclusions: The study findings suggest that older age, fever, cough, and anosmia were associated with COVID-19 among the study participants.

Keywords: COVID; Epidemiology; Public Health

Strengths and limitations of this study

- This study revealed the common factors associated with COVID-19 positivity in 4,295 symptomatic people who underwent RT-PCR tests for detection of COVID-19 between March 19, 2020 to April 15, 2021.
- To the best of our knowledge, this is the first report from Bangladesh where data were collected since the beginning of the pandemic, and a high-quality growing database from a diverse group of population from different socio-economic strata has been maintained.
- Despite a considerably large sample size, it did not fully represent the population of Dhaka city and therefore, generalizability will not be possible.

- Additional data on the presence of chronic diseases, information on BCG vaccination and data on usual physical activities were collected through telephone interviews from only 65% of the participants.

Introduction

The COVID-19 pandemic is a global health challenge the likes of which the world has never been experienced so far to this scale. Since its first documentation in December 2019 in the Wuhan City, Hubei Province, China, this disease has spread across all over the world with deadly consequences [1]. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the etiological agent of this illness [2]. COVID-19 was avowed as a global pandemic on March 11, 2020 by World Health Organization (WHO) [3]. As of September 22, 2021, the disease accounts for 230,446,504 confirmed cases and 4,725,210 deaths worldwide [4]. The first case of COVID-19 in Bangladesh was officially detected on March 8, 2020. As of September 22, 2021, a total number of 1,545,800 confirmed cases were detected with 27,277 deaths in the country [4]. Although some countries have responded quickly enough to contain the disease, we generally witnessed a somewhat casual response on a global scale [1 2]. Resource-limited countries did not have had the means to respond most effectively due to lack of large-scale testing facilities, available testing kits, adequate infrastructure as well as intensive care support for all, and proper quarantine measures [5]. These efforts were further hampered by poor living conditions, high population density and sub-standard health services, subsequently, facilitating the mass spread of the disease [3].

The typical presenting symptoms of COVID-19 are fever, dry cough, sore throat, dyspnea, or fatigue coupled with recent history of exposure [6-9]. Many studies have already reported different factors associated with COVID-19 infection. Most commonly observed factors are older age, male sex, presenting symptoms, for instance, cough, fever, loss of smell, close relationship with index case and family members of COVID positive patients [10-12]. Studies with a larger sample size showed that smoking, and physical inactivity are also associated with COVID-19 infection and mortality [13].

Existing evidence showed that the presence of chronic disease is with a risk factor for both the susceptibility to infection and progression of COVID-19 to severe disease [14]. It was observed that the severity of COVID-19 outcome is higher among patients with hypertension, obesity, type 2 diabetes mellitus (DM) and other chronic disease like chronic lung disease, chronic kidney disease, and coronary heart disease (CHD)[14-16]. Recent studies also reported a relationship between blood group types and positivity as well as the severity of COVID-19 disease [17-19]. Few

studies suggest that BCG vaccination could be protective against COVID-19 infection as countries with compulsory BCG vaccination had fewer COVID-19 cases [20-24].

Although many papers were published on factors associated with COVID-19 positivity, there remains a scarcity of data collected from countries where the data repository systems are not properly developed [25]. Despite commendable efforts so far in Bangladesh to contain the disease within manageable level considering its' high population density, there has been a paucity of data on epidemiology of COVID-19, particularly involving high-quality sources. However, icddr,b, a well-renowned health research institute based in Bangladesh, has been maintaining a high-quality database for its staff and their family members since the inception of COVID-19 in the country. The current analysis took the opportunity of COVID-19 staff database of icddr,b with an aim to explore the factors associated with COVID-19 infection.

METHODS

This is an observational test negative design including data from the staff and their family members of icddr,b, Dhaka, Bangladesh. We reported this study by following STROBE statement checklist for the case-control studies [26].

Study design

This test negative case-control study used clinical, socio-demographic, and laboratory data from the COVID-19 staff database of icddr,b, a health research institute in Dhaka, Bangladesh. Here cases were icddr,b staff or family members who had symptoms suggested of COVID-19, contacted icddr,b staff clinic and were test positive for SARS-COV-2. In contrast, controls are patients from the same population with similar symptoms who underwent the same tests for the COVID-19 at the icddr,b facility and were test negative. Since controls are the same group of patients who present for testing but test negative, a test negative design is very helpful to control for factors which are usually challenging to estimate in observational study particularly care seeking behavior and access to care. The study was conducted between March 19, 2020 to April 15, 2021 during SARS-COV2 pandemic.

Study premise

icddr,b is one of the leading public health research organizations in Bangladesh. Since March 19, 2020, icddr,b started a system to prevent and protect its ~4000 employees and their family members against COVID-19. All staff with any clinical symptom (fever, cough, and cold or respiratory distress) suggesting COVID-19 were instructed to contact icddr,b staff clinic. Subsequently, staff clinic doctors instructed the suspected individual to provide a nasopharyngeal swab to be tested at icddr,b Virology Laboratory using reverse transcription polymerase chain reaction (RT-PCR). All contacts of COVID-19 positive staff were isolated or quarantined and tested accordingly. Besides, all the relevant information from the individual has been entered in the database in collaboration with the Staff Clinic, Dhaka Hospital at icddr,b, Virology Laboratory, and Human Resources. Not to mention, we have utilized the data from this database to conduct our analysis.

Study population

icddr,b employees and their family members who contacted staff clinic with symptoms suggestive of COVID-19 before April 16, 2021, provided naso-pharyngeal swabs and tested for COVID-19 were considered as the study population. For individuals tested more than once, only the first instance was considered.

Sample collection and laboratory assay

From all symptomatic staff and family members, a nasopharyngeal swab was collected by a trained nurse and the swab was sent to the Virology Laboratory at icddr,b to be analyzed using a real-time reverse transcriptase-polymerase chain reaction (rRT-PCR). In brief, total RNA was extracted from nasopharyngeal swabs using the chemagic Viral NA/gDNA (PerkinElmer, MA, USA) Kits. RNA was tested for SARS-CoV-2 by rRT-PCR targeting ORF1ab- and N-gene specific primers and probes following the protocol of Chinese Center for Disease Control and Prevention (briefly as China CDC). A positive case was determined if the CT values of two targets (ORF1ab and N) were < 37 in the same specimen. If CT values of any sample were 37−40 or a single target was positive, it was resampled and retested. If the CT values were still 37−40 and the amplification curves had obvious peaks, the sample was considered positive.

Data collection and staff database

Data were extracted from icddr,b staff database and additional data on chronic disease, blood groups, and life-style factors were collected by interview over phone. icddr,b COVID-19 staff database has been carefully documenting all basic information related to SARS-CoV-2 infection and COVID-19 disease among icddr,b staff and their family members. This includes age, sex, area of residence, history of contact, travel history, presenting symptoms and assay result for COVID-19 positivity and compliance of quarantine/isolation.

Additionally, through telephone interviews, data on blood group, routine physical activity, history of BCG vaccination, pre-existing chronic disease like diabetes mellitus, hypertension, COPD, asthma, IHD, cancer or kidney disease were collected using a short case report form. Data on routine physical activities were collected using pre-tested "International physical activity questionnaire- short form" (www.ipaq.ki.se). Based on the last seven days recall data physical activities were categorized as no, mild, moderate and vigorous categories. To minimize bias, all names of the employees were removed from the Microsoft Access-based study database. Consent to participate in this study was collected in electronic media like email, SMS or WhatsApp based on availability and accessibility.

Variables

This study was done to explore the factors associated with COVID-19 positivity. The outcome variable was COVID-19 positivity based-on RT-PCR assay and the explanatory variables were age, sex, presenting symptoms, area of residence, travel history, history of contacts, presence of chronic disease, smoking, blood group, BCG vaccination and physical activities.

Operational Definitions

Recovery: icddr,b staff and/or family members who were tested positive to COVID-19 were released from isolation based on the following conditions and considered recovered. Symptomatic and non-hospitalized cases were considered recovered 10 days after onset of symptom and if they were without fever for the last 3 days and also there was a significant improvement of their respiratory symptoms. Hospitalized patients were considered recovered 21 days after onset of symptoms and if they were without fever at least for 3 days without the use of antipyretics and there was a significant improvement of respiratory symptoms. For asymptomatic RT-PCR positive cases were considered recovered 10 days after sample

collection. This can be noted that testing for COVID-19 using RT-PCR was not required for release from isolation.

Mild disease: When a COVID-19 test positive case had mild clinical symptom and with no sign of pneumonia on imaging was considered mild disease. Any one or in combination of symptoms like cough, fever, malaise, sore throat, muscle pain, or headache without shortness of breath were considered mild clinical symptoms.

Moderate disease: When a COVID-19 test positive patient presented with signs of pneumonia, with a respiratory rate of ≤30 breaths /min, and a peripheral capillary oxygen saturation (SpO2) of more than 93 at room air was considered moderate COVID-19 disease.

Severe disease: When a COVID-19 test positive case developed respiratory distress (>30 breaths/ min), a peripheral capillary oxygen saturation (SpO2) of ≤93% at rest, and a ratio of arterial oxygen partial pressure (PaO2 in mmHg) to fractional inspired oxygen (PaO2/FiO2) of ≤300mmHg, or lung infiltrates of ≥50% in chest x-ray, was considered severe COVID-19 disease.

Reinfection: For this analysis, reinfection was defined as any study participant who was tested positive for COVID-19 at least 2 months after a positive test result and who was clinically recovered from the initial infection.

Data analysis

At first, we described baseline characteristics of the study population, including age, sex, area of residence, symptoms, dates of disease diagnosis, and co-morbidities. We reported categorical variables as number (%) and continuous variables as median (IQR). To compare the categorical variables, Chi-square or Fisher's exact tests were done, as appropriate. To explore the factors associated with COVID-19 positivity, binary logistic regression was carried out. Bivariate associations between each independent variable with COVID-19 positivity was initially performed. In multivariable model, to remove overfitting, we selected variables which demonstrated a p-value of <0.2 in bivariate analysis. The final multivariable model was also adjusted for seasonality. We calculated seasonality using the formula $\sin(2m\pi/12)+\cos(2m\pi/12)$, where "m" is the calendar month)[27]. A p-value of less than 0.05 was regarded as statistically significant and all analyses were done in STATA (Version 15·1 StataCorp).

Ethical declaration

The Research Review Committee and the Ethics Review Committee of icddr,b, Dhaka, Bangladesh approved this study (icddr,b protocol number: PR# 20089). Due to COVID-19 pandemic and country-wide lock down, informed verbal consent was obtained from all participants over telephone.

RESULT

Between March 19, 2020 to April 15, 2021, a total number of 5,190 testing for SARS-COV-2 were done at icddr,b where 4,295 symptomatic people provided their nasopharyngeal swab. Among them, 47% were icddr,b employees and rest were the family members. Overall 43% were RT-PCR positive for COVID-19 (Figure 1). In order to collect data on lifestyle factors, physical activities, presence of chronic disease, blood grouping and BCG vaccination, telephone interview was successfully done among 3382 participants. The monthly distribution of COVID-19 testing and number of test positives are illustrated in the Figure 2. The first case was detected in March, 2020. The highest testing was done in June 20, 2020 and we observed the highest positivity rate (54%) on April 21, 2021. We observed the lowest numbers of positive cases between December 2020 to February 2021. As of April 15, 2021, 96% of all COVID-19 positive patients were recovered and there are 41 active cases. Among all COVID-19 test positives, 94.7% were mild or asymptomatic, 2.4% had moderate disease and 2.9% had a severe or critical disease. The reinfection rate was 2.1% and a total of 24 deaths including 2 employees and 22 family members.

The median age of COVID-19 negative cases was 34 years which was ranged from 2 months to 100 years and the median age of positive cases was 37 years ranged from 4 months to 88 years. Among the test positive cases, 10% of them were less than 18 years, and this was 14% among test negatives. Age distribution of both the test positives and negatives were almost equally distributed between 18 to 60 years. However, there were more 60+ years old people in test positives than in test negatives (10% vs. 5%). Forty-eight percent of all COVID-19 positives were female and 82% of all participants had BCG scars in their left upper arm. Regarding ABO blood groups, 23% were blood group A, 33% were blood group B and 34% were blood group O. Blood group AB was present in 11% of COVID positive and 8% of negative cases (Table 1).

Distribution of these above mentioned baseline characteristics were similar in non-hospitalized test positives and negatives (Supplementary Table 1).

We were able to collect additional data on presence of chronic diseases, BCG vaccination and usual physical activities through telephone interviews from 2,894 participants. It was due to the fact that many were unavailable over phone during the telephone calls were made. Eleven percent of participants had a pre-existing respiratory illness. Hypertension was higher among COVID-19 positive cases. Twenty-two percent of all COVID-19 positives were hypertensive compared to COVID-19 negatives (17%). Fifteen percent of positive cases and 12% of negative had diabetes mellitus. In both the groups, the prevalence of ischemic heart disease (4%), chronic liver disease (1%), hypothyroidism (4%) and chronic kidney disease (2%) were almost equally distributed (Table 1).

Based-on self-reporting data using the "International physical activity questionnaire", we identified that in the preceding seven days before interviews, overall 58% of the participants did not perform any physical activities, 35% performed mild physical activities, 5% had moderate and 3% had vigorous physical activities. Except for the vigorous physical activities, there was no difference in physical activities between COVID-19 positive and negative cases. Negative cases performed more vigorous physical activities than the positives ($p < 0.05$).

Considering the symptoms before testing for SARS-COV-2, fever was the most frequent presenting symptom followed by cough. Seventy percent of all COVID-19 positives had fever and which was 47% in COVID-19 negative cases. Fifty percent positives and 47% of all negatives had cough. Anosmia was a presenting symptom for 2% COVID-19 positive cases compared to 0.7% of negative cases. Sore throat was higher in COVID-19 negatives (9%) than the COVID-19 test positives (6%). Similarly, shortness of breath was higher in test negatives (4% vs. 2%). Other presenting symptoms like body ache (3%), headache (0.5%), and loose motion (1%) were equally present in both the groups (Table 1).

Factors associated with COVID-19 positivity

To identify factors associated with COVID-19 positivity, multi-variable logistic regression was performed. The adjusted analysis showed that participants older than 60 years had higher odds of being COVID-19 positive than those who were younger than 18 years old (adjusted odds ratio

(AOR) 2.1, 95% CI 1.3-3.3; p<0.05) and participants with blood group AB had higher odds of being test positive than the blood group A (AOR 1.5, 95% CI 1.1-2; p<0.05). Similarly, participants presented with fever (AOR 3.1, 95% CI 2.6-3.7; p<0.05), cough (AOR 1.3, 95% CI 1.1-1.6; p<0.05) and anosmia (AOR 2.7, 95% CI 1.3-5.7; p<0.05) had higher odds of being COVID-19 positive and participants presented with sore throat were found inversely related to COVID-19 test positive (AOR 0.5, 95% CI 0.4-0.7; p<0.05) (Table 2).

DISCUSSION

The analysis showed that older age, blood group AB compared to blood group A, and presence of fever, cough and anosmia before sample collection were associated with an increased risk of COVID-19 test positivity when compared with test negatives. On the other hand, the presence of sore throat during sample collection was found negatively associated with COVID-19 test positivity.

Consistent with other published studies older age has been one of the most common factors that have been associated with COVID-19 positivity [28-31]. The major presenting symptoms among COVID-19 test positives were fever and cough followed by anosmia. Other reported symptoms were cold, shortness of breath, body ache, headache, weakness, sore throat and loose motion. This finding was consistent with a recently reported retrospective cohort study from Bangladesh where they observed that major three symptoms among COVID-19 positive patients were fever, cough and anosmia [321]. Although in the absence of a test negative comparison group that study was not able to ascertain that these factors were associated with positivity [31]. Shortness of breath and sore throat were more common in COVID-19 test negative patients which were also observed in other studies [332]. A recent study used COVID-19 data from five continents showed that over 50% of COVID-19 positives were asymptomatic. The most common presenting symptom was fever (>50%) which was trailed by dry cough (45%), tiredness (38%) and sore throat (30%) [343]. A systematic review showed that the common symptoms were fever (83%), cough (61%), fatigue (34%), myalgia (21%), dyspnea (22%), headache (11%), and diarrhea (7.5%) [35]. Similar findings were observed in other systematic reviews and studies done in other countries [8-9,36]. Therefore, inarguably fever and cough are the most common discriminatory feature of COVID-19 compared to test negatives. Loss of smell (anosmia) was the next most important clinical feature in COVID-19 patients in our study. Several studies also observed the

similar feature that patients presented with anosmia had a higher probability of being tested positive [32, 37-38]. Nevertheless, these results represented discriminating features between COVID-19 positives and COVID suspects.

Previous studies investigated the association between human ABO blood groups and different infectious agents [39]. This is plausible that blood group antigens can increase host susceptibility by acting as a receptor or co-receptor for microorganisms and viruses [39]. As a part of the innate immune system ABO blood group has previously been shown to work against some enveloped viruses carrying ABO-active antigens such as SARS [39]. An association was reported between a higher risk for COVID-19 infection and mortality with blood group A and a lower risk of infection and mortality with blood group O[17]. However, a recent US-based multi-center study observed that patients with blood group B and AB had higher likelihood for a COVID-19 positive test result and blood type O had higher likelihood for a negative test result [21]. Our finding is partially consistent with the US studies as we observed participants with the AB group were more likely to test positive for SARS COV-2 than participants with blood group A.

Reports showed that nations with mandatory BCG vaccination had fewer numbers of COVID-19 patients [20, 21]. Therefore, induction of trained immunity through BCG vaccination was thought to be a potentially effective approach to protect against SARS-COV-2 infection [20-24]. We did not observe any association between COVID-19 infection and BCG vaccination. BCG vaccination coverage is high in Bangladesh and we observed that 82% of both the COVID-19 positives and negatives had BCG scars in the upper arm. We think a limited power could be the reason behind this non-association.

We observed that 20% of all participants had hypertension, 14% had diabetes mellitus (DM) and 92% of participants do not perform any physical exercise. Although, we did not observe any association between COVID-19 positivity and the presence of chronic disease or physical activities, we thought this was still a very important finding. Another probable reason for this lack of association could be most of the cases were mild. Compared to national prevalence (8%-12%), the prevalence of DM is higher in this population [40]. The prevalence of hypertension and DM was similar to a recently published Bangladeshi study among COVID-19 positive patients where they also observed that these co-morbidities were associated with hospitalization [32].

This study was housed in a health research institute. The current staff headcount in icddr,b is 4,383 with a diverse group of employees from different socio-economic strata. These include international scientists, local scientists, doctors, and senior management staff to drivers, security guards, health attendants and their families. Due to nation-wide lock-downs, only essential staff had been attending office in-person except those who worked in the hospital, laboratories and support services. Therefore, it was not possible to pin-point the major source of infection. Although the data indicated that most of the infections were originated from the community.

Since this study was conducted among employees and their families of an organization, this data might not be representative of the general population of Dhaka city. Despite a considerably large sample size, the absence of any standard sampling technique for the selection of study participants also prone to different biases. Moreover, telephone interviews to collect data on chronic disease and physical activities were performed only on 65% of the population during the study period. Another limitation is we could not adjust disease severity in multivariable model due to unavailability of data. It can be noted that controlling for severity could be helpful to address residual bias in health care seeking behavior. Considering the fact that residual confounding due to health seeking behavior may still be present in the non-hospitalized cases and controls, we have compared baseline characteristics between the non-hospitalized cases and controls, and these was almost identical to the baseline data of all COVID-19 positives and negatives (Supplementary Table 1).

Nevertheless, this study reports on factors associated with COVID-19 in a sizable population using a high-quality growing database. The findings might not be a surprise to our recent knowledge on COVID-19, still there has been a paucity of similar data in this part of the world. Moreover, this study also confirms that some findings like older age, presence of fever, cough, and anosmia are almost universal presentations of COVID-19 and features like presence of chronic disease, BCG vaccination and blood groups with COVID-19 infection need more research.

Data availability statement

The data are not publicly available. In the future data will be made available upon request. Request for icddr,b research data should be addressed to Ms. Armana Ahmed at aahmed@icddrb.org

Competing interest

The authors declare that they do not have any competing interests.

Author contributions

TA, JC and MM originated the idea for the study and led the protocol design. MM, SD, MAA, SMF, MR, SMT, SP, IM, SEA, JC, and TA participated in the design of the study. TA, MM, SD, MAA, SMF, MR, IM, and SEA were involved in the development of the study protocol. MR performed the laboratory assays. MM, SD, MAA, SMF, SP, MS and TA were involved in data collection. MM, MAA, SMT, SD, SMF, IM and TA were involved in data analysis. MM, MAA and SMF wrote the manuscript. All authors read and approved the final manuscript.

Ethics statement

Ethical approvals were obtained from Research Review Committee and Ethical Review Committee of icddr,b (Protocol No.: PR-20089; Version 1.01; November 30, 2020)

Patient and public involvement

Patients or the public were not involved in the study

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Table 1. Baseline characteristics of staff and family members

Characteristics	n	COVID-19	
		Negative	Positive
Age group, n (%)	4284		
< 18 years		335 (14%)	194 (10%)
18 – 30 years		693 (29%)	476 (26%)
31 – 40 years		589 (24%)	436 (24%)
41 – 50 years		405 (17%)	318 (17%)
51 – 60 years		276 (11%)	244 (13%)
> 60 years		132 (5%)	182 (10 %)
Female sex, n (%)	4295	1102 (45%)	894 (48%)
BCG scar, n (%)	2845	1299 (82%)	1048 (83%)
ABO Blood group, n (%)	2689		
A		359 (24%)	271 (23%)
B		482 (32%)	415 (35%)
AB		121 (8%)	133 (11%)
O		525 (35%)	383 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2894	169 (11%)	123 (9%)
Hypertension, n (%)	2894	269 (17%)	288 (22%)
Ischemic heart disease (IHD), n (%)	2893	59 (4%)	68 (5%)
Chronic liver disease (CLD), n (%)	2893	20 (1%)	16 (1%)
Diabetes mellitus (DM), n (%)	2893	194 (12%)	195 (15%)
Hypothyroidism, n (%)	2893	59 (4%)	55 (4%)

Chronic kidney disease (CKD), n (%)	2892	23 (1%)	30 (2%)
Physical activity	2846		
No		931 (59%)	737 (58%)
Mild		529 (34%)	451 (35%)
Moderate		63 (4%)	63 (5%)
Vigorous		48 (3%)	24 (2%)
Presenting symptoms	4295		
Fever, n (%)		1140 (47%)	1296 (70%)
Cough, n (%)		1145 (47%)	930 (50%)
Cold, n (%)		201 (8%)	141 (8%)
Shortness of Breath, n (%)		105 (4%)	44 (2%)
Body ache, n (%)		68 (3%)	66 (4%)
Headache, n (%)		11 (0.5%)	10 (0.5%)
Sore throat, n (%)		208 (9%)	106 (6%)
Weakness, n (%)		6 (0.3%)	6 (0.3%)
Anosmia, n (%)		16 (0.7%)	34 (2%)
Loose motion, n (%)		20 (1%)	18 (1%)
Runny nose, n (%)		14 (0.6%)	5 (0.3%)

Table 2. Socio-demographic and clinical factors associated with COVID-19 positivity

Characteristics	OR (95% CI)	p-value	AOR (95% CI)*	p-value
Age in years	Reference: < 18 years			
18 – 30 years	1.1 (0.87, 1.39)	0.419	1.1 (0.82, 1.49)	0.518
31 – 40 years	1.07 (0.84, 1.37)	0.563	1.22 (0.89, 1.66)	0.215
41 – 50 years	1.24 (0.96, 1.6)	0.106	1.33 (0.95, 1.87)	0.100
51 – 60 years	1.33 (1.01, 1.75)	0.044	1.45 (0.98, 2.13)	0.062
> 60 years	2.2 (1.6, 3.03)	0.000	2.05 (1.28, 3.27)	0.003
Female sex	1.18 (1.03, 1.35)	0.019	1.13 (0.95, 1.34)	0.157
BCG scar	1.04 (0.86, 1.27)	0.660		
Blood group	Reference: A group			
B group	1.14 (0.93, 1.4)	0.209	1.13 (0.9, 1.4)	0.287
AB group	1.46 (1.09, 1.95)	0.012	1.46 (1.07, 2)	0.017
O group	0.97 (0.79, 1.19)	0.745	0.97 (0.78, 1.21)	0.775
Pre-existing chronic disease				
COPD/Asthma	0.89 (0.69, 1.13)	0.335		
Hypertension	1.41 (1.17, 1.7)	0.000	1.2 (0.94, 1.53)	0.135
Ischemic heart disease	1.44 (1.01, 2.06)	0.045	1.13 (0.73, 1.75)	0.578
Chronic liver disease	0.99 (0.51, 1.91)	0.966		
Diabetes mellitus	1.28 (1.03, 1.59)	0.023	0.9 (0.69, 1.18)	0.452
Hypothyroidism	1.16 (0.8, 1.68)	0.446		
Chronic kidney disease	1.63 (0.94, 2.81)	0.083	1.29 (0.69, 2.41)	0.430
Physical activity	Reference: No			
Mild	1.08 (0.92, 1.26)	0.359	0.99 (0.82, 1.18)	0.871

Moderate	1.26 (0.88, 1.81)	0.206	1.47 (0.99, 2.18)	0.058
Vigorous	0.63 (0.38, 1.04)	0.071	0.64 (0.37, 1.09)	0.102
Presenting symptoms				
Fever	2.85 (2.47, 3.29)	0.000	3.09 (2.61, 3.66)	0.000
Cough	1.3 (1.13, 1.49)	0.000	1.34 (1.14, 1.58)	0.000
Cold	0.99 (0.76, 1.3)	0.955		
SOB	0.62 (0.43, 0.91)	0.014	0.66 (0.42, 1.03)	0.065
Body ache	1.21 (0.84, 1.75)	0.295		
Head ache	2.19 (0.79, 6.04)	0.130	1.7 (0.54, 5.37)	0.366
Sore throat	0.66 (0.5, 0.86)	0.003	0.52 (0.38, 0.71)	0.000
Weakness	1.57 (0.48, 5.17)	0.454		
Anosmia	2.65 (1.36, 5.17)	0.004	2.69 (1.26, 5.72)	0.010
Loose motion	0.98 (0.41, 2.34)	0.968		

* This model was adjusted by seasonality

Figure legends

Figure 1. Study profile

Figure 2. Monthly distribution of COVID-19 test result from March 19, 2020-April 15, 2021

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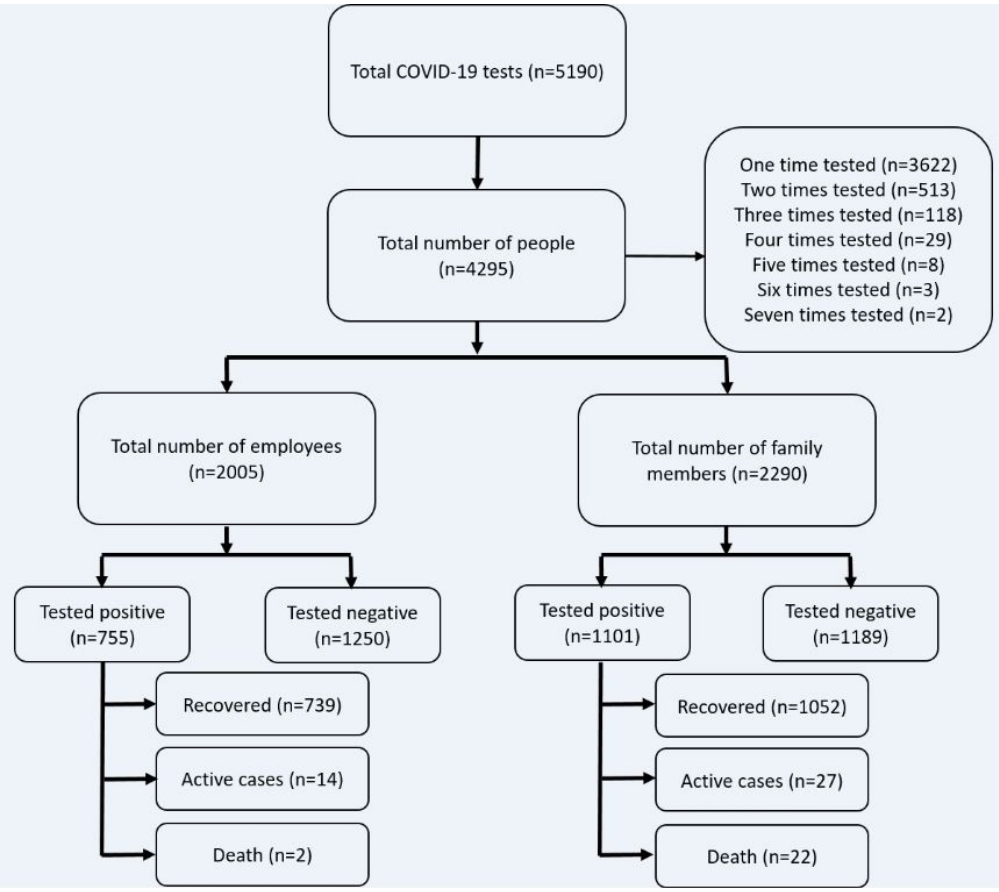

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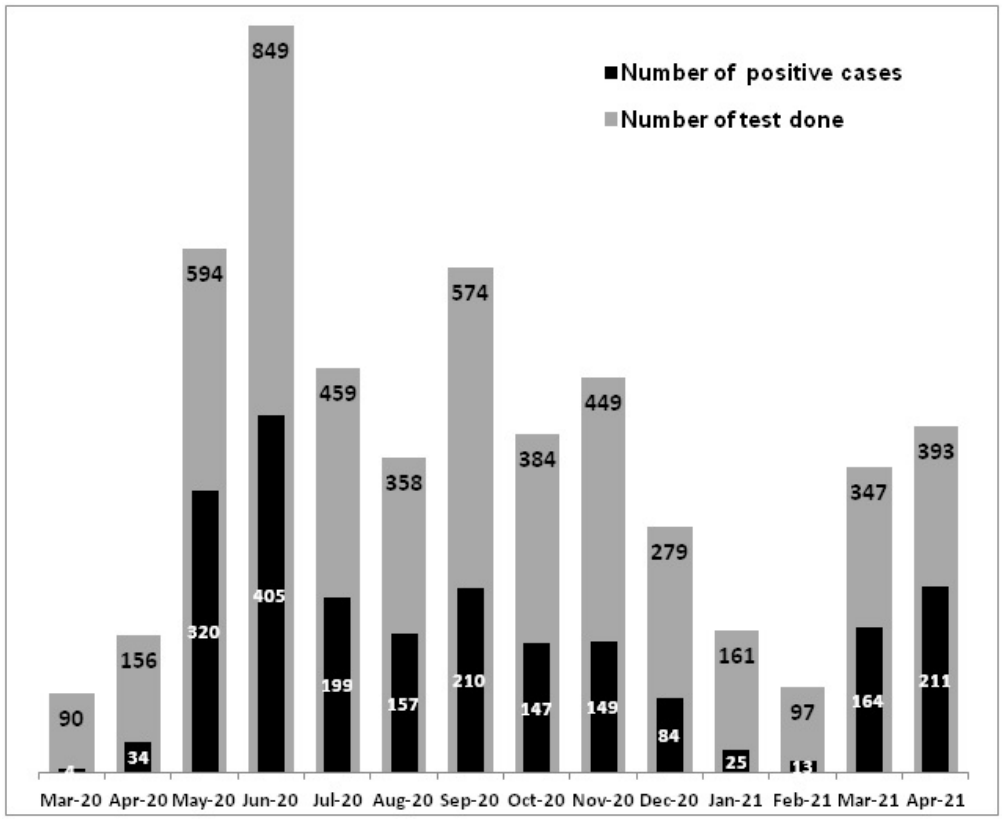

Monthly distribution of COVID-19 test result from March 19, 2020-April 15, 2021

168x137mm (96 x 96 DPI)

Supplementary table 1. Baseline characteristics of non-hospitalized COVID-19 test positives and test negatives

Characteristics	n	COVID-19	
		Negative	Positive
Age group, n (%)	4149		
< 18 years		335 (14%)	194 (10%)
18 – 30 years		689 (29%)	472 (27%)
31 – 40 years		579 (24%)	418 (23%)
41 – 50 years		404 (17%)	299 (17%)
51 – 60 years		266 (11%)	209 (12%)
> 60 years		125 (5%)	159 (9 %)
Female sex, n (%)	4159	1088 (45%)	853 (49%)
BCG scar, n (%)	2772	1285 (82%)	1007 (83%)
ABO Blood group, n (%)	2619		
A		355 (24%)	262 (23%)
B		477 (32%)	397 (35%)
AB		116 (8%)	127 (11%)
O		520 (35%)	365 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2815	164 (11%)	115 (9%)
Hypertension, n (%)	2816	259 (16%)	262 (21%)
Ischemic heart disease (IHD), n (%)	2814	57 (4%)	57 (5%)
Chronic liver disease (CLD), n (%)	2814	20 (1%)	15 (1%)
Diabetes mellitus (DM), n (%)	2816	186 (12%)	167 (13%)
Hypothyroidism, n (%)	2814	57 (4%)	53 (4%)
Chronic kidney disease (CKD), n (%)	2813	23 (1%)	27 (2%)
Physical activity	2772		
No		926 (60%)	710 (58%)
Mild		515 (33%)	428 (35%)
Moderate		62 (4%)	59 (5%)
Vigorous		48 (3%)	24 (2%)
Presenting symptoms	4159		
Fever, n (%)		1125 (47%)	1218 (70%)

Cough, n (%)	1133 (47%)	886 (51%)
Cold, n (%)	199 (8%)	137 (8%)
Shortness of Breath, n (%)	104 (4%)	38 (2%)
Body ache, n (%)	68 (3%)	64 (4%)
Headache, n (%)	11 (0.5%)	9 (0.5%)
Sore throat, n (%)	207 (9%)	102 (6%)
Weakness, n (%)	6 (0.3%)	6 (0.3%)
Anosmia, n (%)	16 (0.7%)	33 (2%)
Loose motion, n (%)	20 (0.8%)	17 (1%)
Runny nose, n (%)	14 (0.6%)	5 (0.3%)

STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	5-7
		(*b*) For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how matching of cases and controls was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9 Table 1
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Figure-1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9 Table-1
		(b) Indicate number of participants with missing data for each variable of interest	Table-1

Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11, Table-2
		(*b*) Report category boundaries when continuous variables were categorized	9-10, Table-2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-13, Suppl. Table 1
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

COVID-19 among staff and their family members of a healthcare research institution in Bangladesh between March 2020 to April 2021: a test-negative case-control study

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Infectious diseases
Keywords:	Epidemiology < INFECTIOUS DISEASES, PUBLIC HEALTH, COVID-19

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COVID-19 among staff and their family members of a healthcare research institution in Bangladesh between March 2020 to April 2021: a test-negative case-control study

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Word count:

Abstract: 271

Main text: 3606

Abstract

Objective: To identify factors associated with COVID-19 positivity among staff and their family members of icddr,b, a health research institute located in Bangladesh.

Setting: Dhaka, Bangladesh

Participants: A total of 4,295 symptomatic people were tested for SARS-CoV-2 by RT-PCR between March 19, 2020, to April 15, 2021. Multivariable logistic regression was done to identify the factors associated with COVID-19 positivity by contrasting test-positives with test-negatives.

Result: Forty-three percent of the participants were tested positive for SARS-CoV-2. The median age was high in positive cases (37 years vs. 34 years). Among the positive cases, 97% were recovered, 2.1% had re-infections, 24 died, and 41 were active cases as of April 15, 2021. Multivariable regression analysis showed that age more than 60 years (AOR=2.1, 95% CI=1.3 to 3.3; p<0.05), blood group AB (AOR=1.5, 95% CI=1.1 to 2; p<0.05), fever (AOR=3.1, 95% CI=2.6 to 3.7; p<0.05), cough (AOR=1.3, 95% CI=1.1 to 1.6; p<0.05) and anosmia (AOR=2.7, 95% CI=1.3 to 5.7; p<0.05) were significantly associated with higher odds of being COVID-19 positive when compared to participants who were tested negative.

Conclusions: The study findings suggest that older age, fever, cough, and anosmia were associated with COVID-19 among the study participants.

Keywords: COVID; Epidemiology; Public Health

Strengths and limitations of this study

- This manuscript used a growing database of employees from a health research institute who underwent COVID-19 tests
- Information was collected in real-time processes as per the directive of the institute management.
- RT-PCR tests for COVID-19 were done in the Virology aboratory at icddr,b, a state-of-the-art laboratory in Bangladesh.

- Data on the presence of chronic diseases, BCG vaccination, and usual physical activities were collected over telephone interviews from only 65% of the participants.
- This study did not address the variants of SARS-CoV-2 circulating in the region or the possible modifications of symptom presentations depending on the variant infecting the patients.

Introduction

The COVID-19 pandemic is a global health challenge the likes of which the world has never been experienced so far to this scale. Since its first documentation in December 2019 in the Wuhan City, Hubei Province, China, this disease has spread across all over the world with deadly consequences[1]. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the etiological agent of this illness[2]. COVID-19 was avowed as a global pandemic on March 11, 2020, by World Health Organization (WHO)[3]. As of September 22, 2021, the disease accounts for 230,446,504 confirmed cases and 4,725,210 deaths worldwide[4]. The first case of COVID-19 in Bangladesh was officially detected on March 8, 2020. As of September 22, 2021, a total number of 1,545,800 confirmed cases were detected with 27,277 deaths in the country[5]. Although some countries have responded quickly enough to contain the disease, we generally witnessed a somewhat casual response on a global scale[1,2]. Resource-limited countries did not have had the means to respond most effectively due to the lack of large-scale testing facilities, available testing kits, adequate infrastructure as well as intensive care support for all, and proper quarantine measures[5]. These efforts were further hampered by poor living conditions, high population density, and sub-standard health services, subsequently, facilitating the mass spread of the disease[3].

The typical presenting symptoms of COVID-19 are fever, dry cough, sore throat, dyspnea, or fatigue coupled with the recent history of exposure[6–9]. Many studies have already reported different factors associated with COVID-19 infection. Most commonly observed factors are older age, male sex, presenting symptoms, for instance, cough, fever, loss of smell, close relationship with index case and family members of COVID positive patients[10–12]. Studies with a larger sample size showed that smoking and physical inactivity are also associated with COVID-19 infection and mortality[13].

Existing evidence showed that the presence of chronic disease is a risk factor for both the susceptibility to infection and progression of COVID-19 to severe disease[14]. It was observed that the severity of COVID-19 outcome is higher among patients with hypertension, obesity, type 2 diabetes mellitus (DM), and other chronic diseases like chronic lung disease, chronic kidney disease, and coronary heart disease (CHD)[14–16]. Recent studies also reported a relationship between blood group types and positivity as well as the severity of COVID-19

disease[17–19]. Few studies suggest that BCG vaccination could be protective against COVID-19 infection as countries with compulsory BCG vaccination had fewer COVID-19 cases[20–24].

Although many papers were published on factors associated with COVID-19 positivity, there remains a scarcity of data collected from countries where the data repository systems are not properly developed[25]. Despite commendable efforts so far in Bangladesh to contain the disease within manageable level considering its' high population density, there has been a paucity of data on the epidemiology of COVID-19, particularly involving high-quality sources[26]. However, icddr,b, a well-renowned health research institute based in Bangladesh, has been maintaining a high-quality database for its staff and their family members since the inception of COVID-19 in the country. The current analysis took the opportunity of the COVID-19 staff database of icddr,b to explore the factors associated with COVID-19 infection.

METHODS

This is an observational test negative design including data from the staff and their family members of icddr,b, Dhaka, Bangladesh. We reported this study by following STROBE statement checklist for the case-control studies[27].

Study design

This test-negative case-control study used clinical, socio-demographic, and laboratory data from the COVID-19 staff database of icddr,b, a health research institute in Dhaka, Bangladesh. Here cases were icddr,b staff or family members who had symptoms suggested of COVID-19, contacted icddr,b staff clinic and tested positive for SARS-COV-2. In contrast, controls are patients from the same population with similar symptoms who underwent the same tests for the COVID-19 at the icddr,b facility and tested negative. Since controls are the same group of patients who present for testing but test negative, a test-negative design is very helpful to control for factors that are usually challenging to estimate in an observational study particularly care-seeking behavior and access to care. However, some of the contacts were symptomless and tested positive included in the analysis as cases and some contacts were tested negative considered as controls. The study was conducted between March 19, 2020, to April 15, 2021, during the SARS-COV2 pandemic.

Study premise

icddr,b is one of the leading public health research organizations in Bangladesh. Since March 19, 2020, icddr,b started a system to prevent and protect its ~4000 employees and their family members (~12,000) against COVID-19. All staff with any clinical symptom (fever, cough, and cold or respiratory distress) suggesting COVID-19 were instructed to contact icddr,b staff clinic. Subsequently, staff clinic doctors instructed the suspected individual to provide a nasopharyngeal swab to be tested at icddr,b Virology Laboratory using reverse-transcription polymerase chain reaction (RT-PCR). All contacts of COVID-19 positive staff were isolated or quarantined and tested accordingly. Besides, all the relevant information from the individual has been entered into the database in collaboration with the Staff Clinic, Dhaka Hospital at icddr,b, Virology Laboratory, and Human Resources. Not to mention, we have utilized the data from this database to conduct our analysis.

Study population

icddr,b employees and their family members who contacted staff clinic with symptoms suggestive of COVID-19 before April 16, 2021, provided nasopharyngeal swabs and tested for COVID-19 were considered as the study population. For individuals tested more than once, only the first instance was considered.

Sample collection and laboratory assay

From all symptomatic staff and family members, a nasopharyngeal swab was collected by a trained nurse, and the swab was sent to the Virology Laboratory at icddr,b to be analyzed using a real-time reverse transcriptase-polymerase chain reaction (rRT-PCR). In brief, total RNA was extracted from nasopharyngeal swabs using the chemagic Viral NA/gDNA (PerkinElmer, MA, USA) Kits. RNA was tested for SARS-CoV-2 by rRT-PCR targeting ORF1ab- and N-gene specific primers and probes following the protocol of the Chinese Center for Disease Control and Prevention (briefly as China CDC). A positive case was determined if the CT values of two targets (ORF1ab and N) were < 37 in the same specimen. If CT values of any sample were 37−40 or a single target was positive, it was resampled and retested. If the CT values were still 37−40 and the amplification curves had obvious peaks, the sample was considered positive.

Data collection and staff database

Data were extracted from icddr,b staff database, and additional data on chronic disease, blood groups, and lifestyle factors were collected by interview over phone. icddr,b COVID-19 staff database has been carefully documenting all basic information related to SARS-CoV-2 infection and COVID-19 disease among icddr,b staff and their family members. This includes age, sex, area of residence, history of contact, travel history, presenting symptoms and assay result for COVID-19 positivity and compliance of quarantine/isolation.

Additionally, through telephone interviews, data on blood group, routine physical activity, history of BCG vaccination, pre-existing chronic disease like diabetes mellitus, hypertension, COPD, asthma, IHD, cancer or kidney disease were collected using a short case report form. Data on routine physical activities were collected using pre-tested "International physical activity questionnaire- short form" (www.ipaq.ki.se), and this questionnaire was already validated[28]. Based on the last seven days' recall data physical activities were categorized as no, mild, moderate, and vigorous categories. To minimize bias, all names of the employees were removed from the Microsoft Access-based study database. Consent to participate in this study was collected in electronic media like email, SMS, or WhatsApp based on availability and accessibility.

Variables

This study was done to explore the factors associated with COVID-19 positivity. The outcome variable was COVID-19 positivity based on RT-PCR assay and the explanatory variables were age, sex, presenting symptoms, area of residence, travel history, history of contacts, presence of chronic disease, smoking, blood group, BCG vaccination, and physical activities.

Operational Definitions

Recovery: icddr,b staff, and/or family members who were tested positive to COVID-19 were released from isolation based on the following conditions and considered recovered. Symptomatic and non-hospitalized cases were considered recovered 10 days after onset of symptom and if they were without fever for the last 3 days and also there was a significant improvement of their respiratory symptoms. Hospitalized patients were considered recovered 21 days after onset of symptoms and if they were without fever at least for 3 days without the use of antipyretics and there was a significant improvement of respiratory symptoms. For

asymptomatic RT-PCR positive cases were considered recovered 10 days after sample collection. This can be noted that testing for COVID-19 using RT-PCR was not required for release from isolation.

Mild disease: When a COVID-19 test positive case had mild clinical symptoms and with no sign of pneumonia on imaging was considered a mild disease. The presence of any one symptom or in a combination of symptoms like cough, fever, malaise, sore throat, muscle pain, or headache without shortness of breath was considered mild clinical symptoms.

Moderate disease: When a COVID-19 test positive patient presented with signs of pneumonia, with a respiratory rate of ≤30 breaths /min, and peripheral capillary oxygen saturation (SpO2) of more than 93 at room air was considered moderate COVID-19 disease.

Severe disease: When a COVID-19 test positive case developed respiratory distress (>30 breaths/ min), a peripheral capillary oxygen saturation (SpO2) of ≤93% at rest and a ratio of arterial oxygen partial pressure (PaO2 in mmHg) to fractional inspired oxygen (PaO2/FiO2) of ≤300 mm Hg, or lung infiltrates of ≥50% in chest x-ray, was considered severe COVID-19 disease.

Reinfection: For this analysis, reinfection was defined as any symptomatic study participant who was tested positive for COVID-19 at least 2 months after a positive test result and who was clinically recovered from the initial infection.

Data analysis

At first, we described baseline characteristics of the study population, including age, sex, area of residence, symptoms, dates of disease diagnosis, and co-morbidities. We reported categorical variables as number (%) and continuous variables as median (IQR). To compare the categorical variables, Chi-square or Fisher's exact tests were done, as appropriate. To explore the factors associated with COVID-19 positivity, binary logistic regression was carried out. Bivariate associations between each independent variable with COVID-19 positivity were initially performed. In the multivariable model, to remove overfitting, we selected variables that demonstrated a p-value of <0.2 in bivariate analysis. The final multivariable model was also adjusted for seasonality. We calculated seasonality using the formula $\sin(2m\pi/12)+\cos(2m\pi/12)$, where "m" is the calendar month)[29]. Multicollinearity was checked by calculating the variance inflation factor (VIF) and variables considered in the final model had a VIF of 2 or less. A p-

value of less than 0.05 was regarded as statistically significant and all analyses were done in STATA (Version 15·1 StataCorp).

Ethical declaration

The Research Review Committee and the Ethics Review Committee of icddr,b, Dhaka, Bangladesh approved this study (icddr,b protocol number: PR# 20089). Due to COVID-19 pandemic and country-wide lock down, informed verbal consent was obtained from all participants over telephone.

RESULT

Between March 19, 2020 to April 15, 2021, a total number of 5,190 testing for SARS-COV-2 were done at icddr,b where 4,295 symptomatic people provided their nasopharyngeal swab. Among them, 47% were icddr,b employees and rest were the family members. Overall 43% were RT-PCR positive for COVID-19 (Figure 1). In order to collect data on lifestyle factors, physical activities, presence of chronic disease, blood grouping and BCG vaccination, telephone interview was successfully done among 3382 participants. The monthly distribution of COVID-19 testing and number of test positives are illustrated in the Figure 2. The first case was detected in March, 2020. The highest testing was done in June 20, 2020 and we observed the highest positivity rate (54%) on April 21, 2021. We observed the lowest numbers of positive cases between December 2020 to February 2021. As of April 15, 2021, 96% of all COVID-19 positive patients were recovered and there are 41 active cases. Among all COVID-19 test positives, 94.7% were mild or asymptomatic, 2.4% had moderate disease and 2.9% had a severe or critical disease. The reinfection rate was 2.1% and a total of 24 deaths including 2 employees and 22 family members.

The median age of COVID-19 negative cases was 34 years which was ranged from 2 months to 100 years and the median age of positive cases was 37 years ranged from 4 months to 88 years. Among the test positive cases, 10% of them were less than 18 years, and this was 14% among test negatives. Age distribution of both the test positives and negatives were almost equally distributed between 18 to 60 years. However, there were more 60+ years old people in test positives than in test negatives (10% vs. 5%). Regarding sex distribution, 48% of all COVID-19 positives were female and 82% of all interviewed participants had BCG scars in their left upper arm. Regarding ABO blood groups, 23% were blood group A, 33% were blood group B and

34% were blood group O. Blood group AB was present in 11% of COVID positive and 8% of negative cases (Table 1). Distribution of these above-mentioned baseline characteristics were similar in non-hospitalized test positives and negatives (Supplementary Table 1).

We were able to collect additional data on presence of chronic diseases, BCG vaccination and usual physical activities through telephone interviews from 2,894 participants. It was due to the fact that many were unavailable over phone during the telephone calls were made. Among all participants, 11% had a pre-existing respiratory illness. Hypertension was higher among COVID-19 positive cases. Hypertension prevalence was 22% for all COVID-19 positives compared to 17% in COVID-19 negatives. Diabetes mellitus was more in positive cases than the negatives (15% vs. 12%). The prevalence of ischemic heart disease (4%), chronic liver disease (1%), hypothyroidism (4%) and chronic kidney disease (2%) were almost equally distributed (Table 1).

Based-on self-reporting data using the "International physical activity questionnaire", we identified that in the preceding seven days before interviews, overall 58% of the participants did not perform any physical activities, 35% performed mild physical activities, 5% had moderate and 3% had vigorous physical activities. Except for the vigorous physical activities, there was no difference in physical activities between COVID-19 positive and negative cases. Negative cases performed more vigorous physical activities than the positives ($p < 0.05$).

Considering the symptoms before testing for SARS-COV-2, fever was the most frequent presenting symptom followed by cough. Fever was the most frequent presenting symptom among COVID-19 positives when compared to negative cases (70% vs. 47%). Cough was present in 50% of positives and 47% of all negatives. Anosmia was a presenting symptom for 2% COVID-19 positive cases compared to 0.7% of negative cases. Sore throat was higher in COVID-19 negatives (9%) than the COVID-19 test positives (6%). Similarly, shortness of breath was higher in test negatives (4% vs. 2%). Other presenting symptoms like body ache (3%), headache (0.5%), and loose motion (1%) were equally present in both the groups (Table 1).

Factors associated with COVID-19 positivity

To identify factors associated with COVID-19 positivity, multi-variable logistic regression was performed. The adjusted analysis showed that participants older than 60 years had higher odds of

being COVID-19 positive than those who were younger than 18 years old (adjusted odds ratio (AOR) 2.1, 95% CI 1.3-3.3; p<0.05) and participants with blood group AB had higher odds of being test positive than the blood group A (AOR 1.5, 95% CI 1.1-2; p<0.05). Similarly, participants presented with fever (AOR 3.1, 95% CI 2.6-3.7; p<0.05), cough (AOR 1.3, 95% CI 1.1-1.6; p<0.05) and anosmia (AOR 2.7, 95% CI 1.3-5.7; p<0.05) had higher odds of being COVID-19 positive and participants presented with sore throat were found inversely related to COVID-19 test positive (AOR 0.5, 95% CI 0.4-0.7; p<0.05) (Table 2).

DISCUSSION

The analysis showed that older age, blood group AB compared to blood group A, and presence of fever, cough, and anosmia before sample collection were associated with an increased risk of COVID-19 test positivity when compared with test negatives. On the other hand, the presence of sore throat during sample collection was found negatively associated with COVID-19 test positivity.

Consistent with other published studies older age has been one of the most common factors that have been associated with COVID-19 positivity[30–33]. The major presenting symptoms among COVID-19 test positives were fever and cough followed by anosmia. Other reported symptoms were cold, shortness of breath, body aches, headache, weakness, sore throat, and loose motion. This finding was consistent with a recently reported retrospective cohort study from Bangladesh where they observed that the major three symptoms among COVID-19 positive patients were fever, cough, and anosmia[34]. Although in the absence of a test negative comparison group that study was not able to ascertain that these factors were associated with positivity[34]. Shortness of breath and sore throat were more common in COVID-19 test negative patients which were also observed in other studies[35]. A recent study that used COVID-19 data from five continents showed that over 50% of COVID-19 positives were asymptomatic[36]. The most common presenting symptom was fever (>50%) which was trailed by dry cough (45%), tiredness (38%) and sore throat (30%)[36]. A systematic review showed that the common symptoms were fever (83%), cough (61%), fatigue (34%), myalgia (21%), dyspnea (22%), headache (11%), and diarrhea (7.5%)[37]. Similar findings were observed in other systematic reviews and studies done in other countries[8,9,38]. Therefore, inarguably fever and cough are the most common discriminatory feature of COVID-19 compared to test negatives. Loss of smell (anosmia) was the

next most important clinical feature in COVID-19 patients in our study. Several studies also observed the similar feature that patients presented with anosmia had a higher probability of being tested positive[34,39,40]. Nevertheless, these results represented discriminating features between COVID-19 positives and COVID suspects.

Previous studies investigated the association between human ABO blood groups and different infectious agents[41]. This is plausible that blood group antigens can increase host susceptibility by acting as a receptor or co-receptor for microorganisms and viruses[41]. As a part of the innate immune system ABO blood group has previously been shown to work against some enveloped viruses carrying ABO-active antigens such as SARS[41]. An association was reported between a higher risk for COVID-19 infection and mortality with blood group A and a lower risk of infection and mortality with blood group O[17,42]. However, a recent US-based multi-center study observed that patients with blood group B and AB had higher likelihood for a COVID-19 positive test result and blood type O had higher likelihood for a negative test result[19]. Our finding is partially consistent with the US studies as we observed participants with the AB group were more likely to test positive for SARS COV-2 than participants with blood group A. However, several meta-analyses and systematic reviews were published on this, and surprisingly, the results were counterintuitive [43–45]. One meta-analysis showed that people with blood group A are more vulnerable to COVID-19 infection and Blood group AB is less susceptible to getting infected with SARS-COV-2 [43], while another meta-analysis observed that both blood group A and AB are linked to COVID-19 infection and individuals with blood group O are relatively less vulnerable [44]. Therefore, the association between blood group and COVID-19 positivity is still enigmatic.

Reports showed that nations with mandatory BCG vaccination had fewer numbers of COVID-19 patients[20,22]. Therefore, induction of trained immunity through BCG vaccination was thought to be a potentially effective approach to protect against SARS-COV-2 infection[20–24]. We did not observe any association between COVID-19 infection and BCG vaccination. BCG vaccination coverage is high in Bangladesh and we observed that 82% of both the COVID-19 positives and negatives had BCG scars in the upper arm. We think a limited power could be the reason behind this non-association.

We observed that 20% of all participants had hypertension, 14% had diabetes mellitus (DM) and 92% of participants do not perform any physical exercise. Although we did not observe any association between COVID-19 positivity and the presence of chronic disease or physical activities, we thought this was still a very important finding. Another probable reason for this lack of association could be most of the cases were mild. Compared to national prevalence (8%-12%), the prevalence of DM is higher in this population [46]. The prevalence of hypertension and DM was similar to a recently published Bangladeshi study among COVID-19 positive patients where they also observed that these comorbidities were associated with hospitalization[34]. Studies showed that the presence of chronic disease is associated with a higher risk of infection and also increased COVID-19 associated hospitalization[34]. Another reason why the current study did not show chronic conditions associated with a higher risk of COVID-19 infection is probably the test-negative case-control design of the study; since the control group was also symptomatic patients, their chance of having chronic conditions may be higher compared to the general population. If the control group were average healthy people, the results might be different.

This study was housed in a health research institute. The current staff headcount in icddr,b is 4,383 with a diverse group of employees from different socio-economic strata. These include international scientists, local scientists, doctors, and senior management staff to drivers, security guards, health attendants, and their families. Due to nationwide lock-downs, only essential staff had been attending office in-person except those who worked in the hospital, laboratories, and support services. Therefore, it was not possible to pinpoint the major source of infection. Although the data indicated that most of the infections were originated from the community.

An important concern is a high percentage of positivity (43%) in the test performed in this research which is above the global trend. Overall, the percentage of positivity is less than 10% for most of the countries [47]. During the pick of the pandemic, in Bangladesh, this was around 25%[48]. The high percentage of positivity in the current study was maybe due to a strong screening process before testing done by experienced physicians in a population who are related to healthcare delivery services.

Since this study was conducted among employees and their families of an organization, this data might not be representative of the general population of Dhaka city. However, the pattern of

monthly distribution of test positivity in the current study followed a similar trend with the national test positivity rate (Figure 2). Despite a considerably large sample size, the absence of any standard sampling technique for the selection of study participants is also prone to different biases[49]. Moreover, telephone interviews to collect data on chronic disease and physical activities were performed only on 65% of the population during the study period. There is a possibility that population characteristics may differ in 35% of the participants whose data on chronic disease is not available. This is also a limitation of the study. To address this, we compared the basic characteristics of this group with the remaining participants who had telephone interview data available and the result showed it was comparable between the groups (Supplementary Table 1). The selection of variables to be studied was based-on data available from the earlier period of the pandemic. Over the period infections by new variants caused a change in disease manifestation[50]. There is a possible time bias in the knowledge of the population and health professionals about some symptoms not initially related to COVID-19. For example, the variable anosmia is studied but not ageusia. Another limitation is we could not adjust disease severity in a multivariable model due to the unavailability of data. It can be noted that controlling for severity could be helpful to address residual bias in healthcare-seeking behavior. Because residual confounding due to health-seeking behavior may still be present in the non-hospitalized cases and controls, we have compared baseline characteristics between the non-hospitalized cases and controls, and the data was almost identical to the baseline data of all COVID-19 positives and negatives (Supplementary Table 2). Finally, one more limitation of the current study is the possible change in symptoms depending on circulating variants of SARS-CoV-2 was not addressed here. Before the Omicron variant, Bangladesh observed the third wave of COVID-19 pandemic and faced a record uprising from June 2021 to September 2021, powered by the highly contagious Delta variant[48]. Unfortunately, the study period for this report was between March 2020 to April 2021. We first started testing for variants in January 2021[51]. At that time the pre-existing variant was Hu-Wuhan-like variants which were dominated till the first week of March 2021[52]. The Alpha variant (B 1.1.7) was discovered first in January and it gradually increased over time and became the most dominant variant in the first week of March 2021[52]. Since, March 2021, the SARS-CoV-2 was dominated by the Beta variant (B.1.351) which replaced almost all other variants until the emergence of the Delta

variant at the beginning of May 2021[52]. Since we have the data on variants for only 4 months, we could not adjust this in our analysis.

Nevertheless, this study reports on factors associated with COVID-19 in a sizable population using a high-quality growing database. The findings might not be a surprise to our recent knowledge on COVID-19, still, there has been a paucity of similar data in this part of the world. Moreover, this study also confirms that some findings like older age, fever, cough, and anosmia are almost universal presentations of COVID-19 and features like the presence of chronic disease, BCG vaccination and blood groups with COVID-19 infection need more research.

Data availability statement

The data are not publicly available. In the future, data will be made available upon request. Request for icddr,b research data should be addressed to Ms. Armana Ahmed at aahmed@icddrb.org

Competing interest

The authors declare that they do not have any competing interests.

Author contributions

TA, JC and MM originated the idea for the study and led the protocol design. MM, SD, MAA, SMF, MR, SMT, SP, IM, SEA, JC, and TA participated in the design of the study. TA, MM, SD, MAA, SMF, MR, IM, and SEA were involved in the development of the study protocol. MR performed the laboratory assays. MM, SD, MAA, SMF, SP, MS and TA were involved in data collection. MM, MAA, SMT, SD, SMF, IM and TA were involved in data analysis. MM, MAA and SMF wrote the manuscript. All authors read and approved the final manuscript.

Ethics statement

Ethical approvals were obtained from Research Review Committee and Ethical Review Committee of icddr,b (Protocol No.: PR-20089; Version 1.01; November 30, 2020)

Patient and public involvement

Patients or the public were not involved in the study

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Table 1. Baseline characteristics of staff and family members

Characteristics	N/n for each characteristic	COVID-19	
		Negative	Positive
Age group, n (%)	4284		
< 18 years	4284/529	335 (14%)	194 (10%)
18 – 30 years	4284/1169	693 (29%)	476 (26%)
31 – 40 years	4284/1025	589 (24%)	436 (24%)
41 – 50 years	4284/723	405 (17%)	318 (17%)
51 – 60 years	4284/520	276 (11%)	244 (13%)
> 60 years	4284/314	132 (5%)	182 (10 %)
Female sex, n (%)	4295/1996	1102 (45%)	894 (48%)
BCG scar, n (%)	2845/2347	1299 (82%)	1048 (83%)
ABO Blood group, n (%)	2689		
A	2689/630	359 (24%)	271 (23%)
B	2689/897	482 (32%)	415 (35%)
AB	2689/254	121 (8%)	133 (11%)
O	2689/908	525 (35%)	383 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2894/292	169 (11%)	123 (9%)
Hypertension, n (%)	2894/557	269 (17%)	288 (22%)
Ischemic heart disease (IHD), n (%)	2893/127	59 (4%)	68 (5%)
Chronic liver disease (CLD), n (%)	2893/36	20 (1%)	16 (1%)

Diabetes mellitus (DM), n (%)	2893/389	194 (12%)	195 (15%)
Hypothyroidism, n (%)	2893/114	59 (4%)	55 (4%)
Chronic kidney disease (CKD), n (%)	2892/53	23 (1%)	30 (2%)
Physical activity	2846		
No	2846/1668	931 (59%)	737 (58%)
Mild	2846/980	529 (34%)	451 (35%)
Moderate	2846/126	63 (4%)	63 (5%)
Vigorous	2846/72	48 (3%)	24 (2%)
Presenting symptoms	4295		
Fever, n (%)	4295/2436	1140 (47%)	1296 (70%)
Cough, n (%)	4295/2075	1145 (47%)	930 (50%)
Cold, n (%)	4295/342	201 (8%)	141 (8%)
Shortness of Breath, n (%)	4295/149	105 (4%)	44 (2%)
Body ache, n (%)	4295/134	68 (3%)	66 (4%)
Headache, n (%)	4295/21	11 (0.5%)	10 (0.5%)
Sore throat, n (%)	4295/314	208 (9%)	106 (6%)
Weakness, n (%)	4295/12	6 (0.3%)	6 (0.3%)
Anosmia, n (%)	4295/50	16 (0.7%)	34 (2%)
Loose motion, n (%)	4295/38	20 (1%)	18 (1%)
Runny nose, n (%)	4295/19	14 (0.6%)	5 (0.3%)

Table 2. Socio-demographic and clinical factors associated with COVID-19 positivity

Characteristics	OR (95% CI)	p-value	AOR (95% CI)*	p-value
Age in years	Reference: < 18 years			
18 – 30 years	1.1 (0.87, 1.39)	0.419	1.1 (0.82, 1.49)	0.518
31 – 40 years	1.07 (0.84, 1.37)	0.563	1.22 (0.89, 1.66)	0.215
41 – 50 years	1.24 (0.96, 1.6)	0.106	1.33 (0.95, 1.87)	0.100
51 – 60 years	1.33 (1.01, 1.75)	0.044	1.45 (0.98, 2.13)	0.062
> 60 years	2.2 (1.6, 3.03)	0.000	2.05 (1.28, 3.27)	0.003
Female sex	1.18 (1.03, 1.35)	0.019	1.13 (0.95, 1.34)	0.157
BCG scar	1.04 (0.86, 1.27)	0.660		
Blood group	Reference: A group			
B group	1.14 (0.93, 1.4)	0.209	1.13 (0.9, 1.4)	0.287
AB group	1.46 (1.09, 1.95)	0.012	1.46 (1.07, 2)	0.017
O group	0.97 (0.79, 1.19)	0.745	0.97 (0.78, 1.21)	0.775
Pre-existing chronic disease				
COPD/Asthma	0.89 (0.69, 1.13)	0.335		
Hypertension	1.41 (1.17, 1.7)	0.000	1.2 (0.94, 1.53)	0.135
Ischemic heart disease	1.44 (1.01, 2.06)	0.045	1.13 (0.73, 1.75)	0.578
Chronic liver disease	0.99 (0.51, 1.91)	0.966		
Diabetes mellitus	1.28 (1.03, 1.59)	0.023	0.9 (0.69, 1.18)	0.452
Hypothyroidism	1.16 (0.8, 1.68)	0.446		
Chronic kidney disease	1.63 (0.94, 2.81)	0.083	1.29 (0.69, 2.41)	0.430
Physical activity	Reference: No			
Mild	1.08 (0.92, 1.26)	0.359	0.99 (0.82, 1.18)	0.871

Moderate	1.26 (0.88, 1.81)	0.206	1.47 (0.99, 2.18)	0.058
Vigorous	0.63 (0.38, 1.04)	0.071	0.64 (0.37, 1.09)	0.102
Presenting symptoms				
Fever	2.85 (2.47, 3.29)	0.000	3.09 (2.61, 3.66)	0.000
Cough	1.3 (1.13, 1.49)	0.000	1.34 (1.14, 1.58)	0.000
Cold	0.99 (0.76, 1.3)	0.955		
SOB	0.62 (0.43, 0.91)	0.014	0.66 (0.42, 1.03)	0.065
Body ache	1.21 (0.84, 1.75)	0.295		
Head ache	2.19 (0.79, 6.04)	0.130	1.7 (0.54, 5.37)	0.366
Sore throat	0.66 (0.5, 0.86)	0.003	0.52 (0.38, 0.71)	0.000
Weakness	1.57 (0.48, 5.17)	0.454		
Anosmia	2.65 (1.36, 5.17)	0.004	2.69 (1.26, 5.72)	0.010
Loose motion	0.98 (0.41, 2.34)	0.968		

* This model was adjusted by seasonality

Figure legends

Figure 1. Study profile

Figure 2. Monthly distribution of COVID-19 test result from March 19, 2020-April 15, 2021

The bar diagram is showing monthly test results for the current study and the interrupted line diagram is showing the incidence of COVID-19 disease in Bangladesh in the same period along the second Y-axis in the right

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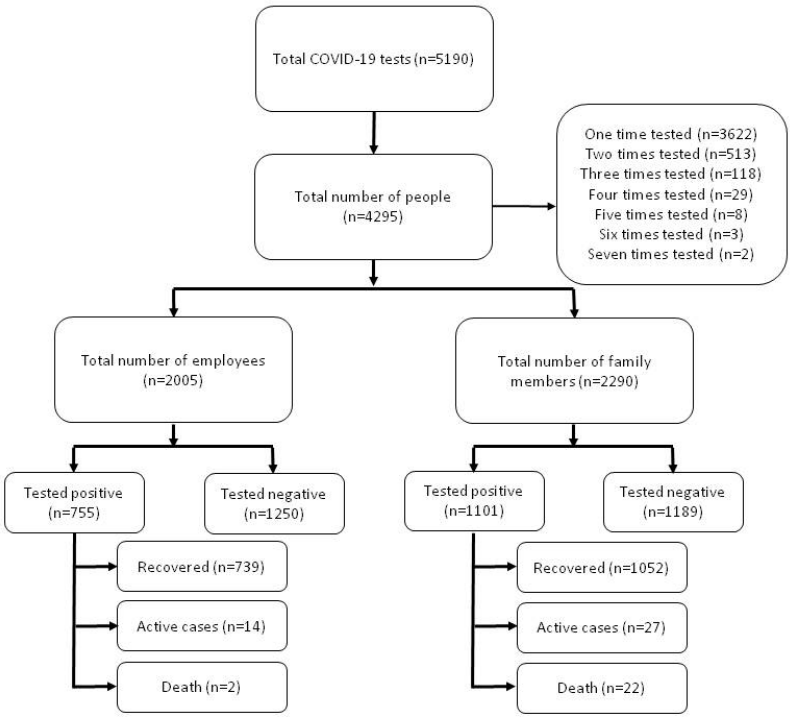

Study profile

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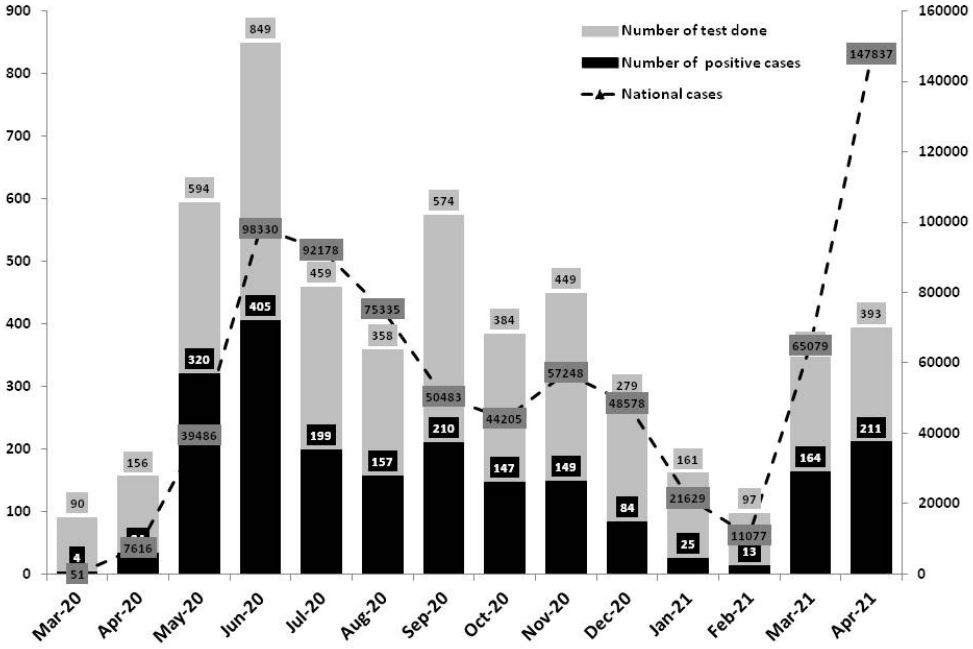

Monthly distribution of COVID-19 test results from March 19, 2020-April 15, 2021
The bar diagram is showing monthly test results for the current study and the interrupted line diagram is showing the incidence of COVID-19 disease in Bangladesh in the same period along the second Y-axis in the right

254x190mm (96 x 96 DPI)

Supplementary Table 1. Characteristics of participants based on phone call success for telephone interviews

Characteristics	Phone call success	
	Yes (n=2894)	No (n=1401)
Covide-19 confirmed case	45%	40%
Age group		
< 18 years	13%	11%
18 – 30 years	28%	26%
31 – 40 years	24%	25%
41 – 50 years	17%	17%
51 – 60 years	11%	14%
> 60 years	7%	8%
Female sex	46%	48%
Fever	56%	58%
Cough	48%	48%
Cold	7%	10%
Shortness of Breath	4%	3%
Body ache	4%	2%
Headache	0.5%	0.5%
Sore throat	7%	7%
Weakness	0.3%	0.3%
Anosmia	1%	1%
Loose motion	0.6%	1%
Runny nose	0.5%	0.3%

Supplementary Table 2. Baseline characteristics of non-hospitalized COVID-19 test positives and test negatives

Characteristics	n	COVID-19	
		Negative	Positive
Age group, n (%)	4149		
< 18 years		335 (14%)	194 (10%)
18 – 30 years		689 (29%)	472 (27%)
31 – 40 years		579 (24%)	418 (23%)
41 – 50 years		404 (17%)	299 (17%)
51 – 60 years		266 (11%)	209 (12%)
> 60 years		125 (5%)	159 (9 %)
Female sex, n (%)	4159	1088 (45%)	853 (49%)
BCG scar, n (%)	2772	1285 (82%)	1007 (83%)
ABO Blood group, n (%)	2619		
A		355 (24%)	262 (23%)
B		477 (32%)	397 (35%)
AB		116 (8%)	127 (11%)
O		520 (35%)	365 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2815	164 (11%)	115 (9%)
Hypertension, n (%)	2816	259 (16%)	262 (21%)
Ischemic heart disease (IHD), n (%)	2814	57 (4%)	57 (5%)
Chronic liver disease (CLD), n (%)	2814	20 (1%)	15 (1%)
Diabetes mellitus (DM), n (%)	2816	186 (12%)	167 (13%)
Hypothyroidism, n (%)	2814	57 (4%)	53 (4%)
Chronic kidney disease (CKD), n (%)	2813	23 (1%)	27 (2%)
Physical activity	2772		
No		926 (60%)	710 (58%)
Mild		515 (33%)	428 (35%)
Moderate		62 (4%)	59 (5%)
Vigorous		48 (3%)	24 (2%)
Presenting symptoms	4159		
Fever, n (%)		1125 (47%)	1218 (70%)

Cough, n (%)	1133 (47%)	886 (51%)
Cold, n (%)	199 (8%)	137 (8%)
Shortness of Breath, n (%)	104 (4%)	38 (2%)
Body ache, n (%)	68 (3%)	64 (4%)
Headache, n (%)	11 (0.5%)	9 (0.5%)
Sore throat, n (%)	207 (9%)	102 (6%)
Weakness, n (%)	6 (0.3%)	6 (0.3%)
Anosmia, n (%)	16 (0.7%)	33 (2%)
Loose motion, n (%)	20 (0.8%)	17 (1%)
Runny nose, n (%)	14 (0.6%)	5 (0.3%)

STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	5-7
		(*b*) For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	14
Study size	10	Explain how the study size was arrived at	6, Figure 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, explain how matching of cases and controls was addressed	N/A
		(*e*) Describe any sensitivity analyses	14
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9 Table 1
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Figure-1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9 Table-1
		(b) Indicate number of participants with missing data for each variable of interest	Table-1

Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11 Table -2
		(*b*) Report category boundaries when continuous variables were categorized	Table-2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Supplementary Table 1 and 2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15-16

*Give information separately for cases and controls.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

COVID-19 among staff and their family members of a healthcare research institution in Bangladesh between March 2020 to April 2021: a test-negative case-control study

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Secondary Subject Heading:	Infectious diseases, Epidemiology, Health services research
Keywords:	Epidemiology < INFECTIOUS DISEASES, PUBLIC HEALTH, COVID-19

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COVID-19 among staff and their family members of a healthcare research institution in Bangladesh between March 2020 to April 2021: a test-negative case-control study

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Abstract

Objective: To identify factors associated with COVID-19 positivity among staff and their family members of icddr,b, a health research institute located in Bangladesh.

Setting: Dhaka, Bangladesh

Participants: A total of 4,295 symptomatic people were tested for SARS-CoV-2 by RT-PCR between March 19, 2020, to April 15, 2021. Multivariable logistic regression was done to identify the factors associated with COVID-19 positivity by contrasting test-positives with test-negatives.

Result: Forty-three percent of the participants were tested positive for SARS-CoV-2. The median age was high in positive cases (37 years vs. 34 years). Among the positive cases, 97% were recovered, 2.1% had re-infections, 24 died, and 41 were active cases as of April 15, 2021. Multivariable regression analysis showed that age more than 60 years (AOR=2.1, 95% CI=1.3 to 3.3; p<0.05), blood group AB (AOR=1.5, 95% CI=1.1 to 2; p<0.05), fever (AOR=3.1, 95% CI=2.6 to 3.7; p<0.05), cough (AOR=1.3, 95% CI=1.1 to 1.6; p<0.05) and anosmia (AOR=2.7, 95% CI=1.3 to 5.7; p<0.05) were significantly associated with higher odds of being COVID-19 positive when compared to participants who were tested negative.

Conclusions: The study findings suggest that older age, fever, cough, and anosmia were associated with COVID-19 among the study participants.

Keywords: COVID; Epidemiology; Public Health

Strengths and limitations of this study

- This manuscript used a growing database of employees from a health research institute who underwent COVID-19 tests
- Information was collected in real-time processes as per the directive of the institute management.
- RT-PCR tests for COVID-19 were done in the Virology aboratory at icddr,b, a state-of-the-art laboratory in Bangladesh.

- Data on the presence of chronic diseases, BCG vaccination, and usual physical activities were collected over telephone interviews from only 65% of the participants.
- This study did not address the variants of SARS-CoV-2 circulating in the region or the possible modifications of symptom presentations depending on the variant infecting the patients.

Introduction

The COVID-19 pandemic is a global health challenge the likes of which the world has never been experienced so far to this scale. Since its first documentation in December 2019 in the Wuhan City, Hubei Province, China, this disease has spread across all over the world with deadly consequences[1]. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the etiological agent of this illness[2]. COVID-19 was avowed as a global pandemic on March 11, 2020, by World Health Organization (WHO)[3]. As of September 22, 2021, the disease accounts for 230,446,504 confirmed cases and 4,725,210 deaths worldwide[4]. The first case of COVID-19 in Bangladesh was officially detected on March 8, 2020. As of September 22, 2021, a total number of 1,545,800 confirmed cases were detected with 27,277 deaths in the country[5]. Although some countries have responded quickly enough to contain the disease, we generally witnessed a somewhat casual response on a global scale[1,2]. Resource-limited countries did not have had the means to respond most effectively due to the lack of large-scale testing facilities, available testing kits, adequate infrastructure as well as intensive care support for all, and proper quarantine measures[5]. These efforts were further hampered by poor living conditions, high population density, and sub-standard health services, subsequently, facilitating the mass spread of the disease[3].

The typical presenting symptoms of COVID-19 are fever, dry cough, sore throat, dyspnea, or fatigue coupled with the recent history of exposure[6–9]. Many studies have already reported different factors associated with COVID-19 infection. Most commonly observed factors are older age, male sex, presenting symptoms, for instance, cough, fever, loss of smell, close relationship with index case and family members of COVID positive patients[10–12]. Studies with a larger sample size showed that smoking and physical inactivity are also associated with COVID-19 infection and mortality[13].

Existing evidence showed that the presence of chronic disease is a risk factor for both the susceptibility to infection and progression of COVID-19 to severe disease[14]. It was observed that the severity of COVID-19 outcome is higher among patients with hypertension, obesity, type 2 diabetes mellitus (DM), and other chronic diseases like chronic lung disease, chronic kidney disease, and coronary heart disease (CHD)[14–16]. Recent studies also reported a relationship between blood group types and positivity as well as the severity of COVID-19

disease[17–19]. Few studies suggest that BCG vaccination could be protective against COVID-19 infection as countries with compulsory BCG vaccination had fewer COVID-19 cases[20–24].

Although many papers were published on factors associated with COVID-19 positivity, there remains a scarcity of data collected from countries where the data repository systems are not properly developed[25]. Despite commendable efforts so far in Bangladesh to contain the disease within manageable level considering its' high population density, there has been a paucity of data on the epidemiology of COVID-19, particularly involving high-quality sources[26]. However, icddr,b, a well-renowned health research institute based in Bangladesh, has been maintaining a high-quality database for its staff and their family members since the inception of COVID-19 in the country. The current analysis took the opportunity of the COVID-19 staff database of icddr,b to explore the factors associated with COVID-19 infection.

METHODS

This is an observational test negative design including data from the staff and their family members of icddr,b, Dhaka, Bangladesh. We reported this study by following STROBE statement checklist for the case-control studies[27].

Study design

This test-negative case-control study used clinical, socio-demographic, and laboratory data from the COVID-19 staff database of icddr,b, a health research institute in Dhaka, Bangladesh. Here cases were icddr,b staff or family members who had symptoms suggested of COVID-19, contacted icddr,b staff clinic and tested positive for SARS-COV-2. In contrast, controls are patients from the same population with similar symptoms who underwent the same tests for the COVID-19 at the icddr,b facility and tested negative. Since controls are the same group of patients who present for testing but test negative, a test-negative design is very helpful to control for factors that are usually challenging to estimate in an observational study particularly care-seeking behavior and access to care. However, some of the contacts were symptomless and tested positive included in the analysis as cases and some contacts were tested negative considered as controls. The study was conducted between March 19, 2020, to April 15, 2021, during the SARS-COV2 pandemic.

Study premise

icddr,b is one of the leading public health research organizations in Bangladesh. Since March 19, 2020, icddr,b started a system to prevent and protect its ~4000 employees and their family members (~12,000) against COVID-19. All staff with any clinical symptom (fever, cough, and cold or respiratory distress) suggesting COVID-19 were instructed to contact icddr,b staff clinic. Subsequently, staff clinic doctors instructed the suspected individual to provide a nasopharyngeal swab to be tested at icddr,b Virology Laboratory using reverse-transcription polymerase chain reaction (RT-PCR). All contacts of COVID-19 positive staff were isolated or quarantined and tested accordingly. Besides, all the relevant information from the individual has been entered into the database in collaboration with the Staff Clinic, Dhaka Hospital at icddr,b, Virology Laboratory, and Human Resources. Not to mention, we have utilized the data from this database to conduct our analysis.

Study population

icddr,b employees and their family members who contacted staff clinic with symptoms suggestive of COVID-19 before April 16, 2021, provided nasopharyngeal swabs and tested for COVID-19 were considered as the study population. For individuals tested more than once, only the first instance was considered.

Sample collection and laboratory assay

From all symptomatic staff and family members, a nasopharyngeal swab was collected by a trained nurse, and the swab was sent to the Virology Laboratory at icddr,b to be analyzed using a real-time reverse transcriptase-polymerase chain reaction (rRT-PCR). In brief, total RNA was extracted from nasopharyngeal swabs using the chemagic Viral NA/gDNA (PerkinElmer, MA, USA) Kits. RNA was tested for SARS-CoV-2 by rRT-PCR targeting ORF1ab- and N-gene specific primers and probes following the protocol of the Chinese Center for Disease Control and Prevention (briefly as China CDC). A positive case was determined if the CT values of two targets (ORF1ab and N) were < 37 in the same specimen. If CT values of any sample were 37−40 or a single target was positive, it was resampled and retested. If the CT values were still 37−40 and the amplification curves had obvious peaks, the sample was considered positive.

Data collection and staff database

Data were extracted from icddr,b staff database, and additional data on chronic disease, blood groups, and lifestyle factors were collected by interview over phone. icddr,b COVID-19 staff database has been carefully documenting all basic information related to SARS-CoV-2 infection and COVID-19 disease among icddr,b staff and their family members. This includes age, sex, area of residence, history of contact, travel history, presenting symptoms and assay result for COVID-19 positivity and compliance of quarantine/isolation.

Additionally, through telephone interviews, data on blood group, routine physical activity, history of BCG vaccination, pre-existing chronic disease like diabetes mellitus, hypertension, COPD, asthma, IHD, cancer or kidney disease were collected using a short case report form. Data on routine physical activities were collected using pre-tested "International physical activity questionnaire- short form" (www.ipaq.ki.se), and this questionnaire was already validated[28]. Based on the last seven days' recall data physical activities were categorized as no, mild, moderate, and vigorous categories. To minimize bias, all names of the employees were removed from the Microsoft Access-based study database. Consent to participate in this study was collected in electronic media like email, SMS, or WhatsApp based on availability and accessibility.

Variables

This study was done to explore the factors associated with COVID-19 positivity. The outcome variable was COVID-19 positivity based on RT-PCR assay and the explanatory variables were age, sex, presenting symptoms, area of residence, travel history, history of contacts, presence of chronic disease, smoking, blood group, BCG vaccination, and physical activities.

Operational Definitions

Recovery: icddr,b staff, and/or family members who were tested positive to COVID-19 were released from isolation based on the following conditions and considered recovered. Symptomatic and non-hospitalized cases were considered recovered 10 days after onset of symptom and if they were without fever for the last 3 days and also there was a significant improvement of their respiratory symptoms. Hospitalized patients were considered recovered 21 days after onset of symptoms and if they were without fever at least for 3 days without the use of antipyretics and there was a significant improvement of respiratory symptoms. For

asymptomatic RT-PCR positive cases were considered recovered 10 days after sample collection. This can be noted that testing for COVID-19 using RT-PCR was not required for release from isolation.

Mild disease: When a COVID-19 test positive case had mild clinical symptoms and with no sign of pneumonia on imaging was considered a mild disease. The presence of any one symptom or in a combination of symptoms like cough, fever, malaise, sore throat, muscle pain, or headache without shortness of breath was considered mild clinical symptoms.

Moderate disease: When a COVID-19 test positive patient presented with signs of pneumonia, with a respiratory rate of ≤30 breaths /min, and peripheral capillary oxygen saturation (SpO2) of more than 93 at room air was considered moderate COVID-19 disease.

Severe disease: When a COVID-19 test positive case developed respiratory distress (>30 breaths/ min), a peripheral capillary oxygen saturation (SpO2) of ≤93% at rest and a ratio of arterial oxygen partial pressure (PaO2 in mmHg) to fractional inspired oxygen (PaO2/FiO2) of ≤300 mm Hg, or lung infiltrates of ≥50% in chest x-ray, was considered severe COVID-19 disease.

Reinfection: For this analysis, reinfection was defined as any symptomatic study participant who was tested positive for COVID-19 at least 2 months after a positive test result and who was clinically recovered from the initial infection.

Data analysis

At first, we described baseline characteristics of the study population, including age, sex, area of residence, symptoms, dates of disease diagnosis, and co-morbidities. We reported categorical variables as number (%) and continuous variables as median (IQR). To compare the categorical variables, Chi-square or Fisher's exact tests were done, as appropriate. To explore the factors associated with COVID-19 positivity, binary logistic regression was carried out. Bivariate associations between each independent variable with COVID-19 positivity were initially performed. In the multivariable model, to remove overfitting, we selected variables that demonstrated a p-value of <0.2 in bivariate analysis. The final multivariable model was also adjusted for seasonality. We calculated seasonality using the formula $\sin(2m\pi/12)+\cos(2m\pi/12)$, where "m" is the calendar month)[29]. Multicollinearity was checked by calculating the variance inflation factor (VIF) and variables considered in the final model had a VIF of 2 or less. A p-

value of less than 0.05 was regarded as statistically significant and all analyses were done in STATA (Version 15·1 StataCorp).

Ethical declaration

The Research Review Committee and the Ethics Review Committee of icddr,b, Dhaka, Bangladesh approved this study (icddr,b protocol number: PR# 20089). Due to COVID-19 pandemic and country-wide lock down, informed verbal consent was obtained from all participants over telephone.

RESULT

Between March 19, 2020 to April 15, 2021, a total number of 5,190 testing for SARS-COV-2 were done at icddr,b where 4,295 symptomatic people provided their nasopharyngeal swab. Among them, 47% were icddr,b employees and rest were the family members. Overall 43% were RT-PCR positive for COVID-19 (Figure 1). In order to collect data on lifestyle factors, physical activities, presence of chronic disease, blood grouping and BCG vaccination, telephone interview was successfully done among 3382 participants. The monthly distribution of COVID-19 testing and number of test positives are illustrated in the Figure 2. The first case was detected in March, 2020. The highest testing was done in June 20, 2020 and we observed the highest positivity rate (54%) on April 21, 2021. We observed the lowest numbers of positive cases between December 2020 to February 2021. As of April 15, 2021, 96% of all COVID-19 positive patients were recovered and there are 41 active cases. Among all COVID-19 test positives, 94.7% were mild or asymptomatic, 2.4% had moderate disease and 2.9% had a severe or critical disease. The reinfection rate was 2.1% and a total of 24 deaths including 2 employees and 22 family members.

The median age of COVID-19 negative cases was 34 years which was ranged from 2 months to 100 years and the median age of positive cases was 37 years ranged from 4 months to 88 years. Among the test positive cases, 10% of them were less than 18 years, and this was 14% among test negatives. Age distribution of both the test positives and negatives were almost equally distributed between 18 to 60 years. However, there were more 60+ years old people in test positives than in test negatives (10% vs. 5%). Regarding sex distribution, 48% of all COVID-19 positives were female and 82% of all interviewed participants had BCG scars in their left upper arm. Regarding ABO blood groups, 23% were blood group A, 33% were blood group B and

34% were blood group O. Blood group AB was present in 11% of COVID positive and 8% of negative cases (Table 1). Distribution of these above-mentioned baseline characteristics were similar in non-hospitalized test positives and negatives (Supplementary Table 1).

We were able to collect additional data on presence of chronic diseases, BCG vaccination and usual physical activities through telephone interviews from 2,894 participants. It was due to the fact that many were unavailable over phone during the telephone calls were made. Among all participants, 11% had a pre-existing respiratory illness. Hypertension was higher among COVID-19 positive cases. Hypertension prevalence was 22% for all COVID-19 positives compared to 17% in COVID-19 negatives. Diabetes mellitus was more in positive cases than the negatives (15% vs. 12%). The prevalence of ischemic heart disease (4%), chronic liver disease (1%), hypothyroidism (4%) and chronic kidney disease (2%) were almost equally distributed (Table 1).

Based-on self-reporting data using the "International physical activity questionnaire", we identified that in the preceding seven days before interviews, overall 58% of the participants did not perform any physical activities, 35% performed mild physical activities, 5% had moderate and 3% had vigorous physical activities. Except for the vigorous physical activities, there was no difference in physical activities between COVID-19 positive and negative cases. Negative cases performed more vigorous physical activities than the positives ($p < 0.05$).

Considering the symptoms before testing for SARS-COV-2, fever was the most frequent presenting symptom followed by cough. Fever was the most frequent presenting symptom among COVID-19 positives when compared to negative cases (70% vs. 47%). Cough was present in 50% of positives and 47% of all negatives. Anosmia was a presenting symptom for 2% COVID-19 positive cases compared to 0.7% of negative cases. Sore throat was higher in COVID-19 negatives (9%) than the COVID-19 test positives (6%). Similarly, shortness of breath was higher in test negatives (4% vs. 2%). Other presenting symptoms like body ache (3%), headache (0.5%), and loose motion (1%) were equally present in both the groups (Table 1).

Factors associated with COVID-19 positivity

To identify factors associated with COVID-19 positivity, multi-variable logistic regression was performed. The adjusted analysis showed that participants older than 60 years had higher odds of

being COVID-19 positive than those who were younger than 18 years old (adjusted odds ratio (AOR) 2.1, 95% CI 1.3-3.3; p<0.05) and participants with blood group AB had higher odds of being test positive than the blood group A (AOR 1.5, 95% CI 1.1-2; p<0.05). Similarly, participants presented with fever (AOR 3.1, 95% CI 2.6-3.7; p<0.05), cough (AOR 1.3, 95% CI 1.1-1.6; p<0.05) and anosmia (AOR 2.7, 95% CI 1.3-5.7; p<0.05) had higher odds of being COVID-19 positive and participants presented with sore throat were found inversely related to COVID-19 test positive (AOR 0.5, 95% CI 0.4-0.7; p<0.05) (Table 2).

DISCUSSION

The analysis showed that older age, blood group AB compared to blood group A, and presence of fever, cough, and anosmia before sample collection were associated with an increased risk of COVID-19 test positivity when compared with test negatives. On the other hand, the presence of sore throat during sample collection was found negatively associated with COVID-19 test positivity.

Consistent with other published studies older age has been one of the most common factors that have been associated with COVID-19 positivity[30–33]. The major presenting symptoms among COVID-19 test positives were fever and cough followed by anosmia. Other reported symptoms were cold, shortness of breath, body aches, headache, weakness, sore throat, and loose motion. This finding was consistent with a recently reported retrospective cohort study from Bangladesh where they observed that the major three symptoms among COVID-19 positive patients were fever, cough, and anosmia[34]. Although in the absence of a test negative comparison group that study was not able to ascertain that these factors were associated with positivity[34]. Shortness of breath and sore throat were more common in COVID-19 test negative patients which were also observed in other studies[35]. A recent study that used COVID-19 data from five continents showed that over 50% of COVID-19 positives were asymptomatic[36]. The most common presenting symptom was fever (>50%) which was trailed by dry cough (45%), tiredness (38%) and sore throat (30%)[36]. A systematic review showed that the common symptoms were fever (83%), cough (61%), fatigue (34%), myalgia (21%), dyspnea (22%), headache (11%), and diarrhea (7.5%)[37]. Similar findings were observed in other systematic reviews and studies done in other countries[8,9,38]. Therefore, inarguably fever and cough are the most common discriminatory feature of COVID-19 compared to test negatives. Loss of smell (anosmia) was the

next most important clinical feature in COVID-19 patients in our study. Several studies also observed the similar feature that patients presented with anosmia had a higher probability of being tested positive[34,39,40]. Nevertheless, these results represented discriminating features between COVID-19 positives and COVID suspects.

Previous studies investigated the association between human ABO blood groups and different infectious agents[41]. This is plausible that blood group antigens can increase host susceptibility by acting as a receptor or co-receptor for microorganisms and viruses[41]. As a part of the innate immune system ABO blood group has previously been shown to work against some enveloped viruses carrying ABO-active antigens such as SARS[41]. An association was reported between a higher risk for COVID-19 infection and mortality with blood group A and a lower risk of infection and mortality with blood group O[17,42]. However, a recent US-based multi-center study observed that patients with blood group B and AB had higher likelihood for a COVID-19 positive test result and blood type O had higher likelihood for a negative test result[19]. Our finding is partially consistent with the US studies as we observed participants with the AB group were more likely to test positive for SARS COV-2 than participants with blood group A. However, several meta-analyses and systematic reviews were published on this, and surprisingly, the results were counterintuitive [43–45]. One meta-analysis showed that people with blood group A are more vulnerable to COVID-19 infection and Blood group AB is less susceptible to getting infected with SARS-COV-2 [43], while another meta-analysis observed that both blood group A and AB are linked to COVID-19 infection and individuals with blood group O are relatively less vulnerable [44]. Therefore, the association between blood group and COVID-19 positivity is still enigmatic.

Reports showed that nations with mandatory BCG vaccination had fewer numbers of COVID-19 patients[20,22]. Therefore, induction of trained immunity through BCG vaccination was thought to be a potentially effective approach to protect against SARS-COV-2 infection[20–24]. We did not observe any association between COVID-19 infection and BCG vaccination. BCG vaccination coverage is high in Bangladesh and we observed that 82% of both the COVID-19 positives and negatives had BCG scars in the upper arm. We think a limited power could be the reason behind this non-association.

We observed that 20% of all participants had hypertension and 14% had diabetes mellitus (DM). Surprisingly, around 58% of respondents did not have any physical activities, and only 34% performed mild physical activities in the preceding 7 days (Table 1). According to the "International Physical Activity Questionnaire (IPAC)" used in this research to evaluate usual physical activities by the respondents, mild activities include only walking and do not include running or vigorous activities or exercise. Therefore, by combining 'no' and 'mild' physical activities, we can see that 92% of the participants who provided data on physical activities did not perform any physical exercise. Although we did not observe any association between COVID-19 positivity and the presence of chronic disease or physical activities, we thought this was still a very important finding. Another probable reason for this lack of association could be most of the cases were mild. Compared to national prevalence (8%-12%), the prevalence of DM is higher in this population [46]. The prevalence of hypertension and DM was similar to a recently published Bangladeshi study among COVID-19 positive patients where they also observed that these comorbidities were associated with hospitalization[34]. Studies showed that the presence of chronic disease is associated with a higher risk of infection and also increased COVID-19 associated hospitalization[34]. Another reason why the current study did not show chronic conditions associated with a higher risk of COVID-19 infection is probably the test-negative case-control design of the study; since the control group was also symptomatic patients, their chance of having chronic conditions may be higher compared to the general population. If the control group were average healthy people, the results might be different.

This study was housed in a health research institute. The current staff headcount in icddr,b is 4,383 with a diverse group of employees from different socio-economic strata. These include international scientists, local scientists, doctors, and senior management staff to drivers, security guards, health attendants, and their families. Due to nationwide lock-downs, only essential staff had been attending office in-person except those who worked in the hospital, laboratories, and support services. Therefore, it was not possible to pinpoint the major source of infection. Although the data indicated that most of the infections were originated from the community.

An important concern is a high percentage of positivity (43%) in the test performed in this research which is above the global trend. Overall, the percentage of positivity is less than 10% for most of the countries [47]. During the pick of the pandemic, in Bangladesh, this was around

25%[48]. The high percentage of positivity in the current study was maybe due to a strong screening process before testing done by experienced physicians in a population who are related to healthcare delivery services.

Since this study was conducted among employees and their families of an organization, this data might not be representative of the general population of Dhaka city. However, the pattern of monthly distribution of test positivity in the current study followed a similar trend with the national test positivity rate (Figure 2). Despite a considerably large sample size, the absence of any standard sampling technique for the selection of study participants is also prone to different biases[49]. Moreover, telephone interviews to collect data on chronic disease and physical activities were performed only on 65% of the population during the study period. There is a possibility that population characteristics may differ in 35% of the participants whose data on chronic disease is not available. This is also a limitation of the study. To address this, we compared the basic characteristics of this group with the remaining participants who had telephone interview data available and the result showed it was comparable between the groups (Supplementary Table 1). The selection of variables to be studied was based-on data available from the earlier period of the pandemic. Over the period infections by new variants caused a change in disease manifestation[50]. There is a possible time bias in the knowledge of the population and health professionals about some symptoms not initially related to COVID-19. For example, the variable anosmia is studied but not ageusia. Another limitation is we could not adjust disease severity in a multivariable model due to the unavailability of data. It can be noted that controlling for severity could be helpful to address residual bias in healthcare-seeking behavior. Because residual confounding due to health-seeking behavior may still be present in the non-hospitalized cases and controls, we have compared baseline characteristics between the non-hospitalized cases and controls, and the data was almost identical to the baseline data of all COVID-19 positives and negatives (Supplementary Table 2). Finally, one more limitation of the current study is the possible change in symptoms depending on circulating variants of SARS-CoV-2 was not addressed here. Before the Omicron variant, Bangladesh observed the third wave of COVID-19 pandemic and faced a record uprising from June 2021 to September 2021, powered by the highly contagious Delta variant[48]. Unfortunately, the study period for this report was between March 2020 to April 2021. We first started testing for variants in January 2021[51]. At that time the pre-existing variant was Hu-Wuhan-like variants which were

dominated till the first week of March 2021[52]. The Alpha variant (B 1.1.7) was discovered first in January and it gradually increased over time and became the most dominant variant in the first week of March 2021[52]. Since, March 2021, the SARS-CoV-2 was dominated by the Beta variant (B.1.351) which replaced almost all other variants until the emergence of the Delta variant at the beginning of May 2021[52]. Since we have the data on variants for only 4 months, we could not adjust this in our analysis.

Nevertheless, this study reports on factors associated with COVID-19 in a sizable population using a high-quality growing database. The findings might not be a surprise to our recent knowledge on COVID-19, still, there has been a paucity of similar data in this part of the world. Moreover, this study also confirms that some findings like older age, fever, cough, and anosmia are almost universal presentations of COVID-19 and features like the presence of chronic disease, BCG vaccination and blood groups with COVID-19 infection need more research.

Data availability statement

The data are not publicly available. In the future, data will be made available upon request. Request for icddr,b research data should be addressed to Ms. Armana Ahmed at aahmed@icddrb.org

Competing interest

The authors declare that they do not have any competing interests.

Author contributions

TA, JC and MM originated the idea for the study and led the protocol design. MM, SD, MAA, SMF, MR, SMT, SP, IM, SEA, JC, and TA participated in the design of the study. TA, MM, SD, MAA, SMF, MR, IM, and SEA were involved in the development of the study protocol. MR performed the laboratory assays. MM, SD, MAA, SMF, SP, MS and TA were involved in data collection. MM, MAA, SMT, SD, SMF, IM and TA were involved in data analysis. MM, MAA and SMF wrote the manuscript. All authors read and approved the final manuscript.

Ethics statement

Ethical approvals were obtained from Research Review Committee and Ethical Review Committee of icddr,b (Protocol No.: PR-20089; Version 1.01; November 30, 2020)

Patient and public involvement

Patients or the public were not involved in the study

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Table 1. Baseline characteristics of staff and family members

Characteristics	N/n for each characteristic	COVID-19	
		Negative	Positive
Age group, n (%)	4284		
< 18 years	4284/529	335 (14%)	194 (10%)
18 – 30 years	4284/1169	693 (29%)	476 (26%)
31 – 40 years	4284/1025	589 (24%)	436 (24%)
41 – 50 years	4284/723	405 (17%)	318 (17%)
51 – 60 years	4284/520	276 (11%)	244 (13%)
> 60 years	4284/314	132 (5%)	182 (10 %)
Female sex, n (%)	4295/1996	1102 (45%)	894 (48%)
BCG scar, n (%)	2845/2347	1299 (82%)	1048 (83%)
ABO Blood group, n (%)	2689		
A	2689/630	359 (24%)	271 (23%)
B	2689/897	482 (32%)	415 (35%)
AB	2689/254	121 (8%)	133 (11%)
O	2689/908	525 (35%)	383 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2894/292	169 (11%)	123 (9%)
Hypertension, n (%)	2894/557	269 (17%)	288 (22%)
Ischemic heart disease (IHD), n (%)	2893/127	59 (4%)	68 (5%)
Chronic liver disease (CLD), n (%)	2893/36	20 (1%)	16 (1%)

Diabetes mellitus (DM), n (%)	2893/389	194 (12%)	195 (15%)
Hypothyroidism, n (%)	2893/114	59 (4%)	55 (4%)
Chronic kidney disease (CKD), n (%)	2892/53	23 (1%)	30 (2%)
Physical activity	2846		
No	2846/1668	931 (59%)	737 (58%)
Mild	2846/980	529 (34%)	451 (35%)
Moderate	2846/126	63 (4%)	63 (5%)
Vigorous	2846/72	48 (3%)	24 (2%)
Presenting symptoms	4295		
Fever, n (%)	4295/2436	1140 (47%)	1296 (70%)
Cough, n (%)	4295/2075	1145 (47%)	930 (50%)
Cold, n (%)	4295/342	201 (8%)	141 (8%)
Shortness of Breath, n (%)	4295/149	105 (4%)	44 (2%)
Body ache, n (%)	4295/134	68 (3%)	66 (4%)
Headache, n (%)	4295/21	11 (0.5%)	10 (0.5%)
Sore throat, n (%)	4295/314	208 (9%)	106 (6%)
Weakness, n (%)	4295/12	6 (0.3%)	6 (0.3%)
Anosmia, n (%)	4295/50	16 (0.7%)	34 (2%)
Loose motion, n (%)	4295/38	20 (1%)	18 (1%)
Runny nose, n (%)	4295/19	14 (0.6%)	5 (0.3%)

Table 2. Socio-demographic and clinical factors associated with COVID-19 positivity

Characteristics	OR (95% CI)	p-value	AOR (95% CI)*	p-value
Age in years	Reference: < 18 years			
18 – 30 years	1.1 (0.87, 1.39)	0.419	1.1 (0.82, 1.49)	0.518
31 – 40 years	1.07 (0.84, 1.37)	0.563	1.22 (0.89, 1.66)	0.215
41 – 50 years	1.24 (0.96, 1.6)	0.106	1.33 (0.95, 1.87)	0.100
51 – 60 years	1.33 (1.01, 1.75)	0.044	1.45 (0.98, 2.13)	0.062
> 60 years	2.2 (1.6, 3.03)	0.000	2.05 (1.28, 3.27)	0.003
Female sex	1.18 (1.03, 1.35)	0.019	1.13 (0.95, 1.34)	0.157
BCG scar	1.04 (0.86, 1.27)	0.660		
Blood group	Reference: A group			
B group	1.14 (0.93, 1.4)	0.209	1.13 (0.9, 1.4)	0.287
AB group	1.46 (1.09, 1.95)	0.012	1.46 (1.07, 2)	0.017
O group	0.97 (0.79, 1.19)	0.745	0.97 (0.78, 1.21)	0.775
Pre-existing chronic disease				
COPD/Asthma	0.89 (0.69, 1.13)	0.335		
Hypertension	1.41 (1.17, 1.7)	0.000	1.2 (0.94, 1.53)	0.135
Ischemic heart disease	1.44 (1.01, 2.06)	0.045	1.13 (0.73, 1.75)	0.578
Chronic liver disease	0.99 (0.51, 1.91)	0.966		
Diabetes mellitus	1.28 (1.03, 1.59)	0.023	0.9 (0.69, 1.18)	0.452
Hypothyroidism	1.16 (0.8, 1.68)	0.446		
Chronic kidney disease	1.63 (0.94, 2.81)	0.083	1.29 (0.69, 2.41)	0.430
Physical activity	Reference: No			
Mild	1.08 (0.92, 1.26)	0.359	0.99 (0.82, 1.18)	0.871

Moderate	1.26 (0.88, 1.81)	0.206	1.47 (0.99, 2.18)	0.058
Vigorous	0.63 (0.38, 1.04)	0.071	0.64 (0.37, 1.09)	0.102
Presenting symptoms				
Fever	2.85 (2.47, 3.29)	0.000	3.09 (2.61, 3.66)	0.000
Cough	1.3 (1.13, 1.49)	0.000	1.34 (1.14, 1.58)	0.000
Cold	0.99 (0.76, 1.3)	0.955		
SOB	0.62 (0.43, 0.91)	0.014	0.66 (0.42, 1.03)	0.065
Body ache	1.21 (0.84, 1.75)	0.295		
Head ache	2.19 (0.79, 6.04)	0.130	1.7 (0.54, 5.37)	0.366
Sore throat	0.66 (0.5, 0.86)	0.003	0.52 (0.38, 0.71)	0.000
Weakness	1.57 (0.48, 5.17)	0.454		
Anosmia	2.65 (1.36, 5.17)	0.004	2.69 (1.26, 5.72)	0.010
Loose motion	0.98 (0.41, 2.34)	0.968		

* This model was adjusted by seasonality

Figure legends

Figure 1. Study profile

Figure 2. Monthly distribution of COVID-19 test result from March 19, 2020-April 15, 2021

The bar diagram is showing monthly test results for the current study and the interrupted line diagram is showing the incidence of COVID-19 disease in Bangladesh in the same period along the second Y-axis in the right

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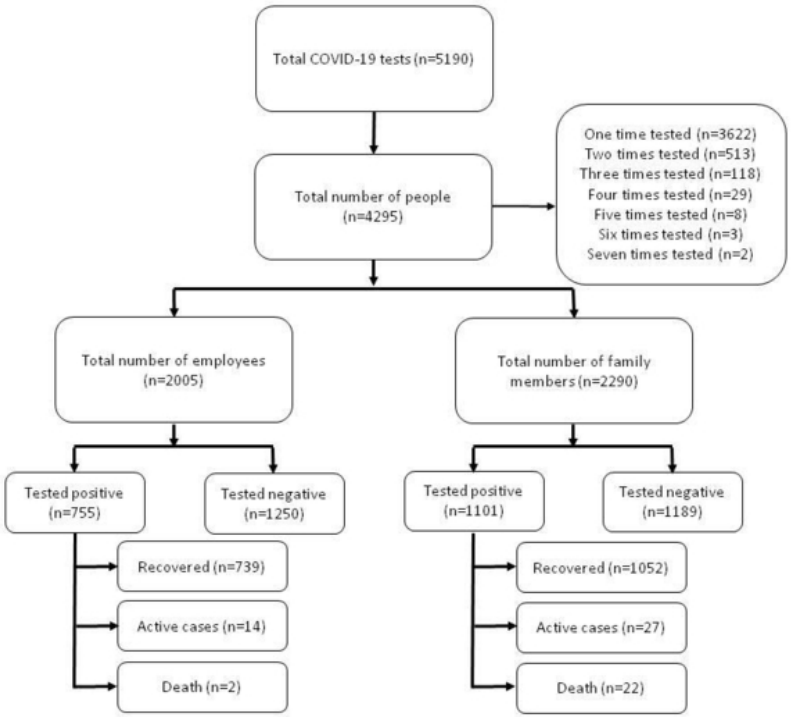

Study profile

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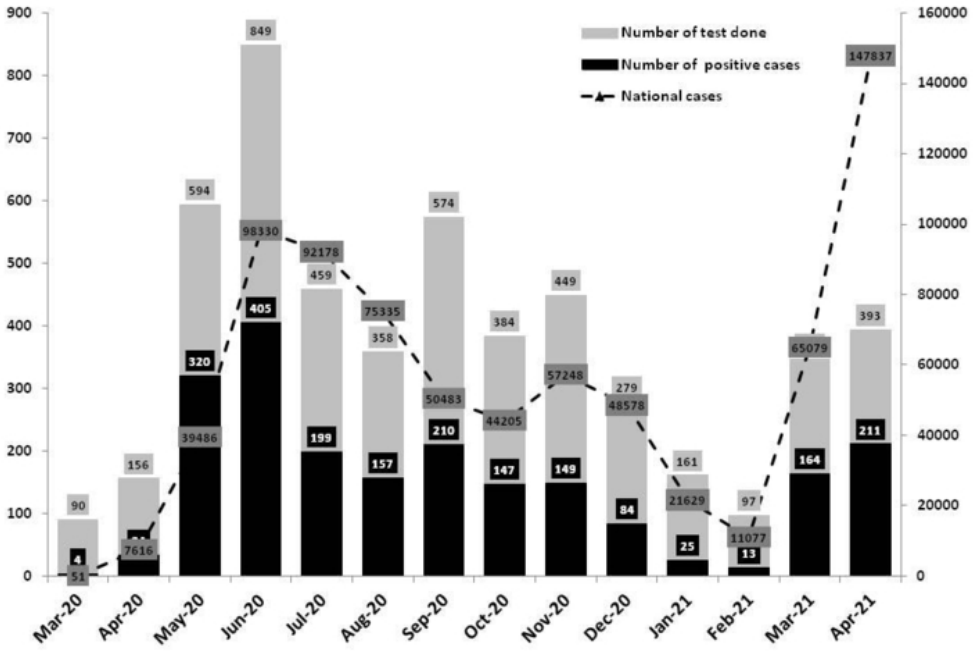

Monthly distribution of COVID-19 test result from March 19, 2020-April 15, 2021

The bar diagram is showing monthly test results for the current study and the interrupted line diagram is showing the incidence of COVID-19 disease in Bangladesh in the same period along the second Y-axis in the right

60x45mm (300 x 300 DPI)

Supplementary Table 1. Characteristics of participants based on phone call success for telephone interviews

Characteristics	Phone call success	
	Yes (n=2894)	No (n=1401)
Covide-19 confirmed case	45%	40%
Age group		
< 18 years	13%	11%
18 – 30 years	28%	26%
31 – 40 years	24%	25%
41 – 50 years	17%	17%
51 – 60 years	11%	14%
> 60 years	7%	8%
Female sex	46%	48%
Fever	56%	58%
Cough	48%	48%
Cold	7%	10%
Shortness of Breath	4%	3%
Body ache	4%	2%
Headache	0.5%	0.5%
Sore throat	7%	7%
Weakness	0.3%	0.3%
Anosmia	1%	1%
Loose motion	0.6%	1%
Runny nose	0.5%	0.3%

Supplementary Table 2. Baseline characteristics of non-hospitalized COVID-19 test positives and test negatives

Characteristics	n	COVID-19	
		Negative	Positive
Age group, n (%)	4149		
< 18 years		335 (14%)	194 (10%)
18 – 30 years		689 (29%)	472 (27%)
31 – 40 years		579 (24%)	418 (23%)
41 – 50 years		404 (17%)	299 (17%)
51 – 60 years		266 (11%)	209 (12%)
> 60 years		125 (5%)	159 (9 %)
Female sex, n (%)	4159	1088 (45%)	853 (49%)
BCG scar, n (%)	2772	1285 (82%)	1007 (83%)
ABO Blood group, n (%)	2619		
A		355 (24%)	262 (23%)
B		477 (32%)	397 (35%)
AB		116 (8%)	127 (11%)
O		520 (35%)	365 (32%)
Pre-existing chronic disease			
COPD/Asthma/Respiratory illness, n (%)	2815	164 (11%)	115 (9%)
Hypertension, n (%)	2816	259 (16%)	262 (21%)
Ischemic heart disease (IHD), n (%)	2814	57 (4%)	57 (5%)
Chronic liver disease (CLD), n (%)	2814	20 (1%)	15 (1%)
Diabetes mellitus (DM), n (%)	2816	186 (12%)	167 (13%)
Hypothyroidism, n (%)	2814	57 (4%)	53 (4%)
Chronic kidney disease (CKD), n (%)	2813	23 (1%)	27 (2%)
Physical activity	2772		
No		926 (60%)	710 (58%)
Mild		515 (33%)	428 (35%)
Moderate		62 (4%)	59 (5%)
Vigorous		48 (3%)	24 (2%)
Presenting symptoms	4159		
Fever, n (%)		1125 (47%)	1218 (70%)

Cough, n (%)	1133 (47%)	886 (51%)
Cold, n (%)	199 (8%)	137 (8%)
Shortness of Breath, n (%)	104 (4%)	38 (2%)
Body ache, n (%)	68 (3%)	64 (4%)
Headache, n (%)	11 (0.5%)	9 (0.5%)
Sore throat, n (%)	207 (9%)	102 (6%)
Weakness, n (%)	6 (0.3%)	6 (0.3%)
Anosmia, n (%)	16 (0.7%)	33 (2%)
Loose motion, n (%)	20 (0.8%)	17 (1%)
Runny nose, n (%)	14 (0.6%)	5 (0.3%)

STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	5-7
		(*b*) For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	14
Study size	10	Explain how the study size was arrived at	6, Figure 1
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, explain how matching of cases and controls was addressed	N/A
		(*e*) Describe any sensitivity analyses	14
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9 Table 1
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Figure-1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9 Table-1
		(b) Indicate number of participants with missing data for each variable of interest	Table-1

Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11 Table -2
		(*b*) Report category boundaries when continuous variables were categorized	Table-2
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Supplementary Table 1 and 2
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15-16

*Give information separately for cases and controls.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.