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Vaccination and Long-Term Follow-up of Post-COVID-19 Complications

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Abstract

In recent years, the coronavirus pandemic disease has been raised to fatal levels in the world. In most cases, the infected person suffers from mild to severe damage to some body organs, like the lungs, with a worse prognosis of COVID-19 related complications. This study reported the progression and persistence of COVID-19 complications even after a post-recovery period, and the effects of vaccination on the remediation of complications among the people of Bangladesh. A cross-sectional study was conducted with direct interviews of 1002 patients in different parts of Bangladesh following a well-organized questionnaire. Moreover, a systematic follow-up study up to four months has also been carried out to investigate the longevity of post-COVID-19 complications in patients. It is very clear from the obtained results that some sociodemographic parameters like age, occupation, health condition, vaccination, and preexisting health problems are the main risk factors for the degree of health complications after the post-COVID-19 period of infectious people. The vaccination can significantly reduce the severity and longevity of post-COVID complications. In addition, this will be useful for the prediction of possible ways to avoid the complications of long COVID by getting vaccination and health awareness.

Keywords: Cross-sectional study; Post COVID-19 complications; Long COVID; Vaccination.

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1. Introduction

COVID-19 a pandemic disease caused by SARS-CoV-2 develops as a result of severe acute respiratory syndrome. COVID-19 is an extremely contagious disease which has certainly become the biggest challenge to global health today [1,2]. The COVID-19 infection was first identified in Wuhan, China, and spread quickly all over the world. Now it's turned into an unprecedented global pandemic [3-6]. According to Johns Hopkins University (JHU), by the end of August 2022, a total of 607 million cases and 6.51 million deaths will have been recorded around the world [7]. In Bangladesh, total cases were 2.01 million and total deaths were 29329 people until August 2022, after the first case of COVID-19 was confirmed on March 8th, 2020 [8]. Anyone can be infected by breathing around someone if he/she is near someone who has COVID-19, or by touching a contaminated surface and then their eyes, nose, or mouth. The risk of spreading this virus is higher indoors and in crowded settings [9]. COVID-19 affects different people in different ways. In most cases, the infected person suffers from mild to moderate illness, and sometimes hospitalization is not required. However, A fair number of the infected individuals are seriously ill and require hospitalization [10]. The most commonly reported symptoms of COVID-19 infection include fever, headache, shortness of breath, cough, fatigue, loss of smell, myalgia (muscular pain) and joint pain [11-14]. The COVID-19 virus affects mainly the respiratory tract and also different organs in the human body. COVID-19 can cause damage to the liver tissue, lung, kidney, heart vessels, and other organs [15]. Acute respiratory distress syndrome (ARDS) and respiratory malfunction are the most common complications of severe COVID-19 infection [15-17]. The probable risk factors for developing serious illness may be old age and people living with preexisting health problems (comorbidities) like diabetes, chronic respiratory disease, or cardiovascular disease [18].

COVID-19 outpatient requires several weeks to completely recover from disease manifestation. Approximately one third of patients do not return to their normal state of health until approximately two to three weeks after diagnosis, which is called post COVID-19 syndrome [19]. Post COVID-19 syndrome (also known as long COVID-19) was reported in some studies as a country-wide case and represents chronic, long-lasting symptoms including dyspnea, fatigue, coughing, chest pain, myalgia, insomnia, and arthralgia. Other symptoms that have been reported include depression, congestive disorder, headache, and palpitation [20]. For instance, in Italy, a study done among 143 individuals was followed up to seven weeks after their discharge from hospitals and found that 53% of patients had fatigue, 43% had breathlessness, and 27% had joint pain [21]. The patients also suffered from various post-COVID-19 complications, such as dementia, depression, sleepiness, anxiety, stress, and so on [22]. On the other hand, long-term uncontrolled sugar levels, neuropsychiatric, cardiac, and respiratory problems were reported following infections with COVID-19 [23, 24].

An epidemiological study done in Bangladesh identified that the recovered individuals had experienced some short-term complications, such as pains and aches (31.8%), anxiety or depression (23.1%), and weakened attention span (24.4%) [25]. It was also reported in this study that subclinical lung abnormalities had been identified by a CT scan among those patients with asymptomatic COVID-19 [26]. There were some studies on COVID-19 patients done in the eastern province of Saudi Arabia that confirmed that abnormalities occur in chest radiographs among 15.5% of asymptomatic and 46% of symptomatic patients [27]. Still, it is hard to define the post COVID-19 complications among the symptomatic and asymptomatic COVID-19 cases in

Bangladesh as limited number of studies was done.

In the present study, we intend to explore the association of COVID-19 complications with the major characteristic parameters of patients following an interview-based cross-sectional study. In addition, the possible advantages of vaccination for the remediation and/or prevention of COVID-19 related health complications have also been reported here. Moreover, a long-term follow-up study up to four months has been conducted to find out the prevalence of COVID-19 related complications in the post-COVID period for the infected individuals.

2. Methodology of the Study

2.1. Study population and sample collection

The cross-sectional study was carried out from July 2021 to May 2022. For this study, reverse transcription-polymerase chain reaction (RT-PCR) report was used to identify the patients with COVID-19. How many days later a patient obtained COVID-19 negative results was confirmed by RT-PCR report. In here, at least after two RT-PCR tests at a gap of 24 hours, it was considered as "Days to become negative." In addition, after confirming COVID-19 negative, from that point it was counted as a post-COVID-19 period for that individual. Only the patients who took the vaccine prior to 30 days of COVID-19 infection were considered as vaccinated. Patients were excluded from this study who did not give their consent during the interview. Following evaluation of a total of 1134 people, different ages (between 18 and 70 years) and genders (both male and female) were selected. Finally, a total of 1002 data points was used for final analysis after removing incomplete responses.

2.2. Independent Variables

In this study, various sociodemographic characteristics such as age, gender, occupation, education, vaccination, BMI, residence status, etc. were considered as independent variables and their influential dependent variables was determined by direct interview. Participants were also asked if they were suffering from other co-morbidity complications, such as asthma, hypertension, heart disease, cardiovascular disease, diabetes, and others.

2.3. Variables that are dependent

The independent variables of this work were some factors that have a direct influence on the choice of dependent variables. Some of the important variables such as days to become COVID-19, shortness of breath, loss of taste and smell, fever, cough, mental stress, sleeping disturbance, hypertension, diabetes condition, etc. were used for determining their significance in relation to the persistence of post-COVID-19 complications up to four months.

2.4. Ethical consideration

The ethics committee at Primeasia University in Dhaka granted ethical approval for this study (Reference: PAU/IEAC/22/13) This study was carried out among the COVID-19 infected patients confirmed by the various

COVID-19 dedicated hospitals in four metropolitan cities in Bangladesh. Written permission was obtained from the hospital authorities for collecting the patients information. Oral permission was taken from the patients at the beginning of the interview. The results of this research were used only for scientific purposes and not for any other aims, and strict confidentiality was strictly maintained.

2.5. Statistical analysis

Before formal analysis, raw data was processed and shortened by Microsoft Excel 2020 after collection. Then the data was analyzed using the Statistical Package (SPSS) version 26. Descriptive statistics (*i.e.*, percentage, frequency, mean, etc.) and inferential statistics (i.e., p-value) were executed in the study. A chi-square test was also used to evaluate the relations between dependent and independent variables. A *p*-value of 0.05 was set as the statistical significance level.

3. Results and Discussion

3.1. Participant socio-demographic characteristics

Finally, 1002 patients' information was collected and analyzed using a structured questionnaire-based interview. At first, some basic information about the study populations was recorded from four COVID-19 dedicated hospitals that are operated in four different metropolitan cities in Bangladesh. The sociodemographic variables of all participants are summarized in Table 1. The total number of populations was (n) 1002, among which the percentages of males and females were almost similar. Selected age group populations were below 20 to around 70 years old, with a maximum of 23.5% being 30–39 years old, and almost 34% of the patient age range was 50 to 60+ years. In the case of education, 51% were graduated and only 3.9% were school-going children in this study (below 20 years old). Furthermore, 31% of businessmen, 15% of students, 6.0% of housewives, and the same percentage of day laborers were infected by COVID-19. Only 6% of people were obese, while 67.0% had normal body weight (based on BMI). In Bangladesh, city corporation and district town areas house more than one-third (78%) of the population. According to the calculation, 67% of patients who belong to different age groups are healthy, whereas only 5% are underweight and about 28% are overweight-obese. Comparative MBI values among males and females show a similar distribution pattern. Among the COVID-19 patients, only 34% were vaccinated, and the rest of them (66%) were unvaccinated. Furthermore, 65% of patients did not require hospitalization, while 8.2% were in ICU.

Table 1: Distribution of the sociodemographic variables of the respondents.

Variables		Frequency (n=1002)	Percentage (%)
Gender	Male	511	51.0
	Female	491	49.0
Age	Below 20	67	6.7
	20-29	207	20.6
	30-39	236	23.5
	40-49	155	15.4
	50-59	159	15.8
	60+	180	17.9
Educational status	No schooling	40	3.9
	Primary	77	7.7
	SSC	166	16.5
	HSC	170	17.0
	Bachelor	343	34.2
	Masters & above	208	20.7
Occupation	Unemployed	186	18.6
	Student	152	15.3
	Employee	224	22.3
	Day Labor	64	6.4
	House wife	61	6.1
	Businessman	315	31.5
Residence	City/town	781	77.8
	Urban	223	22.2
BMI	Underweight	49	4.9%
	Normal	669	66.8%
	Overweight	222	22.2%
	Obese	62	6.2%
Vaccination status	Unvaccinated	662	66%
	Vaccinated	340	34%
Patient condition	No hospital	651	65%
	Hospital in general ward	269	26.8%
	Hospital in ICU	82	8.2%

3.2. Association of days to become COVID-19 negative with various sociodemographic variables

Table 2 shows number of days which were required to confirm COVID-19 negative has significant relation with characteristics of participants except BMI (p=0.956). Occupation, vaccination, patient hospitalization and respiratory problems have strong interaction with the required days to become COVID-19 negative ($p \leq 0.001$). More than 14 days was necessary for getting COVID negative of 58% male and 65% female (p=0.029). With increasing the age, number of days to become COVID-19 negative was increased ($p = 0.003$) to >14 to 21 days. In addition, about 70% of patients aged over 50 years old became COVID-19 negative more than 14 days later. Among the various professions of participants, a maximum of 69% were housewives and 63% were businessmen who were confirmed as COVID-19 negative reports more than 14 days later. When

compared to unvaccinated COVID-19 patients (> 14 days), vaccination strongly correlates with the time to be COVID-19 negative, which was less than 14 days (aveg. 11 days) after infection ($p \leq 0.001$). In particular, 75% of vaccinated patients become negative in less than 14 days, whereas the same percentage of unvaccinated people get negative results in more than 14 days. More than 14 days was required for 76% of the lung-infected and hospitalized patients to obtain a COVID-19 negative result.

Table 2: Association of required days to become COVID-19 negative and various sociodemographic variables of patients.

Parameters		Aveg. Days to become COVID-19 Negative		P-Value
		≤14 days	>14 days	
Gender	Male =511 [51.0%]	216 [42.4%]	294 [57.6%]	0.029
	Female=491 [49.0%]	172 [34.9%]	319 [65.1%]	
Age	Below 20 =67[6.7%]	26 [38.9%]	41 [61.1%]	0.003
	20-29 =206[20.6%]	96 [46.4%]	110 [53.6%]	
	30-39=235[23.5%]	111 [47.1%]	124 [52.9%]	
	40-49=155[15.5%]	55 [35.3%]	100 [64.7%]	
	50-59 =159[15.9%]	52[32.6%]	107 [67.4%]	
	60+ =180[18%]	53 [29.6%]	127 [70.4%]	
Occupation	Unemployed= 186[18.6%]	123[65.9%]	63[34.1%]	0.000
	Student=152 [15.2%]	93[54.7%]	69[45.3%]	
	Labor=64[6.4%]	40[62%]	24[38%]	
	Housewife=86 [8.6.4%]	26[30.7%]	60[69.3%]	
	Businessman= 315[31.5%]	117[37.0%]	198[63.0%]	
	Employee=224 [25.3%]	115[51.5%]	109[48.5%]	
Vaccination status	Unvaccinated= 662[66%]	169 [25.5%]	493 [74.5%]	0.000
	Vaccinated =340 [34%]	254 [74.6%]	86 [25.4%]	
Patient condition	No hospital=651 [65%]	350 [53.8%]	301 [46.2%]	0.000
	Hospitalized =269 [26.8%]	78 [28.9%]	191 [71.1%]	
	In ICU= 82 [8.2%]	6 [7.5%]	76 [92.5%]	
Lung Problem	Normal=834[83.2%]	626[75.0%]	208[25.0%]	0.000
	Infected=168[16.8%]	41[24.4%]	127[75.6%]	
BMI	Underweight=49[4.9 %]	18[37.8%]	31[62.2%]	0.956
	Normal=669[66.8%]	256[38.3%]	413[61.7%]	
	Overweight=222 [22.2%]	87[39.4%]	135[60.6%]	
	Obese=62[6.2%]	26[42.5%]	36[57.5%]	

3.3. Association of selected post COVID-19 complications with sociodemographic variables

Table 3 demonstrates that shortness of breath was strongly associated with most of the sociodemographic variables ($p \leq 0.001$) except gender ($p = 0.924129$). Statistically, shortness of breath was noticeable depending on the age of the patients. As shown in the results, only 12% of patients under 20 years of age were suffering from this complication, whereas for patients over 50 years of age, this figure was over 55%. The same pattern of breath problems was also observed for unvaccinated businessmen (59%), housewives (58%), and day laborers (75%). In addition, 96% of ICU patients and 83% of lung infected patients were suffering from breathing problems. Vaccination (32%) markedly reduces this problem compared to unvaccinated patients (66%).

Table 3: Significant relationship between the shortness of breath and loss of taste, smell with various sociodemographic variables of patient.

Parameters (n=1002)		Shortness of breath			Loss of taste and smell		
		{Yes}	{No}	P-Value [Yes vs No]	{Yes}	{No}	P-Value [Yes vs No]
Gender	Male =511 [51.0%]	173 [33.7 %]	338 [66.3%]	0.924	235[46.0%]	276[54.0%]	0.260
	Female=491 [49.0%]	167 [34%]	324 [66.0%]		241[49.0%]	250[51.0%]	
Age	Below 20 =67 [6.7%]	8 [11.9%]	59 [88.1%	0.000	34[50.7%]	33[49.3%]	0.000
	20-29 =206 [20.6%]	46 [22.2%]	160[77.8%]		90[47.7%]	116[56.3%]	
	30-39=235 [23.5%]	65 [28.0%]	170 [72.0%]		139[59.1%]	96[40.9%]	
	40-49=155 [15.5%]	50 [32.5%]	105 [67.5%]		102[65.8%]	53[34.2%]	
	50-59 =159 [15.9%]	88 [55.3%]	71[44.7%]		96[60.3%]	63[39.7%]	
	60+ =180 [18.0%]	98 [54.7%]	82[45.3%]		129[71.6%]	61[28.4%]	
Occupation	Unemployed= 186 [18.6%]	72[38.9%]	114[61.1%]	0.000	118[63.4%]	68[36.6%]	0.000
	Student=152 [15.2%]	24[15.8%]	128[84.2%]		59[39.0%]	93[61.0%]	
	Day Labor=64 [6.4%]	48[75.0%]	16[25.0%]		43[67.0%]	21[33.0%]	
	Housewife=86 [8.6.4%]	50[58.2%]	36[41.8%]		54[62.8%]	32[37.2%]	
	Businessman= 315[31%]	186[59.0%]	129[41.0%]		187[59.0%]	128[41.0%]	
	Employee=224 [25.3%]	89[39.7%]	135[60.3%]		161[71.8%]	63[28.2%]	
Vaccination status	Unvaccinated= 662 [66%]	436 [65.7%]	226 [34.3%]	0.001	390[60.0%]	261[40.0%]	0.000
	Vaccinated =340 [34%]	109 [32.8%]	223 [67.2%]		174[65.0%]	95[35.0%]	
Patient condition	No hospital= 651[65%]	132[20.2%]	519 [79.8%]	0.000	71[86.5%]	11[13.5%]	0.021
	Hospital in general=269 [26.8%]	129 [48.0%]	140 [52.0%]		375[56.0%]	296[44.0%]	
	Hospital in ICU=82[8.2%]	79[96.3%]	3 [3.7%]		104[31.4%]	227[68.6%]	

Lung Problems	Normal=834 [83.2%]	69[8.3%]	765[91.7%]	0.000	208[25.0%]	626[75.0%]	0.093
	Infected=168 [16.8%]	140 [83.5%]	28[16.5%]		39[23.0%]	129[75.6%]	
BMI	Underweight=49 [4.9%]	19 [33.7%]	30 [66.3%]	0.129	21[38.8%]	28[61.2%]	0.802
	Normal=669 [66.8%]	209 [35.0%]	460 [65.0%]		276[41.3%]	393[58.7%]	
	Overweight=222 [22.2%]	84[37.4%]	138[62.6%]		87[39.4%]	135[60.6%]	
	Obese=62 [6.2%]	20[39.0%]	42[61.0%]		24[40.5%]	38[59.5%]	

Table 3 also demonstrates that loss of taste and smell by COVID-19 patients had significant interaction with some demographic characteristics of the patients like age, occupation, and hospitalization status ($p \leq 0.001$). In contrast, gender, BMI, and lung problems were not associated with the loss of taste and smell by the COVID-19 patients. Compared to the young (age 20 years, 47%) patients, a higher percentage (24%) of older people (over 50 years) were suffering from this problem (71%). Beyond this, 65–85% of hospitalized patients, 56% of unvaccinated patients, as well as 72% of employee patients were facing these types of outcomes after COVID-19 infection. Moreover, gender ($p = 0.260$) and BMI ($p = 0.802093$) did not interact with the complications of taste and smell of COVID-19 patients.

As shown in Table 4, except for gender ($p = 0.453$), lung infection ($p = 0.114$), and BMI ($p = 0.572$), all other sociodemographic parameters were significantly related to the fever and cough of COVID-19 infected patients. Among these variables, occupation ($p \leq 0.001$) and vaccination ($p \leq 0.001$) were strongly related to the symptoms like fever and cough. In addition, age (p 0.018) and hospitalization (p 0.013) status of patients were less likely to be associated with this type of complication.

In addition, Table 4 also exhibit that patient mental health problems like sleeping disturbance, depression, dementia, anxiety etc were significantly associated with their age, occupation, vaccination and patient health conditions ($p \leq 0.001$). Interestingly, mental health problems were not significantly related to the patient's BMI (p=0.275). Males and females were equally affected by the mental health problem (p=0.14). Compared to the young patients (8%), older people were suffering more (over 60%). In addition, the maximum percentage of sufferers was found to be unemployed (53%) and businessmen (67%), whereas students suffered a minimum percentage of mental stress (21%). Vaccination reduces this kind of mental health problem by up to 3.5-fold compared to unvaccinated patients. The suffering rate among the hospitalized patients with respiratory problems was more than double that of the other patients.

Table 4: Association of fever-cough and mental health problems Specifically, sleep disturbance, depression, and dementia. with participants' sociodemographic characteristics.

Parameters (n=1002)		Fever and Cough		P-Value [Yes vs No]	Mental health problems		P-Value [Yes vs No]
		{Yes}	{No}		{Yes}	{No}	
Gender	Male=511[51.0%]	204[40.0%]	307[60.0%]	0.453	187[39.6%]	324[60.4%]	0.140
	Female=491[49.0%]	191[39.0%]	300[61.0%]		202[41.1%]	289[58.9%]	
Age	Below 20 =67[7.0%]	29[43.3%]	38[56.7%]	0.018	5[7.5%]	62[92.5%]	0.000
	20-29 =206[20.6%]	80[39.0%]	126[61.0%]		67[32.5%]	139[67.5%]	
	30-39=235[23.4%]	89[38.0%]	146[62.0%]		88[37.4%]	147[62.6%]	
	40-49=155[15.0%]	53[34.2%]	102[65.8%]		61[39.4%]	94[60.6%]	
	50-59=159[15.7%]	59[37.0%]	100[63.0%]		66[41.5%]	93[58.5%]	
	60+ =180[18.3%]	60[28.0%]	130[72.0%]		102[56.7%]	78[43.3%]	
Occupation	Unemployed=186 [18.6%]	62[33.0%]	124[67.0%]	0.000	99[53.2%]	87[46.8%]	0.000
	Student=152[15.2%]	51[34.0%]	101[66.0%]		34[21.2%]	18[74.3%]	
	Day Labor=64[6.4%]	17[27.0%]	47[73.0%]		13[38.2%]	21[61.8%]	
	Housewife=86[8.6.4%]	28[33.0%]	58[67.0%]		150[47.3%]	166[52.7%]	
	Businessman=315 [31.5%]	120[38.0%]	195[62.0%]		41[67.2%]	20[32.8%]	
	Employee=224[25.3%]	58[26.0%]	166[74.0%]		80[31.6%]	173[68.4%]	
	>14 days=671[67.1%]	350[52.0%]	321[48.0%]		363[54.0%]	208[46.0%]	
Patient conditions	No hospital=651 [65.0%]	203[31.0%]	448[69.0%]	0.013	54[16.0%]	277[84.0%]	0.000
	Hospital in general ward=269[27.0%]	162[60.0%]	107[40.0%]		190[29.2%]	461[70.8%]	
	Hospital in ICU= 82[8.0%]	68[83.0%]	14[17.0%]		154[57.2%]	115[42.8%]	
Vaccination status	Unvaccinated=671 [67.0%]	363[54.0%]	208[46.0%]	0.000	363[54.0%]	208[46.0%]	0.000
	Vaccinated=331 [33.0%]	54[16.0%]	277[84.0%]		54[16.0%]	277[84.0%]	
Lung Problem	Normal=834[83.2%]	199[23.6%]	644[76.4%]	0.114	218[27.0%]	616[73.0%]	0.004
	Infected=168[16.8%]	61[36.0%]	127[64.0%]		40[24.0%]	128[76.0%]	
BMI	Underweight=49[4.9%]	24[49.0%]	25[51.0%]	0.572	15[36.0%]	34[64.0%]	0.275
	Normal=669[66.8%]	270[40.3%]	399[59.7%]		266[39.3%]	403[60.7%]	
	Overweight=222 [22.2%]	87[39.4%]	135[60.6%]		89[38.4%]	133[61.6%]	
	Obese=62[6.2%]	27[42.5%]	35[57.5%]		22[39.5%]	40[60.5%]	

3.4. Follow-up results of post COVID-19 complications of patients based on their vaccination status

Table 5 describes that the percentage of post-COVID-19 complications was higher (over 80%) among unvaccinated patients compared to the vaccinated population. In the 1st month after becoming COVID-19 negative, loss of taste and smell (79%), sleeping disorder (81%), shortness of breath (82%), mental stress and anxiety (80%) were the most severe complications for the unvaccinated COVID-19 patients, whereas for the

vaccinated COVID-19 patients, these percentages were 48%, 50%, 57%, and 54%, respectively. In addition, fever, cough, dementia, physical weakness, and acidity problems were 72%, 68%, 73%, 69%, and 72% for unvaccinated patients and 43%, 47%, 44%, 46%, and 45% for vaccinated patients, respectively. Moreover, sneezing, skin rash and itching, hair loss, acidity, and weakness were more severe in the non-vaccinated population. Within 2-3 months, the severity of all the complications was reduced by over 70% (Table 5).

Table 5: Summary data for the long-term follow-up of post-COVID-19 complications. For up to four months, the total number of responding patients was (n) = 446. Among them, the vaccinated were 287 (64.0%) and the unvaccinated were 159 (36.0%).

Symptoms	Vaccination status	1st month	2-3 months	3-4 month
Fever	Vacc.	43.2%	16.5%	5.4%
	Unvacc.	71.5%	27.6%	8.6%
Cough	Vacc.	47.8%	14.6%	2.6%
	Unvacc.	68.5%	24.2%	7.3%
Loss of taste and smell	Vacc.	48.7%	18.2%	4.8%
	Unvacc.	79.4%	37.1%	11.5%
shortness of breath	Vacc.	50.4%	17.9%	4.7%
	Unvacc.	81.5%	34.1%	12.4%
Sleeping disturbance	Vacc.	57.2%	28.7%	9.1%
	Unvacc.	80.3%	43.9%	16.8%
Hypertension	Vacc.	46.9%	15.4%	3.6%
	Unvacc.	63.1%	27.3%	7.7%
Uncontrolled diabetes	Vacc.	49.7%	16.8%	2.4%
	Unvacc.	61.6%	24.4%	4.2%
Dementia	Vacc.	48.5%	21.4%	6.8%
	Unvacc.	73.7%	39.2%	19.8%
Anxiety/Stress	Vacc.	44.3%	18.7%	4.8%
	Unvacc.	81.6%	37.8%	9.2%
Vision problem	Vacc.	12.5%	5.8%	1.6%
	Unvacc.	35.3%	14.8%	3.2%
Hair loss	Vacc.	33.6%	18.4%	2.4%
	Unvacc.	61.4%	29.2%	16.7%
Weight gain	Vacc.	13.7%	5.8%	1.7%
	Unvacc.	22.4%	9.6%	3.4%
Body ache	Vacc.	32.6%	19.5%	1.8%
	Unvacc.	61.4%	31.6%	7.2%
Weakness	Vacc.	46.5%	17.0%	3.8%
	Unvacc.	69.0%	38.4%	16.9%
Skin rash and itching	Vacc.	11.3%	4.4%	1.6%
	Unvacc.	24.3%	11.7%	3.9%
Acidity	Vacc.	45.7%	18.5%	5.1%
	Unvacc.	71.6%	39.8%	14.3%
Sneezing	Vacc.	29.4%	13.6%	2.7%
	Unvacc.	57.6%	30.8%	9.2%
Irregular period of women	Vacc.	2.1%	3.8%	5.2%
	Unvacc.	3.6%	5.2%	7.8%

The obtained results show that only about 5% of vaccinated patients and less than 10% of unvaccinated patients

were suffering from various post-COVID complications, with some exceptions like breath problems (13%), sleeping disorders (17%), dementia (20%), hair loss (17%), physical weakness (17%), and acidity (14%). A few new complications were identified even after 3–4 months. For instance, around 8% of unvaccinated and 5% of vaccinated women reported having irregular menstrual cycles.

4. Discussion

Movement restriction and confinement are essential to control the infection rate of the COVID-19 virus. Such a prolonged situation to stay at home was stressful and affected the way of normal living for the people. Therefore, people were suffering from both physical and mental health problems due to the COVID-19 infection. Some post-COVID-19 complications persisted even after 4–12 weeks of recovery from infection, which was referred to as "long COVID" or "post COVID conditions" [28].

As the coronavirus causes inflammation and fluid to fill up the air sacs in the lungs, an insufficient amount of oxygen can reach through the bloodstream. Therefore, pulmonary damage in the lung can cause asthma or aggravate preexisting asthma problems, including shortness of breath [29]. Moreover, because of the low supply of oxygen, the heart needs to work hard to pump blood through the whole body. This effect can cause cardiovascular diseases like hypertension, palpitation, uncontrolled blood pressure and so on [30, 31]. Other factors, including the sickness for a long time, prolonged physical inactivity and spending weeks in bed to improve the conditions, could also be reasons for weight gain, physical weakness, mental health problems including sleep disturbances, uncontrolled blood sugar level, acidity etc.

The results of this study demonstrate that most of the post-COVID complications were not dependent on the gender of the infected patients. The prevalence rate of post-COVID-19 complications among elderly patients (above 50 years of age) was more than two times higher compared to younger people aged below 20–30 years. Patients in some occupations, those who need to meet many people or work together, like businessmen, employees, or workers, were more susceptible to suffering than students and unemployed individuals who were staying at home during the pandemic situation. Exceptionally, around 60% of COVID-19 infected housewives were suffering from symptoms like loss of taste and smell, mental health problems, and elevated sugar levels, even though they were at home for the maximum time. The reason could be a lack of physical exercise during the lockdown situation for a long time as well as excess mental stress about the consequences of a COVID pandemic in the future. The same thing happened for many businessmen and unemployed people due to the uncertainty about their business and sources of income. Therefore, over 60% of the businessmen were suffering from mental health problems, hypertension, and breathing problems as reported in the results section.

Vaccination markedly reduced the post-COVID complications as described in the results section. The statistical analysis reveals that vaccination decreased post-COVID symptoms from 40% to 50% in some special cases like shortness of breath, hospitalization, cardiovascular problems, and physical and mental weakness. Development of immunity in the human body against the COVID virus was the main reason for obtaining success. More research and advancement are necessary to boost the body's disease system permanently against this lethal virus [28].

Finally, this study, for the first time in Bangladesh, assessed (i) the prevalence rates of complications of COVID-19 infection in patients, and (ii) the role of vaccination in the reduction of severity of COVID-19 symptoms (iii) long-term monitoring of the longevity of post-COVID-19 complications on the basis of the vaccination status of Bangladeshi people. However, this studies have some limited because its nature is cross-sectional, where causality can be inferred. As a result, more information on some other factors, such as a comparative study on the effect of single, double, and triple doses of vaccine on COVID-19 complications, and the effect of comorbidities such as preexisting asthma, diabetes, and heart problems as risk factors on COVID-19 complications, are major limitations of this study.

5. Conclusions

Based on an overview of recent research, it can be concluded that post-COVID-19 complications were more serious among the unvaccinated patients. In particular, elderly people over 60 years old were suffering from some of the complications that were found for over 4 months. Again, some new complications, like an irregular menstrual cycle, were also identified during the long-term follow-up studies. In the case of the vaccinated population, the complications were less severe with short-term persistence compared to the unvaccinated patients. With the exception of gender and BMI, all other sociodemographic factors were significantly related to post COVID complications. However, continuous monitoring is required for a significant population in the post-COVID state in the future. Female patients with respiratory distress, weakness, and patients with a disease for a prolonged duration require special attention in the post COVID-19 state. Additionally, a well-designed cohort study can identify more in-depth associations between vaccination and post-COVID-19 complications.

6. Competing Interests

The authors of the research work do not have any conflict of interest.

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