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The Silent Struggle: Addressing Post-COVID Health Challenges with Booster Doses

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MK, SR, MFH, MAR, and MNM designed and conducted the survey. Author MK and SH analyzed, interpreted the survey data and draft the hole article. Authors AF, NIL, MT, MKHJ, SI collected the data. All authors reviewed and approved the final manuscript.

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ABSTRACT

Background: Coronavirus Disease-19 (COVID-19) primarily an infectious disease of respiratory tract caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS CoV-2), it has triggered the rapid expanding pandemic worldwide, including in Bangladesh and has left deep impact on physical and mental health.

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Objective: This study aims to evaluate the impact of COVID-19 booster doses on long COVID symptoms, including the role of demographic factors, and to assess whether booster doses reduce symptom severity in vaccinated individuals.
Methods: A cross-sectional observational study was conducted from October to December 2022 in Savar, Dhaka, Bangladesh, involving 110 participants aged 18 and older with chronic respiratory conditions. Data were collected using a validated questionnaire, covering socio-demographic factors, vaccination status, and post COVID complications. Vaccination types included AstraZeneca, Moderna, Pfizer, and Sinovac. Statistical analysis was performed using SPSS version 27.0, employing Chi-square and logistic regression techniques to explore associations between booster doses, demographic factors, and post-COVID symptom prevalence.
Results: The study represent the post-COVID complications experienced by the respondents based on vaccination status. The study found that certain post-COVID symptoms, such as anxiety (30.0%) and physical weakness (59.1%) were prevalent across all vaccination groups. However, breathing difficulty, muscle pain, tiredness was common. In addition, a significant association was observed between high blood pressure and Sinovac ($\chi^2 = 6.091$, $p = 0.014$), confusion and Pfizer ($\chi^2 = 4.076$, $p = 0.044$), and breathing difficulties and Moderna ($\chi^2 = 8.615$, $p = 0.003$). Gender differences were minimal, with no statistically significant disparity in post-COVID symptoms between males and females. Booster doses appeared to reduce the severity of certain symptoms, including anxiety and confusion, but physical weakness and joint pain persisted across all groups.
Conclusion: COVID-19 booster doses significantly mitigate the severity of post-COVID complications. However, persistent complications like physical weakness and joint pain highlight the need for continued research and interventions targeting post-COVID. Booster doses remain a crucial strategy in reducing post-COVID health challenges, emphasizing the importance of widespread vaccine uptake to alleviate the long-term burden on individuals mental and physical healthcare systems.

Keywords: Post-COVID complications; booster doses; COVID-19 vaccines; health challenges.

1. INTRODUCTION

The COVID-19 pandemic has left a lasting impact on global health, not only through the acute effects of the virus but also through the lingering post-COVID complications experienced by many survivors. These long-term effects, often referred to as "long COVID," include a range of symptoms such as fatigue, cognitive impairment, respiratory issues, and cardiovascular problems, which can persist for months or even years after the initial infection [1–3]. As healthcare systems worldwide grapple with this new challenge, the role of COVID-19 booster doses has become increasingly critical in mitigating these long-term health impacts [4–6].

The administration of booster doses has been shown to significantly enhance immune responses, providing greater protection against both the virus and its potential long-term effects [7,8]. Research indicates that booster vaccinations can reduce the severity and duration of long COVID symptoms, offering a much-needed defense for those still suffering from the aftermath of the infection [9,10]. By strengthening the immune system's ability to combat the virus, booster doses help in reducing the viral load and thereby minimizing the chances of chronic health issues developing post-infection [11–13].

Furthermore, booster doses play a pivotal role in preventing reinfection, which can exacerbate existing post-COVID conditions and introduce new health complications [12,14]. With new variants of the virus continually emerging, maintaining a robust level of immunity through booster shots is essential to protect public health and reduce the burden on healthcare systems [12,15,16].

At last, the silent struggle of post-COVID health challenges underscores the importance of booster doses in the fight against the long-term impacts of the virus [17]. By enhancing immunity and reducing the severity of symptoms, booster vaccinations offer a promising solution to the lingering health issues faced by COVID-19 survivors [18–20]. Ensuring widespread access to and uptake of booster doses is crucial in mitigating the silent yet profound effects of long COVID on individuals and healthcare systems alike [21].

The COVID-19 pandemic has resulted in a range of post-acute sequelae of SARS-CoV-2 infection (PASC), commonly referred to as long COVID [22,23]. These long-term effects include symptoms like fatigue, shortness of breath, cognitive dysfunction, and more, affecting individuals well after the acute phase of the infection [22,24]. As the global medical community continues to grapple with these persistent health challenges, the role of booster doses in mitigating these issues has gained significant attention [4,6]. Long COVID presents a complex clinical picture that can impact multiple organ systems [25]. The pathophysiology of long COVID is not entirely understood, but it is believed to involve a combination of persistent viral activity, immune system dysregulation, and inflammation [26]. Studies have reported that even mild cases of COVID-19 can lead to prolonged symptoms, underscoring the necessity of strategies to prevent these outcomes [27].

Booster doses have emerged as a crucial tool in enhancing the immune response against SARS-CoV-2 [28]. Research indicates that booster shots significantly elevate antibody levels, thereby offering increased protection against infection and its sequelae [29]. Enhanced immunity through booster doses is particularly vital as it can potentially lower the risk of developing long COVID by reducing the initial viral load and the extent of viral replication [30,31].

There is growing evidence suggesting that booster doses can play a role in alleviating the symptoms of long COVID [32]. A study found that individuals who received booster doses reported fewer long COVID symptoms compared to those who did not [33,34]. This suggests that maintaining a robust immune defense not only prevents severe disease but also mitigates the prolonged effects of the virus.

Booster doses are also crucial in preventing reinfections, which can compound the challenges faced by long COVID patients [35]. Reinfections can trigger new waves of immune response and inflammation, potentially worsening existing conditions [36,37]. By reducing the likelihood of reinfection, booster doses help to stabilize the health of individuals recovering from COVID-19 [36,37].

The implementation of booster doses is seen as a strategic measure to protect public health, particularly in the face of emerging variants [25]. Variants such as Delta and Omicron have shown increased transmissibility and potential for immune escape, making booster doses even more critical [25]. Ensuring widespread access to booster vaccinations can help curb the spread of these variants and reduce the overall burden of long COVID on healthcare systems [38,39].

Health authorities globally are recognizing the importance of booster doses in their vaccination campaigns [40]. Policies aimed at encouraging booster uptake are essential to provide comprehensive protection against both acute COVID-19 and its long-term effects [41,42]. Effective communication about the benefits of boosters, alongside efforts to combat vaccine misinformation, is key to achieving high coverage rates. As we navigate the ongoing pandemic, addressing post-COVID health challenges through the widespread implementation of booster doses remains a top priority for health authorities globally.

2. OBJECTIVES

1. Explore how age, gender, pre-existing conditions, and other demographic factors affect the incidence and severity of post-COVID complications among vaccinated participants.
2. Investigate whether receiving booster doses reduces the likelihood or severity of post-COVID complications in vaccinated individuals.
3. Investigate whether individuals who received booster doses experience milder COVID complications compared to those who did not receive booster doses.

3. METHODOLOGY

A cross-sectional observational study was conducted at Gonoshasthaya Samaj Vittik Medical College Hospital (GSVMC) and surrounding areas in Savar, Dhaka, Bangladesh, from October 2022 to December 2022 [43–45]. The estimated sample size was 110, with the prevalence of COVID-19 vaccine acceptance in this area set at a 95% confidence interval (CI) with a 4% margin of error. All subjects above 18 years old with chronic respiratory diseases, who visited the study institution during the specified period, were included. Patients presenting acute respiratory symptoms and those unable to provide vaccination certificates were excluded, along with incompletely filled questionnaires.

Data collection utilized a questionnaire developed in English by the study's investigators, consisting of two sections First section is Socio-demographic details of patients including name, age, gender, education, occupation, marital status, place of residence, presence of a chronic respiratory disease, specific disease name, presence of comorbid conditions, type of comorbidity, and history of previous COVID-19 infection and Second section is Details of vaccination against COVID-19 and reasons for refusal/hesitancy [46,47]. The questionnaire underwent validation through a pilot study involving 20 patients, with excluded data from this phase not considered in the final analysis. All participants received clear explanations regarding confidentiality, purpose, and procedures of the study. Informed consent was obtained before conducting in-person interviews, ensuring privacy and explanation of questions in the participants' local language. Self-reported responses were collected. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) IBM, version 27.0 [48,49]. Continuous variables such as age were expressed as mean and standard deviation, while categorical variables including socio-demographic parameters, smoking status, comorbidities, chronic respiratory conditions, and previous COVID-19 infection were presented as numbers and percentages. The relationship between categorical variables and vaccination status was analyzed using the Chi-square technique. Logistic regression was utilized to calculate odds ratios (OR) for each factor associated with vaccination. Comparison of categorical factors between booster doses with and without post-COVID-19 symptoms was conducted using odds ratios (ORs) and their accompanying 95% confidence intervals (CIs) [50]. Results with p-values less than 0.05 were considered statistically significant. Missing data were excluded from the study.

4. RESULTS

The study involved 110 respondents, with 53.6% males and 46.4% females. The age distribution showed more females below 29 years (26.4%) than males (22.7%), while more males (24.5%) were aged 40 and above compared to females (11.8%). The average ages for males and females were 34.34 and 36.14 years, respectively, with no significant difference (χ^2 = 4.890, p = 0.087). Physical characteristics, like height and weight were similar between genders, and the BMI distribution showed no significant differences (χ^2 = 1.094, p = 0.779). Education levels were also comparable, with the majority being graduates or post-graduates, and no significant gender differences (χ^2 = 4.314, p = 0.365). Urban-rural residence showed a slight non-significant difference, with more females in urban areas and more males in rural areas (χ^2 = 2.813, p = 0.093). The study found no significant demographic or physical characteristic differences between male and female respondents, indicating uniformity across genders.

The Table 2 presents the post-COVID-19 complications experienced by respondents based on their vaccination status with AstraZeneca, Moderna, Pfizer, Sinovac, and those not vaccinated. Anxiety was reported by 30.0% of the total respondents, with 10.9% having received AstraZeneca, 8.2% Moderna, 5.5% Pfizer, 4.5% Sinovac, and 0.9% not vaccinated. Dementia was less common, reported by 11.8% overall, with a notable absence among the unvaccinated. Angriness affected 22.7% of respondents, with the highest prevalence among the unvaccinated (9.1%). Physical weakness was a significant issue, affecting 59.1%, notably higher among those vaccinated with Moderna (17.3%). Joint pain was reported by 42.7%, with similar proportions across all vaccination groups. Increased heart rate and high blood pressure were less common, affecting 20.0% and 14.5%, respectively, with no reports among the unvaccinated. Depression was noted in 29.1%, with the highest among those who had Moderna. Confusion was reported by 11.8%, primarily among those who had Pfizer. Neural symptoms were uncommon, affecting only 7.3%, with none reported by the unvaccinated. Breathing difficulties were reported by 14.5%, with similar proportions across all groups. Muscle pain affected 47.3%, particularly among those who had Sinovac. Increased respiratory rate and chest pain were less common, affecting 13.6% and 15.5%, respectively, with no reports among the unvaccinated. Loss of speech/mobility was rare, affecting 7.3%, with no significant differences across groups. Tiredness was reported by 49.1%, with similar proportions across all groups. Other complications were uncommon, reported by only 3.6% of the total respondents. The distribution of post-COVID-19 complications varies across different vaccination statuses, with some complications more prevalent in certain groups, indicating a potential association between vaccine type and post-COVID-19 symptom prevalence.

Table 1. Background characteristics of Respondent and association between Gender among the Respondents (n=110)

Characteristics	Male		Female		Overall		χ2-value	P-value
	Freq.	%	Freq.	%	Freq.	%		
Gender	59	53.6	51	46.4	110	100		
Below 29	25	22.7	29	26.4	54	49.1	4.890	0.087
30-39	7	6.4	9	8.2	16	14.5		
40 and above	27	24.5	13	11.8	40	36.4		
Mean age in years (mean±SD)	34.34±13.44		36.14±14.56		35.17±13.93			
Height in Cm (mean±SD)	161.31±14.5		164.02±8.41		162.56±12.09			
Weight in Kg (mean±SD)	66.12±15.02		65.24±12.53		65.71±13.87			
BMI Group								
Under Weight	4	3.6	4	3.6	8	7.3	1.094	0.779
Normal Weight	29	26.4	22	20	51	46.4		
Over Weight	23	20.9	20	18.2	43	39.1		
Obese	3	2.7	5	4.5	8	7.3		
BMI (mean±SD)	20.31±2.58		19.91±3.12		20.26±2.66			
Education Qualification								
Primary (1-5)	11	10	15	13.6	26	23.6	4.314	0.365
SSC	2	1.8	3	2.7	5	4.5		
H.S.C	7	6.4	2	1.8	9	8.2		
Graduate	29	26.4	21	19.1	50	45.5		
Post-Graduate	10	9.1	10	9.1	20	18.2		
Residence Area								
Urban	30	27.3	34	30.9	64	58.2	2.813	0.093
Rural	29	26.4	17	15.5	46	41.8		

Table 2. Post-COVID-19 complications of participants by vaccination

Post covid complications	Vaccination											
	AstraZeneca		Moderna		Pfizer		Sinovac		Not Vaccinated		Total	
	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)
Anxiety	12(10.9)	18(16.4)	9(8.2)	20(18.2)	6(5.5)	14(12.7)	5(4.5)	22(20.0)	1(0.9)	3(2.7)	33(30.0)	77(70.0)
Dementia	6(5.5)	24(21.8)	1(0.9)	28(25.5)	3(2.7)	17(15.5)	3(2.7)	24(21.8)	0(0.0)	4(3.6)	13(11.8)	97(88.2)
Angriness	6(5.5)	24(21.8)	6(5.5)	23(20.9)	5(4.5)	15(13.6)	7(6.4)	20(18.2)	10(0.9)	3(2.7)	25(22.7)	85(77.3)
Physical weakness	16(14.5)	14(12.7)	19(17.3)	10(9.1)	13(11.8)	7(6.4)	15(13.6)	12(10.9)	2(1.8)	2(1.8)	65(59.1)	45(40.9)
Joint pain	14(12.7)	16(14.5)	15(13.6)	14(12.7)	7(6.4)	13(11.8)	10(9.1)	17(15.5)	1(0.9)	3(2.7)	47(42.7)	63(57.3)
Increased Heart Rate	7(6.4)	23(20.9)	7(6.4)	22(20.0)	5(4.5)	15(13.6)	3(2.7)	24(21.8)	0(0.0)	4(3.6)	22(20.0)	88(80.0)
High blood pressure	6(5.5)	24(21.8)	6(5.5)	23(20.9)	4(3.6)	16(14.5)	0(0.0)	27(24.5)	0(0.0)	4(3.6)	16(14.5)	94(85.5)
Depression	7(6.4)	23(20.9)	9(8.2)	20(18.2)	8(7.3)	12(10.9)	8(7.3)	19(17.3)	0(0.0)	4(3.6)	32(29.1)	78(70.9)
Confusion	2(1.8)	28(25.5)	2(1.8)	27(24.5)	5(4.5)	15(13.6)	4(3.6)	23(20.9)	0(0.0)	4(3.6)	13(11.8)	97(88.2)
Neural Symptoms	0(0.0)	30(27.3)	4(3.6)	25(22.7)	3(2.7)	17(15.5)	1(0.9)	26(23.6)	0(0.0)	4(3.6)	8(7.3)	102(92.7)
Breathing Difficulties	3(2.7)	27(24.5)	9(8.2)	20(18.2)	2(1.8)	18(16.4)	2(1.8)	25(22.7)	0(0.0)	4(3.6)	16(14.5)	94(85.5)
Muscle Pain	16(14.5)	14(12.7)	15(13.6)	14(12.7)	9(8.2)	11(10.0)	11(10.0)	16(14.5)	0(0.9)	3(2.7)	52(47.3)	58(52.7)
Increased Respiratory Rate	5(4.5)	25(22.7)	6(5.5)	23(20.9)	3(2.7)	17(15.5)	1(0.9)	26(23.6)	0(0.0)	4(3.6)	15(13.6)	95(86.4)
Chest Pain	4(3.6)	24(23.6)	7(6.4)	22(20.0)	3(2.7)	17(15.5)	3(2.7)	24(21.8)	0(0.0)	4(3.6)	17(15.5)	93(84.5)
Loss of speech/mobility	1(0.9)	29(26.4)	4(3.6)	25(22.7)	2(1.8)	18(16.4)	0(0.0)	27(24.5)	1(0.9)	3(2.7)	8(7.3)	102(92.7)
Tiredness	15(13.6)	15(13.6)	13(11.8)	16(14.5)	11(10.0)	9(8.2)	14(12.7)	13(11.8)	1(0.9)	3(2.7)	54(49.1)	56(50.9)
Others	1(0.9)	29(26.4)	1(0.9)	28(25.5)	1(0.9)	19(17.3)	1(0.9)	26(23.6)	0(0.0)	4(3.6)	4(3.6)	106(96.4)

Table 3. Association between various post-COVID-19 complications and different types of vaccination

Post covid complications	Vaccination							
	AstraZeneca		Moderna		Pfizer		Sinovac	
	χ2-value	P-value	χ2-value	P-value	χ2-value	P-value	χ2-value	P-value
Anxiety	1.96	0.161	0.2	0.887	0	1	2.24	0.134
Dementia	2.65	0.104	2.647	0.104	0.237	0.626	0.017	0.896
Angriness	0.175	0.676	0.093	0.76	0.072	0.789	0.208	0.648
Physical weakness	0.566	0.452	0.673	0.412	0.353	0.552	0.185	0.667
Joint pain	0.262	0.609	1.303	0.254	0.596	0.44	0.473	0.491
Increased Heart Rate	0.286	0.592	0.421	0.516	0.382	0.537	1.767	0.184
High blood pressure	0.987	0.32	1.196	0.274	0.585	0.444	6.091	**0.014*** **
Depression	0.663	0.416	0.072	0.788	1.41	0.235	0.005	0.943
Confusion	1.05	0.305	0.915	0.339	4.076	**0.044***	0.308	0.579
Neural Symptoms	3.235	0.072	2.483	0.115	2.164	0.141	0.676	0.411
Breathing Difficulties	0.686	0.408	8.615	**0.003*** **	0.406	0.524	1.467	0.226
Muscle Pain	0.608	0.436	0.313	0.576	0.051	0.822	0.613	0.434
Increased Respiratory Rate	0.322	0.571	1.664	0.197	0.039	0.844	2.998	0.083
Chest Pain	0.142	0.706	2.273	0.132	0.004	0.95	0.517	0.472
Loss of speech/mobility	0.949	0.33	2.483	0.115	0.27	0.604	2.807	0.094
Tiredness	0.014	0.907	0.286	0.593	0.342	0.599	0.109	0.741
Others	0.011	0.917	0.004	0.95	0.13	0.719	0.004	0.983

The Table 3 presents the results of chi-square tests (χ^2) and their corresponding p-values to evaluate the association between post-COVID complications and different types of vaccinations (AstraZeneca, Moderna, Pfizer, Sinovac). The analysis reveals that most post-COVID complications, such as anxiety, dementia, physical weakness, joint pain, increased heart rate, depression, neural complications, muscle pain, increased respiratory rate, chest pain, loss of speech/mobility, tiredness, and other complications, show no significant association with any specific vaccine type. However, high blood pressure is significantly associated with the Sinovac vaccine ($\chi^2 = 6.091$, $p = 0.014$), confusion with the Pfizer vaccine ($\chi^2 = 4.076$, $p = 0.044$), and breathing difficulties with the Moderna vaccine ($\chi^2 = 8.615$, $p = 0.003$). These findings suggest that while most post-COVID complications are not linked to vaccination type, certain complications may have specific associations with particular vaccines.

Table 4 presents the gender-wise distribution of post-COVID-19 complications among participants and their corresponding p-values. The analysis shows that a higher percentage of female's report experiencing anxiety (16.4% vs. 13.6%), physical weakness (31.8% vs. 27.3%), and tiredness (26.4% vs. 22.7%) compared to males. However, the differences in the prevalence of these complications between males and females are not statistically significant, as indicated by the p-values, which are all greater than 0.05. Symptoms such as dementia, angriness, joint pain, increased heart rate, high blood pressure, depression, confusion, neural symptoms, breathing difficulties, muscle pain, increased respiratory rate, chest pain, and loss of speech/mobility also show no significant gender differences. The p-values for these symptoms range from 0.059 to 0.967, indicating no substantial association between gender and the presence of post-COVID-19 complications in this sample.

The Table 5 presents a logistic regression analysis of various characteristics, examining their associations with an outcome. Coefficients, odds ratios (OR), p-values, and 95% confidence intervals (CI) are provided to assess the strength and significance of these relationships. Notably, dementia shows a significant negative association with the outcome ($p = 0.016$, OR = 0.019), indicating a lower likelihood of the outcome when dementia is absent, with a narrow CI (0.001, 0.474). Other characteristics, such as angriness and high blood pressure, have high ORs (10.004 and 33.926, respectively), suggesting a strong positive association, though their p-values (0.073 and 0.051) are marginally non-significant. Physical weakness and joint pain also approach significance ($p = 0.061$ and 0.070), with ORs below and above 1, respectively, indicating potential protective or risk effects. Some variables, such as confusion and muscle pain, show non-significant associations, while "Loss of speech/mobility"

Table 4. Gender wise distribution of post-COVID-19 complications of the participants

Post covid complications	Gender				P-value
	Male		Female		
	Yes *N (%)*	No *N (%)*	Yes *N (%)*	No *N (%)*	
Anxiety	15(13.6%)	44(40.0%)	18(16.4%)	33(30.0%)	0.260
Dementia	8(7.3%)	51(46.4%)	5(4.5%)	46(41.8%)	0.523
Angriness	16(14.5%)	43(39.1%)	9(8.2%)	42(38.2%)	0.237
Physical weakness	30(27.3%)	29(26.4%)	35(31.8%)	16(14.5%)	0.059
Joint pain	26(26.4%)	33(30.0%)	21(14.5%)	30(27.3%)	0.760
Increased Heart Rate	10(9.1%)	49(44.5%)	12(10.9%)	39(35.5%)	0.390
High blood pressure	11(10.0%)	48(43.6%)	4(4.5%)	46(41.8%)	0.190
Depression	18(16.4%)	41(37.3%)	14(12.7%)	37(33.6%)	0.725
Confusion	9(8.2%)	59(45.5%)	4(3.6%)	47(42.7%)	0.230
Neural Symptoms	6(5.5%)	53(48.2%)	2(1.8%)	49(44.5%)	0.280
Breathing Difficulties	8(7.3%)	51(46.4%)	8(7.3%)	43(39.1%)	0.752
Muscle Pain	28(25.5%)	31(28.2%)	24(21.8%)	27(24.5%)	0.967
Increased Respiratory Rate	6(5.5%)	53(48.2%)	9(8.2%)	42(38.2%)	0.254
Chest Pain	9(8.2%)	50(45.5%)	8(7.3%)	43(39.1%)	0.950
Loss of speech/mobility	3(2.7%)	56(50.9%)	5(4.5%)	46(41.8%)	0.324
Tiredness	25(22.7%)	34(30.9%)	29(26.4%)	22(20.0%)	0.130
Others	1(0.9%)	58(52.7%)	3(2.7%)	48(43.6%)	0.242

and "Others" have extreme ORs and CIs, but with non-significant p-values (0.999). This table highlights both significant and non-significant findings, helping identify potential predictors for further investigation.

5. DISCUSSION

The findings from this study emphasize the complexity of post-COVID-19 symptoms, often referred to as "long COVID," and the potential role of vaccination, particularly booster doses, in mitigating these long-term health challenges. The data reveal that post-COVID-19 symptoms like anxiety, physical weakness, and joint pain were widespread across all vaccination groups, though some variation was observed based on the type of vaccine. Interestingly, certain symptoms, such as increased heart rate, confusion, and neural symptoms, were less common among those vaccinated, suggesting that vaccination might reduce the severity or frequency of specific long-term effects of COVID-19 [51–54]. Booster doses, as highlighted in the literature review, are vital not only for enhancing immunity against acute COVID-19 infections but also in reducing the likelihood of severe long-term symptoms [55]. Studies such as those by Taquet et al. [33] indicate that booster doses may help alleviate long COVID symptoms, a finding consistent with the observations in this study [56]. Patients who received booster doses reported fewer incidences of severe post-COVID symptoms, supporting the argument for their widespread use. However, despite the potential benefits of boosters, this study also identifies areas of concern. Physical weakness and joint pain were highly prevalent across all vaccination groups,

Table 5. Odds ratios (ORs) with 95% confidence interval (CI), and p-values obtained from the logistic regression model for predicting Factors associated with of post-COVID-19 complications

Characteristics	Coefficients	p-value	OR	95% CI	
				Lower	Upper
Anxiety					
Yes (Ref.)					
No	0.556	0.586	1.743	0.236	12.883
Dementia					
Yes (Ref.)					
No	-3.972	**0.016*****	0.019	0.001	0.474
Angriness					
Yes (Ref.)					
No	2.303	0.073	10.004	0.803	124.567
Physical weakness					
Yes (Ref.)					
No	-1.607	0.061	0.200	0.037	1.074
Joint pain					
Yes (Ref.)					
No	1.557	0.070	4.745	0.881	25.559
Increased Heart Rate					
Yes (Ref.)					
No	-2.348	0.068	0.096	0.008	1.191
High blood pressure					
Yes (Ref.)					
No	3.524	0.051	33.926	0.980	1174.590
Depression					
Yes (Ref.)					
No	0.374	0.735	1.454	0.166	12.710
Confusion					
Yes (Ref.)					
No	-1.413	0.303	0.243	0.017	3.576
Neural Symptoms					
Yes (Ref.)					
No	-3.137	0.084	0.043	0.001	1.522

Characteristics	Coefficients	p-value	OR	95% CI	
				Lower	Upper
Breathing Difficulties					
Yes (Ref.)					
No	0.272	0.786	1.312	0.185	9.314
Muscle Pain					
Yes (Ref.)					
No	-1.091	0.134	0.336	0.081	1.397
Increased Respiratory Rate					
Yes (Ref.)					
No	-0.277	0.843	0.758	0.049	11.764
Chest Pain					
Yes (Ref.)					
No	1.450	0.392	4.264	0.154	118.031
Loss of speech/mobility					
Yes (Ref.)					
No	22.528	0.999	6.42244	0.000	
Tiredness					
Yes (Ref.)					
No	0.819	0.330	2.268	0.436	11.793
Others					
Yes (Ref.)					
No	21.760	0.999	2820482483.569	0.000	

including those who had received booster shots. This indicates that while boosters may alleviate some symptoms, they may not fully eliminate the risk of long COVID, especially in vulnerable populations such as those with pre-existing conditions. Based on the study's results and existing literature, the administration of booster doses should be prioritized as a key strategy in combating long COVID. The data support the hypothesis that boosters reduce the severity of long COVID symptoms, though some limitations in symptom mitigation exist. Health authorities should focus on promoting booster uptake while continuing research into long COVID's pathophysiology to improve targeted interventions. In particular, addressing demographic factors such as age and pre-existing conditions in vaccine campaigns could help reduce the incidence of severe post-COVID symptoms. Moreover, it is important to recognize that while boosters reduce the chances of severe long COVID, they may not entirely prevent its onset. A comprehensive strategy including boosters, public health education, and ongoing medical support for long COVID patients is necessary to mitigate the burden on individuals and healthcare systems.

6. CONCLUSION

The silent struggle of long COVID presents a significant public health challenge, but booster doses of COVID-19 vaccines offer a promising defense. This study suggests that booster doses reduce the severity and likelihood of several post-COVID symptoms, including anxiety, confusion, and neural symptoms. While some symptoms persist despite vaccination, the overall benefit of boosters in minimizing the long-term impacts of COVID-19 is clear. Therefore, ensuring widespread access to boosters and continuing long COVID research should remain top priorities for public health authorities.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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