CCI JOURNAL CRITICAL CARE INNOVATIONS

ORIGINAL ARTICLE

Crit. Care Innov. 2023; 6(1): 17-28

Retrospective comparative study of clinical profile and pulmonary involvement in unvaccinated and vaccinated individuals diagnosed with COVID-19.

ISSN 2545-2533

Received: 30.12.2022

Accepted: 20.02.2023

First online: 21.02.2023

Published: 31.03.2023

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ABSTRACT

INTRODUCTION: This study aims to assess the clinical profile, co-morbidities and pulmonary involvement by means of CT-SS and CO-RADS in unvaccinated and completely vaccinated individuals diagnosed with COVID-19 infection.

MATERIAL AND METHODS: A total of 138 adult patients infected with SARS-CoV-2 Virus between January 2021 and January 2022 in Bharati Hospital and Research Centre, Pune, Maharashtra, India were recruited for this retrospective, comparative study. Data was collected from medical records. All patients presenting to the institute with clinical features suggestive of SARS-CoV-2 infection were subjected to confirmative testing and the patients who tested positive for SARS-CoV-2 infection underwent a standardized HRCT thorax imaging. Clinical features, co-morbidities, vital parameters and the association of CTSS scores and CO-RAD scores between vaccinated and unvaccinated individuals were analyzed.

RESULTS: Out of the 138 patients included in this study, 69 (39 male, 30 female) were unvaccinated and 69 (49 male, 20 female) were vaccinated. Mean CO-RADS and CTSS in the unvaccinated cohort was significantly higher than the vaccinated ($p < 0.001$). Mean CO-RADS = 5.14 (unvaccinated) vs 3.72 (vaccinated) and mean CTSS = 15.23 (unvaccinated) vs 10.54 (vaccinated). Patients with no co-morbidities had significantly lower CTSS and CO-RADS scores, regardless of vaccination status. Vaccinated patients suffered from mild disease, as noted by lower requirement of supplemental oxygen, higher SpO_2 on room air, and lower incidence of nonspecific symptoms, respiratory symptoms, and gastrointestinal symptoms.

CONCLUSIONS: This study finds that complete vaccination is necessary in order to prevent severe symptoms, high oxygen requirement, and extensive pulmonary involvement in COVID-19.

KEY WORDS: Vaccination, pandemic, pulmonary, radiological.

INTRODUCTION

SARS-CoV-2 is a member of a large family of viruses called coronavirus. This highly infectious virus is commonly known today to cause corona virus disease 19 (COVID-19) which presents as severe respiratory syndrome. Having been declared a pandemic on 11th March 2020, COVID-19 had a devastating effect on the entire world. The first case of COVID-19 was reported in India on January 30, 2020 and since then India has reported over 27 million cases and more than 3,00,000 deaths [1].

The COVID-19 vaccine drive was launched in India on 16th January, 2021. By July 20, 2021 23.4% of the Indian population had received the first dose of the vaccine and 6.1% had received the second dose [2]. Vaccination was encouraged for healthcare workers, elderly population and those with co-morbid conditions. Despite being armed with vaccines, the virus continues to infect the population well into present day. After the initial outbreak, India suffered through a second wave starting in March 2021 and a third wave starting in January 2022, despite the ongoing vaccination drives throughout the country. Case fatality rate in Pune, Maharashtra, India declined from 1.80 per 1000 person-days (PD) in the first wave, to 0.77 per 1000 person-days (PD) in the second wave [3]. It is expected that with the rise of vaccinations the case fatality rate and severity of symptoms will continue to decline in the third wave of COVID-19. On admission to a tertiary care center for COVID-19, patients highly suspected or proven to be infected with SARS-CoV-2 virus displaying respiratory involvement are subjected to high-resolution computed tomography (HRCT) thorax from which the HRCT-derived severity score (CT-SS) and COVID-19 Reporting and Data System (CO-RADS) scores are calculated. Evaluation by HRCT thorax has reported high sensitivity and is a standardized assessment useful for prognostication and treatment [4]. Developed by the Dutch Radiological Society, CO-RADS assesses the suspicion for pulmonary involvement on a scale from 0 (not interpretable) through to 5 (very high - characteristically seen in COVID-19) and 6 (proven - SARS-CoV-2 RTPCR Positive) [5]. Developed in China by Yang R et al in March 2020, CT-SS was defined by summing up individual scores from 20 pre-defined lung regions wherein the total CT-SS was higher in severe COVID-19 when compared to mild cases with 83.3% sensitivity and 94% specificity [6]. CT-SS can be classified into mild (score < 10/25), moderate (score 10-16) and severe (>16/25) based on results of the HRCT scan [7].

A plethora of literature is available stating the benefits of vaccination against SARS-CoV-2 in patients with advancing age and co-morbidities. This study aims to assess the clinical profile, including age, gender and co-morbid conditions and pulmonary involvement (by means of CT-SS, CO-RADS, oxygen requirement) in unvaccinated and completely vaccinated individuals infected with COVID-19.

MATERIAL AND METHODS

After attaining approval from the institutional ethical committee (Ref: BVDUMC/IEC/20D), a total of 138 adult patients infected with SARS-CoV-2 virus between January 2021 and January 2022 in Bharati Hospital and Research Centre, Pune, Maharashtra, India were chosen for this retrospective, comparative

study in accordance with Helsinki Declaration. Data was collected from medical records of patients admitted to the general COVID-19 ward during the stipulated time period. All patients admitted with a test positive for SARS-CoV-2 infection (as detected by RT-PCR or rapid antigen testing) and who underwent a standardized HRCT thorax imaging were included in this study. Vaccination status of all patients was noted. According to the Centres for Disease Control and Prevention, a person is considered “up to date” in their Covid-19 vaccination if they have completed the primary series of vaccination (two-dose series of Covid-19 vaccination). Those patients who fulfill this criteria were deemed as “vaccinated” in the present study, regardless of type of vaccine, while all other patients were deemed “unvaccinated” (including those with only one dose of vaccine). Comparison of CT-SS and CO-RAD scores were made between vaccinated and unvaccinated patients. CT-SS findings were further categorized into mild (<10 out of 25), moderate (10-16 out of 25) and severe (>16 out of 25). Epidemiological factors, clinical features, co-morbid conditions and supplemental oxygen requirement were also compared between the two groups. Statistical analysis was done considering p value <0.05 as statistically significant.

RESULTS

Epidemiological Factors

Among 138 patients, 69 (39 male, 30 female) were unvaccinated, while 69 (49 male, 20 female) were vaccinated. Majority of male subjects were vaccinated (56%), while majority of female subjects were unvaccinated (60%). Comparison among male subjects, in terms of CORADS and CT-SS in vaccinated males versus unvaccinated males shows significant difference. Males who completed vaccination showed significantly lower CORADS (3.57 ± 1.15 vs. 5.21 ± 1.15 in vaccinated vs. unvaccinated, respectively, p <0.001) and CT-SS (10.63 ± 4.60 vs. 15.31 ± 4.29 in vaccinated vs. unvaccinated, respectively, p <0.001) compared to their unvaccinated counterparts (Table 1a).

Table 1a. Comparison of vaccination status, age, CO-RADS and CT-SS in male patients.

	Vaccination Status	CO-RADS	p value	CT-SS	p value
Male	Vaccinated (n=49)	3.57 ± 1.15	**< 0.001**	10.63 ± 4.60	**< 0.001**
	Unvaccinated (n=39)	5.21 ± 1.15		15.31 ± 4.29	

Analysed using ANOVA test. P <0.05 is significant.

Comparison among female subjects, in terms of CORADS and CT-SS in vaccinated females versus unvaccinated females shows significant difference. Females who completed vaccination showed significantly lower CORADS (4.10 ± 1.29 vs. 5.07 ± 0.91 in vaccinated vs. unvaccinated, respectively, p <0.01) and CT-SS (10.3 ± 5.75 vs. 15.13 ± 5.27 in vaccinated vs. unvaccinated, respectively, p <0.01) compared to their unvaccinated counterparts (Table 1b).

Table 1b. Comparison of vaccination status, CO-RADS and CTSS in female patients.

	Vaccination Status	CO-RADS	p value	CTSS	p value
Female	Vaccinated (n=20)	4.10 ± 1.29	**< 0.01**	10.3 ± 5.75	**< 0.01**
	Unvaccinated (n=30)	5.07 ± 0.91		15.13 ± 5.27	

Analysed using ANOVA test. P <0.05 is significant.

14.5% (n= 20) of the total population were newly diagnosed with a co-morbidity (such as diabetes mellitus n=8, pre-diabetes n=6 or hypertension n=6) at the time of initial evaluation. The vaccinated population suffered from hypertension (64%, n=39), diabetes mellitus (44%, n=25), with some patients suffering from both (38%, n=8) (Table 2). Other co-morbid conditions included: hypothyroidism (7.2% unvaccinated, 4.3% vaccinated patients), cerebrovascular accident (7.2% vaccinated patients only), obstructive sleep apnoea (7.2% of vaccinated patients only), bronchial asthma (5.7% vaccinated patients only), kidney disease (2.9% unvaccinated, 8.7% vaccinated), ischemic heart disease (4.3% unvaccinated, 2.9% vaccinated); and chronic liver disease, HCV positive status, HIV positive status (1.4%, 1.4% and 5.8% vaccinated patients only, respectively).

Table 2. Demographic features and co-morbidities of patients.

Characteristics	Number of patients n (%)	Vaccinated n (%)	Unvaccinated n (%)
Total number of study participants	138 (100)	69 (50)	69 (50)
Age (in years)			
Mean +/- Standard deviation	52.66 ± 14.57	56.14 ± 13.69	49.17 ± 14.66
Median	51	56	46
Mode	44	50	44
Gender			
Male	88 (63)	49 (56)	39 (44)
Female	50 (37)	20 (40)	30 (60)
Co-morbid conditions			
No co-morbidities	32 (23)	6 (19)	26 (81)
Diabetes Mellitus (incl. Pre-Diabetes)	57 (41)	25 (44)	32 (56)
Hypertension	61 (44)	39 (64)	22 (36)
Both Diabetes Mellitus and Hypertension	21 (15)	8 (38)	13 (62)
Other	42 (30)	32 (76)	10 (24)

Clinical Features

The most common symptoms included fever (76.8%), cough (70%, of which dry cough 76%) generalized weakness and loss of appetite (both 61.6%) and breathlessness (51.4%). Severe symptoms like breathlessness (59.4%), cough (55.2%), chest pain (14.5%), hemoptysis (11.6%), diarrhea and vomiting (36.2% and 14.5% respectively) were seen predominantly in unvaccinated patients, while mild symptoms like generalized weakness (63.8%) and body ache (39.1%) were noted in vaccinated patients (Table 3).

Table 3. Clinical features.

Clinical Feature	Number of patients n (%)	Vaccinated n (%)	Unvaccinated n (%)
Non-specific			
Fever	106 (76.8)	50 (72.5)	56 (81.2)
Loss of smell	28 (20.3)	3 (4.3)	25 (36.2)
Loss of taste	66 (47.8)	15 (21.7)	51 (73.9)
Generalized weakness	85 (61.6)	44 (63.8)	41 (59.4)
Headache	46 (33.3)	21 (30.4)	25 (36.2)
Bodyache	51 (37.0)	27 (39.1)	24 (34.8)
Joint pain	7 (5.1)	3 (4.3)	4 (5.8)
Respiratory Symptoms			
Sore throat	31 (22.5)	14 (20.3)	17 (24.6)
Cough	96 (70.0)	Dry 40 (58.0) Wet 3 (4.3)	Dry 33 (60.9) Wet 20 (7.2)
Hemoptysis	9 (6.5)	1 (1.4)	8 (11.6)
Rhinitis	20 (14.5)	5 (7.2)	15 (21.7)
Chest pain	15 (10.9)	5 (7.2)	10 (14.5)
Breathlessness	71 (51.4)	30 (43.5)	41 (59.4)
Gastrointestinal Symptoms			
Loss of appetite	85 (61.6)	30 (43.5)	55 (79.7)
Diarrhoea	37 (26.8)	12 (17.4)	25 (36.2)
Vomiting	15 (10.9)	5 (7.2)	10 (14.5)

Statistical Significance Difference between symptoms of unvaccinated and vaccinated subjects did not show statistical significance (accept the null hypothesis by Mann-Whitney U test). Comparison of Pulmonary Involvement in Vaccinated versus Unvaccinated Patients

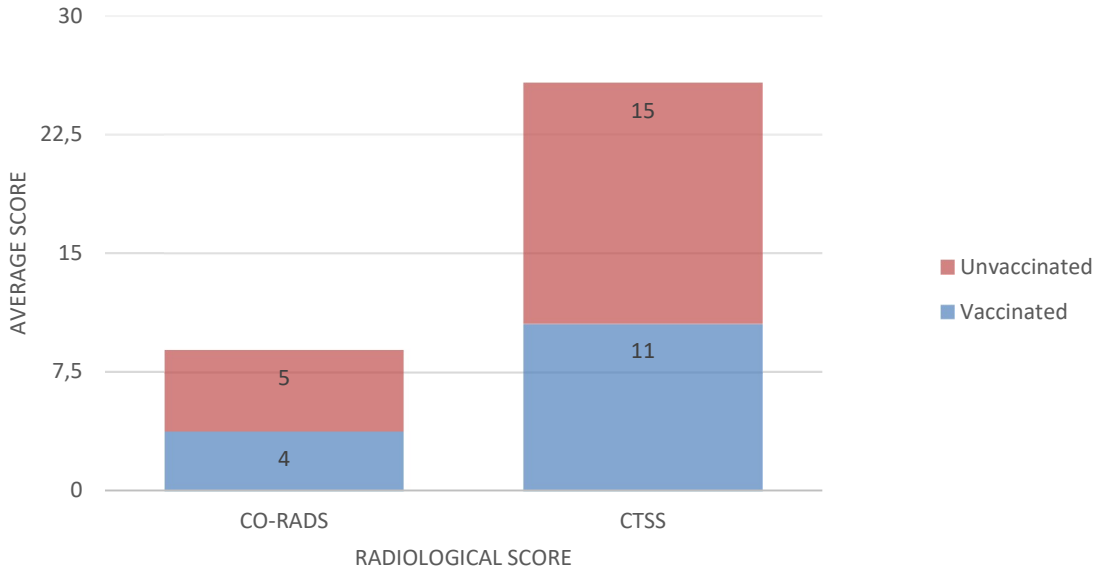

Figure 1. Comparison of pulmonary involvement using CO-RADS and CT-SS based on Vaccination Status.

On average, the CO-RADS and CT-SS in unvaccinated patients was significantly higher, and therefore worse than those who were vaccinated. The average CO-RADS for unvaccinated patient was 5.14 ± 1.05 compared to 3.72 ± 1.21 in vaccinated ($p < 0.001$). The average CT-SS for unvaccinated patients was 15.23 ± 4.70 compared to 10.54 ± 4.92 in vaccinated patients ($p<0.001$) (Figure 1).

Vital Parameters

A significant difference was discovered between the patient's SpO_2 on room air and the requirement of supplemental oxygen for both unvaccinated and vaccinated patients ($p < 0.05$ for both parameters). Unvaccinated patients on average presented with lower mean oxygen saturation (SpO_2) on room air of 92.71 ± 4.59% (p 0.02) (regardless of presence or absence of comorbidity). Out of 69 unvaccinated patients, 34 required oxygen support (average 6.24 ± 3.17 L/min O_2, $p <0.001$). Vaccinated individuals displayed a higher mean SpO_2 on room air of 94.58 ± 4.92% ($p<0.001$). Only 19 patients required supplemental oxygen with a lower average requirement of 3.68 ± 1.42 L/min ($p<0.02$).

Pulse rate and respiratory rate were both significantly higher in unvaccinated subjects (mean pulse 93.93 ± 12.01 beats per minute and mean respiratory rate 21.38 ± 4.34 breaths per minute) as compared to their vaccinated counterparts (mean pulse 87.97 ± 11.38 beats per minute and mean respiratory rate 19.61 ± 3.66 breaths per minute) ($p= 0.003$ and $p=0.01$ respectively). Blood pressure was not significantly affected between the two groups (p value not significant).

Correlation of Pulmonary Involvement, Co-morbid conditions and Vaccination Status

Vaccination in patients with co-morbid conditions significantly lowers the pulmonary involvement ($p<0.001$). Lower values of CT-SS (average in vaccinated was 10.50 ± 4.95 versus 16.19 ± 4.25 in unvaccinated, $p<0.001$), lower CO-RADS (average in vaccinated was 3.71 ± 1.18 versus 5.47 ± 0.74 in unvaccinated, $p<0.001$), higher SpO_2 on room air (average in vaccinated was 94.35 ± 5.08 versus 91 ± 4.09 in unvaccinated, $p<0.001$) and less requirement of supplemental oxygen (average in vaccinated was 3.68 ± 1.42 versus 6.33 ± 3.23 in unvaccinated, $p<0.001$) was noted. While the average SpO_2 of unvaccinated patients regardless of comorbidity was 92.71 ± 4.59% (p 0.02), patients who were unvaccinated and also had comorbidity fared worse (91 ± 4.09% , p <0.001) than those who were unvaccinated and without a comorbidity (95.54 ± 3.98). Patients with comorbidity, who completed vaccination, fared better than those who were unvaccinated (Table 4). The most common co-morbidities encountered were diabetes mellitus and hypertension, which did not show significant difference in pulmonary involvement between them (Table 5).

Table 4. Effect of vaccination on pulmonary involvement in patients with and without comorbidity.

Comorbidity	Vaccination Status	Mean CT-SS (out of 25)	p value	Mean CO-RADS (out of 6)	p value	Mean SpO_2 on Room Air (%)	p value	Mean O_2 requirement (L/min)		p value
Present	Vaccinated (n=63)	10.59 ± 4.95	**< 0.001**	3.71 ± 1.18	**< 0.001**	94.35 ± 5.08	**<0.001**	n=19	3.68 ± 1.42	**<0.001**
	Unvaccinated (n=43)	16.19 ± 4.25		5.47 ± 0.74		91 ± 4.09		n= 30	6.33 ± 3.23	
Absent	Vaccinated (n=6)	10 ± 5.02	0.149	4.44 ± 1.27	0.3	97 ± 1.09	0.11	n=0	4.4 ± 3.0	0.035
	Unvaccinated (n=26)	13.65 ± 5.07		4.62 ± 1.27		95.54 ± 3.98		n=4	5.5 ± 3	

Analysed using ANOVA test. P <0.05 is significant.

Table 5. Comparison of pulmonary involvement between vaccinated and unvaccinated diabetic and hypertensive patients.

Co-Morbidities	Vaccination Status	Mean CT-SS (out of 25)	p value	Mean CO-RADS (out of 6)	p value	Mean SpO_2 on Room Air (%)	p value	Mean O_2 requirement (L/min)	p value
Diabetes Mellitus (n=57)	Vaccinated (n=25)	11.88 ± 5.66	0.002	3.56 ± 1.29	< 0.001	93.52 ± 5.44	0.03	4.44 ± 1.33	0.03
	Unvaccinated (n=3)	16.34 ± 4.58		5.41 ± 0.78		90.66 ± 3.99		6.33 ± 3.31	
Hypertension (n=61)	Vaccinated (n=39)	10.82 ± 4.64	< 0.001	3.79 ± 1.20	< 0.001	94.36 ± 5.04	0.01	3.33 ± 1.37	< 0.001
	Unvaccinated (n=22)	16.39 ± 4.74		5.57 ± 0.59		91.13 ± 4.32		7.5 ± 3.67	

Analysed using ANOVA test. P <0.05 is significant.

Unvaccinated patients (n=69), especially those with comorbidity, were more likely to have severe CT-SS scores (n=23, average=19.39 ± 1.47) compared to vaccinated patients (n=69) with comorbidity, who suffered more from mild (n= 22, 5.14 ± 2.03) to moderate scores (n=33, 12.27 ± 2.10) (Figure 2). The average mild CT-SS score of vaccinated patients was significantly lower than unvaccinated (p 0.025). The average moderate and severe CT-SS scores were not significantly affected by vaccination status, nor gender (p > 0.05) (Table 6).

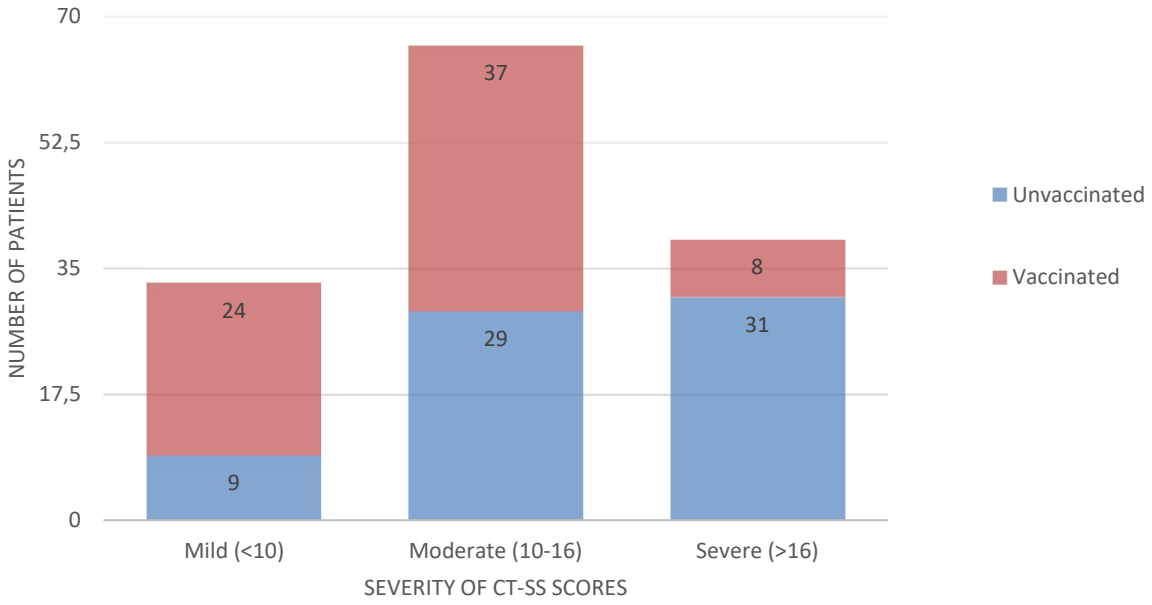

Figure 2. Comparison of severity of CT-SS with vaccination status.

Table 6. Effect of vaccination status in patients with comorbidity on CT-SS scores.

	Mild (<10)	p value	Moderate (10-16)	p value	Severe (>16)	p value
Vaccinated + Comorbidity	n=22 average CT-SS 5.14 ± 2.03	**0.025**	n=33 average CT-SS 12.27 ± 2.10	**> 0.05**	n=8 average CT-SS 18.63 ± 2.00	**> 0.05**
Unvaccinated + Comorbidity	n=3 average CT-SS 6.33 ± 1.53		n=17 average CT-SS 13.58 ± 2.00		n=23 average CT-SS 19.39 ± 1.47	

Analysed using ANOVA test. P <0.05 is significant.

No significant difference between average CT-SS in males (12.70 ± 5.02) and females (13.20 ± 5.91), regardless of vaccination status (p >0.05). Among males, vaccination significantly lowers CT-SS and similar among females (p <0.001 and 0.005, respectively) (Table 7). 31.9% males (vaccinated n=17, unvaccinated n=5) suffered from mild CTSS (score <10), versus 15.9% females (vaccinated n=7, unvaccinated n=4) with mild CTSS.

Table 7. Comparison of gender and vaccination status on CTSS.

	CTSS	p value
Vaccinated male	10.63 ± 4.60	**< 0.001**
Unvaccinated male	15.31 ± 4.29	
Vaccinated female	10.3 ± 5.75	**0.005**
Unvaccinated female	15.13 ± 5.27	

Analysed using ANOVA test. P <0.05 is significant.

DISCUSSION

138 patient files were retrospectively examined and compared. Equal numbers of vaccinated (n=69) and unvaccinated (n=69) patients were included in this study, whereas more unvaccinated patients were seen in comparable studies including Atre et al (768 unvaccinated, 76.6%) and Madhu et al. (180 unvaccinated, 87.4%) [8,9]. Lakhia et al. demonstrated more vaccinated rather than unvaccinated (87 unvaccinated, 38.0%) [10]. The average age of this study's participants was 52.66 ± 14.57 years. Males constituted 63% of the cohort. Atre et al. conducted a similar study in which the average age was lower (49.0 ± 15.6), and the division of male and female was similar (64% male subjects) to the present study. A study by Wang et al. in Wuhan, China studied 344 subjects in ICU with COVID-19, of which 179 (52%) subjects were male, and the average age was 64 years (range 52-72 years) [11]. The current study saw more males with complete vaccination (n=49, 56%) and more females with incomplete vaccination (n=30, 60%). Unlike the current study, Lakhia at al. displayed more unvaccinated males than vaccinated. A study by Potdar et al. observed gender disparities towards vaccination in Maharashtra state, India which showed that for every 100 men only 84 women were vaccinated [12].

The present study showed higher percentage of patients with comorbidity (77%) as compared to Atre et al who had only 26.2% patients with comorbidity. The most common comorbidity to be encountered was Diabetes Mellitus (41%), followed by Hypertension (44%), with some patients having both (15%). In the study by Wang et al., 141 (41%) had hypertension, 64 patients (18.6%) had diabetes mellitus. Our study demonstrated higher mean CT-SS in co-morbid patients compared to patients without comorbidity, similar to Atre et al., but did not show significant difference in CT-SS scores between diabetics and hypertensives (p > 0.05). Patients with diabetes and hypertension, who completed vaccination, recorded better parameters than unvaccinated diabetics and hypertensives (p< 0.05, Table 5).

The current study was focussed on determining the incidence of extensive lung involvement in patients with co-morbidities which would account for the difference between both studies. The present study found that vaccinated patients were more likely to suffer from non-specific mild symptoms (such as fever (n=50, 72.5%), generalized weakness (n=44, 63.8%) and body ache (n=27, 39.1%)). Unvaccinated patients suffered from severe respiratory symptoms like breathlessness (n=41, 59.4%), dry cough (n=33, 60.9%), fever (n=56, 81.2%), loss of taste (n=51, 73.9%) as well as gastrointestinal symptoms of loss of appetite (n=55, 79.9%), diarrhoea (n=25, 36.2%) and vomiting (n=10, 14.5%). Similar findings were noted in a study by Khan et al. who found that vaccinated cohort suffered less from breathlessness and cough than the unvaccinated cohort [13]. In another study, Antonelli et al. noted that almost all symptoms were reported less frequently in infected vaccinated individuals [14].

This study found that vaccines have an impact on pulmonary involvement as witnessed by lower CT-SS, lower CO-RADS, higher oxygen saturation on room air and less requirement of supplemental oxygen. This was observed in lower values of CT-SS (vaccinated average 10.54 ± 4.92 versus unvaccinated average 15.23 ± 4.70, $p<0.001$), lower CO-RADS (vaccinated average 3.72 ± 1.21 versus unvaccinated average 5.14 ± 1.05, $p<0.001$), higher SpO_2 on room air (average in vaccinated was 94.58 ± 4.92% versus 92.71 ± 4.59% in unvaccinated, $p<0.02$) and less requirement of supplemental oxygen (average in vaccinated was 3.68 ± 1.42 versus 6.24 ± 3.17 in unvaccinated, $p<0.001$). A study by Verma et al. also found patients receiving complete vaccination had a low mean CT-SS (3.5 ± 6.3) compared to unvaccinated (10.1 ± 11.4) [15]. Dubey et al. demonstrated similar findings to the present study in that their vaccinated cohort displayed normal or mild CT-SS (defined as < 8 out of 25 in their study), whereas moderate (42% showed 8-15 out of 25) or severe scores (42% showed >15 out of 25) were predominantly noted in the unvaccinated cohort [16]. Vaccinated patients with co-morbidities, regardless of age or gender, were more prone to developing mild to moderate pulmonary involvement (average CT-SS 10.59 ± 4.95, average CO-RADS 3.71 ± 1.18), average SpO_2 on room air 94.35+/- 5.08%, and average supplemental oxygen requirement 3.68 +/- 1.42 L/min; ($p<0.001$ for all). Unvaccinated patients who had comorbidity demonstrated average CT-SS 16.19 +/- 4.25, average CO-RADS 5.47 ± 0.74, average SpO_2 on room air 91.00 ± 4.09%, average supplemental oxygen requirement 6.33 ± 3.23 L/min; $p<0.001$ for all.

Although infected vaccinated patients did show pulmonary involvement in terms of positive findings on HRCT thorax, they predominantly displayed mild to moderate score of CT-SS as compared to infected unvaccinated patients. Atre et al also demonstrated significantly lower mean CT-SS in infected patients with no co-morbidities (mean CT-SS 7.12 versus 8.75 in hypertensive patients and 10.39 in diabetic patients). The current study shows similar results. Vaccinated patients with no co-morbidities CT-SS 10.59 ± 4.95, vaccinated hypertensive patients 10.82 ± 4.64, vaccinated diabetics 11.88 ± 5.66 compared to unvaccinated; $p<0.02$, $p<0.001$ and $p< 0.002$ respectively) and, and also further states that vaccinated individuals with no co-morbidities have the lowest CT-SS score among all (10.00 ± 5.02) (Table 4).

Atre et al found that males showed significantly higher CT-SS than females (8.0 versus 7.05 respectively), whereas the current study found no significant difference between males (12.70 ± 5.02) and females (13.20 ± 5.91), regardless of vaccination status (p >0.05) (Table 7). In our study, it was found that majority of males 31.9% (vaccinated n=17, unvaccinated n=5) suffered from mild CT-SS, versus 15.9% females (vaccinated n=7, unvaccinated n=4) with mild CT-SS. This differs from Atre et al who found mild CT-SS scores in females (64.1%), rather than males.

Limitation of the study - Relatively small sample size is a limitation of the present study. While significant relationships were studied in the data procured, the generalizability of the study is affected by the sample size. The population of the study only studies the effect of vaccinations given in the Indian subcontinent on the Indian population, which can also hamper generalizability to other parts of the world. As this was a retrospective study, the study findings (such as clinical features) were solely dependent on the clinical skills of the physicians under which the patients were admitted at that time, and may unknowingly produce bias. Also, the division of patients does not include patients with a single dose of vaccination as a separate division; rather, they have been counted as “unvaccinated” along with those patients without a single dose.

CONCLUSIONS

This study stands to reinforce the need for vaccination against the SARS-CoV-2 virus, commonly known to cause COVID-19 disease. This study finds that complete vaccination is necessary in order to prevent severe symptoms, high oxygen requirement, and extensive pulmonary involvement in COVID-19 especially with those who already suffer from co-morbidities such as diabetes mellitus and hypertension. Moderate to severe scores of CT-SS were noted in unvaccinated patients, while vaccinated patients were likely to suffer from mild scores. Overall, vaccinated patients had better oxygen saturation on room air, required less supplemental oxygen, experienced lower CORADS and CT-SS scores, as well as suffered from mild symptoms as compared to their unvaccinated counterparts. Patients with comorbidity who were vaccinated fared better than unvaccinated patients with comorbidity.

SUPPLEMENTARY INFORMATION

Funding: *No fund was received related to this study.*
Institutional Review Statement: *The study was conducted according to the guidelines of the Declaration of Helsinki.*
Informed Consent Statement: *Informed consent was obtained from all subjects involved in the study.*
Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.*
Conflicts of Interest: *The authors declare no conflicts of interest.*

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