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# A Comparative Study of Lung Involvement Among Vaccinated and Unvaccinated Covid - 19 Patients

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ABSTRACT

COVID-19 caused by a novel agent SARS-CoV-2 progressed to a pandemic condition and resulted in a major public health concern worldwide, leading to social and economic issues at the same time. Vaccinated people getting infected with SARS-COV2 brings a dilemma among the population whether to get vaccinated or not. The primary objective of this study is to evaluate the impact of vaccination by comparing the lung involvement in vaccinated and un vaccinated Covid – 19 patients. Retrospective anonymised data of COVID-19 inpatients who underwent HRCT scan during the second wave of pandemic were collected through a validated data collection form, from the medical records of tertiary care private medical college hospital. Vaccinated and non-vaccinated COVID-19 positive participants of 33 each were included in the study. CT severity score (CTS), D-dimer, IL-6 level, oxygen requirement and duration of hospital stay were statistically analysed using appropriate methods. The mean age of the study participants were 56.93 ± 16.01 years. There was no statistical significance between both the groups with respect to gender distribution in vaccinated and unvaccinated groups. There was a statistically significant difference in mean CTS score($p<0.001$) and oxygen requirement($p<0.05$) among vaccinated and unvaccinated patients. There was no statistical significance between CORADS, IL-6, D – Dimer and duration of hospital stay. In COVID-19 patients, vaccination reduces the extent of lung involvement and the need for oxygen. The COVID-19 vaccination conundrum is somehow resolved by this study, which also gives us a clear picture of the vaccine's efficacy.

**Keywords:** COVID19; Vaccination; HRCT Scan; CORADS Severity

## INTRODUCTION

COVID -19 caused by a novel agent SARS-CoV-2 progressed to a pandemic condition and resulted in a major public health concern worldwide, leading to social and economic issues at the same time. After its initial outbreak in Wuhan in 2019, the coronavirus disease (COVID-19) pandemic is still raging, with fresh infection waves continuing to emerge with various mutations that continue to challenge the efficacy of established vaccines and diagnostic tests[1]. Worldwide immunization campaigns that are extensive helped to contain the outbreak, but the population coverage varied greatly between countries, depending on vaccine availability, changing its vaccination guidelines and administering a different vaccine to its populace[2]. The pathogenesis of COVID - 19 starts with the bonding of the virus to ACE2 receptors. It is expressed mainly in human airway epithelia as well as in lung parenchyma. The sites of infections, correlate with the ACE expression and localization. The symptoms of COVID-19 can range in intensity from mild to severe, and some people may experience more serious symptoms like shortness of breath with pneumonia. The angiotensin-converting enzyme 2 (ACE2) receptor is the

entry point for the corona virus 2 (SARS-CoV-2)[3]. Despite the fact that several organs, primarily lung parenchyma and airway epithelia, have already been found to contain it, by using ACE2 immunohistochemistry analysis, it was discovered that some tissues, like the sinuses, vocal cords, salivary glands, and oral cavity epithelial cells, have enriched with ACE2 receptor expression. This explains why the oropharyngeal and nasal sample was used for the RT-PCR analysis[4]. Early diagnosis, containment measures, and other preventive efforts are crucial for the control of this disease. The early detection and treatment of COVID-19 patients depend greatly on radiological evaluation as a standard imaging tool. The early diagnosing process is greatly aided by thin section CT. As a result, it might be considered a primary diagnostic procedure, particularly during pandemic. It is more capable of identifying these subtle changes than simple chest radiography. It also has a decreased rate of COVID-19 missed diagnoses. The most frequent CT findings were air bronchograms, ground glass opacities, consolidation, interlobular septal thickening and surrounding pleura thickening. Only HRCT (High resolution Computed Tomography) of the lung can be used to determine the extent of pulmonary involvement in COVID-19[5]. It is the best approach for determining the disease stage and is helpful in circumstances when Covid - 19 RT- PCR results were negative to confirm the diagnosis. Of the four stages of COVID-19 evolution (early, progressive, peak and absorption), imaging was done on the days 5 to 14 (stage 2 & 3 i.e. progressive & peak stage) for the majority of patients to determine their severity. Stage 2 and 3 are considered the most important stage to know the extent of lung involvement that corelate with HRCT score and included in the study. Because include the scans from earlier stages could potentially confuse interpretation, we have only included the scans from this stage in our analysis[6].

Time interval between the initial onset of symptoms and CT changes is $4.6 \pm 2.9$ days. According to a study done in Israel, hospital admissions, cases of severe illness, and deaths were significantly decreased after receiving the two doses of the SARS – CoV-2 vaccine. This was especially true for patients 65 years of age and older. Covishield and covaxin, two vaccinations that were both licensed in India at the time of the study, two doses were needed for the complete immunization[7]. The effectiveness of vaccines against developing variations of concern may be severely diminished, according to new data, including indications of breakthrough infections. As a result, secondary vaccines may need to be created in order to sustain population-level protective immunity[8]. The use of a booster dose following a complete vaccination series is being introduced by several countries to lessen the severity of symptoms and serious outcomes for hospitalized patients due to increasing the most important evidence[9]. Uncertainty persists regarding the effectiveness of the SARS - CoV-2 immunity in preventing further infections or lessening the severity of the sickness, particularly when it comes to patients who had additional vaccinations after contracting the infection.

Hence, in this study we have assessed the severity of the disease among vaccinated and unvaccinated COVID-19 patients by comparing their lung involvement through HRCT scores (Stage 3 is considered the most important stage to know the extent of lung involvement that corelate with HRCT score) and various other parameters (oxygen need, and length of hospital stay).

## MATERIALS AND METHODS

The study was conducted in KMCH Institute of Health Sciences & Research, Coimbatore, a tertiary care private medical college hospital. Retrospective anonymized data of COVID-19 inpatients who underwent HRCT scans during the second wave of the pandemic were collected after permission from the institutional human ethics committee. The information was gathered using a verified data collection form.

The study comprised 66 patients with COVID-19 positive status who were both vaccinated and unvaccinated. The CT severity score, D-dimer, IL - 6 level, oxygen need, and length of hospital stay were examined. The CT severity (CTS) score for lung involvement was divided into three categories: mild (8), moderate (9–15), and severe (>15).

### *Statistical analysis*

Statistical analysis was performed using SPSS software version 27. Categorical variables were presented as frequency and percentages, Continuous variables were presented as Mean $\pm$ Standard deviation. Independent sample T- test were used to measure the association between the continuous variables between vaccinated and non-vaccinated. Association between the categorical variables were measured using Chi-square/Fischer Exact test. $P<0.05$ was considered as statistically significant.

## RESULTS

This cross- sectional study was done among 66 participants (33 vaccinated and 33 unvaccinated). Study participants were distributed between 23 - 82 years. The mean age of the study participants were $56.93 \pm 16.01$ yrs. Nearly $3/4^{th}$ (75.8%) were above 40 years and nearly half (45%) were above 60 years. The age distribution and mean age was more or less similar in both the groups ($P<0.05$). 37.9% were females and 62.1% were males. There was no statistical significance between both the groups with respect to gender distribution in vaccinated and unvaccinated groups. Among vaccinated 36.36% had covaxin (live attenuated vaccine) and the rest 63.64% had covishield (viral Vector Vaccine). Among those who got vaccinated, 39.39% had single dose while the rest 60.4% had two doses of vaccine. 33.3% of the study

population were diabetics. 27.3% of the study population were hypertensives. The mean CTS score, Corads score, IL6, D-dimer among the study participants were 3.38 ± 3.91, 5.91 ± 0.63, 61.01 ± 82.36, 1.03 ± 1.7 respectively.

The association between vaccinated and unvaccinated was sort for difference in Gender, corads score, presence of diabetes, hypertension and outcome. There was no significant association between any of the parameter measured (Table 1) .

Mean score of measured parameters was compared between both the groups. The mean CTS score among vaccinated individuals were 1.63 ± 2.36 compared to 5.12 ± 4.39 among unvaccinated. Also, the need for oxygen among the vaccinated group was 0.3 ± 1.42 L/min compared to 1.93 ± 3 litres among unvaccinated. The results were statistically significant. There was no statistically significant association. The mean score for CORADS score, D dimer and number of days in the hospital were more or less similar in both the groups. The IL-6 was 44.69 ± 38.76 among vaccinated compared to 77.33 ± 108.28 among unvaccinated. There was no statistical significance between CORADS, IL-6, D – Dimer and duration of hospital stay (Table 2). Non parametric test done for the above-mentioned parameters also revealed the same results.

## DISCUSSION

This study was conducted to observe the impact of the vaccine on the severity in COVID -19 patients. The gold standard test for COVID-19 pneumonia diagnosis is still the RT-PCR. However, viral burden, novel COVID-19 altered strains, insufficient sampling methods, and standby time for viral detection with RT-PCR testing can postpone the diagnosis. Many patients have negative results from the first test; however, it has been noted that positivity can appear in the second, third, or even later testing. Quantifying parenchymal involvement, identifying consequences (such as pulmonary embolism or superinfection), and even dividing up COVID-19 patients based on priority in the event of scarce medical resources are all made possible by the CT scan. As a result, CT has become a popular diagnostic and therapeutic method for individuals with confirmed or suspected COVID-19 [10,11].

CT scan of the chest - The sum of the individual lobar scores, or the total CT score, is a semi-quantitative scoring system that ranges from 0 (no involvement) to 25 (highest involvement). Maximum lung involvement peaked at around 10 days after the onset of symptoms. Age >55 years, numerous comorbidities, hypoxia, certain CT findings indicative of substantial lung involvement, various lab abnormalities, and indicators of end organ damage are factors that are linked to greater disease severity/mortality [12,13].

Covishield, Covaxin, Sputnik, Moderna, and other vaccines are frequently used to prevent COVID -19 infection. In India, Covaxin & Covishield are two of them that are frequently utilized. The Oxford-AstraZeneca COVID-19 vaccine is a viral vector vaccine that is used to prevent COVID-19. It is marketed under the name Covishield. The vaccine is produced using a repurposed chimpanzee adenovirus termed ChAdOx1, which carries spike glycoprotein — a protein found in SARS-CoV-2 coronavirus. The adenovirus inserts its DNA into the nucleus of the host cell once it has been vaccinated. The coronavirus spike protein gene may be read by the cell and transcribed into a molecule known as messenger RNA, or mRNA, but the adenovirus is designed to prevent it from replicating itself. When the mRNA exits the nucleus, the cells begin to make spike proteins. The immune system recognizes the spike proteins and responds strongly to merely a single dosage. The immunization is administered intramuscularly. It has been demonstrated to be safe and well tolerated, despite the possibility of brief adverse effects like fever, flu-like symptoms, headaches, or sore arms [14].

A complete inactivated virus-based COVID-19 vaccine called Covaxin (development name, BBV152) was created by Bharat Biotech in association with the National Institute of Virology of the Indian Council of Medical Research.

In India, 2.2 billion doses of the COVID-19 vaccine have been given out as of September 2023, while 110.6 million doses of the vaccine had been delivered as of October 2021. The vaccine was approved for use in emergencies by the World Health Organization (WHO) on November 3, 2021. Thirteen nations had approved the use of Covaxin for emergency use as of January 31, 2022 [15].

According to earlier research, immunization over 300 days decreased the overall infection rate from 9.0% to 4.6 The highest relative reduction (54 – 62%) was observed among individuals aged 65 and older. Vaccination significantly decreased negative outcomes, including decreases in non - ICU hospitalizations, ICU hospitalizations, and fatalities of 63.5%, 65.6%, and 69.3% over the same time period. Numerous research that evaluated the effectiveness and safety of vaccinations came to the conclusion that immunization decreases lung involvement in COVID-19 and also affects the systemic inflammatory and coagulopathic reactions to this disease [16,17].

One of the most significant risk factors for death in COVID-19 patients is age. Complete immunization reduces the need for hospital stay and prevents death. However, SARS-CoV-2 infection was associated with a significant mortality rate in these fully immunized patients, which was most likely due to their older age and greater number of comorbidities. This hypothesis matches those put out in earlier papers [18,19]. But in this study there is no significant difference in hospital stay among vaccinated and unvaccinated patients In a hospital-based cross-sectional study on vaccination status and COVID-19-related mortality, Muthukrishnan et al. discovered that fully vaccinated patients who had a significantly lower COVID-19 mortality

**Table 1: Association between groups and parameters**

| | Parameters | Vaccinated | | Unvaccinated | | CSV | P value |
|---|---|---|---|---|---|---|---|
| | | F | % | F | % | | |
| Gender | Female | 42 | 36.4 | 13 | 39.4 | 0.064 | 1.000 |
| | Male | 21 | 63.6 | 20 | 60.6 | | |
| CORADS | 1.0 | 1 | 3.0 | 0 | 0.0 | 2.063 | 0.492 |
| | 5.0 | 1 | 3.0 | 0 | 0.0 | | |
| | 6.0 | 31 | 93.9 | 33 | 100.0 | | |
| Diabetes | Absent | 21 | 63.3 | 23 | 69.7 | 0.273 | 0.794 |
| | Present | 12 | 36.4 | 10 | 30.3 | | |
| Hypertension | Absent | 20 | 60.6 | 28 | 84.8 | 4.889 | 0.051 |
| | Present | 13 | 39.4 | 5 | 15.2 | | |
| Patient outcome | Cured | 33 | 100.0 | 29 | 87.9 | 4.285 | 0.114 |
| | Referred | 0 | 0.0 | 4 | 12.1 | | |

Data are expressed in Mean ±SD. p value *p<0.05, **p<0.01, ***p<0.001

**Table 2: Comparison of mean parameters between both groups using T test**

| Parameter | Vaccinated | | Unvaccinated | | MD | t Value | P Value |
|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | | | |
| CTSS (/20) | 1.63±2.36 | | 5.12±4.39 | | 3.484 | -4.011 | 0.000** |
| CORADS | 5.81±0.88 | | 6.00±0.00 | | 0.181 | -1.184 | 0.241 |
| IL-6 | 44.69±38.76 | | 77.33±108.28 | | 32.636 | -1.630 | 0.108 |
| D-DIMER | 0.92±1.31 | | 1.13±2.03 | | 0.210 | -0.500 | 0.619 |
| Duration of Hospital stay | 6.06±1.93 | | 6.87±3.05 | | 0.818 | -1.298 | 0.199 |
| Oxygen requirement (L/min) | 0.30±1.42 | | 1.93±3.00 | | 1.536 | -2.823 | 0.006* |

Data are expressed in Mean ±SD. p value *p<0.05, **p<0.01, ***p<0.001

rate[20].

Our study's primary drawback was its retrospective methodology. Additionally, it was carried out before the Omicron strain of SARS-CoV-2 disseminated widely. The Delta strain predominated in during the study period. Another drawback was that the anti-spike antibody titres in the patients who had received the vaccination were not assessed. Maybe the patients who received the vaccinations did not have serious illnesses that produced a positive serology.

In this study there was no significant association between any of the parameter measured and there was a significant result in oxygen requirement and mean CTS score. Additionally, it was evident that full immunization was linked to less severe disease manifestations among patients hospitalized with COVID-19 (even in the presence of comorbidities).

The COVID-19 second wave affected younger people and severely taxed India's healthcare system. With the advent of novel COVID-19 variations such the B1617 (delta) or B117 (alpha) mutants, which seem to have higher transmissibility and case fatality than the older version of the virus, surveys of vaccine effectiveness have been conducted. Numerous investigations on the effectiveness of vaccinations during the pandemic have revealed that vaccinations are successful in reducing severe sickness by protecting against variations. Numerous research have examined the effectiveness of COVID-19 vaccination and highlighting their part in averting serious illness, which lowers hospital admissions and mortality. Research conducted in the United Kingdom Pritchard E. et al.'s demonstrated that 21 days following a single dosage rates of the Pfizer or AstraZeneca vaccines, the rates of all new Infection with SARS-CoV-2 had decreased by 65%, and infections with symptoms by 72%, and infections without symptoms by 57% (p<0.0001). Amid infections were found in those who received a second dose of the Pfizer vaccination. 70%, p < 0.0001) 90% (p<0.0001) of lower and symptomatic infections reduced[21] .

Further research conducted in the UK by Wei J et al. revealed that the type of vaccination, the number of doses administered, age, Gender, and past infection status all affect postvaccine anti-spike Immunoglobulin G responses. Following their initial immunization, individuals of all ages who had previously been infected showed substantial antibody responses. After receiving a single dose of the vaccine, older participants showed less reaction than

younger participants in those without evidence of past infection; the effects were particularly noticeable in those over 60. High responses were obtained with two doses in all age groups, with the elderly experiencing the greatest increase in seroconversion, reaching levels comparable to those following a single dosage after a previous infection. A single dose of the Covishield (ChAdOx1-S) vaccine was found to be roughly 60–75% effective against symptomatic sickness and to have an extra protective effect against hospital admission, according to a study by Lopez Bernal J et al. on the elderly population of England [22,23].

The COVID-19 vaccine has decreased hospital expenses and mortality, however older patients who were not vaccinated as well as unvaccinated people still need to be admitted to the hospital. The causes are yet unknown because patients with the same age, vaccination status, and risk factors experience various outcomes (not hospitalized, hospitalized, and deaths).

### *Limitations*

This study does not evaluate the effectiveness of immunization at the individual dose level. Dose level analysis would have given a clearer picture of the vaccine's efficacy. This study's assessment of lung involvement at each dose level could be investigated further.

## CONCLUSION

In COVID-19 patients, vaccination reduces the extent of lung involvement and the need for oxygen, The COVID-19 vaccination conundrum is resolved by this study, which also gives us a clear picture of the vaccine's efficacy.

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