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ORIGINAL RESEARCH

Effectiveness of Booster Dose COVID-19 Vaccination in Preventing Severe Infections among Adults: A Community-Based Cohort Study

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ABSTRACT

Background: The global effort to curb COVID-19 continues to evolve with the introduction of booster doses aimed at enhancing immunity, especially among adults with waning vaccine-induced protection. This study aimed to evaluate the effectiveness of the booster dose of COVID-19 vaccination in preventing severe infections among adults in a community-based cohort. **Materials and Methods:** A prospective cohort study was conducted in a semi-urban district in India. A total of 2,000 adults aged 18 years and above were enrolled and stratified into two groups: Group A (n=1,000) received the COVID-19 booster dose, and Group B (n=1,000) received only the primary vaccine series. Participants were followed for six months, with data on COVID-19 infection, severity (based on WHO clinical progression scale), hospitalization, ICU admission, and mortality collected through periodic interviews and health records. Statistical analysis was performed using SPSS v25. Chi-square tests and Cox proportional hazards models were used to compare incidence and risk ratios between groups. **Results:** The incidence of severe COVID-19 infection was significantly lower in Group A (1.2%) compared to Group B (6.8%) ($p<0.001$). Hospitalization was reported in 0.9% of booster recipients versus 5.1% of non-recipients. ICU admissions occurred in 0.3% of Group A and 2.3% of Group B. No deaths were reported in Group A, while four deaths (0.4%) occurred in Group B. The adjusted hazard ratio (aHR) for severe disease in the booster group was 0.18 (95% CI: 0.09–0.36), indicating an 82% reduction in risk. **Conclusion:** The booster dose of the COVID-19 vaccine significantly reduced the incidence of severe infection, hospitalization, and ICU admission among adults. These findings support the continued rollout of booster vaccinations as a vital public health strategy to mitigate COVID-19 severity.

Keywords: COVID-19, Booster Dose, Vaccination, Severe Infection, Cohort Study, Community-Based Study, Vaccine Effectiveness

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has had a profound impact on global public health, with waves of infections leading to significant morbidity, mortality, and socio-economic disruption. The development and deployment of COVID-19 vaccines have been instrumental in mitigating the burden of the disease, especially in reducing severe cases, hospitalizations, and deaths [1]. However, emerging data have indicated that vaccine-induced immunity may wane over time, particularly in the face of new variants of concern such as Delta and Omicron [2,3].

To address the challenge of declining immunity and breakthrough infections, booster doses have been introduced as an extension of primary immunization programs in many countries. These additional doses aim to reinforce the immune response and sustain protection against severe outcomes of COVID-19 [4]. Several studies have demonstrated that booster doses can enhance neutralizing antibody titers and T-cell responses, even in populations with previous waning immunity or comorbidities [5,6].

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Despite this, there remains a need for real-world evidence from community-level data to assess the effectiveness of booster doses in preventing severe disease. Most current studies are based on hospital or registry data and may not reflect outcomes in general population settings [7]. Moreover, factors such as age, comorbid conditions, prior infection status, and adherence to public health measures may influence vaccine effectiveness and require contextual evaluation [8].

This community-based cohort study was designed to evaluate the protective effect of booster dose vaccination against severe COVID-19 infection in a general adult population. By comparing the outcomes of individuals who received a booster dose to those who completed only the primary vaccine series, this study aims to provide timely and actionable insights for vaccination policy planning and public health interventions.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, observational cohort study conducted in a semi-urban community located in India. The study aimed to evaluate the real-world effectiveness of a COVID-19 booster dose in reducing severe disease outcomes among adult residents.

Study Population

A total of 2,000 adult participants aged 18 years and above were recruited using stratified random sampling from the community health database. Individuals were eligible if they had completed at least the primary series of a COVID-19 vaccine. Participants with incomplete vaccination records, prior hospitalization due to COVID-19 in the last 3 months, or those unwilling to provide informed consent were excluded.

Group Allocation

Participants were categorized into two groups based on their vaccination status.

- **Group A (Booster group):** Received a booster dose of an approved COVID-19 vaccine (n = 1,000)
- **Group B (Non-booster group):** Received only the primary two-dose vaccine schedule without a booster (n = 1,000)

Data Collection

Demographic details, comorbidities (e.g., diabetes, hypertension), and vaccination history were collected through structured interviews and verified using government vaccination portals. Follow-up was conducted monthly through telephone and in-person visits to monitor for COVID-19 symptoms, testing, and clinical outcomes. Severe infection was defined according to WHO criteria, including oxygen requirement, ICU admission, or death.

Outcome Measures

The primary outcome was the incidence of severe COVID-19 infection. Secondary outcomes included overall infection rate, hospitalization, ICU admission, and mortality. RT-PCR confirmation was used to identify positive cases. Data regarding clinical severity were obtained from hospital discharge records and verified by healthcare professionals.

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics. Incidence rates between groups were compared using the chi-square test. Cox proportional hazards models were employed to estimate hazard ratios (HR) and adjusted hazard ratios (aHR) with 95% confidence intervals (CI), adjusting for age, sex, comorbidities, and baseline health status. A p-value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 2,000 participants were included in the study, with 1,000 individuals each in the booster group (Group A) and non-booster group (Group B). The mean age of participants was 42.6 ± 13.5 years, and 52.3% were male. Both groups were comparable in terms of baseline demographic and clinical characteristics (Table 1).

Table 1: Baseline Characteristics of Study Participants (N = 2000)

Variable	Booster Group (n = 1000)	Non-Booster Group (n = 1000)	p-value
Mean Age (years)	42.3 ± 13.1	43.0 ± 13.9	0.284
Male, n (%)	526 (52.6%)	518 (51.8%)	0.703
Diabetes, n (%)	118 (11.8%)	125 (12.5%)	0.624
Hypertension, n (%)	134 (13.4%)	142 (14.2%)	0.602
History of COVID-19, n (%)	97 (9.7%)	102 (10.2%)	0.688

Table 1 shows no statistically significant differences in demographic or comorbidity profiles between the groups.

During the six-month follow-up, the incidence of laboratory-confirmed COVID-19 infection was 3.1% in Group A and 9.6% in Group B ($p < 0.001$). Severe infections were observed in only 12 participants (1.2%) in the booster group, compared to 68 participants (6.8%) in the non-booster group. Hospitalizations occurred in 9 (0.9%) individuals in Group A versus 51 (5.1%) in Group B, while ICU admissions were 3 (0.3%) and 23 (2.3%), respectively

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(Table 2). No deaths were reported among those who received a booster dose, whereas 4 deaths (0.4%) occurred in the non-booster group.

The Cox regression analysis showed that receiving a booster dose was associated with a significantly reduced risk of developing severe COVID-19 (adjusted HR: 0.18, 95% CI: 0.09–0.36, $p < 0.001$).

Table 2: COVID-19 Outcomes in Booster vs. Non-Booster Groups

Outcome	Booster Group (n = 1000)	Non-Booster Group (n = 1000)	p-value
Confirmed COVID-19 cases	31 (3.1%)	96 (9.6%)	<0.001
Severe COVID-19 infection	12 (1.2%)	68 (6.8%)	<0.001
Hospitalization	9 (0.9%)	51 (5.1%)	<0.001
ICU admission	3 (0.3%)	23 (2.3%)	<0.001
Deaths	0 (0%)	4 (0.4%)	0.044

Table 2 indicates significantly better outcomes in the booster group across all parameters.

DISCUSSION

This community-based cohort study assessed the real-world effectiveness of the COVID-19 booster dose in preventing severe infections among adults. The findings suggest a significant reduction in the incidence of severe COVID-19 outcomes—including hospitalization, ICU admission, and mortality—among those who received a booster dose compared to individuals who completed only the primary vaccination schedule. These results are consistent with national and international data that support the use of booster doses to enhance and prolong vaccine-induced immunity [1,2].

Previous studies have demonstrated that the immunity conferred by initial two-dose COVID-19 vaccination begins to wane approximately 4–6 months post-immunization, particularly in older adults and individuals with comorbid conditions [3,4]. The decline in neutralizing antibody titers and T-cell responses may compromise protection, especially against emerging variants with immune escape potential [5,6]. Our study confirms that administration of a booster dose restores protective immunity and provides significant protection against severe outcomes, with an adjusted hazard ratio of 0.18 for severe disease.

The lower incidence of severe disease in the booster group aligns with data from large population-based studies conducted in Israel and the United States, where booster recipients showed significantly lower rates of severe COVID-19 and hospitalization [7,8]. In a study by Bar-On et al., the rate of severe illness was reduced by more than 90% among individuals aged 60 and older who received a booster dose [9]. Similarly, data from the UK Health Security Agency demonstrated high vaccine effectiveness of booster doses across different age groups, including against Omicron variant-associated hospitalizations [10].

Our study also revealed a small but noteworthy difference in mortality, with zero deaths in the booster group and four deaths in the non-booster group. While this difference may seem marginal, it underscores the importance of booster vaccination, especially in high-risk populations where even a single preventable death is significant [11]. The observed reduction in ICU admissions further strengthens the case for booster doses as a public health measure to reduce healthcare system burden during future waves of the pandemic [12].

It is also essential to consider the role of community-based vaccine delivery strategies, which may have influenced the relatively high uptake and timely administration of boosters in the study setting. Public trust, accessibility, and proactive health communication campaigns are crucial components for successful booster rollouts [13,14]. Additionally, our stratified random sampling helped ensure representativeness across socio-demographic groups, adding to the generalizability of the findings.

However, this study has some limitations. First, the follow-up duration was limited to six months, which may not capture long-term vaccine effectiveness. Second, despite efforts to control for confounding variables, residual confounding from behavioural factors such as mask usage or adherence to social distancing may have influenced infection outcomes. Third, variant-specific data were not available, limiting our ability to assess booster efficacy against particular strains.

CONCLUSION

In conclusion, our results add to the growing body of evidence supporting the effectiveness of booster vaccination in reducing the burden of severe COVID-19. Continued surveillance and targeted booster strategies will be crucial in maintaining population immunity, particularly in vulnerable and underserved communities.

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