



Prevalence and factors associated with vaccine hesitancy for the booster dose of COVID-19 among undergraduate medical students in Puducherry: a cross-sectional study

Srimadhi Muthaiyan¹, Rajsri Thuthikadu Rajasekaran¹, Bhuvaneswari Natarajan²

¹ Assistant Professor, Department of Community Medicine, Faculty of Medicine, Sri Lalithambigai Medical College and Hospital, Dr. MGR Educational and Research Institute, Chennai

² Assistant Professor, Department of Community Medicine, ESIC Medical College and Hospital, KK Nagar, Chennai

***Corresponding author:** Dr Srimadhi Muthaiyan, **Address:** A block- D4, Golden fortune apartment, Mogappair east, Chennai 6000037, **Email:** srinadhi1410@gmail.com, **Tel:** +9677832189

Abstract

Background & Aims: COVID-19, caused by SARS-CoV-2, has severely impacted global public health and economies, including India. Vaccination remains the primary preventive measure against the pandemic. Despite its importance, vaccine hesitancy remains a significant barrier, even among healthcare workers (HCWs). This study aimed to estimate the prevalence and identify factors associated with vaccine hesitancy for the COVID-19 booster dose among undergraduate medical students in Puducherry.

Materials & Methods: A cross-sectional study was conducted from April to June 2022 among undergraduate medical students in Puducherry. A sample of 476 participants was selected using simple random sampling. Data were collected through an online semi-structured questionnaire based on the WHO SAGE tool, which included socio-demographic details, vaccination history, and perceptions about COVID-19 and vaccination. Statistical analysis was performed using SPSS version 23. Bivariate analysis (Chi-square test) was conducted to assess associations between socio-demographic factors and vaccine hesitancy.

Results: Among the 476 participants, 13.03% were classified as vaccine-hesitant (score < 30). Significant associations were found between vaccine hesitancy and age ($p = 0.027$), year of study ($p = 0.002$), religion ($p = 0.010$), and the presence of comorbidities ($p = 0.005$). Hesitancy was higher among participants under 20 years of age, in their 4th year of study, and among Christians. Personal or community negative experiences with vaccination, fear of injection pricks, and perceived lack of scientific evidence were major reasons for hesitancy.

Conclusion: Vaccine hesitancy for the COVID-19 booster dose among undergraduate medical students is influenced by multiple socio-demographic, experiential, and perceptual factors. Addressing these factors through targeted education, engagement with religious leaders, clear communication about vaccine safety and benefits, and supportive interventions at vaccination sites is crucial. These strategies could enhance vaccine uptake and contribute to controlling the pandemic. Further research should explore vaccine hesitancy in diverse populations and evaluate the effectiveness of these interventions.

Keywords: Booster dose, COVID-19, Vaccine hesitancy, WHO SAGE tool

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Introduction

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a novel zoonotic coronavirus that emerged in Wuhan, China (1). The outbreak of SARS-CoV-2 has caused significant negative impacts on public health systems and the economic status of many countries, including India (2). Since there is no cure available for COVID-19 to date, the best way to prevent this ongoing pandemic is to administer the COVID-19 vaccine, which can provide clinical and socio-economic benefits (3).

In a global survey on the potential acceptance of the COVID-19 vaccine, vaccine hesitancy ranged from 11.4% to 45.2% across countries (4). In India, the hesitancy rate among undergraduate medical students was 46.9%.² According to SAGE, vaccine hesitancy refers to a delay in acceptance or refusal of vaccination despite the availability of vaccination services. There are three key components of vaccine hesitancy: the first is confidence, which deals with a lack of trust in the vaccine's safety, efficacy, or the healthcare system delivering it; the second is complacency, which involves the perceived low risk of the disease, leading to an undervaluation of the need for vaccination; and the third is convenience, which includes barriers such as accessibility, affordability, and availability of vaccines (5). Vaccine hesitancy affects not only the individual who is hesitant to take the vaccine but also the whole community, making it difficult to reach the threshold required to confer herd immunity (6). The predictors for vaccine hesitancy include socio-demographic, experiential, and perceptual factors, vaccination history, and perceptions about vaccine safety, efficacy, and the importance of booster doses.

In view of the upcoming third wave caused by the Omicron and Delta variants, booster dose vaccination is recommended for all healthcare workers and the elderly aged > 60 years. There is evidence showing that vaccine hesitancy among the general population is invariably linked to vaccine hesitancy among healthcare workers (7). Additionally, there are many studies on vaccine hesitancy in the general population, but very few studies

focus on undergraduate medical students in India. All the available studies pertain only to the primary two doses and not to the booster dose. Therefore, this study aimed to estimate the prevalence and factors associated with vaccine hesitancy for the booster dose of COVID-19 among undergraduate medical students in Puducherry.

Materials & Methods

This institution-based observational cross-sectional study was carried out among undergraduate medical college students in Puducherry over 3 months, from April 2022 to June 2022. The inclusion criteria were undergraduate medical students aged ≥ 18 years who were enrolled in the institute and willing to participate in the study. Participants who had not received any prior doses of the COVID-19 vaccine and those who had already received the booster dose were excluded from the study. Using Open Epi version 3.0, and based on a study conducted in Surat by Shah et al. (8), where the prevalence of vaccine hesitancy among undergraduate medical students was 46.9%, 8 with $\alpha = 5\%$, $\beta = 20\%$, of margin of error = 5%, and a non-response rate = 20% the minimum sample size was calculated to be 459.

After obtaining clearance from the Institutional Human Ethics Committee, the list of MBBS students was obtained from the institute. Using a simple random sampling technique, study participants were selected from each year, and a pretested, semi-structured questionnaire was distributed via an online data collection platform (Google Forms). Three email reminders were sent to the participants, and those who did not complete the Google Form after three reminders were considered non-responders. The study tool included sections on the socio-demographic profile, previous history of COVID-19 infection, COVID-19 vaccination details, perceived threat of new COVID-19 variant infections, and willingness to receive the COVID-19 booster dose, using the WHO SAGE questionnaire.

Statistical Analysis

The data were collected via Google Forms, downloaded in spreadsheet format, and analyzed using

SPSS version 23. The results were summarized using proportions (%) for categorical variables and mean (SD) or median (IQR) for continuous variables. Bivariate analysis (Chi-square test/Fisher's Exact test) was conducted to assess the association between socio-demographic factors and vaccine hesitancy. Factors with a *P-value* of less than 0.05 were considered statistically significant.

Results

This study aimed to determine the prevalence of vaccine hesitancy among undergraduate medical students in Puducherry and to identify the factors influencing this hesitancy. A total of 476 students participated in the study, and the results revealed that 13.03% of participants were vaccine-hesitant, as per the WHO SAGE questionnaire. Certain socio-demographic factors, such as age, educational year, and religion, were

significantly associated with hesitancy. Additionally, experiential and perceptual factors, including fear of side effects, inadequate communication regarding vaccine safety, and perceived invulnerability to severe disease, also played crucial roles.

The following sections present a detailed analysis of these findings, including associations between socio-demographic characteristics and vaccine hesitancy, as well as specific reasons for hesitancy.

Vaccine Hesitancy and Acceptance (Table 1)

The study analysed vaccine hesitancy among 476 participants using the WHO SAGE questionnaire. The mean $\pm$ SD score was 29.08 ± 3.45 . Among the participants, 62 (13.03%) were classified as vaccine-hesitant (score < 30), while 414 (86.97%) were classified as accepting the vaccine (score > 30) (Table 1).

Table 1. WHO SAGE questionnaire for vaccine hesitancy (Mean $\pm$ SD = 29.08 ± 3.45) (N = 476)

SAGE classification	Score	Percentage %
Vaccine hesitant (score < 30)	62	13.03%
Vaccine accepted (score > 30)	414	86.97%

Socio-demographic Factors and Vaccine Hesitancy (Table 2)

The association between vaccine hesitancy and various socio-demographic factors was evaluated using chi-square tests:

Age: Participants under 20 years were significantly more likely to be vaccine-hesitant (46.8%) compared to those over 20 years (53.2%) ($\chi^2 = 4.921$, $p = 0.027$). **Gender:** No significant difference was observed between males (42%) and females (58%) in terms of vaccine hesitancy ($\chi^2 = 0.178$, $p = 0.673$). **Socioeconomic status:** No significant association was found between socioeconomic status and vaccine hesitancy ($\chi^2 = 2.226$, $p = 0.527$). **Educational year:** A significant difference was observed among educational years, with the highest hesitancy in the 4th year (35.5%) and the lowest in the 2nd year (8.1%) ($\chi^2 = 15.376$, $p = 0.002$). **Religion:** Religion was significantly associated with vaccine hesitancy. Hindu participants were less

hesitant (80.6%) compared to Christians (17.7%) and Muslims (1.6%) ($\chi^2 = 9.123$, $p = 0.010$). **Residence:** There was no significant difference in vaccine hesitancy between urban (82.3%) and rural (17.7%) residents ($\chi^2 = 0.146$, $p = 0.702$). **Co-morbidity:** Participants with no co-morbidities were less hesitant (93.5%) compared to those with conditions such as diabetes (3.2%) and hypertension (1.6%) ($\chi^2 = 18.561$, $p = 0.005$). **COVID-19 experience and vaccine hesitancy:** Previous COVID-19 infection: No significant association was found between past COVID-19 infection and vaccine hesitancy ($\chi^2 = 1.988$, $p = 0.159$). **Hospitalization due to COVID-19:** Hospitalization history did not significantly affect vaccine hesitancy ($\chi^2 = 0.144$, $p = 0.661$). **Family members' COVID-19 history:** No significant association was found between family members' COVID-19 history and vaccine hesitancy ($\chi^2 = 1.801$, $p = 0.180$). **Vaccination details and hesitancy:** Vaccination Status: The majority of vaccine-hesitant (95.2%) and

non-hesitant (97.3%) participants were vaccinated ($\chi^2 = 0.899$, $p = 0.408$). Vaccine dose received: A significant association was found between the number of vaccine doses and hesitancy. Participants who received zero, 1, or 2 doses were more hesitant (83.9%) compared to those who received 3 doses (16.1%) ($\chi^2 = 7.632$, $p = 0.006$). Type of vaccine: No significant difference was found based on the type of vaccine received ($\chi^2 = 0.536$, $p = 0.764$). Place of vaccination: The place of vaccination (government or private hospital) did not significantly impact vaccine hesitancy ($\chi^2 = 0.14$, $p = 0.708$). Perception of infection risk: No significant

association was found between perceived risk of infection with the new variant and vaccine hesitancy ($\chi^2 = 3.847$, $p = 0.427$). Importance of booster dose: A significant difference was found in the perception of the importance of a booster dose, with vaccine-hesitant participants significantly less likely to strongly agree (3.2%) compared to non-hesitant participants (28%) ($\chi^2 = 118.051$, $p = 0.001$). Willingness to take booster dose: Vaccine-hesitant participants were significantly less willing to take a booster dose (21%) compared to non-hesitant participants (74.6%) ($\chi^2 = 85.685$, $p = 0.001$).

Table 2. Association between WHO SAGE vaccine hesitancy with various socio demography factors (N = 476)

Variables		Vaccine hesitancy		Chi square
		Yes (< 30)	No (> 30)	P-value
Age	< 20 years	29 (46.8%)	255 (6.6%)	4.921
	> 20 years	33 (53.2%)	159 (38.4%)	0.027
Gender	Male	26 (42%)	162 (39%)	0.178
	Female	36 (58 %)	252 (61%)	0.673
Socioeconomic status	Upper class	52 (83.9%)	325 (78.5%)	
	Upper middle class	9 (14.5%)	71 (17.1%)	2.226
	Middle class	0	12 (2.9%)	0.527
	Lower middle class	1 (1.6%)	6 (1.4%)	
Educational year	1 st year	17 (27.4%)	133 (32.1%)	
	2 nd year	5 (8.1%)	109 (26.3%)	15.376
	3 rd year	18 (29%)	91 (22%)	0.002
	4 th year	22 (35.5%)	81 (19.6%)	
Religion	Hindu	50 (80.6%)	364 (88%)	
	Christian	11 (17.7%)	29 (7%)	9.123
	Muslim	1 (1.6%)	21 (5%)	0.010*
Residence	Urban	51 (82.3%)	332 (80.2%)	0.146
	Rural	11 (17.7%)	82 (19.8%)	0.702
Co-morbidity	None	58 (93.5%)	400 (96.6%)	
	DM	2 (3.2%)	1 (0.2%)	
	HTN	1 (1.6%)	1 (0.2%)	18.561
	COPD/ Asthma	0	4 (1%)	0.005
	Thyroid disorder	0	6 (1.4%)	
	CVD	1 (1.6%)	0	
	Others specify	0	2 (0.5%)	
Study participant tested positive for COVID-19 in the past	Yes	14 (22.6%)	130 (31.4%)	1.988
	No	48 (77.4%)	284 (68.6%)	0.159

Variables		Vaccine hesitancy		Chi square
		Yes (< 30)	No (> 30)	P-value
Study participant hospitalized for COVID-19 infection	Yes	2 (3.2%)	10 (2.4%)	0.144
	No	60 (96.8%)	404 (97.6%)	0.661*
Family members tested positive for COVID-19 in the past	Yes	24 (38.7%)	198 (47.8%)	1.801
	No	38 (61.3%)	216 (52.2%)	0.180
Family members hospitalized for COVID-19 in the past	Yes	10 (16%)	77 (18.6%)	0.220
	No	52 (84%)	337 (81.4%)	0.639
Vaccinated for COVID19 (N = 476)	Yes	59 (95.2%)	403 (97.3%)	0.899
	No	3 (4.8%)	11 (2.7%)	0.408*
Vaccine Dose received (N = 462)	0, 1 & 2 dose	52 (83.9%)	275 (66.4%)	7.632
	3 doses	10 (16.1%)	139 (33.6%)	0.006
Type of vaccine (N = 462)	Covaxin	5 (%)	47 (%)	0.536
	Covishield	54 (%)	354 (%)	0.764*
	Sputnik	0	2 (%)	
Place of vaccination (N = 462)	Government Hospital	53 (%)	368 (%)	0.14
	Private hospital	6 (%)	35 (%)	0.708*
How do you perceive risk of infection with the new variant?	No risk	13 (21%)	58 (14%)	
	Low risk	12 (19.4%)	106 (25.6%)	3.847
	Moderate Risk	30 (48.4%)	193 (46.6%)	0.427
	High risk	7 (1.3%)	49 (11.8%)	
	Very high risk	0	8 (1.9%)	
Do you think booster dose for COVID-19 vaccine is important to prevent the severity of the disease?	Strongly agree	2(3.2%)	116 (28%)	
	Agree	9 (14.5%)	218 (52.7%)	118.051
	Neutral	40 (64.5%)	72 (17.4%)	0.001*
	Disagree	5 (8.1%)	6 (1.4%)	
	Strongly disagree	6 (9.7%)	2 (0.5%)	
Willingness to take booster dose of COVID19 vaccine	Willing to take	13 (21%)	309 (74.6%)	
	Will wait for a while before taking the booster dose of vaccine	19 (30.6%)	59 (14.3%)	85.685
	Not sure about taking the booster dose of vaccine	21 (33.9%)	40 (9.7%)	0.001
	Do not intend to take the booster dose of vaccine	9 (14.5%)	6 (1.4%)	

Reasons for Vaccine Hesitancy (Table 3)

The study also explored reasons for vaccine hesitancy among participants:

Contextual influences: Media reports of adverse events following vaccination were a significant concern, with 45% strongly agreeing that these reports influenced

their hesitancy. Religious influence, long travel distances, and the unavailability of vaccines were also notable factors. Individual and group influences: Personal or community members' negative experiences with vaccination (58.9%) and fear of injection pricks (52.7%) were significant influences.

Vaccine/Vaccination influences: Lack of scientific evidence (51.1%), changing vaccine schedules (50.9%), and inadequate disclosure of vaccine safety and adverse effects (51.1%) were major concerns contributing to hesitancy.

Table 3. Distribution of the study participants' likely reasons for being vaccine hesitant (N = 476)

	I. Contextual influences	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a	Media reports adverse events following vaccination	214 (45%)	42 (8.8%)	174 (36.6%)	38 (8%)	8 (1.7%)
b	My religious priest/ guru advocates against vaccination	31 (6.5%)	198 (41.6%)	87 (18.3%)	12 (2.5%)	148 (31.1%)
c	Long distant travel to get the vaccine	69 (14.5%)	210 (44.1%)	112 (23.5%)	23 (4.8%)	62 (13%)
d	Non availability of vaccine	66 (13.9%)	203 (42.6%)	134 (28.2%)	17 (3.6%)	56 (11.8%)
II. Individual and group influences						
a	Personal, family and /or community members bad experience with vaccination	85 (17.9%)	195 (41%)	129 (27.1%)	17 (3.6%)	50 (10.5%)
b	Bad experience at the vaccination site or by vaccine provider	39 (8.2%)	240(50.4%)	112(23.5%)	13 (2.7%)	72 (15.1%)
c	Not aware of the place of vaccination	33 (7%)	255 (53.6%)	92 (19.3%)	10 (2.1%)	86 (18%)
d	I knew someone who had serious side effect following vaccination	87 (18.3%)	191 (40.1%)	120 (25.2%)	22 (4.6%)	56 (11.8%)
e	Frequent vaccination is unsafe as it overloads the immune system	102 (21.4%)	134 (28.2%)	187 (39.3%)	19 (4%)	34 (7.1%)
f	Vaccination is harmful to development of natural immunity	53 (11%)	207 (43.5%)	154 (32.4%)	15 (3.2%)	47 (10%)
g	Friends and relative advice not to take the vaccine	45 (9.5%)	228 (47.9%)	109 (22.9%)	18 (3.8%)	76 (16%)
h	Fear of injection prick	62 (13%)	189 (39.7%)	96 (20.2%)	29 (6.1%)	100 (21%)
III. Vaccine/vaccination influences						
a	Not enough scientific evidence on vaccine	89 (18.7%)	154 (32.4%)	189 (39.7%)	13 (2.7%)	32 (6.7%)
b	Changing vaccine schedule	88 (18.5%)	154 (32.4%)	189 (39.7%)	13 (2.7%)	32 (6.7%)
c	The adverse effects and safety of the vaccines are not disclosed and discussed fully	125 (26.3%)	118 (24.8%)	185 (38.9%)	24 (5%)	24 (5%)

I. Contextual influences		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
d	Cost of vaccine at private facility	109 (22.3%)	122 (25.6%)	168 (35.3%)	33 (6.9%)	44 (9.2%)
e	Non availability of desired brand of vaccine	98 (20.6%)	138 (29%)	188 (39.5%)	22 (4.6%)	30 (6.3%)

Discussion

The study aimed to explore vaccine hesitancy among participants using the WHO SAGE questionnaire and to identify socio-demographic factors, COVID-19 experiences, and perceptions influencing vaccine acceptance. The findings reveal a complex interplay of factors contributing to vaccine hesitancy, providing insights for targeted interventions to enhance vaccine uptake.

Socio-demographic Factors

The significant association between age and vaccine hesitancy aligns with previous studies suggesting that younger individuals are more hesitant toward vaccination (9, 10). This may be attributed to a perceived invulnerability to severe COVID-19 outcomes and reliance on social media for information, which often includes misinformation. Interestingly, educational year was significantly associated with vaccine hesitancy, with hesitancy peaking in the fourth year. This could be due to increased exposure to clinical rotations and direct patient care, potentially heightening concerns about vaccine safety and efficacy.

Gender and socioeconomic status did not show significant associations with vaccine hesitancy, contrasting with some literature suggesting higher hesitancy among males (11). This discrepancy may be due to the specific population studied, predominantly higher education students, which could mitigate these differences.

Religion and Residence

Religious affiliation was significantly associated with vaccine hesitancy, particularly among Christian participants. Religious beliefs and the influence of religious leaders can play a crucial role in shaping health behaviours, including vaccination (12). Urban versus rural residence did not significantly impact hesitancy,

suggesting that access to healthcare and information might be relatively uniform in the study population (13).

COVID-19 Experience

Previous COVID-19 infection and hospitalization, both personal and within the family, were not significantly associated with vaccine hesitancy. This contrasts with some studies suggesting that prior infection reduces hesitancy due to perceived natural immunity (14, 15). The lack of association in this study might indicate a more complex perception of immunity and vaccine necessity among the participants.

Vaccination Details and Perceptions

The number of vaccine doses received was significantly associated with hesitancy, with fewer doses correlating with higher hesitancy. This highlights the importance of ensuring complete vaccination schedules to reduce hesitancy. However, the type and place of vaccination did not significantly affect hesitancy, suggesting that vaccine delivery strategies should focus more on education and reassurance rather than logistical changes.

The perception of the importance of booster doses was a critical determinant of vaccine hesitancy. Vaccine-hesitant individuals were less likely to see the importance of boosters, indicating a need for targeted communication about the benefits of booster doses in maintaining immunity against COVID-19 variants (16).

Reasons for Vaccine Hesitancy

Contextual influences, such as adverse media reports and religious guidance against vaccination, were major reasons for hesitancy. This underscores the need for accurate, transparent communication from trusted sources to counteract misinformation (17, 18). Individual and group influences, including personal or community negative experiences and fear of injections, also played a significant role. Addressing these fears

through education and positive reinforcement at vaccination sites could help alleviate concerns (19, 20).

Limitations and Future Research

The study is limited by its focus on a specific population, which may not generalize to the broader public. Future research should explore vaccine hesitancy in diverse populations and longitudinally assess how perceptions change over time. Additionally, interventions based on these findings should be implemented and evaluated for their effectiveness in reducing vaccine hesitancy.

Conclusion

The study's findings suggest several strategies to combat vaccine hesitancy:

- **Targeted Education:** Focused efforts to educate younger individuals and students, particularly in clinical settings, about the safety and efficacy of vaccines.
- **Engagement with Religious Leaders:** Collaboration with religious leaders to disseminate positive messages about vaccination.
- **Clear Communication:** Transparent information about vaccine safety, potential side effects, and the necessity of booster doses should be prioritized.
- **Addressing Personal Concerns:** Providing support at vaccination sites to ensure positive experiences and address fears of injections.

In conclusion, vaccine hesitancy among the study participants is influenced by a range of socio-demographic, experiential, and perceptual factors. Addressing these through targeted education, clear communication, and supportive interventions is crucial for improving vaccine acceptance and achieving public health goals.

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Ethical statement

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Data availability

The data was collected anonymously and is not available in any other public platform.

Conflict of interest

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Author contributions

Srimadhi M - Planning, Data collection

Rajsri TR – Data analysis, manuscript writing and review

Bhuvaneswari N – Research ideation and Data analysis

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