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Original Article

Factors related to first COVID-19 booster vaccine acceptance in Indonesia: A cross-sectional multi-center study

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Abstract

A positive community perception of the coronavirus disease 2019 (COVID-19) vaccination program is crucial for increasing vaccination coverage and achieving herd immunity. This study aimed to identify factors influencing the acceptance of a COVID-19 booster vaccine in Indonesia. It was conducted as a cross-sectional, multicenter study using a validated questionnaire distributed online to Indonesian participants aged 18 years and older. The questionnaire covered sociodemographic characteristics, clinical conditions of both the participants and their closest contacts, the Health Belief Model (HBM) domain, and preferences for the location of receiving a booster vaccine, as well as reasons for declining a booster vaccine. Of 1550 respondents, 78.6% had received the first COVID-19 booster dose. Sociodemographic factors influencing first booster vaccine acceptance in Indonesia included age ($OR_{36–45 \text{ vs } 18–25 \text{ years}}$: 2.43; 95%CI: 1.13–5.24; $OR_{>45 \text{ vs } 18–25 \text{ years}}$: 3.58, 95%CI: 1.96–6.52), length of education ($OR_{13–16 \text{ vs } <12 \text{ years}}$: 1.34; 95%CI: 1.00–1.80; $OR_{>16 \text{ vs } <12 \text{ years}}$: 4.15, 95%CI: 2.12–8.09), monthly income ($OR_{IDR3,500,000 \text{ vs } 1,500,000}$: 1.72; 95%CI: 1.19–2.49), and occupation ($OR_{\text{Health workers vs not-working}}$: 1.81; 95%CI: 1.00–3.29). Clinical aspects and HBM domains associated with booster vaccine acceptance were the presence of chronic disease (OR: 1.94; 95%CI: 1.03–3.66), previously tested positive for COVID-19 (OR: 1.90; 95%CI: 1.24–2.89), having a family member or friend who was hospitalized due to COVID-19 (OR: 1.86; 95%CI: 1.32–2.62), perceived susceptibility (OR: 1.20; 95%CI: 1.02–1.41), perceived access barriers to COVID-19 vaccination (OR: 0.52; 95%CI: 0.44–0.61), and perceived benefits of COVID-19 vaccination (OR: 1.67; 95%CI: 1.41–1.97). In conclusion, factors influencing the first COVID-19 booster vaccine acceptance in Indonesia ranged from demographic and clinical characteristics as well as HBM domains. Effective strategies to expand COVID-19 booster vaccine coverage should consider these factors to encourage participation in the vaccination program.

Keywords: COVID-19, booster, vaccine acceptance, health belief model, Indonesia

Introduction

The most effective means of reducing COVID-19 morbidity and mortality is through the use of a COVID-19 vaccine [1]. However, the success rate of the vaccination program depends on public acceptance of the vaccine [2]. Several studies conducted in different countries to assess the acceptance level of the COVID-19 vaccine have yielded mixed results. In Brazil and Peru, studies

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Received: May 10, 2024 - Accepted: July 2, 2024 - Published online: July 4, 2024

indicate relatively high levels of acceptance, approximately 84.4% and 78.7%, respectively [3,4]. The acceptance rate of COVID-19 vaccination in ten countries across Asia, Africa, and South America varies overall, depending on differing levels of perceived safety and efficacy [5]. Meanwhile, a study conducted in Afghanistan revealed a relatively low COVID-19 vaccine acceptance rate of only 57.7% [6]. This low acceptance rate can be attributed to several factors, including public concerns about potential side effects, negative information about the vaccine, and doubt about its effectiveness [6].

In Indonesia, four vaccination programs are being implemented to mitigate COVID-19 cases. Based on data from the Ministry of Health of the Republic of Indonesia as of June 2024, vaccination coverage for the first dose stands at 86.88%, for the second dose at 74.56%, for the third dose at 39.08%, and for the fourth dose at less than 2.01% [7]. These data underscore the notable proportion of Indonesian individuals who have not completed the prescribed third and fourth doses of the vaccination regimen.

The World Health Organization (WHO) recommends the administration of booster doses of COVID-19 vaccines to individuals aged 18 years and older, and particularly to populations at highest risk, following completion of the primary vaccination series [8]. A COVID-19 booster vaccine may significantly boost immunogenicity and provide an additional measure of protection against COVID-19, especially in immunocompromised condition [9]. Over time, immunity can wane following vaccination, leading to a decreased immune response and reduced vaccine efficacy [10]. Booster vaccines are therefore crucial to enhancing immunity and maintaining vaccine efficacy, thereby providing vital additional protection against the disease.

A systematic review and meta-analysis found significant regional disparities in acceptance rates of booster vaccines [8]. The Western Pacific region exhibited the highest acceptance rate at 89%, followed by Europe at 86%, the Eastern Mediterranean at 59%, and the Southeast Asian region registering the lowest acceptance rate at 52% [8]. Factors significantly influencing the acceptance rate of COVID-19 booster vaccines include belief in the vaccine's effectiveness, concern about contracting COVID-19, and a history of chronic illness [11]. Conversely, rejection of booster vaccines is attributed to concerns about potential side effects and the perception that additional vaccination post-primary dose is redundant [11].

Therefore, grasping the community's perception of the COVID-19 vaccination program is pivotal for increasing vaccination coverage and achieving herd immunity. Tailoring effective strategies to the factors influencing individuals' willingness to participate in the vaccination program is essential. By understanding these determinants, intervention programs can be systematically developed to enhance coverage and raise awareness about the importance of booster vaccination in controlling the spread of COVID-19.

To date, some research has explored the willingness and perceptions of Indonesians regarding receiving a COVID-19 booster vaccine [12,13]. Key factors influencing booster vaccine acceptance among residents of Jakarta and Bali include beliefs about health, the impact of social media, and trust in official information sources [12]. Moreover, vaccine hesitancy toward the booster in Indonesia is influenced by intrinsic factors, such as limited knowledge of its benefits, concerns about side effects, and questions regarding its halal status [13]. Additionally, extrinsic factors, such as beliefs about the vaccine's effectiveness and safety, also contribute [13]. The Health Belief Model (HBM) is a commonly used theoretical framework to measure perceptions and identify factors influencing people's willingness to receive vaccines [14,15]. The HBM comprises six primary domains that shape health behavior, including perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy beliefs [14,15]. Therefore, the aim of the study was to investigate factors influencing people's acceptance of the first COVID-19 booster vaccine in Indonesia.

Methods

Study design and setting

This study utilized a cross-sectional, multicenter design, administering validated questionnaires online to a representative sample of the Indonesian population. Indonesia, with an estimated population of 275.5 million, is composed of five main islands and divided into 38 provinces at the

first level of administrative division. According to reports from the Ministry of Health, over six million cases of COVID-19 have been confirmed in Indonesia, with the number of fatalities exceeding 162,000 [15]. Data collection was conducted between June and September 2023.

Sample and sampling method

The study included Indonesian citizens aged 18 years or older who had received at least one dose of the COVID-19 vaccine. Participants with incomplete questionnaires were excluded from the study. The minimum sample size was calculated according to the Slovin formula [16], using a margin of error of 5% and a target vaccination population of 234,666,020 [7], resulting in 400. The sampling method utilized was convenience sampling.

Questionnaire structure

The questionnaire comprised three sections: (1) sociodemographic characteristics and clinical conditions of both the participants and their closest contacts; (2) the HBM domain section; and (3) the preferred location for receiving a booster vaccine and reasons for declining a booster vaccine.

The first section comprised items regarding age, sex, living location, level of education, monthly income, marital status, occupation, history of chronic diseases, clinical conditions of both patients and their close contacts, comorbidities, history of COVID-19 exposure, sources of information regarding the COVID-19 booster vaccine and COVID-19 booster vaccination status.

The domain section of the HBM, as the second section, comprised items assessing various aspects: three questions on perceived severity, three questions on perceived susceptibility, three questions on perceived clinical barriers to vaccination, three questions on perceived access barriers, and three questions on perceived specific benefits of the vaccine. Responses for the HBM domains were expressed using a Likert scale ranging from 'strongly disagree' to 'strongly agree,' with each option assigned a numerical value from 1 to 5, respectively. The perception data for each HBM domains were treated as interval data and were presented using the median and interquartile range (IQR).

The third section consisted of individuals' preferred location for receiving a booster vaccine and the rationale behind their decision to decline a booster vaccine. The response options regarding the preferred location to receive the booster vaccine were presented using a Likert scale, ranging from 'very uncomfortable' to 'very comfortable,' with intermediate options including 'somewhat uncomfortable,' 'normal/neutral,' and 'somewhat comfortable. Subsequently, these options were numerically coded from 1 to 5 and presented as the median and IQR.

Questionnaire development and validity

The instrument was adapted from a previous study's questionnaire to assess perceptions and factors influencing readiness for a COVID-19 booster vaccine [17]. The translation process involved two distinct stages: forward and backward translation. Initially, two independent translators translated the English instrument into Indonesian. Then, two other translators re-translated it back into English to verify the accuracy, as previously recommended [18]. This translation was then contextualized for an Indonesian audience. The resulting instrument was reviewed by a panel of experts, including a medical microbiologist, pharmacists, and pharmacologists.

A pre-test was conducted by distributing the questionnaire online to a sample of individuals (n=30) who met the inclusion criteria. The purpose was to assess the clarity of the items. Participants provided feedback on any items that were unclear, and their suggestions were incorporated to refine and improve the questionnaire.

The validity test for the HBM domain employed the confirmatory factor analysis (CFA) method [19,20]. To ensure the suitability of the CFA method for validating the developed questionnaire, parameters such as Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) and Bartlett's test of sphericity were assessed. In this study, KMO MSA values exceeding 0.7 and a *p*-value less than 0.05 for Bartlett's Test of Sphericity were set as the criteria for the suitability of conducting CFA, as recommended previously [21,22]. Following this initial assessment, the validity test proceeded to evaluate both convergent and discriminant validity. In line with the previous recommendation, convergent validity was ensured by setting a factor

loading value >0.4 [22]. Meanwhile, discriminant validity was assessed through an examination of the Hetero Trait-Mono Trait (HTMT) ratio, which should be below 0.85 [23,24]. To evaluate the fit of the CFA model to the observed data, we assessed statistical indices such as the comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA) [22]. A threshold of >0.92 was set for both CFI and TLI, indicating a good model fit [22]. The RMSEA and the standardized root mean square residual (SRMR) values of <0.08 were considered acceptable to indicate a close fit between the model and the data, as recommended in prior literature [22].

To evaluate the reliability of the questionnaire, we measured both Cronbach's alpha and McDonald's omega values. A minimum threshold of 0.6 was established for both metrics, indicating acceptable reliability, as previously recommended [25,26].

Data collection

The data collection process was conducted using an online platform, specifically a Google Form, which was strategically disseminated across multiple social media channels, including WhatsApp, Instagram, Telegram, and Facebook. This method was selected to enhance the recruitment process by maximizing outreach and engagement, thereby ensuring the inclusion of participants from diverse backgrounds and demographics.

To uphold the principles of privacy and confidentiality, all collected data underwent anonymization procedures. This involved the removal of any identifiable information, safeguarding the anonymity of participants. Furthermore, stringent measures were implemented to ensure the security of the data. The information was securely stored in a database accessible exclusively to the research team, thus minimizing the risk of unauthorized access.

Study variables

In this study, the dependent variable was the status of receiving a COVID-19 booster vaccine, with the outcome defined as having received the first booster dose. The independent variables included sociodemographic characteristics (age, sex, living location, level of education, monthly income, marital status, and occupation), clinical conditions (presence of chronic diseases, health risks of participants and their close contacts, history of COVID-19 infection, history of COVID-19 hospitalization, and whether the participant had lost a family member or friend to COVID-19), and the HBM domains (perceived severity of COVID-19, perceived susceptibility to COVID-19, perceived barriers to vaccination, and perceived benefits of the vaccine).

Statistical analysis

Sociodemographic data and clinical conditions were analyzed using descriptive statistics and presented as number (percentage), median (IQR), or mean (standard deviation (SD)). Bivariate logistic regression and multivariate logistic regression analyses were employed to evaluate the association between sociodemographic, clinical characteristics, and HBM domains with the acceptance of the first COVID-19 booster vaccine. The results were presented as odds ratios (OR) and adjusted odds ratios (AOR) with 95% confidence intervals (95%CI). A $p<0.05$ was used as the cut-off value for indicating a significant association.

Results

Questionnaire validation

The characteristics of the 300 respondents used for testing the validation and reliability of the questionnaire were comparable to those of the participants in the main analysis (see **Underlying data**). The obtained KMO MSA value was 0.78, and Bartlett's Test of Sphericity yielded a $p<0.001$, indicating that factor analysis is suitable for validating the questionnaire. All goodness-of-fit indicators met the expected standards, with a CFI value of 0.96, TLI of 0.94, RMSEA of 0.06, and SRMR of 0.06.

In the convergent validity test, two items, PHK1 ("I will experience side effects from the COVID-19 booster vaccine") and PHK2 ("The COVID-19 booster vaccine will be safe"), within the perceived clinical barriers subdomain of the HBM, had factor loading values below 0.4 and were consequently removed from the questionnaire. The discriminant validity test indicated that the

correlation between the general benefit and specific benefit subdomains exceeded 0.7, suggesting they measure the same construct. Therefore, the general benefit subdomain was eliminated. The factor loadings of the remaining HBM subdomains met the expected standards, and the HTMT ratios were all below the threshold of 0.85. The reliability of all HBM subdomains was confirmed with McDonald's ω and Cronbach's α values of 0.82 and 0.78, respectively. The complete results of validation tests can be found in this **Underlying data**.

Factors influencing acceptance of COVID-19 booster vaccine in Indonesia

The characteristics of the respondents (n=1550) involved in this study are presented in **Table 1** and the distribution of respondents across 38 provinces in Indonesia is illustrated in **Figure 1**.

Table 1. Characteristics of respondents (n=1550)

Respondent characteristics	Frequency (percentage)
Age (in years)	
18–25	810 (52.3)
26–35	242 (15.6)
36–45	185 (11.9)
>45	313 (20.2)
Gender	
Male	536 (34.6)
Female	1014 (65.4)
Location	
Western region	769 (49.6)
Central region	544 (35.1)
Eastern region	237 (15.3)
Length of education	
≤12 years	686 (44.3)
13–16 years	625 (40.3)
>16 years	239 (15.4)
Income per month (IDR)	
<1,500,000	438 (28.3)
1,500,000–3,500,000	575 (37.1)
>3,500,000	537 (34.6)
Marital status	
Unmarried	1006 (64.9)
Married	544 (35.1)
Occupation	
Not working/retired	647 (41.7)
Health worker	257 (16.6)
Non-health worker	646 (41.7)
History of chronic disease	
No	1381 (89.1)
Yes	169 (10.9)
High risk of COVID-19	
No	1366 (76.5)
Yes	184 (23.5)
Living with people at high risk of COVID-19	
No	1185 (76.5)
Yes	365 (23.5)
Have tested positive for coronavirus (COVID-19)	
No	1174 (75.7)
Yes	376 (24.3)
Have been hospitalized due to COVID-19	
No	1441 (93.0)
Yes	109 (7.0)
Have a family member or friend who has tested positive for COVID-19	
No	574 (37.0)
Yes	976 (63.0)
Have a family member or friend who has been hospitalized due to COVID-19	
No	842 (54.3)
Yes	708 (45.7)
Have a family member or friend who died from COVID-19	
No	1121 (72.3)
Yes	429 (27.7)

Respondent characteristics	Frequency (percentage)
COVID-19 booster vaccination status	
Have not received first booster vaccine	331 (21.4)
Received first booster vaccine	1219 (78.6)

Most respondents (52.3%) were aged between 18 and 25 years, with females constituting a significant portion (65.4%) (**Table 1**). The participants were mostly from western Indonesia (44.3%). Education levels varied, with nearly half (44.3%) having less than 12 years of education. Monthly income distribution showed two prominent categories: IDR 1.5–3.5 million (37.1%) and exceeding IDR 3.5 million (34.6%). Additionally, a majority (64.9%) were single. The percentage of unemployed individuals was identical (41.7%) to those employed outside the healthcare sector. Most respondents did not have a chronic disease (89.1%) and 76.5% perceived themselves as not being at high risk of COVID-19. The majority (76.5%) had no history of living with people at high risk of COVID-19. About 76% had never tested positive for COVID-19, and 93% had never been hospitalized due to COVID-19. Most respondents (63%) had a family member or friend who had tested positive for COVID-19. More than 50% of respondents did not have a family member or friend who had been hospitalized due to COVID-19, but about 70% had a family member or friend who died due to COVID-19. Overall, 78.6% of the participants had received a first COVID-19 booster vaccine (**Table 1**).

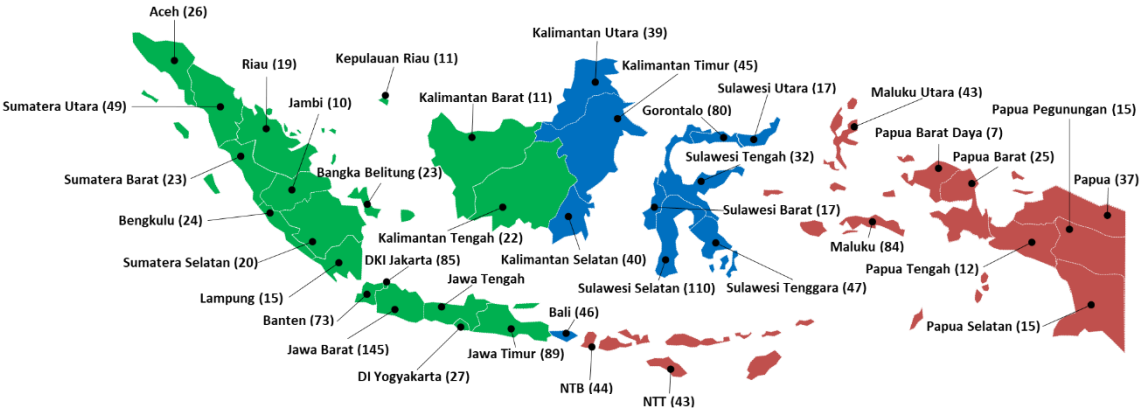

Figure 1. Illustration of the geographical distribution of respondents participating in the cross-sectional study across 38 provinces in Indonesia.

The distribution of vaccine types among respondents in the study is presented in **Table 2**. The predominant vaccine type was Sinovac, with 990 respondents, followed by AstraZeneca (415), Pfizer (276), and Moderna (248).

Table 2. Types of vaccines administered to the study respondents (n=1471)

Vaccine type	Total (percentage)
Sinovac	990 (67.30)
Astrazeneca	415 (28.21)
Pfizer	276 (18.76)
Moderna	248 (16.86)
Sinopharm	36 (2.45)
Novavax	15 (1.02)
Sputnik-V	6 (0.41)
Convidencia	5 (0.34)
Janssen	4 (0.27)
Zifivax	2 (0.14)

Bivariate analysis, indicating several sociodemographic factors potentially influencing an individual's acceptance of the first COVID-19 booster vaccine, is presented in **Table 3**. Compared to respondents aged 18–25 years, those aged 26–35 years (OR: 1.95; 95%CI: 1.36–2.80), 36–45 years (OR: 4.16; 95%CI: 2.47–7.00), and over 45 years (OR: 3.83; 95%CI: 2.57–5.72) showed higher acceptance of the vaccine. Other sociodemographic factors that may influence acceptance include being female, living in eastern regions, having 13–16 years or more than 16 years of

education, having monthly incomes of IDR 1.5–3.5 million and above IDR 3.5 million, being married, and being either a health worker or a non-health worker (**Table 3**).

Clinical history variables potentially influencing vaccine acceptance include having a chronic disease, being at high risk for COVID-19, living with someone at high risk, previously testing positive for COVID-19, a history of hospitalization due to COVID-19, having family or friends who tested positive, were hospitalized, or died due to COVID-19 (**Table 3**). In the HBM domain, perceptions of susceptibility to COVID-19, clinical barriers, access barriers, and perceived benefits were identified as potential factors motivating respondents to receive the first COVID-19 booster vaccine (**Table 3**).

Table 3. Potential factors influencing first COVID-19 booster vaccine acceptance

Variable	COVID-19 booster vaccine		OR 95%CI	*p*-value
	Yes (n=1219)	No (n=331)		
	n (%)	n (%)		
Age (in years)				
18–25	570 (46.8)	240 (72.5)	Reference	
26–35	199 (16.3)	43 (13.0)	1.95 (1.36–2.80)	<0.001
36–45	168 (13.8)	17 (5.1)	4.16 (2.47–7.00)	<0.001
>45	282 (23.1)	31 (9.4)	3.83 (2.57–5.72)	<0.001
Sex				
Male	453 (37.2)	83 (25.1)	Reference	
Female	766 (62.8)	248 (74.9)	0.57 (0.43–0.74)	<0.001
Location				
Western region	598 (49.1)	171 (51.7)	Reference	
Central region	421 (34.5)	123 (37.2)	0.98 (0.75–1.27)	0.873
Eastern region	200 (16.4)	37 (11.2)	1.55 (1.05–2.28)	0.029
Length of education				
≤12 years	492 (40.4)	194 (58.6)	Reference	
13–16 years	501 (41.1)	124 (37.5)	1.59 (1.23–2.06)	<0.001
>16 years	226 (18.5)	13 (3.9)	6.85 (3.83–12.28)	<0.001
Income per month (IDR)				
<1,500,000	290 (23.8)	148 (44.7)	Reference	
1,500,000–3,500,000	463 (38.0)	112 (33.8)	2.11 (1.59–2.81)	<0.001
>3,500,000	466 (38.2)	71 (21.5)	3.35 (2.44–4.61)	<0.001
Marital status				
Unmarried	745 (61.1)	261 (78.9)	Reference	
Married	474 (38.9)	70 (21.1)	2.37 (1.78–3.16)	<0.001
Occupation				
Not working/retired	452 (37.1)	195 (58.9)	Reference	
Health worker	236 (19.4)	21 (6.3)	4.85 (3.01–7.81)	<0.001
Non-health worker	531 (43.6)	115 (34.7)	1.99 (1.53–2.59)	<0.001
History of chronic disease				
No	1067 (87.5)	314 (94.9)	Reference	
Yes	152 (12.5)	17 (5.1)	2.63 (1.57–4.41)	<0.001
High risk of COVID-19				
No	1058 (86.8)	308 (93.1)	Reference	
Yes	161 (13.2)	23 (6.9)	2.04 (1.29–3.21)	0.002
Living with people at high risk of COVID-19				
No	915 (75.1)	270 (81.6)	Reference	
Yes	304 (24.9)	61 (18.4)	1.47 (1.08–2.00)	0.014
Have tested positive for COVID-19				
No	886 (72.7)	288 (87.0)	Reference	
Yes	333 (27.3)	43 (13.0)	2.52 (1.78–3.55)	<0.001
Have been hospitalized due to COVID-19				
No	1119 (91.8)	322 (97.3)	Reference	
Yes	100 (8.2)	9 (2.7)	3.18 (1.60–6.39)	0.001
Have a family member or friend who has tested positive for COVID-19				
No	419 (34.4)	155 (46.8)	Reference	
Yes	800 (65.6)	176 (53.2)	1.68 (1.31–2.15)	<0.001
Have a family member or friend who has been hospitalized due to COVID-19				
No	616 (50.5)	226 (68.3)	Reference	
Yes	603 (49.5)	105 (31.7)	2.11 (1.63–2.72)	<0.001

Variable	COVID-19 booster vaccine		OR 95%CI	*p*-value
	Yes (n=1219)	No (n=331)		
	n (%)	n (%)		
Have a family member or friend who died from COVID-19				
No	862 (70.7)	259 (78.2)	Reference	
Yes	357 (29.3)	72 (21.8)	1.49 (1.12–1.98)	0.007
HBM domain, mean (IQR)				
Perceived severity	3.33 (1.33)	3.33 (1.00)	1.12 (0.98–1.27)	0.112
Perceived vulnerability	3.33 (1.67)	3.00 (1.67)	1.41 (1.25–1.58)	<0.001
Perception of clinic barriers	2.00 (1.00)	2.33 (1.33)	0.86 (0.75–0.98)	0.028
Perception access barriers	2.00 (1.33)	2.67 (1.00)	0.63 (0.56–0.71)	<0.001
Perception of special benefits	4.00 (1.33)	3.00 (1.00)	1.78 (1.54–2.06)	<0.001

The multivariate analysis revealed that several sociodemographic factors independently influenced the acceptance of the first COVID-19 booster vaccine (**Table 4**). Respondents aged 36–45 years ($OR_{36–45 \text{ vs } 18–25 \text{ years}}$: 2.43; 95%CI: 1.13–5.24) and those over 45 years ($OR_{>45 \text{ vs } 18–25 \text{ years}}$: 3.58; 95%CI: 1.96–6.52) showed higher acceptance. Length of education also played a role, with respondents having 13–16 years of education ($OR_{13–16 \text{ vs } ≤12 \text{ years}}$: 1.34; 95%CI: 1.00–1.80) and more than 16 years of education ($OR_{>16 \text{ vs } ≤12 \text{ years}}$: 4.15; 95%CI: 2.12–8.09) being more likely to accept the vaccine. Additionally, a monthly income of about IDR 3.5 million ($OR_{IDR3,500,000 \text{ vs } <1,500,000}$: 1.72; 95%CI: 1.19–2.49) and being a health worker ($OR_{\text{Health workers vs not working}}$: 1.81; 95%CI: 1.00–3.29) were significant factors influencing vaccine booster acceptance.

Moreover, the multivariate analysis indicated that having a history of chronic disease (OR: 1.94; 95%CI: 1.03–3.66), previously tested positive for COVID-19 (OR: 1.90; 95%CI: 1.24–2.89), having a family member or friend who was hospitalized due to COVID-19 (OR: 1.86; 95%CI: 1.32–2.62), perceived susceptibility (OR: 1.20; 95%CI: 1.02–1.41), perceived access barriers to COVID-19 vaccination (OR: 0.52; 95%CI: 0.44–0.61), and perceived benefits of COVID-19 vaccination (OR: 1.67; 95%CI: 1.41–1.97) were clinical factors influencing the acceptance a COVID-19 booster vaccine (**Table 4**).

Table 4. Multivariate analysis of factors influencing acceptance of first COVID-19 booster vaccine

Variables	Adjusted OR (95%CI)	*p*-value
Age (year)		
18–25	Reference	
26–35	1.14 (0.71–1.85)	0.582
36–45	2.43 (1.13–5.24)	0.021
>45	3.58 (1.96–6.52)	<0.001
Gender		
Male	Reference	
Female	0.88 (0.62–1.24)	0.460
Location		
Western region	Reference	
Central region	0.82 (0.62–1.20)	0.180
Eastern region	0.76 (0.47–1.23)	0.260
Length of education		
≤12 years	Reference	
13–16 years	1.34 (1.00–1.80)	0.050
>16 years	4.15 (2.12–8.09)	<0.001
Income per month (IDR)		
<1,500,000	Reference	
1,500,000–3,500,000	1.35 (0.98–1.86)	0.06
>3,500,000	1.72 (1.19–2.49)	<0.001
Marital status		
Unmarried	Reference	
Married	0.77 (0.48–1.22)	0.270
Occupation		
Not working/retired	Reference	
Health workers	1.81 (1.00–3.29)	0.050
Non-health worker	1.03 (0.71–1.48)	0.890
Clinical characteristics		
History of chronic disease		
No	Reference	

Variables	Adjusted OR (95%CI)	*p*-value
Yes	1.94 (1.03–3.66)	0.040
High risk of COVID-19		
No	Reference	
Yes	1.39 (0.78–2.47)	0.270
Living with people at high risk of COVID-19		
No	Reference	
Yes	1.07 (0.75–1.54)	0.700
Have tested positive for COVID-19		
No	Reference	
Yes	1.90 (1.24–2.89)	0.003
Have been hospitalized due to COVID-19		
No	Reference	
Yes	1.15 (0.50–2.64)	0.750
Have a family member or friend who has tested positive for COVID-19		
No	Reference	
Yes	0.85 (0.61–1.17)	0.320
Have a family member or friend who has been hospitalized due to COVID-19		
No	Reference	
Yes	1.86 (1.32–2.62)	<0.001
Have a family member or friend who died from COVID-19		
No	Reference	
Yes	0.75 (0.52–1.08)	0.130
HBM domain		
Perceived severity	0.91 (0.76–1.08)	0.270
Perceived vulnerability	1.20 (1.02–1.41)	0.030
Perception of clinic barriers	1.09 (0.91–1.31)	0.340
Perception access barriers	0.52 (0.44–0.61)	<0.001
Perception of special benefits	1.67 (1.41–1.97)	<0.001

Sources of information about the COVID-19 booster vaccine

The sources from which respondents obtained information about the COVID-19 booster vaccine are presented in **Table 5**. The majority of respondents reported obtaining information through social media (908), followed by television (609), family members (512), and the health department (420).

Table 5. Sources of information about the COVID-19 booster vaccine (n=1550)

Sources of information	Frequency (percentage)
Social media	908 (58.58)
Television	609 (39.29)
Family members	512 (33.03)
Health Department	420 (27.10)
Friends	409 (26.39)
Government	406 (26.19)
Doctor	289 (18.64)
Nurse	119 (7.68)
Pharmacist	92 (5.93)
Midwife	49 (3.16)
Radio	36 (2.32)

Preferred location to receive COVID-19 booster vaccine

The preferred locations for receiving COVID-19 booster vaccines among respondents are presented in **Table 6**. The majority expressed a preference for hospitals (835), followed closely by community health centers (818), pharmacies (703), subdistrict offices (654), and drive-thru vaccination sites (631).

Table 6. Preferred location to receive COVID-19 booster vaccine (n=1550)

Location of vaccine receipt	Frequency (percentage)
Convenience of receiving vaccines at the hospital	835 (53.87)
Convenience of receiving vaccines at the community health center	818 (52.77)
Convenience of receiving vaccines at the pharmacy	703 (45.35)
Convenience of receiving vaccines at the subdistrict office	654 (42.19)
Convenience of receiving vaccines via drive-thru	631 (40.70)

Reasons for refusing to receive a first COVID-19 booster vaccine

The reasons for refusing to accept COVID-19 booster vaccines among respondents are outlined in **Table 7**. The most common reasons include concerns about short-term side effects (n=219) and long-term side effects (n=214). Additionally, significant numbers of respondents expressed doubts about the safety of the booster vaccine (n=165) and were not convinced that a booster vaccine was still necessary after receiving the first and second doses (n=156).

Table 7. Reasons for refusing to receive a first COVID-19 booster vaccine (n=1550)

Reasons	n (%)
I am concerned about the short-term side effects of the booster vaccine	219 (14.13)
I am concerned about the long-term side effects of the booster vaccine	214 (13.81)
I have doubts about the safety of the booster vaccine	165 (10.64)
I am not convinced that a booster vaccine is still necessary after I have received the first and second vaccines	156 (10.06)
I have doubts about the effectiveness of the booster vaccine	145 (9.35)
I am tired of the vaccination process	145 (9.35)
I have a low risk of being infected with COVID-19	58 (3.74)
I do not need a booster vaccine because I have good immunity	43 (2.77)
I have certain medical conditions that cause me to be unable to receive a booster vaccine	43 (2.77)
I have already had COVID-19, so I do not need a booster vaccine	31 (2.00)
Other recorded reasons	
Still no desire for a booster	1 (0.06)
I got sick often and my immunity decreased after receiving vaccines 1 and 2	1 (0.06)
I do not like being obligated to do something that is not mandatory	1 (0.06)
After getting the vaccine, I was sick for three days	1 (0.06)
Now there is no need to use vaccination	1 (0.06)
Being pregnant	1 (0.06)
Lazy to queue	1 (0.06)

Discussion

The WHO specifies that COVID-19 booster vaccines are administered to individuals who have completed their primary vaccination series [27]. These additional doses are crucial for addressing situations where the immune response from the primary series is insufficient [27]. Booster vaccines significantly enhance immunogenicity, providing additional protection while reducing transmission and severity of infection [28]. In the context of the COVID-19 pandemic, booster vaccines are essential for maintaining immune resilience against the coronavirus, including the continually emerging new variants [29,30].

Previous research reported that 95% of Indonesians are willing to receive a COVID-19 booster vaccine if it is provided free of charge by the government [13]. However, the actual prevalence of receiving a COVID-19 vaccine booster in this study was only 78.6%, despite the vaccines being offered at no cost. The primary reasons cited by respondents for refusing a booster vaccine included concerns about the potential side effects and safety of the COVID-19 booster vaccine. Many respondents also expressed uncertainty about the necessity of a booster vaccine following the initial dose, doubting its efficacy. Additionally, another study conducted in Indonesia from December 2022 to January 2023 revealed that only approximately 15% of respondents had received a COVID-19 booster vaccine [12]. The discrepancies between these studies can be attributed to variations in data collection periods—this study was conducted from June to September 2023—and differences in the coverage of the study areas. While the earlier study was limited to two provinces, Jakarta and Bali, our research extended its scope to include all 38 provinces across Indonesia [12].

In this study, we observed associations between age groups and the acceptance of a COVID-19 booster vaccine, indicating that older individuals exhibit a higher willingness to receive it. This finding is consistent with a prior study conducted in Indonesia, which demonstrated that age positively impacts an individual's likelihood of accepting the COVID-19 booster vaccine [12]. This increased acceptance among older individuals is likely due to their higher risk of COVID-19 exposure and complications [31,32]. Immune function diminishes with age, resulting in a decreased response to pathogens, a phenomenon known as "immunosenescence" [33]. Over time, this results in a deterioration of the immune system, increased susceptibility to infectious

diseases, diminished response to vaccination, and heightened vulnerability to age-related inflammation [34].

Additionally, this study examines the impact of education level and monthly income on the acceptance of COVID-19 booster vaccines. We found that acceptance of a COVID-19 booster vaccine increases with both education level and income. A study involving 135,821 fully vaccinated adults in the United States similarly concluded that individuals with higher education and income levels are more likely to opt for booster vaccines [35]. This association is likely because individuals with higher levels of education tend to have better health awareness [36]. They are also more likely to have strong beliefs in science and the effectiveness of vaccines, making them less susceptible to anti-vaccine campaigns [36]. Respondents with lower incomes, whose livelihoods depend on their daily work, are more likely to avoid getting a booster vaccine due to concerns about side effects that could prevent them from working [12]. In contrast, respondents with higher incomes, who typically have stable earnings and the ability to work from home, are more likely to get the booster vaccine. This is probably because they are more aware of the long-term health benefits and the risks of COVID-19, making them more willing to get vaccinated to protect their health [37].

In this study, respondents employed as healthcare workers exhibited a higher acceptance of a COVID-19 booster vaccine compared to respondents without occupations. Healthcare workers have a good understanding of the benefits and potential side effects of booster vaccines. Additionally, the Indonesian government prioritizes this group as the initial recipients of the COVID-19 vaccine due to their higher need for protection against the virus [38].

This study also found that acceptance of a COVID-19 booster vaccine is higher among those who have previously tested positive for COVID-19 and those with family or friends hospitalized due to the virus. Similar studies in Pakistan and Jordan show that individuals with a history of COVID-19 infection are more likely to accept booster doses [39,40]. Moreover, a study from Italy emphasized that having a family member or friend diagnosed with COVID-19 is a significant predictor of accepting the COVID-19 booster vaccine [41]. This is likely because witnessing the consequences of COVID-19 infection increases awareness and concern for health. As a result, individuals are more inclined to protect themselves by accepting a COVID-19 booster vaccine [41].

Another predictor of a COVID-19 booster vaccine acceptance is the history of chronic disease among respondents. This association may stem from patients with chronic illnesses perceiving themselves to be at higher risk of contracting COVID-19 [42]. Given that individuals with a history of chronic illness often have compromised immune systems, they are more vulnerable to infectious diseases, including COVID-19 [43]. Notably, a booster dose of the COVID-19 vaccine has been observed to significantly increase antibody levels in patients with cirrhotic conditions [44].

The acceptance of COVID-19 booster vaccines is also influenced by several domains of the HBM, including perceived susceptibility, perceived access barriers, and perceived benefits. Individuals who perceive higher access barriers are less willing to receive a booster COVID-19 vaccine. Conversely, those who perceive higher susceptibility to COVID-19 and greater benefits from the booster vaccine are more likely to accept it. A systematic review study has shown that perceived barriers are among the three perceptions (perceived benefits, barriers, and cues to action) most frequently identified as predictors of an individual's willingness to receive either a primary or booster series of COVID-19 vaccines [45]. Additionally, the perception of specific benefits has been identified as a predictor of COVID-19 vaccine acceptance [17]. This belief is further reinforced by the understanding that booster vaccines are effective and provide protection against infection [46].

In this study, the most common types of vaccines reported by respondents were Sinovac, AstraZeneca, Pfizer, and Moderna. These four types of vaccines are widely accepted by the Indonesian public [13] and are known to provide effective protection against COVID-19 and its variants [47]. However, we could not analyze vaccine acceptance based on vaccine type due to individuals potentially receiving more than one type of vaccine, necessitating further research. The primary source of information about the COVID-19 booster vaccine is predominantly through social media platforms. This trend might be attributed to the substantial number of internet and social media users in Indonesia, accounting for 77% and 60.4% of the total population,

respectively [48]. This raises concerns because many social media sources disseminate invalid and negative information about COVID-19 and vaccines, leading to a reported twofold increase in vaccine rejection among social media users [49].

The three most convenient locations for respondents to receive a COVID-19 booster vaccine were hospitals, community health centers, and pharmacies. This trend likely stems from the level of public trust in hospitals and community health centers as the primary healthcare providers in Indonesia. Interestingly, even though pharmacies currently do not offer COVID-19 vaccination services, respondents still perceive them as convenient locations for vaccination. This perception could be attributed to the widespread presence of pharmacies within communities, facilitating easy access to vaccines even in remote areas. While drive-thru vaccination sites are an optimal option for minimizing contact between healthcare workers and vaccine recipients during the COVID-19 pandemic, they may not be the most practical option [50]. In this study, the drive-thru services were not the primary option because the proportion of Indonesians who own cars is not as substantial as in developed countries.

One limitation of this study is its reliance on online methods for data collection, which may exclude Indonesians living in remote areas with limited internet access or without smartphone ownership. The extensive geographical expanse of Indonesia and the significant proportion of internet users were the primary factors necessitating the online methodology employed in this research. Despite these limitations, we were able to successfully collect data from respondents across all regions of Indonesia, including all 38 provinces.

The application of the HBM in this study, which incorporates perceptions of risk, susceptibility, benefits, and barriers, provides a comprehensive understanding of the psychological factors that influence individual decisions regarding vaccination programs [51]. The findings of this study can serve as a foundation for enhancing communication strategies, information campaigns, and personalized approaches to motivate individuals to receive vaccines. This applies not only to the COVID-19 booster vaccine but also to vaccination efforts in general. Therefore, this study is expected to improve public understanding of the significance of vaccination in preventing infectious diseases and to support government initiatives aimed at achieving optimal vaccination coverage.

Previous study has identified four strategies to increase vaccination program coverage among individuals [52]. The first approach integrates community health training for parents alongside home visits by healthcare professionals. The second strategy is an incentive-based approach tailored for individuals in rural areas and lower socio-economic strata. The third strategy focuses on improving health literacy through information technology, such as electronic posters, leaflets, short informative videos, social media platforms, etc. The fourth strategy entails a reminder system using media such as emails, short messages, and phone calls. These strategies have demonstrated significant effectiveness in increasing vaccine acceptance rates.

Conclusion

Based on our research, it can be concluded that factors influencing people's acceptance of the COVID-19 booster vaccine in Indonesia include sociodemographic factors (such as age, length of education, monthly income, and occupation), clinical history (including a history of chronic disease, prior COVID-19 infection, and having family members or friends hospitalized due to COVID-19), as well as domains outlined in the HBM notably perceived vulnerability and perceived access barriers to vaccine reception, along with recognizing the special benefits associated with receiving the first COVID-19 vaccine booster.

Ethics approval

This study was conducted in compliance with the Helsinki Declaration. This study obtained ethical approval from the Ethics Commission of the Faculty of Public Health, Universitas Hasanuddin, with Approval Number: 4507/UN4.14.1/TP.01.02/2023.

Acknowledgments

The authors would like to thank the Faculty of Pharmacy, Universitas Hasanuddin, for its support during the research.

Competing interests

There was no conflict of interest.

Funding

This study received no specific grant from public, commercial, or not-for-profit funding agencies.

Underlying data

The questionnaire and complete validity and reliability test results can be accessed through this link: https://doi.org/10.6084/m9.figshare.25930405.v1.

How to cite

Mohi AR, Kusuma IY, Massi MN, Bahar MA. Factors related to first COVID-19 booster vaccine acceptance in Indonesia: A cross-sectional multi-center study. Narra J 2024; 4 (2): e858 - http://doi.org/10.52225/narra.v4i2.858.

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