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Acceptance of COVID-19 vaccine booster doses among the Adult Population in Ghana: a cross-sectional study using the Health Belief Model

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Abstract

Background The Health Belief Model (HBM) is a widely utilised framework for understanding vaccination behaviour against COVID-19. This study assessed the acceptance of COVID-19 vaccine booster doses in Ghana and identified predictors using HBM domains, including perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action. Additionally, it examined the sources of information about COVID-19 vaccines.

Methods We employed a cross-sectional quantitative design, using convenient and snowball sampling methods to recruit participants. Between March 20 and May 10, 2023, 822 Ghanaians completed a predesigned self-administered online survey via commonly used social media platforms (WhatsApp, Facebook, X (Twitter), and LinkedIn). The study used a binary logistic regression to predict COVID-19 booster dose acceptance.

Results The respondents had a mean age of 29.3 ± 6.2, with 55.5 being males, 53.0% being single/never married, 93.7% having tertiary education, 83.0% being Christians, 59.1% were healthcare workers, 57.8% residing in urban areas, 95.5% having no chronic disease, 90.6% reporting negative COVID-19 history, and 78.3% reporting no reported relative/friend infected with COVID-19. The study showed that 81.1% [95% confidence interval (CI) = 78.4 – 83.8%] of respondents received the COVID-19 vaccine, and 58.3% [95% CI = 54.2 – 62.5%] of respondents were willing to accept the COVID-19 booster dose. The main reasons for non-acceptance of COVID-19 vaccine booster doses were personal reasons (41.7%) and experienced side effects or fear of side effects (32.4%). Regression analysis revealed that perceived benefits and perceived barriers (specifically worrying about serious risk factors) were the significant predictors of accepting COVID-19 booster doses in Ghana.

Conclusions Many respondents were willing to receive the COVID-19 booster dose. Personal reasons, fear of side effects, and experienced side effects were the main reasons for refusing COVID-19 booster doses. Perceived benefits

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and perceived barriers predicted COVID-19 booster dose acceptance in Ghana. Policymakers should consider these factors in designing public health interventions to increase the patronage of COVID-19 booster doses.

Keywords Ghana, COVID-19, Booster dose, Vaccine hesitancy, Health belief model

Background

Since the global pandemic of coronavirus disease 2019 (COVID-19), it has caused devastating effects on individuals and economies worldwide [1–4]. As of 14 April 2024, there were confirmed 775,335,916 reported cases of COVID-19 worldwide, while confirmed 7,045,569 persons died from COVID-19 [5, 6]. On 5 May 2023, the World Health Organization (WHO) declared that COVID-19 no longer poses a global public health emergency [7].

Despite this declaration, it is important to acknowledge that the virus still causes a threat and can lead to fatalities if preventive measures, such as vaccination, are not maintained [1]. As of December 31, 2023, a total of 13.64 billion COVID-19 vaccines have been administered globally to help reduce the spread of the virus [8]. The WHO continues to emphasise vaccination as a key strategy for maintaining progress in COVID-19 control, as outlined in its Strategic Preparedness and Response Plan for April 2023–April 2025 [9].

Research has shown that COVID-19 vaccine booster doses effectively combat variants of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for the disease [10, 11]. As of November 26, 2023, an estimated 5,602,516,381 individuals worldwide have received at least one dose of the COVID-19 vaccine, while 2,493,620,878 individuals have received at least one booster dose [8]. As of April 7, 2024, Ghana has reported 172,075 confirmed cases of COVID-19, resulting in 1,462 confirmed deaths [12]. As of December 31, 2023, approximately 6,691,825 individuals in Ghana have received at least one COVID-19 vaccine booster [12].

Studies have shown that one of the 10 threats to global health is vaccine hesitancy (VH), which was widely prevalent in the context of COVID-19 vaccination [13–15]. VH is defined as the "delay in acceptance or refusal of vaccination despite the availability of vaccination services" [16]. This attitude represents a threat hindering progress in combating vaccine-preventable illnesses [17]. Previous studies have identified several predictors of acceptance of COVID-19 vaccine booster doses, including socio-demographic characteristics (such as age, sex, educational level, and profession), health-related factors (including vaccination history, chronic illness status, and previous COVID-19 positive tests), and trust in government [18–20]. Also, studies have identified sources of information about COVID-19 (information from the Ministry of Health), perceptions towards the COVID-19 vaccine, and health belief model (HBM) constructs (perceived susceptibility, severity, and risks of side effects about COVID-19) as factors influencing the acceptance of COVID-19 vaccine booster dose [18–20].

Though there are studies in Ghana on the acceptance of COVID-19 vaccines [21–26], only one study focused on the acceptance of COVID-19 vaccine booster doses [18]. Storph and colleagues' study found that factors such as being male, testing positive for COVID-19, high trust in the government, experiencing side effects from primer dose, and having positive perceptions about COVID-19 vaccines were predictors of acceptance of COVID-19 vaccine booster doses [18]. Also, to the best of our knowledge, no study in Ghana has used the HBM constructs to predict acceptance of acceptance of COVID-19 vaccine booster doses in Ghana. The HBM aids in the explanation and prediction of individuals' health-related behaviours based on their beliefs and attitudes.

Therefore, to bridge this knowledge gap, this study examined the extent of COVID-19 vaccine booster doses acceptance and its predictors in Ghana using the HBM constructs. Also, the study examined the source of information regarding COVID-19 vaccines and perceptions about COVID-19 vaccine booster doses. HBM is one of the most popular models for analyzing individuals' behaviour against vaccination for COVID-19 [27]. The model hypothesises that several variables influence the individual's health-related behaviour, such as cues to action, self-efficacy, perception of susceptibility, severity, benefits, and barriers [28]. The findings of this study will inform the development of strategies to enhance acceptance of COVID-19 vaccine booster doses in Ghana.

Methods

Study Design and sampling procedure

This study used a cross-sectional study design to examine the acceptance and predictors of acceptance of COVID-19 vaccine doses in Ghana. Convenience and snowball sampling methods were used to select respondents for this study. A self-administered online survey was created using Google Forms and disseminated across various social media platforms, including Meta (WhatsApp), Facebook, X (formerly Twitter), and LinkedIn, by a team of researchers. Additionally, participants were encouraged to share the online survey with their eligible family members, friends, and colleagues.

The study population is persons aged 18 years or older residing in Ghana. The study applied specific inclusion criteria to determine participants' eligibility. Respondents were eligible if they were 18 years or older, residents of

Ghana, had internet access, and provided consent to participate. Individuals with communication challenges, such as blindness that could interfere with completing the questionnaire were excluded.

The Epi Info software was used to estimate the minimum sample size for our study. We based the population size on Ghana's estimated population of 30.8 million as of 2021. An acceptance rate of 50% for the COVID-19 booster dose and a design effect of 2 was assumed, following estimates from a previous study on booster dose acceptance in Ghana [18]. A 95% confidence level was applied, resulting in an estimated minimum of 768 respondents. The final sample size included in the study was 822 participants giving an expected non-response rate of 15%.

Study setting

Ghana is located in Africa, specifically West Africa. It shares a boundary with Burkina Faso on the North, Togo on the East, the Gulf of Guinea on the South, and Cote d'Ivoire on the West. Ghana is a lower-middle-income country with 16 administrative regions. Accra is Ghana's capital in the Greater Accra region [29]. The Greater Accra and Ashanti regions are the most populous regions in Ghana, with estimated populations of 17.7 million and 17.6 million, respectively [29]. In 2023, the Government of Ghana commissioned the National Vaccine Institute to develop its vaccine [30].

In Ghana, the Ministry of Health is responsible for providing policy direction for all stakeholders involved healthcare delivery across the country [31]. The varied stakeholders involved healthcare delivery in Ghana include Ghana Health Service (public), faith-based organisations, private not-for-profit organisations, and private for-profit organisations [32]. In Ghana, the healthcare system is structured at four levels: tertiary, regional, district and sub-district levels. Ghana Health Service is responsible for the provision of primary health care services at the regional, district and sub-district levels [33]. At the tertiary level, boards of various tertiary hospitals ensure the implementation of policies to ensure the provision of quality care to patients [33].

Description and conceptualisation of variables

Dependent variable

The dependent variable for this study is acceptance of the COVID-19 booster dose, and it was measured by asking respondents who had ever received the COVID-19 vaccine whether they will receive a COVID-19 booster dose. The responses were "yes" and "no". A "yes" response indicates willingness to accept a COVID-19 booster dose, while a "no" response means unwillingness to accept a COVID-19 booster dose. The measurement of acceptance of the COVID-19 booster dose in this study is similar to a previous study in Ghana [18]. Storph et al.'s [18] study among 812 adult Ghanaians evaluated the factors associated with the acceptability of the COVID-19 booster dose in Ghana.

Independent variables

The independent variables for this study included socio-demographic characteristics, source of information, and HBM. The socio-demographic characteristics were age, sex (male and female), residence (urban and rural), education (before tertiary and tertiary), marital status (married and non-married), employment status (employed and unemployed), religion (Christian, Islam, and other), and chronic disease (yes and no). Regarding the source of information, respondents were asked whether they received information regarding the COVID-19 vaccine from health workers, and the responses were "yes" and "no." The HBM captures six dimensions: perceived susceptibility to COVID-19 infection, perceived severity of COVID-19, perceived benefit of COVID-19 booster, a perceived barrier to receiving COVID-19 booster doses, cues to actions, and self-efficacy.

Data collection

The data for this study was collected from 20 March to 10 May 2023. A pre-dsigned questionnaire previously used by Ghazy et al. [20] was adapted for this study (see supplementary file 1). The online survey had three sections. The first section covered the socio-demographic characteristics of respondents (i.e., age, sex, education, marital status, religion, employment status, history of chronic disease, previous COVID-19 infection, COVID-19 among relatives, and immunocompromising diseases). The second section addressed participants' COVID-19 vaccination status, sources of information about COVID-19 vaccines, and their willingness to receive COVID-19 booster doses, including reasons for any refusal.

The third section included HBM questions, featuring 13 items designed to assess respondents' perceptions of COVID-19 infection and booster vaccination. The perceived susceptibility to COVID-19 infection, perceived severity of COVID-19, and cues to actions had 2 items each. Also, the perceived benefit of COVID-19 booster and perceived barrier to receiving COVID-19 booster doses had 3 items each. In addition, self-efficacy had one item. According to HBM, behaviour is more likely to happen among people who may think there will be little or no obstacles to adopting behaviours, that it will lower the chance of a negative health outcome, that it will have a significant negative impact on their health, and if they think they are vulnerable to it [34].

Statistical analysis

The SPSS (Statistical Package for Social Science Software) Armonk, NY: IBM Corp version 27.0 was used to analyze the data of the study. Descriptive statistics, such as frequency and percentages, were used to describe the socio-demographic characteristics of respondents, the source of information regarding COVID-19 vaccines, and the COVID-19 vaccine status of respondents. Pearson's chi-square test was used to examine the association between acceptance of COVID-19 booster doses and respondent's socio-demographic characteristics, source of information regarding COVID-19 vaccines, and perception of COVID-19 booster doses respectively. Furthermore, a binary logistic regression was conducted to evaluate factors influencing COVID-19 booster dose acceptance. The dependent variable was COVID-19 booster dose acceptance, with two response categories: "Yes" and "No." Variables that showed significant associations in the bivariate analysis were included in the model. The Enter method in SPSS software was employed, allowing all selected variables to be simultaneously incorporated into the model. To assess the strength and precision of the associations between predictors and willingness to accept the booster dose, odds ratios (OR) and 95% confidence intervals (CI) were calculated. Significance was considered when $p \leq 0.05$.

Table 1 Socio-demographic characteristics of the studied sample

Studied variables ($n=822$)	Socio-demographic data	*n* (%)
Sex	Male	456 (55.5)
	Female	366 (44.5)
Age (years)	Min. – Max.	16.0–61.0
	Mean ± SD	29.97 ± 6.24
Residence	Urban	475 (57.8)
	Rural	347 (42.2)
Religion	Christian	682 (83.0)
	Islam	123 (15.0)
	Other	17 (2.0)
	Traditionalist	7 (0.9)
	Jew	1 (0.1)
	No religion	9 (1.1)
Marital status	Never married/single	436 (53.0)
	Informal/ living together	22 (2.7)
	Married	351 (42.7)
	Separated	5 (0.6)
	Divorced	6 (0.7)
	Widow	2 (0.2)
Education	No formal education	2 (0.2)
	JSS/JHS	1 (0.1)
	Middle	1 (0.1)
	SSS/SHS	34 (4.1)
	Vocational/Technical	12 (1.5)
	Tertiary	772 (93.9)
Working status	Unemployed	185 (22.5)
	Non-healthcare	151 (18.4)
	Healthcare	486 (59.1)
Presence of chronic disease	Yes	37 (4.5)
	No	785 (95.5)
Previous COVID-19 infection	Yes	77 (9.4)
	No	745 (90.6)
Having a relative or friend infected with COVID-19	Yes	178 (21.7)
	No	644 (78.3)

Ethical considerations and approval

The study followed ethical guidelines concerning collecting data from human subjects. Ethical approval was sought and received from the ethical committee of the High Institute of Public Health, Alexandria University (IRB number 00013692). The study's objectives were presented on the front page of the online survey. Respondents provided written informed consent by selecting either "I agree to participate" or "I do not agree to participate." Only those who selected "I agree to participate" were allowed to proceed to the online questionnaire. All participant information was managed confidentially and anonymously to ensure privacy.

Results

The mean age of the respondents was 29.97 ± 6.24, 55.5% were males, 93.7% had tertiary education, 83.0% were Christians, 59.1% were healthcare workers, 57.8% resided in urban areas, and 53.0% were single or never married (53%) (Table 1). The majority of respondents had no chronic disease (95.5%), no previous history of SARS-CoV-2 infection (90.6%), and no relative or friend infected with COVID-19 (78.3%).

Sources of information regarding COVID-19 vaccines

Healthcare workers (62.9%) and social media (61.7%) were the primary sources of information about COVID-19 vaccines (Fig. 1). Fewer than half of the respondents (48.3%) cited scientific websites as a source, while approximately one-fifth relied on relatives or friends (20.6%) and literature articles (19.0%) for information on COVID-19 vaccines.

COVID-19 vaccine situation among the studied sample

Table 2 represents the COVID-19 vaccine situation among respondents. Of the total sample, 81.1% (95% CI = 78.4 – 83.8%) of respondents received the COVID-19 vaccine. Over half of the respondents (52.2%) had received a COVID-19 vaccine booster dose. Among the 259 respondents who had not received the COVID-19 vaccine booster dose, 58.3% (95% CI = 54.2 – 62.5%) were willing to receive the COVID-19 vaccine booster dose.

Figure 2 shows that 41.7% of respondents cited personal reasons for refusing the COVID-19 vaccine booster

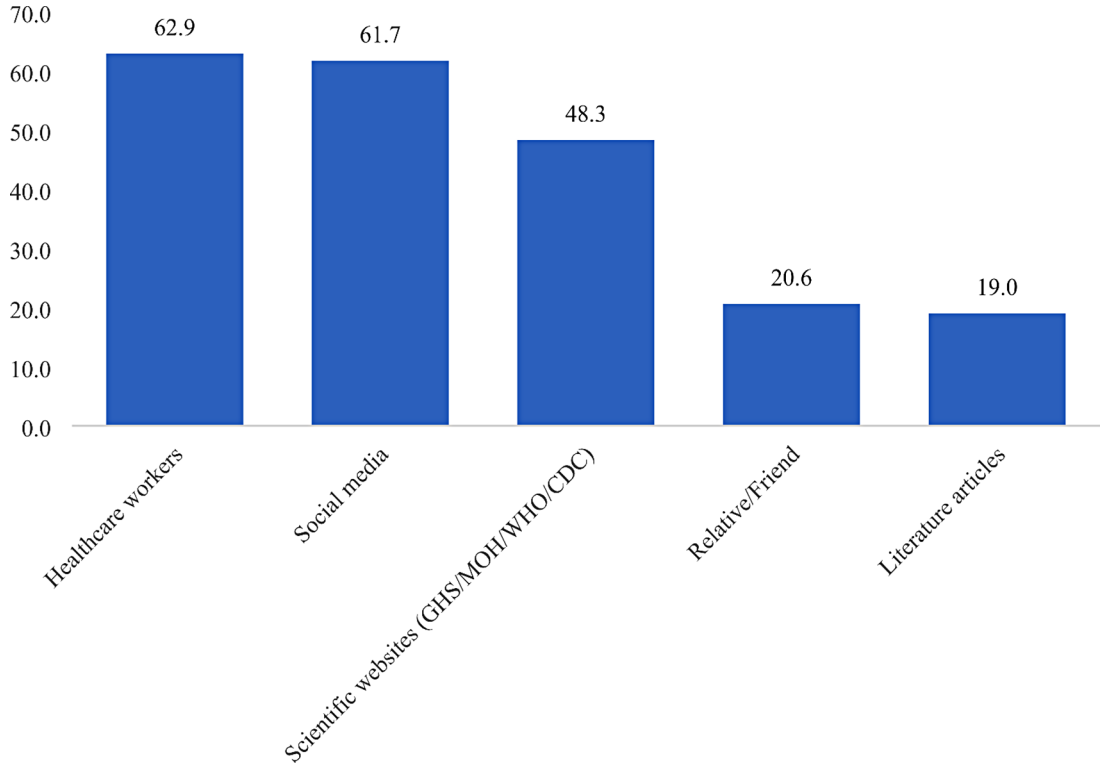

Fig. 1 Sources of information regarding COVID-19 vaccines

Table 2 COVID-19 vaccine situation among the studied sample

Studied variable (*n* = 822)		Study sample
Received COVID-19 vaccine	Yes	667 (81.1)
	No	155 (18.9)
COVID-19 vaccine status (*n* = 667)	I took the first dose, and only one dose is required	85 (12.7)
	I took the first dose and waiting for the second dose	68 (10.2)
	I took the first dose and will not take the second dose	57 (8.5)
	I took the second dose	457 (68.5)
Received COVID-19 vaccine booster dose (*n* = 542)	Yes	283 (52.2)
	No	259 (47.8)
Willing to receive COVID-19 booster dose (*n* = 259)	Yes	151 (58.3)
	No	108 (41.7)

dose. Also, 32.4% of respondents were concerned about potential side effects or feared severe side effects of COVID-19 vaccine booster dose. Additionally, 9.3% of respondents felt the pandemic was over, so they did not need the COVID-19 vaccine booster dose. Other reasons (Scared or experienced side effects from vaccines, thinking vaccination is a political game, seeing that the pandemic is over or having personal reasons) were cited by 16.7% of the respondents.

Acceptance of COVID-19 vaccine booster dose was higher among males than females (54.8% vs. 45.2%); this sex difference was not statistically significant (P=0.795) (Table 3). Respondents who accepted the COVID-19 vaccine booster dose were older than those who rejected the booster dose (31.27±5.38 vs. 30.24±6.63). However, this difference was not statistically significant (P=0.094) as well. The COVID-19 vaccine booster dose acceptance among respondents in rural areas was higher than in urban areas (51.2% vs. 49.8%). More respondents in urban areas rejected the COVID-19 vaccine booster dose than those residing in rural areas (59.3% vs. 40.7%), and the difference did not show statistical significance (P=0.077). Being married was significantly associated with COVID-19 vaccine booster dose acceptance despite equal numbers of married and unmarried respondents who accepted the COVID-19 vaccine booster doses. Education, working status, industry, presence of chronic disease, previous COVID-19 infection, and having a relative or friend infected with COVID-19 were not statistically associated with COVID-19 vaccine booster dose acceptance. Healthcare workers as a source of information about COVID-19 vaccination was significantly associated (P=0.001) with accepting or rejecting the COVID-19 vaccine booster doses. Most respondents (71.2%) who received information about COVID-19 vaccines from healthcare workers accepted the COVID-19 vaccine booster dose compared to those who did not receive information from healthcare workers. Neither social media, relatives/friends, scientific websites, nor literature as a source of information about the COVID-19 vaccine

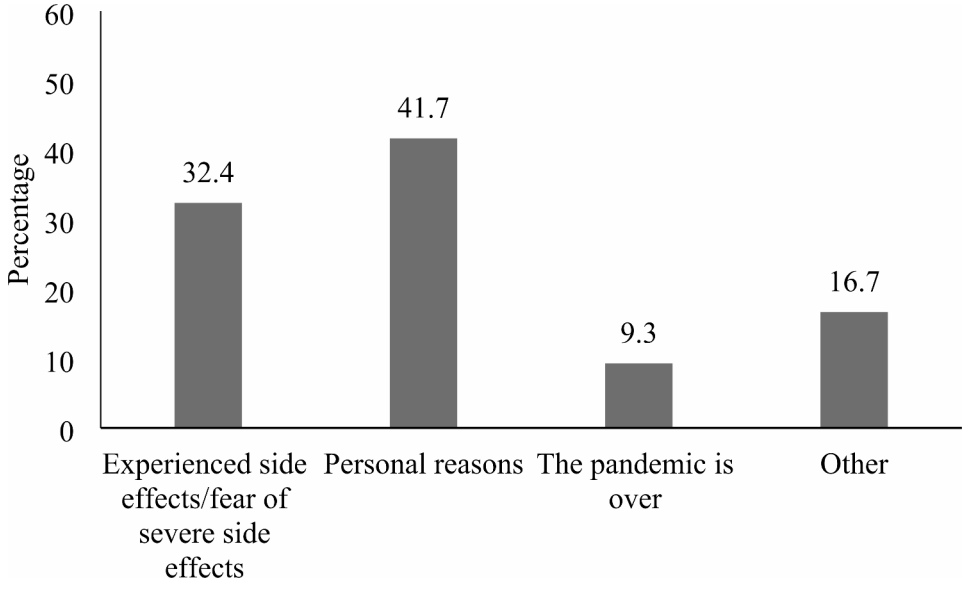

Fig. 2 Reasons for refusing COVID-19 booster dose

Table 3 Comparison of different characteristics among accepting and rejecting COVID-19 booster dose participants ($n=542$)

Variables	Socio-demographic data	Accepting booster dose ($n=434$)	Rejecting booster dose ($n=108$)	*P*
Sex	Male	238 (54.8)	61 (56.5)	0.759
	Female	196 (45.2)	47 (43.5)	
Age (years)	Mean ± SD	31.27 ± 5.38	30.24 ± 6.63	0.094
Residence	Urban	216 (49.8)	64 (59.3)	0.077
	Rural	218 (51.2)	44 (40.7)	
Religion	Christian	358 (82.5)	98 (90.7)	0.107
	Islam	66 (15.2)	9 (8.3)	
	Other	10 (2.3)	1 (0.9)	
Marital status	Married	217 (50.0)	41 (38.0)	**0.025***
	Non-married	217 (50.0)	67 (62.0)	
Education:	Before tertiary	24 (5.5)	8 (7.4)	0.459
	Tertiary	410 (94.5)	100 (92.6)	
Working status	Unemployed	64 (14.7)	20 (18.5)	0.188
	Non-healthcare	51 (11.8)	18 (16.7)	
	Healthcare	319 (73.5)	70 (64.8)	
Presence of chronic disease		20 (4.6)	3 (2.8)	0.398
Previous COVID-19 infection		41 (9.4)	15 (13.9)	0.175
Having a relative or friend infected with COVID-19		99 (22.8)	25 (23.1)	0.941
Source of information	Social media	245 (45.5)	58 (53.7)	0.607
	Healthcare workers	309 (71.2)	59 (54.6)	**0.001***
	Relative/Friend	81 (18.7)	23 (21.3)	0.534
	Scientific websites	228 (52.5)	51 (47.2)	0.323
	Literature articles	84 (19.4)	17 (15.7)	0.388

were statistically associated with COVID-19 vaccine booster dose acceptance.

Perception of COVID-19 vaccine booster doses based on HBM

With exception to second point of perceived severity, third point of perceived barriers and cues to action, all other domains of HBM (i.e., perceived susceptibility, perceived severity, perceived benefit, perceived barriers, and perceived efficacy) were significantly associated with accepting and rejecting COVID-19 vaccine booster dose ($P<0.05$) (Table 4).

Table 4 Perception of COVID-19 vaccine booster doses based on the health belief model

	Dependent: vaccination		Accepting booster dose (*n* = 434)	Rejecting booster dose (*n* = 108)	*P*
Perceived susceptibility	I think there is a risk of COVID-19 infection	Strongly disagree/Disagree	29 (6.7)	15 (13.9)	**< 0.001***
		Neutral	59 (13.6)	29 (26.9)	
		Agree/ Strongly agree	346 (79.7)	64 (59.3)	
	I think COVID-19 variants have higher risk of infection than the existing strains	Strongly disagree/ Disagree	32 (7.4)	11 (10.2)	**0.017***
		Neutral	88 (20.3)	34 (31.5)	
		Agree/ Strongly agree	314 (72.4)	63 (58.3)	
Perceived severity	I think COVID-19 infection is severe disease	Strongly disagree/ Disagree	15 (3.5)	9 (8.3)	**0.01***
		Neutral	44 (10.1)	18 (16.7)	
		Agree/ Strongly agree	375 (86.4)	81 (75.0)	
	I agree that COVID-19 variants can cause more severe illness than the existing strains	Strongly disagree/ Disagree	27 (6.2)	9 (8.3)	0.154
		Neutral	71 (16.4)	25 (23.1)	
		Agree/ Strongly agree	336 (77.4)	74 (68.5)	
Perceived benefit	I belief the COVID-19 vaccines are effective against early circulating COVID-19 strains	Strongly disagree/ Disagree	18 (4.1)	23 (21.3)	**< 0.001***
		Neutral	61 (14.1)	42 (38.9)	
		Agree/ Strongly agree	355 (81.8)	43 (39.8)	
	I belief the COVID-19 vaccines are effective to extend protection against COVID-19 infection?	Strongly disagree	16 (3.7)	20 (18.5)	**< 0.001***
		Neutral	37 (8.5)	39 (36.1)	
		Agree/ Strongly agree	381 (87.8)	49 (45.4)	
	I belief the COVID-19 vaccines are effective against COVID-19 variants	Strongly disagree/ Disagree	15 (3.5)	19 (17.6)	**< 0.001***
		Neutral	54 (12.4)	41 (38.0)	
		Agree/ Strongly agree	365 (84.1)	48 (44.4)	
Perceived barriers	I think COVID-19 vaccines are safe	Strongly disagree/ Disagree	6 (1.4)	10 (9.3)	**< 0.001***
		Neutral	39 (9.0)	46 (42.6)	
		Agree/ Strongly agree	389 (89.6)	52 (48.1)	
	I am worried about serious adverse reaction after vaccination	Strongly disagree/ Disagree	104 (24.0)	19 (17.6)	**0.028***
		Neutral	119 (27.4)	21 (19.4)	
		Agree/ Strongly agree	211 (48.6)	68 (63.0)	
	I know persons had severe side effects after being vaccinated	Strongly disagree/ Disagree	93 (21.4)	14 (13.0)	0.058
		Neutral	86 (19.8)	30 (27.8)	
		Agree/ Strongly agree	255 (58.8)	64 (59.3)	
Perceived Efficacy	It is easy for me to get the COVID-19 vaccine if I wanted to	Strongly disagree/ Disagree	22 (5.1)	4 (3.7)	**0.019***
		Neutral	26 (6.0)	15 (13.9)	
		Agree/ Strongly agree	386 (88.9)	89 (82.4)	
Cue to action	Did you use to have confirmed or suspected cases in your daily close contacts?	No	302 (69.6)	75 (69.4)	0.977
		Yes	132 (30.4)	33 (30.6)	
	Do you know about the following COVID-19 variants?	I don't know	136 (31.3)	37 (34.3)	0.771
		One types	152 (35.0)	36 (33.3)	
		Two types	69 (15.9)	19 (17.6)	
		Three types	31 (7.1)	4 (3.7)	
		Four types	18 (4.1)	6 (5.6)	
		All types	28 (5.6)	6 (5.6)	

Predictors of COVID-19 vaccine booster dose acceptance

Respondents who expressed neutrality regarding concerns over serious adverse reactions showed more acceptance of the booster vaccine ($p<0.001$, OR = 3.9, 95% CI: 1.83–8.32) (Table 5). Additionally, there was a marginally significant association between believing that the vaccines are effective against early circulating strains and increased vaccine acceptance ($p=0.042$, OR = 3.56, 95% CI: 1.04–12.1). Overall, belief in the safety of the COVID-19 vaccines was a significant predictor of COVID-19 vaccine booster dose acceptance, with respondents who considered the vaccines safe being much more likely to accept them ($p<0.001$). The regression model was statistically significant ($p<0.001$), explaining 84.1% of variability with $R^2 = 35.0\%$.

Table 5 Regression analysis of predictors affecting COVID-19 vaccine booster dose acceptance

Independent variables	*P*	OR	95% CI	
			Lower	Upper
Marital status				
Married	0.182	1.42	0.85	2.38
Non-married (Ref)				
Source of information (Healthcare workers)				
Yes	0.068	1.64	0.96	2.80
No (Ref)				
I think there is a risk of COVID-19 infection	0.581			
Strongly disagree/ disagree (Ref)				
Neutral	0.987	1.01	0.32	3.21
Agree/ Strongly agree	0.496	1.46	0.49	4.36
I think COVID-19 variants have a higher risk of infection than the existing strains	0.725			
Strongly disagree/ disagree (Ref)				
Neutral	0.785	0.85	0.25	2.84
Agree/ Strongly agree	0.521	0.67	0.20	2.25
I think COVID-19 infection is severe disease	0.486			
Strongly disagree/ disagree (Ref)				
Neutral	0.924	0.93	0.22	4.02
Agree/ Strongly agree	0.448	0.59	0.15	2.29
I believe the COVID-19 vaccines are effective against early circulating COVID-19 strains	0.071			
Strongly disagree/ disagree (Ref)				
Neutral	0.319	1.89	0.54	6.56
Agree/ Strongly agree	**0.042***	3.56	1.04	12.10
I believe the COVID-19 vaccines are effective in extending protection against COVID-19 infection	**0.05***			
Strongly disagree/ disagree (Ref)				
Neutral	0.106	0.29	0.07	1.3
Agree/ Strongly agree	0.849	0.86	0.18	4.08
I believe the COVID-19 vaccines are effective against COVID-19 variants	0.381			
Strongly disagree/ disagree (Ref)				
Neutral	0.239	2.39	0.56	10.14
Agree/ Strongly agree	0.165	2.96	0.64	13.67
I think COVID-19 vaccines are safe	**< 0.001***			
Strongly disagree/ disagree (Ref)				
Neutral	0.254	0.457	0.12	1.75
Agree/ Strongly agree	0.257	2.16	0.57	8.19
I am worried about serious adverse reactions after vaccination	**0.002***			
Strongly disagree/ disagree	0.676	1.15	0.60	2.21
Neutral	**< 0.001***	3.9	1.83	8.32
Agree/ Strongly agree (Ref)				
I know persons had severe side effects after being vaccinated	0.157			
Strongly disagree/ disagree	0.891	0.99	0.42	2.33
Neutral	0.070	0.52	0.25	1.06
Agree/ Strongly agree (Ref)				
It is easy for me to get the COVID-19 vaccine if I want to	0.299			
Strongly disagree/ disagree (Ref)				
Neutral	0.178	0.34	0.07	1.63
Agree/ Strongly agree	0.122	0.35	0.10	1.32

Ref: Reference category

Discussion

This study examined the magnitude of acceptance of COVID-19 vaccine booster doses and its predictors in Ghana using HBM constructs. The discussion is organized into these thematic sections: pattern of acceptance of COVID-19 vaccine booster doses, COVID-19 vaccination, reasons for refusal of COVID-19 vaccine booster dose, sources of information about COVID-19

vaccine, and predictors of acceptance of COVID-19 vaccine booster doses.

Prevalence comparison of acceptance of COVID-19 vaccine booster dose

The study found that the prevalence of acceptance of COVID-19 vaccine booster dose was 58.3%. The acceptance of COVID-19 vaccine booster dose in this study was higher than those reported in previous studies conducted in emerging economies, such as Ghana and Algeria, which ranged between 22.8% and 51.6% [18, 19, 35, 36]. However, the acceptance of COVID-19 vaccine booster dose in this study was lower than studies in developed economies, such as Germany and the United States of America, which ranged between 81.2% and 92.6% [37–39]. Several factors may explain these discrepancies. First, the characteristics of the study participants can greatly influence acceptance. The current study included the general adult population, whereas previous studies focused on specific groups like university students or employees, who may have different levels of education, access to information, and health literacy [37]. Variations in evaluation techniques, such as survey design and question-wording, can also influence reported acceptance rates. The cultural environment and societal norms may also influence how respondents interpret questions concerning vaccine acceptance. Furthermore, the time of data collection is critical, as public opinions regarding vaccines can change quickly due to new knowledge, adjustments in vaccine availability, or changes in government regulations.

Prevalence comparison of COVID-19 vaccine

Also, most respondents (81.1%) had received the COVID-19 vaccine, which is higher than what was reported in other studies in Ghana [25, 40]. The difference in the COVID-19 vaccine uptake could be attributed to several factors, including sample size, geographical area, and year of data collection. For example, Forkuo et al.'s [25] study was conducted among 325 outpatient department attendants at a public health facility in the Bono region of Ghana in 2021, and it found that 9.8% of respondents had received the COVID-19 vaccine. Also, Sampene et al.'s [40] found that among 400 adult Ghanaians, 4.5% of respondents had received the COVID-19 vaccine. This finding suggests that authorities should enhance public health initiatives about COVID-19 in order to maintain recent gains in vaccine uptake. During COVID-19 public health initiatives, the public should be educated on the value of taking booster doses of the vaccine to improve COVID-19 control.

Reasons for refusal of COVID-19 vaccine booster dose

The main reasons for refusing the COVID-19 vaccine booster dose were personal (41.7%), fear of side effects, and experienced side effects (32.4%). This finding supports previous studies that found that the experience of side effects hindered the acceptance of the COVID-19 booster dose [19, 20, 39, 41, 42]. To promote uses of the COVID-19 booster dose, policymakers should address the population's concerns about it, particularly its side effects, through public health education and promotion.

Sources of information about COVID-19 vaccine

Similar to previous studies [18, 20, 43], this study revealed that healthcare workers, social media, and scientific websites were important sources of information about COVID-19. Previous studies have indicated that right-leaning media outlets contributed to COVID-19-related misinformation, reflecting the stance of Republican leadership, which minimised the necessity for government interventions to control the virus's spread [5, 6]. So, policymakers need to use these sources of information about COVID-19 to enhance the uptake of COVID-19 vaccine booster doses.

Predictors of acceptance of COVID-19 vaccine booster doses

Several items of HBM including perceived benefits and barriers were significantly affecting the willingness to receive COVID-19 booster doses in Ghana. Respondents who were neutral to the statement "I am worried about serious adverse reaction after vaccination" were more willing to receive a COVID-19 booster dose. Thus, respondents who were uncertain regarding the perhaps presence of serious adverse reactions after vaccination were more likely to receive a COVID-19 booster dose. This finding supports previous studies that found adverse reactions after COVID-19 vaccination as a barrier to acceptance of COVID-19 vaccine booster dose [41, 42]. Perceived benefits and thinking that the COVID-19 vaccine boosters are safe were also predicting the acceptance of booster doses. This was also supported by other studied which found that both perceived benefits and perceived risk factors affecting the choice of participants to accept booster doses [21, 44].

Limitations of study

This study has some limitations. First, it was cross-sectional, so we cannot establish causality among the variables of interest. Second, only respondents with internet access could participate in this study, so the findings may not represent the entire country. Third, convenient and snowballing sampling methods were used to recruit respondents for the study, so the findings may not be representative and should be interpreted cautiously. Despite

these limitations, the study contributes to the limited studies on the acceptance of COVID-19 booster doses in Ghana, and it will help policymakers design interventions to increase the uptake of COVID-19 booster doses in the country.

Conclusions

This study demonstrated that acceptance of COVID-19 vaccine booster dose was moderate. Also, the study highlighted that HBM, specifically the perceived benefits and barriers to receive COVID-19 vaccine booster doses were significant predictors of acceptance of COVID-19 vaccine booster doses in Ghana. Policymakers should consider these factors in designing public health interventions to increase the patronage of COVID-19 vaccine booster doses.

Abbreviations

CDC	Centers for Disease Control and Prevention
COVID-19	Coronavirus disease 2019
GHS	Ghana Health Service
HBM	Health belief model
MOH	Ministry of Health
NPIs	Non-pharmaceutical interventions
SPSS	Statistical Package for the Social Sciences
V.H.	Vaccine hesitancy
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions

Conceptualization, G.E., F.K.A. and R.M.G.; Methodology: G.E., M.S.A., and R.M.G; Data Analysis: M.S.A and R.M.G; Data Curation, G.E., M.W.A., M.S., J.K.A., S.A.A., J.A.A., N.O., and J.K.T.; Writing—Original Draft Preparation, G.E., F.K.A., M.S.A, M.S. and J.K.A; Writing—Review and Editing: G.E., F.K.A. and R.M.G.; Visualization, M.S.A. All authors critically reviewed, revised the article, and gave final approval for publication.

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Data availability

The datasets generated and/or analysed during the current study are available from the corresponding at reasonable request.

Declarations

Ethical approval and consent to participate

The study observed all ethical guidelines concerning data collection from human subjects. Ethical approval was sought and received from the ethical committee of the High Institute of Public Health, Alexandria University (#00013692). Participation in the study was voluntary, and all respondents provided written informed consent before participating.

Consent for publication

Not applicable.

Competing interests

Gilbert Eshun has no competing interests. Frank Kyei-Arthur has no competing interests. Marwa Shawky Abdou has no competing interests. Martin Wiredu Agyekum has no competing interests. Michael Sarfo has no competing interests. John Kwame Agbenyeavu has no competing interests. Sylvia Agyeman Addai has no competing interests. Jeremiah Akuffo Adjei has no competing interests. Nelson Obeng has no competing interests. Justice Kwadwo Turzin has no competing interests. Ramy Mohamed Ghazy is a member of the BMC Public Health editorial board.

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