

Factors Influencing COVID-19 Vaccination Demand and Intent in Resource-Limited Settings: Based on Health Belief Model

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Background: Vaccination is, without doubt, one of the most outstanding health interventions in reducing unprecedented damages of coronavirus disease (COVID-19). Globally, several vaccines have been produced to be effective against COVID-19. This survey aimed to assess the demand and intent towards the COVID-19 vaccine among the general population in Ethiopia. Also, factors influencing their demand, intention, and willingness to pay for the COVID-19 vaccine were described, which is poorly understood in resource-limited settings.

Methods: Subjects were 1160 individuals who completed an online questionnaire from February to March 2021. The study used the health belief model (HBM) to evaluate participants' intention to receive and willingness to pay (WTP) regarding the COVID-19 vaccine. Chi-square and binary logistic regression were conducted to identify the prevalence and associated factors of demand and WTP. Multinomial regression was done to examine the intent to receive a vaccine.

Results: In total 1116 responses were collected. The results indicated a moderate level of demand and WTP among participants (64.7% and 56.0%, respectively). Further, the researchers examined participants' readiness towards COVID-19 vaccination, where 46.6% of participants had a definite intent, and close to half of the participants are unsure (32.8%) or unwilling (20.7%) to get vaccinated. Among other factors, items under perceived susceptibility and perceived benefits constructs in the HBM have been associated with participants' demand, willingness to vaccinate, and WTP.

Conclusion: This study demonstrates the usefulness of the HBM model in evaluating the demand, intention, and willingness of participants to pay for COVID-19. Improving public awareness of the vulnerability should be a major point of attention to reduce the barriers, and improve demand and intention for COVID-19. Moreover, public health messages should be tailored to enhance vaccine literacy.

Keywords: COVID-19, health belief model, demand, intention, willingness-to-pay, Ethiopia

Introduction

Coronavirus Disease 2019 (COVID-19) is a major public health problem related to adverse health outcomes and high costs.^{1,2} Almost a year after, COVID-19 has been declared a pandemic by World Health Organization (WHO),³ this pandemic continues to be a major global health crisis resulting in devastating social, economic and political crises.^{1,2,4} The COVID-19 pandemic had affected over 125 million people worldwide by the end of March 2021.⁵ Ethiopia announced the first case of COVID-19 on 25 January 2020.^{6,7} By the end of March 2021, the number of confirmed cases had surpassed two hundred thousand.

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Despite the progress that is made by public health measures, such as restrictions to movement, absenteeism, behavioral changes, closure of institutions, and interruption of the supply chain, etc.^{4,8} Dealing with the COVID-19 pandemic has yet to progress to the point where it can be considered effective. Vaccination is, without doubt, one of the most outstanding health interventions in reducing unprecedented damages caused by COVID-19, saving millions of lives, and sparing peoples from pain and absence from various socio-economic activities.^{9–13} WHO and its member states set an ambitious plan for the provision of the COVID-19 vaccine throughout the world, these goals depend on vaccination outcomes.

The government of Ethiopia plans to vaccinate 20% of the population,^{14,15} which does not meet the WHO goal of vaccinating 70% of the population to reach population-level herd immunity.¹⁶ Thus, the provision of vaccine is necessary and vital, more evidence about public willingness to pay for the COVID-19 vaccine is essential to evaluate its feasibility in resource-limited settings and also to provide insights into future pricing considerations and demand forecasts. Willingness-to-pay (WTP) is defined as “the maximum amount in monetary terms that an individual would be willing to sacrifice to obtain the benefits of a program, service, or health technology”.¹⁷ Interventions to improve vaccination outcomes are commonly grouped into those targeting health services delivery or supply and those that stimulate demand for vaccines.^{11,18,19}

Intention or demand to be vaccinated against infectious disease is recognized as a foremost issue affecting the success of vaccination programs. In high-income countries, a low proportion of people have a definite intent to take the vaccine than the required number for herd immunity.^{20–23} A survey conducted among the general population indicated that 54.1% of in the UK and 42.3% in the US show a definite intention to take COVID-19 vaccine.²² Moreover, a similar survey indicated a lower level of acceptance, 38% in the UK and 34.2% in the USA.²⁰ A review in low-middle-income countries reported a lower level of demand to take a vaccine. Among low-middle-income countries, 26% in Bangladesh²⁴ indicated a demand, a survey conducted in African countries indicated the majority of respondents would take a COVID-19 vaccine.²⁵ The major influencing is sociodemographic characteristics, such as gender, education, employment, and religion, exposure to misinformation, perception towards a vaccine efficiency, and effectiveness.^{20,22,25,26}

There are multiple factors influencing vaccination intention and demand.^{12,19,23,27–32} One of the most widely used models to assess intention towards vaccine is the Health Belief Model (HBM), which describes and predicts a range of human behaviors.^{27,33} According to the HBM, an individual probability of adopting a specific health behavior is measured by their belief in a personal risk of illness or disease, as well as their belief in the efficacy of the prescribed behavior. Furthermore, HBM model have been utilized to explain the willingness to pay for the vaccines.³⁴ Assessing the public WTP for COVID-19 vaccine is essential for determining the feasibility of implementing the vaccination program in Ethiopia, as well as providing insight into future pricing considerations, demand forecasts, and the potential private sector engagement in COVID-19 immunization.

Therefore, this study aimed to assess the demand and intent to vaccinate, and the willingness of the public to pay for the COVID-19 vaccine. This findings will serve as an empirical basis for targeting public health messages and interventions to improve vaccination outcomes.

Methods

Study Design, Setting, and Participants

This study assessed the demand, intention, WTP of the general population regarding the COVID-19 vaccine by using a cross-sectional study, employing a self-administered online questionnaire with close-ended questions. The survey was conducted from February 15 to March 10, 2021, in Ethiopia. Ethical approval to conduct the study was obtained from Institutional Review Board of College of Health and Medical Sciences, Dilla University (Reference No: 011/2021), and conducted following the guidelines of the Declaration of Helsinki.

The survey was commenced by using an online google form platform, respondents were required to sign in to a google account in order to complete the survey. The data collection process was led by all research team members, the survey link was advertised and distributed to the research team members via social media and email. The survey was used the two most popular social media platforms in Ethiopia (Facebook, Telegram), and email to advertise and circulate the survey link among members who were from any part of the country. Further, members of the network were requested to spread the survey. The respondents had to be Ethiopians, at least 18 years old, and able to understand and read English or Amharic languages.

Study Tool

The survey consisted of twenty-nine questions divided into four sections: demographics, self-perceived health status, perception towards COVID-19 vaccination by using HBM, and vaccination acceptability and willingness to pay.

The first section included questions related to participants' basic socio-demographic details (seven items). The second section assessed participant's experience of COVID-19 and perceived health status (three items). Participants' perception of COVID-19 and COVID-19 vaccination, such as perceived susceptibility (three items), perceived severity (three items), perceived benefits (two items), perceived barriers (five items), and cues to action (two items), were collected in the third section. The perception of participants was assessed by using an item rated on a five-point Likert scale that ranged from "1 =strongly disagree" to "5= strongly agree".^{33,35}

The final section of the questionnaire dealt with vaccine acceptance. In the fourth section participants' level of intent, demand, and willingness for the vaccine were assessed. Intention to receive a COVID-19 vaccine was assessed using the two items: first, they were asked about their intent to receive a vaccine, if a vaccine is available in the market, to which they were asked to respond in either "Yes" or "No". Moreover, participants were shown how likely there were to urge inoculated for COVID-19 when a vaccine gets to be accessible on a 5-point scale. Participants were classified as either:

- (1) undecided (responses of unsure), (2) unwilling to vaccinate (responses of somewhat or very unlikely to vaccinate), or (3) willing to vaccinate. (responses of somewhat or very likely to vaccinate)

WTP was measured using two-items questions, first, they were asked about their willingness to pay for a vaccine to protect themselves and their family against COVID-19 which is to be answered in either "Yes" or "No". Second, participants indicated the maximum amount they are willing to pay on a five-point scale (Ethiopian birr (ETB) 1000/ United States dollar (USD) 25 to ETB 5000/USD125, at a currency ratio of 1 ETB:0.025 USD). The value range of the vaccines was based on the minimum and maximum price range of the COVID-19 vaccine at the time of the investigation.³⁶

To accommodate participants' preferences, the questionnaire was provided in both Amharic and English. Following the design of the English version, two

independent translators translated the questionnaire separately and compared the two adaptations to reach an agreement after consulting with three authors to ensure the questionnaire's intended purpose was maintained. Furthermore, STATA version 14.1 was used for the calculation of reliability coefficients. The internal consistency of the perception towards COVID-19 vaccination by using the HBM constructs was assessed by calculating the Cronbach alpha values for each HBM concepts. With the exception of perceived benefits construct, Cronbach alpha values were acceptably high (≥ 0.7) for the constructs (Table 1).

Statistical Analysis

In this study, STATA version 14.1 was used to analyze the data. descriptive statistic was utilized to describe participants' characteristics and study objectives. chi-square test was used to explore the association between demand, WTP, and intent levels of participants with HBM constructs and basic characteristics. The binary logistic regression was employed to assesses variables associated with the demand and WTP of participants towards the COVID-19 vaccine. Both models fitted the data well, as confirmed by the Hosmer and Lemeshow tests that were not significant. First, in the demand model, significant chi-square and Nagelkerke R2 was 0.54, which means 54% of the variance in demand was explained by the model. Second, the WTP model is still significant and explained sixty-one percent (Nagelkerke R2 = 0.61) of variance in participants' WTP for the vaccine. Further, multinomial logistic regression was used to examine participants' intention/willingness to vaccinate. We checked the multicollinearity among the predictors using variance inflation factor (VIF). VIF value ≤ 2.0 indicates absence of multicollinearity. We performed stepwise backward likelihood ratio method and 0.05 of P-value was used as cut-point for likelihood ratio method.

Further, Odd ratios (OR), and relative risk ratios (RRR) were used to measure the association of outcome variables

Table 1 Reliability Test of the Study

Constructs		Cronbach's Alpha (α)
HBM model	Perceived susceptibility	0.72
	Perceived severity	0.84
	Perceived benefits	0.53
	Perceived barriers	0.87
	Cues to action	0.71

with predictor variables, accompanied by 95% CI (confidence interval), and a p-value <0.05 to assess statistical significance.

Ethics Statement

The survey procedure was approved by Institutional Review Board of College of Health and Medical Sciences, Dilla university (Reference No: 011/2021), and it was carried out following the Declaration of Helsinki. All participants provided written informed consent prior to participating in the study, after a brief description of the study objectives, data confidentiality issues. Further, the survey was self-administered without any intervention, the data have been de-identified and it did not contain any identifying data of the participants to ensure confidentiality. The collected data were stored in a password-protected computer to prevent unauthorized access.

Results

Basic Demographic Characteristics

The survey link was distributed from February 15 to March 10, 2021, and One thousand one hundred sixty (1160) complete responses were received during 3 weeks. Most of the responses (N=1114, 96%), were based on the English questionnaire, the rest filled in Amharic. The share of collected responses in relation to the language (English or Amharic) does not vary among residents. [Table 2](#) shows the demographic details of the participants. Participants were predominately male; the sample included 800 males (68.9%) and 360 (31%) females, 65.5% of participants were below the age of 30 years. Of the total sample, (62.1%) were unmarried and (69.4%) had a university/college level of education. The majority were professional and managerial occupations (55.5%) and urban residents (87.1%). Out of participants, a majority of them (50.9%) had a median income between 2000 and 10,000 ETB. These findings matches reports from Ethiopian national workforce and the world bank statistics when compared with the general population in Ethiopia, reports revealed the median income in Ethiopian is under 9080 ETB (227\$) in 2019.^{37,38}

In terms of COVID-19 experience, 430 respondents (37.1%) reported that they had experience/contact with COVID-19 infected persons. Regarding the history of illness, 70 respondents (6.0%) reported having chronic diseases and 69 (2.1%) reported health status as poor/fair (26.6%).

Table 2 Demographic Characteristics of Study Participants (N=1160)

Variables	Classification	N(%)
Gender	Male	800 (68.9)
	Female	360 (31.0)
Age	18–29	760 (65.5)
	30–40	300 (25.8)
	>41	100 (8.6)
Marital status	Married	440 (37.9)
	Single	720 (62.1)
Education	Primary school	40 (3.6)
	Secondary school	300 (27.0)
	College/university	770 (69.4)
Occupation	Professionals /managerial	780 (67.2)
	Self-employed	120(10.3)
	Students	170 (14.7)
	Unemployed/housewife	70(7.8)
Monthly income	<2000 ETB	220 (18.9)
	2000–10,000 ETB	590 (50.9)
	>10,000 ETB	350 (30.2)
Residence	Urban	1010 (87.1)
	Rural	150 (12.9)

Participants Demand and Willingness to Pay for the COVID-19 Vaccine

[Figure 1](#) shows the demand and willingness of the participants to pay for the COVID-19 vaccine. Regarding the demand of participants for the COVID-19 vaccine, 64.66% (750/1160) indicated they would take the vaccine if it is available in the market. More than 89.2% (580/650) from the 64.66% participants who show a demand towards vaccination, indicated they are willing to pay to get a vaccine. Referring to [Figure 1](#), as for willingness out of total participants, a slim majority of them were willing to pay for the COVID-19 vaccine.

[Table 2](#) depicts the relationship between demographics and health belief constructs and participants' demand and willingness to pay for COVID-19 vaccination. Gender, age, marital status, income, previous COVID-19 experience, and almost all variables of HBM constructs were found to be significantly correlated with vaccine demand in bivariate analysis. Further, In the analysis, the willingness of participants to pay for a vaccine was associated with marital status, occupation, income, previous experience on COVID-19 ([Table 3](#)), and some factors from health belief constructs ([Table 4](#)).

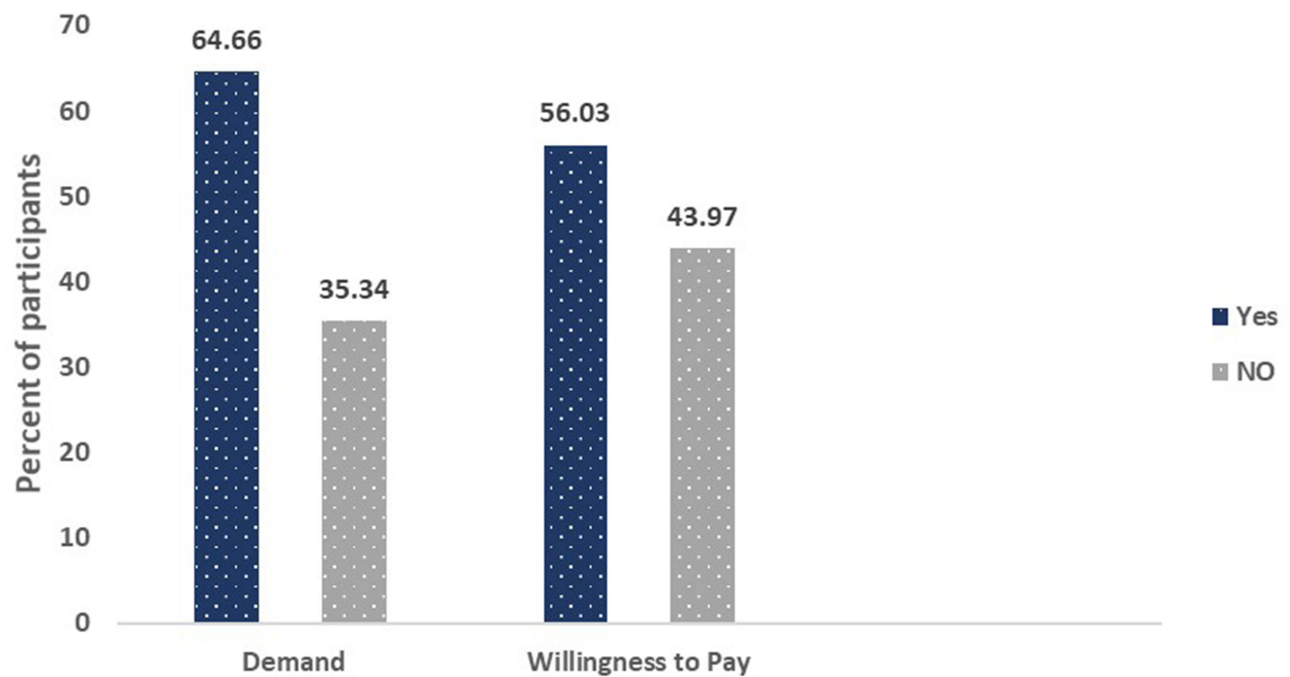


Figure 1 Describe overall demand and willingness of participants to pay for COVID-19 vaccine.

Participants Willingness to Vaccinate Against COVID-19

Figure 2 shows the proportion of responses for intention or willingness to receive a COVID-19 vaccine. Of the total sample, 46.55% of participants responded the possibilities of getting a vaccine are very likely, 32.76% were unsure, and 20.69% responded unlikely to the COVID-19 vaccine.

As Figure 3 shows, more than 85.44% of the participants were willing to pay an amount of less than ETB1000/25USD for a COVID-19 vaccine. One-half of one-fourth of the participants were willing to pay between 1001 and 2000 ETB/USD25-50, very few were willing to pay an amount greater than 2000 ETB/ USD125.

Factors Associated with Participants' Demand and Willingness to Pay for the COVID-19 Vaccine

In multivariate analysis, older participants were about 3.4 times more likely to take the COVID-19 vaccine (AOR=3.4, 95% CI: 1.1–5.1) as compared to younger participants. Participants who had worries about the possibility of getting COVID-19 had 36% higher odds (AOR=1.36, 95% CI: 1.02–2.31) of demand to take the vaccine compared to participants who had no worries about getting COVID-19. Moreover, participants who

requested adequate information about the COVID-19 vaccine have greater odds of demand to take the vaccine (AOR=2.7, 95% CI=1.8–4.3) (Table 5).

Further, after fitting multivariable logistic regression model on demographic and HBM constructs/factors, constructs from perceived susceptibility and perceived benefits of HBM, namely the belief that getting COVID-19 is a possibility (AOR=3.4, 95% CI: 1.1–5.1) and that vaccination decreases the chance of getting COVID-19 or its complications were found to have higher odds of willingness to pay for the COVID-19 vaccine (AOR=3.4, 95% CI: 1.1–5.1) (Table 5).

Factors Associated with Willingness to Vaccinate Against COVID-19

Using a multinomial multiple logistic regression model, the risk of uncertainty and unwillingness to vaccinate against COVID-19 were identified by demo-social factors (Table 6). Factors associated with a higher risk of uncertainty and unwillingness to vaccinate against COVID-19 were being male, and being in the younger age group, conversely, participants who had an experience/ contact with COVID-19 infected person shows lower risk of uncertainty and unwillingness. Age was unrelated to lack of willingness regarding COVID-19 vaccine but related to uncertainty, with adults ages between 30 and 40 more

Table 3 Association of Willingness and Demand to Get a Vaccine by Demographics and Characteristics

Variables	Categories	Demand		p-value	WTP		p-value
		Yes n(%)	No n(%)		Yes n(%)	No n(%)	
Gender	Male	490(65.3)	310(75.6)	0.25	460(70.8)	340(66.8)	0.64
	Female	260(34.7)	100(24.4)		190(29.2)	170(33.3)	
Age	18–29	430(57.3)	330(80.5)	0.03	390(60)	370(72.5)	0.34
	30–40	230(30.7)	70(17.1)		119(29.2)	110(21.6)	
	>41	90(12.0)	10(2.4)		70(10.8)	30(5.9)	
Marital status	Married	320(42.7)	120(29.3)	0.15	280(43.1)	160(31.4)	0.19
	Single	430(57.3)	290(70.7)		370(56.9)	350(68.6)	
Education	Primary	40(5.6)	0(0)	0.29	30(4.9)	10(2.0)	0.44
	Secondary	180(25.4)	120(30.0)		140(23.0)	160(32.0)	
	Above college	490(69.0)	280(70.0)		440(72.1)	330(66.0)	
Occupation	Professionals	510(68.0)	270(65.8)	0.36	460(70.7)	320(62.8)	0.08
	Self-employed	100(13.3)	20(4.9)		90(13.9)	30(5.9)	
	Students	90(12.0)	80(19.5)		80(12.3)	90(17.7)	
	Unemployed	50(6.7)	40(9.8)		20(3.1)	70(13.7)	
Monthly income(ETB)	<2000	100(13.3)	120(29.3)	0.02	70(10.8)	150(29.4)	0.00
	2000–10,000	370(49.3)	220(53.7)		320(49.2)	270(52.9)	
	>10,000	280(37.3)	70(17.1)		260(40.0)	90(17.7)	
Residence	Urban	650(86.7)	360(87.8)	0.86	580(89.2)	430(84.3)	0.43
	Rural	100(13.3)	50(12.2)		70(10.8)	80(15.7)	
Had experience with COVID-19	Yes	330(44.0)	100(24.4)	0.03	270(41.5)	160(31.4)	0.26
	No	420(56.0)	310(75.6)		380(58.5)	350(68.6)	
Had a chronic disease	Yes	50(6.7)	20(4.9)	0.69	50(7.7)	20(3.9)	0.39
	No	700(93.3)	390(95.1)		600(92.3)	490(96.1)	
Perceived overall health	Very good	340(45.3)	200(48.8)	0.61	290(44.6)	250(49.0)	0.85
	Good	310(41.3)	180(43.9)		280(43.1)	210(41.2)	
	Poor	100(13.3)	30(7.3)		80(12.3)	50(9.8)	

likely to be willing than younger adults (ages 18–29) to take the COVID-19 vaccine.

Further, results of the multinomial regression model on HBM predicting risk for uncertainty and unwillingness to vaccinate against COVID-19 are shown in (Table 7). The result of multinomial multiple logistic regression revealed that constructs from perceived susceptibility, perceived benefit, perceived barriers, and cue to the action of HBM were significantly associated with uncertainty and unwillingness to vaccinate against the COVID-19 vaccine.

Participants perceived susceptibility of COVID-19, namely the belief that the chance of getting COVID-19 in the next months is great (RRR: 0.732, 95% CI: 0.522–0.937), and currently, the chance of getting COVID-19 is a possibility (RRR: 0.921, 95% CI:

0.896–0.946) were associated with a lower chance of being in the uncertainty group when compared with the willingness group. Similarly, participants with a higher risk of uncertainty and unwillingness to vaccinate against COVID-19 were those who Concerned about the affordability of getting a vaccine (uncertain: RRR = 3.402; 95% CI: 3.201–3.546; unwilling: RRR = 4.132; 95% CI: 2.021 –7.103), those who believed in faulty of COVID-19 vaccine (uncertain: RRR = 1.101; 95% CI: 1.0–1.256; unwilling: RRR = 1.511; 95% CI: 1.243–1.727), and participants who are agreed to take a vaccine after getting adequate information and if a vaccine taken by a large section of a population were associated with membership in the uncertainty and unwillingness group.

Table 4 Association of Participants Willingness and Demand Towards a Vaccine with Health Belief Model Constructs (N=1160)

HBM Constructs	Demand		p-value	WTP		p-value	
	Yes n(%)	No n(%)		Yes n(%)	No n(%)		
Perceived susceptibility							
(1)The chance of getting COVID-19 in the next few months is great							
	Agree	420(56.0)	140(34.2)	0.02	390(60.0)	170(33.3)	0.00
	Disagree	330(44.0)	270(65.9)		260(40.0)	340(66.7)	
(2)Worry about the likelihood of getting COVID 19							
	Agree	330(55.9)	100(25.6)	0.00	300(57.7)	190(28.3)	0.00
	Disagree	260(44.1)	290(74.4)		220(42.3)	330(71.7)	
(3)Getting COVID-19 is currently a possibility for me							
	Agree	350(54.7)	120(30)	0.01	340(63.0)	130(26.0)	0.00
	Disagree	290(45.3)	280(70.0)		200(37.0)	370(74.0)	
Perceived severity							
(1)Complications from COVID-19 are serious							
	Agree	390(75.0)	190(59.4)	0.13	340(77.3)	240(60.0)	0.08
	Disagree	130(25.0)	130(40.6)		100(22.7)	160(40.0)	
(2)I will be very sick if I get COVID-19							
	Agree	210(33.9)	80(20.5)	0.14	190(34.6)	100(21.7)	0.15
	Disagree	410(66.1)	310(79.5)		360(65.5)	360(78.3)	
(3)I am afraid of getting COVID-19							
	Agree	60(9.2)	40(10.3)	0.86	70(12.5)	30(6.3)	0.28
	Disagree	590(90.8)	350(89.7)		490(87.5)	450(93.8)	
Perceived benefits							
(1)Vaccination is a good idea because it makes me feel less worried about catching COVID-19							
	Agree	570(76.0)	100(24.4)	0.00	510(78.5)	160(31.2)	0.00
	Disagree	180(24.0)	310(75.6)		140(21.5)	350(68.6)	
(2)Vaccination decreases my chance of getting COVID-19 or its complications							
	Agree	670(89.3)	120(29.3)	0.00	560(86.2)	230(45.1)	0.00
	Disagree	80(10.7)	290(70.7)		90(13.9)	280(54.9)	
Perceived barriers							
(1)Worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities							
	Agree	300(40.0)	200(48.8)	0.36	260(40.0)	240(47.1)	0.44
	Disagree	450(60.0)	210(51.2)		390(60.0)	270(52.9)	
(2)Concern about the efficacy of the COVID-19 vaccination							
	Agree	480(64.0)	190(46.3)	0.06	420(64.6)	250(49.0)	0.09
	Disagree	270(36.0)	220(53.7)		230(35.4)	260(50.9)	

(Continued)

Table 4 (Continued).

HBM Constructs	Demand		p-value	WTP		p-value
	Yes n(%)	No n(%)		Yes n(%)	No n(%)	
(3)Concern about the safety of the COVID-19 vaccination						
Agree	410(54.7)	230(56.0)	0.88	360(55.4)	280(54.9)	0.95
Disagree	340(45.3)	180(43.9)		290(44.6)	230(45.1)	
(4)Concern of my affordability (high cost) of getting the COVID-19 vaccination						
Agree	500(66.7)	140(34.2)	0.00	400(61.5)	240(47.1)	0.12
Disagree	250(33.3)	270(65.9)		250(38.5)	270(53)	
(5)Concern about the faulty/fake COVID-19 vaccine						
Agree	380(50.7)	270(65.9)	0.11	330(50.8)	320(62.8)	0.19
Disagree	370(49.3)	140(34.2)		320(49.2)	190(37.3)	
Cues to action						
(1)I will only take the COVID-19 vaccine if I was given adequate information about it						
Agree	560(74.7)	200(48.9)	0.00	440(67.7)	320(62.8)	0.57
Disagree	190(25.3)	210(51.2)		210(32.3)	190(37.3)	
(2)I will only take the COVID-19 vaccine if the vaccine is taken by many in the public						
Agree	190(31.7)	90(25.7)	0.53	170(31.5)	110(26.8)	0.62
Disagree	410(68.3)	260(74.3)		370(68.5)	300(73.2)	

Abbreviation: WTP, Willingness-to-pay.

Discussion

As COVID-19 pandemic continues to ravage the world, vaccination is without a doubt the most viable intervention for permanent control of this pandemic.^{9,10} The vaccination program’s success, however, is highly dependent on the population’s willingness and demand

to be vaccinated. There is limited evidence concerning public demand, intention, and willingness to pay for the COVID-19 vaccine in resource-constrained contexts. In this study, we examined the demand and intention towards the COVID-19 vaccine, along with the willingness of the public to pay for a vaccine in Ethiopia. The

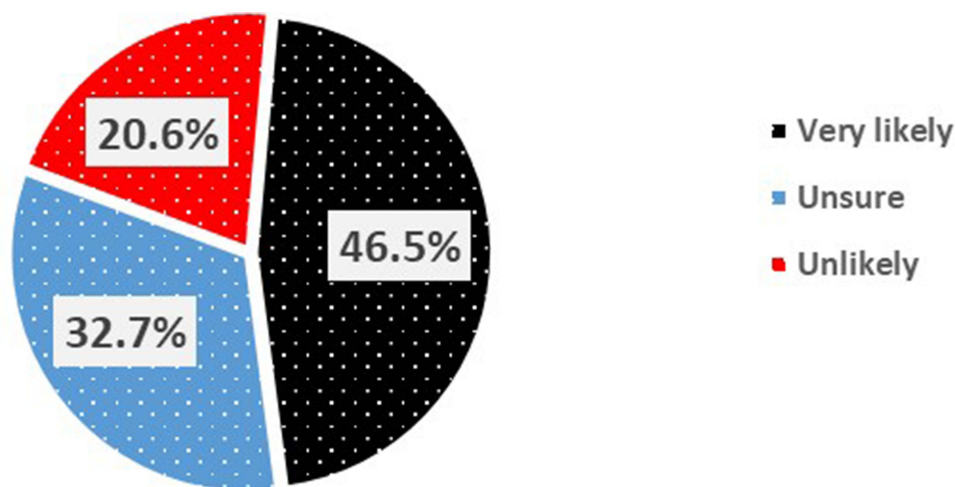


Figure 2 Describe the intention of participants in regard to COVID-19 vaccine.

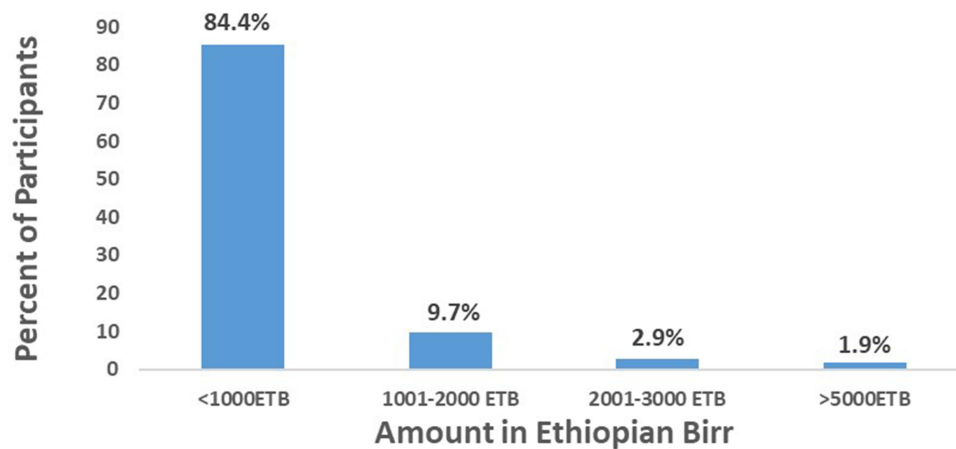


Figure 3 Describe the amount of payment towards a vaccine.

HBM model was used for assessing willingness and intention regarding the COVID-19 vaccine, which was the most commonly used model to explain and predict human behavior.³³

According to our descriptive analysis, 46.55% of participants have a definite intent to vaccinate against COVID-19, which is lower than the willingness to vaccinate found in the United Kingdom (63.5%),³⁰ United States (59.9%),²³ and China (83.5%).³⁹ This could be due to a lack of access to a wide variety of conspiracy theories and doubts. Furthermore, multinomial regression revealed that being a woman, being older, or having no prior experience/contact with COVID-19 infected person were associated with having lower uncertainty or unwillingness to receive the COVID-19 vaccine. Similarly, a study conducted in the United Kingdom indicated a significantly greater willingness among older participants.³⁰ Conversely, in other studies being women or younger age groups were related to higher uncertainty towards the COVID-19 vaccine.^{23,28} HBM constructs were also linked to vaccination intention, which is consistent with previous research.^{27,32,39} The results of this study indicate that high perceptions of susceptibility and benefits, as well as low perceptions of barriers and cues to actions towards a vaccine, were the most significant constructs affecting a definite willingness to be vaccinated against COVID-19.

Regarding to the demand of taking the COVID-19 vaccine if the vaccine is available in the market, our study indicated over 64.66% of participants had a demand. This finding is lower than a study conducted in Malaysia (94.3%).³² This implies the provision of a vaccine through individual expenditure permits further consideration to improve the vaccination uptake in resource-limited settings. Further, the result from our

logistic regression indicated that participants who were older were found to have higher demand. The HBM constructs, namely worries about getting COVID-19 and the need for adequate information about a vaccine had considerably associated with having demand COVID-19 vaccine, which is in line with other research studies.^{12,32,40}

Moreover, the public's willingness to pay for the COVID-19 vaccination was analysed, focusing on the willingness to pay a price and the amount of payment for the vaccine. In general, our finding revealed 65% were willing to pay for a vaccine. Further, 85% of participants were willing to pay an amount of less than 1000ETB/35USD for the COVID-19 vaccine. However, it is important to note that the public from many parts of the country may not be able to afford to get a vaccine.

On the other hand, among socio-demographic and economic factors fitted into the logistic regression model, no factor was found to be associated with WTP. However, HBM predicts that those who feel susceptible to COVID-19, have a high perception of benefits are most likely to be willing to pay for the COVID-19 vaccine. This result is in line with a study conducted in China¹² and Malaysia.³² As HBM constructs are significantly associated with WTP, the HBM model should be used to inform the development of interventions to promote vaccination against COVID-19 as a priority for expenditure.

Strength and Limitations of the Study

As far as our search is concerned, this is one of the first online surveys to assess public intention, demand, and WTP

Table 5 Result of Multivariate Logistic Regression Factors Associated with Willingness to Pay and Demand Towards Vaccine in Ethiopia, 2020

Variables	Categories	Demand		WTP	
		AOR (95% CI)	p-value	AOR (95% CI)	p-value
Gender	Male	1.06[0.24–4.8]	0.931	-	-
	Female	1		-	-
Age	18–29	1	0.023	-	-
	30–40	3.4[1.0–5.1]		-	-
Marital status	Married	1	0.541	1	0.527
	Single	1.5[0.34–7.2]		0.64[0.2–2.4]	
Had experience with COVID-19	Yes	1.77[0.4–7.8]	0.447	1.6[0.3–4.7]	0.601
	No	1		1	
The chance of getting COVID-19 is great	Agree	1.68[0.3–7.4]	0.492	1.3[0.4–4.6]	0.697
	Disagree	1		1	
Worry about getting of COVID 19	Agree	3.8[0.8–3.2]	0.001	1.8[1.0–5.1]	0.530
	Disagree	1		1	
Getting COVID-19 is a possibility for me	Agree	2.2[0.5–9.3]	0.248	3.4[1.0–5.1]	0.033
	Disagree	1		1	
Complications of COVID-19 are serious	Agree	1.1.8[0.3–2.1]	0.442	1.2[0.3–3.3]	0.824
	Disagree	1		1	
I will be very sick if I get COVID-19	Agree	0.43[0.7–2.3]	0.332	1.1[0.2–4.2]	0.959
	Disagree	1		1	
Vaccination makes me less worried about catching COVID-19	Agree	0.53[0.1–1.4]	0.415	0.44[0.1–1.8]	0.253
	Disagree	1		1	
Vaccination decreases getting COVID-19 or its complications	Agree	1.2[0.3–1.6]	0.746	0.17[0.0–0.60]	0.015
	Disagree	1		1	
Worry COVID-19 vaccination interfere with my usual activities	Agree	1.6[0.3–3.6]	0.534	-	-
	Disagree	1		-	-
Concern about efficacy of COVID-19 vaccination	Agree	1.3[0.3–2.6]	0.746	0.76[0.2–2.9]	0.693
	Disagree	1		1	
Concern affordability of getting the COVID-19 vaccination	Agree	1.6[0.4–5.6]	0.534	0.43[0.1–2.1]	0.306
	Disagree	1		1	
Concern faulty COVID-19 vaccine	Agree	0.46[0.1–2.0]	0.300	0.51[0.13–1.9]	0.317
	Disagree	1		1	
I will only take it if I was given adequate information about the COVID-19 vaccine	Agree	2.7[0.86–5.8]	0.013	0.79[0.2–3.7]	0.773
	Disagree	1		1	

Table 6 Socio-Demographic Factors Associated with Uncertainty and Unwillingness to Vaccinate Against COVID-19 Using Multivariable Multinomial Regression

Variable	Classification	Willingness to Vaccinate	
		Unsure RRR (95% CI)	Unwilling RRR (95% CI)
Gender	Male	1.6 (1.5–1.6)*	1.4 (1.2–1.7)*
	Female	I	I
Age	18–29	I	I
	30–40	1.6 (1.4–1.8)*	1.7 (0.8–3.5)
	>41	2.0 (0.8–2.3)	1.9 (0.4–3.1)
Marital status	Married	I	I
	Single	1.2 (0.9–1.3)	1.5 (0.8–1.7)
Education	Primary school	2.5 (0.2–3.9)	5.2 (0.7–4.4)
	Secondary school	2.0(0.9–2.2)	3.7 (0.5–5.1)
	College/university	I	I
Occupation	Professionals /managerial	I	I
	Self employed	1.0 (0.9–1.1)	0.9 (0.5–1.8)
	Students	1.0 (0.9–1.1)	0.9 (0.5–1.7)
	Unemployed/housewife	0.9 (0.8–1.1)	0.9 (0.4–1.7)
Monthly income	<2000 ETB	I	I
	2000–10,000 ETB	0.9 (0.3–3.1)	2.3 (0.9–6.2)
	>10,000 ETB	1.5 (0.8–1.6)	3.3 (0.6–4.4)
Residence	Urban	1.2 (0.5–1.3)	1.5 (0.8–2.8)
	Rural	I	I
Had contact with an infected person	Yes	0.7(0.5–0.8)*	0.9(0.81–0.94)**
	No	I	I

Notes: RRR, Relative Risk Ratio *p-value<0.05 ** P-value <0.01 and I=Reference

regarding COVID-19 vaccination in Ethiopia: it has been carried out at a time when COVID-19 vaccines were developed but vaccinating not started during the survey in Ethiopia. The results may be useful for the implementation of other larger studies and define communication strategies.

There are some limitations of the current study that need to be considered in interpreting the results. In this study, misinformation towards the COVID-19 vaccine was not measured and this might have resulted in imprecise estimation in the vaccine intention measurement. As this was an online survey and the link of the questionnaire was shared through social media platforms, it results in lower participation of people with lower educational levels and the elderly due to less Internet use among the elders in Ethiopia.⁴¹ Moreover, self-reported metrics may not correlate with future behavior, in particular for small samples of the population. However, the findings from the survey provide valuable information about the vaccination demand and intent of a sample of a relevant part of the

Ethiopian population. Moreover, WTP for a COVID-19 vaccine was reported which could be an alternative to support vaccination programs.

Conclusion

Overall, constructs of HBM were found to affect the intention and demand of participants towards the COVID-19 vaccine. If people underestimate their susceptibility and benefits, they could often unnecessarily reduce their utilization. Similarly, over-estimation of barriers may lead to a reduced likelihood of getting this intervention. Therefore, the HBM model can be used to develop strategies for enhancing COVID-19 vaccination intent and demand. Furthermore, promoting individuals' and communities' engagement through consistent health education and promotion efforts is important to tackle this pandemic. However, the effect of misinformation on the intent to get a vaccine should be studied in the future.

Table 7 Health Belief Model Constructs Associated with Uncertainty and Unwillingness to Vaccinate Against COVID-19 Using Multivariable Multinomial Regression

Variable	Willingness to Vaccinate	
	Unsure RRR (95% CI)	Unwilling RRR (95% CI)
Chance of getting COVID-19 is great [Disagree as Reference]		
Agree	0.732 (0.522–0.937)*	0.962 (0.911–1.015)
Worry about getting of COVID 19 [Disagree as Reference]		
Agree	0.973 (0.607–1.559)	0.674 (0.433–1.050)
Getting COVID-19 is a possibility for me [Disagree as Reference]		
Agree	0.921 (0.896–0.946)*	1.118 (1.093–1.144)
Complications of COVID-19 are serious [Disagree as Reference]		
Agree	1.067 (0.583–1.955)	1.842 (1.204–2.816)
I will be very sick if I get COVID-19 [Disagree as Reference]		
Agree	0.977 (0.510–1.869)	0.848 (0.428–1.684)
I am afraid of getting COVID-19[Disagree as Reference]		
Agree	0.933 (0.421–2.068)	0.477 (0.283–0.802)*
Vaccination makes me less worried about catching COVID-19		
Agree	0.795 (0.370–1.707)	1.286 (0.553–2.988)
Vaccination decreases getting COVID-19 or its complications [Disagree as Reference]		
Agree	1.058 (1.028–1.089)*	0.991 (0.963–1.019)
Worry COVID-19 vaccination interfere with my usual activities [Disagree as Reference]		
Agree	0.998 (0.992–1.005)	1.009 (1.005–1.014)
Concern about efficacy of COVID-19 vaccination [Disagree as Reference]		
Agree	0.996 (0.978–1.015)	1.051 (1.037–1.066)**
Concern about safety of the COVID-19 vaccination [Disagree as Reference]		
Agree	1.255 (0.999–1.576)	1.000 (0.821–1.232)
Concern affordability of getting the COVID-19 vaccination [Disagree as Reference]		
Agree	3.402 (3.201–3.546)*	4.132 (2.021–7.103)*
Concern faulty COVID-19 vaccine[Disagree as Reference]		
Agree	1.101 (1.0–1.256)*	1.511 (1.243–1.727)*
I will only take if adequate information COVID-19 vaccine [Disagree as Reference]		
Agree	1.944 (1.825–2.101)***	2.811 (1.803–4.432)*
I will only take the COVID-19 vaccine if the vaccine is taken by many in the public [Disagree as Reference]		
Agree	1.201(1.103–1.346)*	1.132 (1.347–1.906)*

Notes: RRR, Relative Risk Ratios *p-value<0.05 ** P-value <0.01.

Abbreviations: COVID-19, Coronavirus Disease 2019; ETB, Ethiopian Birr; HBM, Health Belief Model; OR, odd ratios; RRR, relative risk ratios; USD, United States dollar; WHO, World Health Organization; WTP, Willingness-to-pay.

The identified characteristics with COVID-19 vaccination can be used to inform localized intervention and strategies to improve the public demand, intent, and willingness towards a vaccine. As a practical recommendation, the authors believe that providing information and increasing awareness on proper feeding through electronic medias such as social media would be useful. The government should increase the magnitude of efforts done to vaccinate larger section of the population and engage the private sector to take part.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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Author Contributions

All authors have a substantial contribution in the conception and design, or analysis and interpretation of data took part in revising and finalizing the manuscript. All authors read and approved the final manuscript.

Disclosure

The authors declare that they have no competing interests in this work.

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