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Prior and Post-Covid-19 vaccination in Developing Countries: Does Household Willingness to Pay for Vaccine Matter?

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Abstract

The emergence of the COVID-19 pandemic negatively impacted human life and made it necessary to examine the WTP for vaccines against the pandemic. Studying factors affecting the WTP for the COVID-19 vaccine before and after vaccination is crucial to understand the household WTP in these two situations. Following the panic from the pandemic, we anticipate different views and responses before and after the vaccine arrives in the country. We interviewed (461 and 396) respondents before and after the vaccine arrived in the country, respectively. The study aimed to uncover the driving factors of household WTP for vaccines before and after arrival in the country. In this study we found before and after vaccine arrived in Tanzania 95.23% and 99.49%, respectively were aware about the COVID-19 pandemic. The main source of information before and after vaccines arrived was social media. However, fear of the vaccine's adverse health effects was the main driver of unwillingness to pay for the vaccine in both situations. Furthermore, results show that people's occupations positively and significantly influenced the WTP for the COVID-19 vaccine. To increase vaccination uptake and reduce fears of adverse health effects, we recommend government establish educational programs about the benefits and possible side effects before and after the adoption of vaccines in a particular country.

Keywords: COVID-19 vaccine, Willingness to pay, Before and after arrival, Vaccine

1. Introduction

Coronavirus disease (COVID-19) is an infectious disease that emerged in 2019 and spread rapidly globally, causing a high number of deaths, psychological effects, and mental disorders among the human race worldwide (Abbas, 2021). The World Health Organization (WHO) declared COVID-19 as a worldwide pandemic that needs all nations to take pharmaceutical control measures such vaccination (Mbogo, & Odhiambo, 2021). COVID-19 has remained a worldwide hazard regardless of the suggested control measures since 270,786,857 cases and 5,325,879 deaths were reported globally as of December 2021, of which 3.34% and 4.23% of cases and deaths, respectively, are from the African continent.

As per these global statistics, as of the reference date, the of study constitutes 0.0097% of COVID-19 cases and 0.014% of deaths (Worldometer, 2021), while, in March 2022, there were about 33,726 confirmed cases reported, with around 800 deaths (WHO, 2022). The need for vaccine was considered an essential measure to prevent the further spread of COVID-19 in the country (Algaissi, et al., 2020). So far, the non-pharmaceutical control measures against COVID-19 have been declared inadequate due to the rapid increase in COVID-19 cases and human deaths, and therefore, the need for individual vaccination is inevitable (Karasneh, et al., 2021).

In some settings, the challenges encountered are the results of the new health intervention. For example, due to religious beliefs, many communities in Africa reject vaccine programs since they don't believe in vaccines to conquer diseases (Fawad Ali Shah et al, 2019). Several studies confirmed contagious human diseases such as measles, rabies, tetanus, polio, diphtheria, and yellow fever have been prevented and eradicated through vaccination (e.g Aaby & Benn, 2019; Cherian & Mantel, 2019).

In the case of COVID-19, however, the vaccine acceptance and willingness-to-pay (WTP) debate remains inconclusive. Different studies indicate reasons for acceptance and WTP but vary from country to country (Syed Alwi et al., 2021; Wong et al, 2020). Some studies indicated that the direct costs of purchasing vaccines are an obstacle if not borne by government or private institutional bodies (Yu et al, 2018). Other factors, including social capital, such as peers and religious members, reported could affect uptake and the success of immunization programs (Doherty et al., 2018; Amo-Adjei et al., 2022). Although knowledge of WTP for COVID-19 vaccines towards individuals was quickly shared, information on the uptake and WTP for vaccines in pre- and post-vaccine introduction remain limited across countries.

This study is of practical and scientific importance as it aims to help gather relevant information about WTP for the COVID-19 vaccine before and after the introduction or arrival of vaccines in developing countries and the respective study areas being the case study. We have analyzed the determinants of the WTP for the COVID-19 vaccine for policy-making when such a related crisis occurs. The results will help plan, implement and ensure successful immunization programs across developing countries.

2. Literature Review

Several theories have been employed in studying COVID-19 and health-related crises (Syed Alwi et al., 2021; Caserotti et al., 2021). This study is therefore rooted in two theories: The Health Belief Model (HBM), and Theory of Planned Behavior (TPB). Briefly HBM is used to explain and predict individual changes in health behaviors, and it is one of the most widely used model for understanding health behaviors. Further, Planned Behavior Theory (TPB) emphasizes that an individual's attitudes, social norms, and perceived behavioral control can influence the intention to perform a goal behavior.

The Health Belief Model (HBM) is a theory that attempts to understand why many people refuse to accept disease prevention or asymptomatic disease screening tests (Dolan and Taylor-Piliae, 2019). The model assumes that "people are largely rational in their thoughts and actions and take the best health-promoting actions when they feel it is possible to address a negative health problem or when they believe they can take the proposed action" (Bae & Chang, 2021). HBM compounds four dimensions: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers (Mercadante and Law, 2021; Wong et al., 2020).

Wong et al., (2020), assessed the people's intent of the COVID-19 vaccine acceptance and WTP by using HBM and propounded that the vaccine uptake decisions depends on the society's WTP if the benefits of the vaccines outweigh the risks. Further, Mercadante and Law, (2021) used HBM to study patient intent for influenza and COVID-19 vaccines and pointed out that individual beliefs and intentions are directly influenced by patient characteristics, demographics, and certain bodies of knowledge. Furthermore, employing HBM, Bae, and Chang, (2021) examined the impact of COVID-19 risk insight on behavioural intent towards untapped tourism and emphasized that the key factors driving individuals' health promotion behaviors are perceived health risks.

Based on the Health Belief Model, disease preventive measures' adoption and acceptance increase due to high levels of infection susceptibility (Ritter et al, 2017). Therefore, this theory shows that if a person sets a high value on the goals of the COVID-19 vaccination and believes the vaccine will be effective and have no side effects, they will acquire a favourable attitude (perception) toward accepting the vaccine. As a result, the higher the value of immunization programs and the more accurate the estimations of their efficacy, the more inclined people are to accept them (Wong et al., 2020).

A Theory of Planned Behaviour (TPB) is a theory that predicts a person's intention to engage in a behaviour at a specific time and place. It assumes that, "Individuals act rationally, according to their attitudes, subjective norms, and perceived behavioural controls" (Bae and Chang, 2021). The component of this model is behavioural intent. Behavioral intent are influenced by attitudes about the likelihood that the behavior will have the expected outcome. It requires assessments of loss and benefit of that outcome.

Bae and Chang (2021) used an extended theory of planned behavior to examine the impact of COVID-19 on WTP for untapped tourism. The TPB highlighted how people make informed decisions and their willingness to take action. Attitudes, social norms, and perceived

behavioral control are examples of such influences. As a result, this idea encourages people to make well-informed judgments concerning the COVID-19 vaccine.

Based on theatrical approaches in examining WTP, several studies used different methods and models to determine factors affecting an individual's WTP for vaccines. Wong et al. (2020) used the multinomial logistic model to analyze the WTP for vaccines and found socioeconomic factors such as education, occupation, and people with higher incomes were associated with the WTP for the COVID-19 vaccine. Harapan et al. (2020; Nguyen et al. (2021)) used multivariable linear regression to analyze the impact of WTP on vaccines and found that high income and perceived risk were associated with WTP on vaccines. Cerda and Garcia (2021) used the double bounded model and probit distribution approach and found income, education level, and family members with COVID-19 increased the likelihood of a WTP for the vaccine.

Based on the studies reviewed above, little is known about the main factors affecting the WTP for vaccines before and after introduction or arrival of COVID-19 vaccine across developing countries. Several studies have highlighted factors associated with WTP for vaccines only during COVID-19, but none have evaluated factors influencing WTP for vaccine pre- and post-adoption of COVID-19 vaccines.

3. Methodology

In this study, we used a local language as a means of communication for native speakers commonly used in their communication. We selected the study areas because it is among the areas within the country where many tourists visit to attractive tourist areas, which in turn has a positive impact on the spread of the COVID-19 pandemic. The target group of interest for this study, was the adult community member aged 18 years and over from the selected households. We excluded individuals under the age of 18 to avoid the complexity of obtaining parental or guardian consent during data collection and to minimize the possibility of collecting inaccurate data.

We adopted the Kish-Leshlie formula to obtain the sample size for this study (Ilesanmi et al., 2021).

$$S = \frac{Z_{\frac{\alpha}{2}}^2 * p(1-p)}{d^2}$$ Where: S = sample size desired, $Z_{\frac{\alpha}{2}}$ = the value of standard normal distribution, set as 1.96 at a 95% confidence interval, p = 50% a proportion of target population estimates, d = standard error (precision) set at 5% (0.05). We assumed non-response and incomplete response rates to obtain 461 and 396 respondents before and after the vaccination arrival in the country, respectively.

The logistic regression model was used in this study to examine the WTP of the COVID-19 vaccine. The research design used in this study is descriptive cross-sectional since descriptive research explains phenomena by describing the characteristics and nature that help the researcher apply several research methods to study one or more variables.

3.1 Data Collection Method

The data of this study were collected before and after the arrival of the COVID-19 vaccine in the areas of study, and that was between April and June 2021. We interviewed approximately 461 people with structured questionnaires before the introduction of COVID-19. Another 361 respondents were interviewed in July and December 2021, and these second data were collected after launching the vaccines. The questionnaire involved information about respondents such as gender, age, marital status, the highest level of education and household members. Further, the questionnaire was designed to capture household income household head or any household member's occupation, sources of income including employment, agriculture, and business. Lastly, the questionnaire was designed to collect the contingent valuation, assessment of community awareness and knowledge of COVID-19. Using closed-ended questions, we asked about awareness of the COVID-19 vaccine, vaccine types, WTP for vaccines, and reasons for and not accepting vaccines. For simplicity and accurate data collection, we translated the questionnaires into Swahili, the commonly spoken language nationwide in the areas of study.

Age, gender, marital status, education level, occupation, monthly income, and the source of the COVID-19 data were among the sociodemographic characteristics that made up the independent variables. Knowledge of the COVID-19 vaccine, and the willingness to pay for the vaccine were dependent variables.

4. Results and Discussion

4.1 Summary Statistics

Based on evidence gathered before and after the arrival or introduction of the COVID-19 vaccine, the majority of respondents surveyed ranged in age from 18 to 59 years old (Table 1and 2). More than half of them, 321 (69.63%), were male, and 305 (66.16%) had education level of secondary school or above. Almost half of the respondents earned between TZS320,000 and TZS1,260,000 (US$137.03-US$539.57) per month, followed by those earning less than TZS319,000 (US$136.61). The vast majority of respondents work full-time in both agriculture and business. More detailed socio-demographic information is presented in Tables 1 and 2.

Table 1. Socio-demographic characteristics of households before COVID-19 vaccine availability in Tanzania

Socio-demographic characteristics	**Frequency**	**%**	**95% Confidence interval**	
			Upper	**Lower**
Age group (Years)				
18-39	161	34.92	0.39	0.31
40-59	218	47.29	0.52	0.43
≥ 60	82	17.79	0.21	0.14
Gender				
Male	321	69.63	0.74	0.65
Female	140	30.37	0.35	0.26
Marital status				
Single	55	11.93	0.15	0.09

Married	375	81.34	0.78	0.85
Others*	31	6.72	0.09	0.04
Highest education level				
Primary school and below	156	33.84	0.38	0.30
Secondary school and above	305	66.16	0.70	0.62
Occupation				
Agriculture	88	19.09	0.23	0.15
Business	98	21.26	0.25	0.18
Employment	55	11.93	0.15	0.09
Both agriculture and business	118	25.60	0.30	0.22
Both agriculture and employment	35	7.59	0.10	0.05
Both business and employment	40	8.86	0.11	0.06
Agriculture, business and employment	27	5.86	0.08	0.04
Average monthly income				
≤ TZS. 319,000	174	37.74	0.42	0.33
TZS. 320,000 – TZS. 1,260,000	227	49.24	0.54	0.45
> TZS. 1,261,000	60	13.02	0.16	0.10

Note * Widow/Divorced

Table 2. Socio-demographic characteristics of households after COVID-19 vaccine availability in Tanzania

Socio-demographic characteristics	**Frequency**	**%**	**95% Confidence interval**	
			Upper	**Lower**
Age group (Years)				
18-39	239	60.35	0.65	0.56
40-59	133	33.59	0.38	0.29
≥ 60	24	6.06	0.08	0.04
Gender				
Male	315	79.55	0.84	0.76
Female	81	20.45	0.24	0.16
Marital status				
Single	126	31.82	0.36	0.27
Married	247	62.37	0.67	0.58
Others*	23	5.81	0.08	0.03
Highest education level				
Primary school and below	74	18.69	0.23	0.15
Secondary school and above	322	81.31	0.85	0.77
Occupation				
Agriculture	23	5.81	0.08	0.35
Business	106	26.77	0.22	0.31
Employment	78	19.70	0.16	0.24
Both agriculture and business	58	14.65	0.11	0.18
Both agriculture and employment	31	7.83	0.05	0.10
Both business and employment	68	17.17	0.13	0.21
Agriculture, business and employment	32	8.08	0.05	0.11
Average monthly income				
≤ TZS. 319,000	85	21.46	0.26	0.17
TZS. 320,000 – TZS. 1,260,000	239	60.35	0.65	0.56
> TZS. 1,261,000	72	18.18	0.22	0.14

Note * Widow/Divorced

Before the introduction of the COVID-19 vaccine, 439 (95.23%) of the respondents knew about COVID-19, and 429 (93.06%) of them had information about the COVID-19 vaccine. Among the respondents, more than half 299 (64.86%) of respondents received information about the COVID-19 vaccine through social media. Other sources include church 201 (43.60%), from internet 151 (32.75%) platforms, 138 (29.93%) were informed about it from newspapers, and 54 (11.71%) of the respondents received the information from other sources they named, including radio and television. In more details, Figure 1 depicts sources of information on the COVID-19 vaccine.

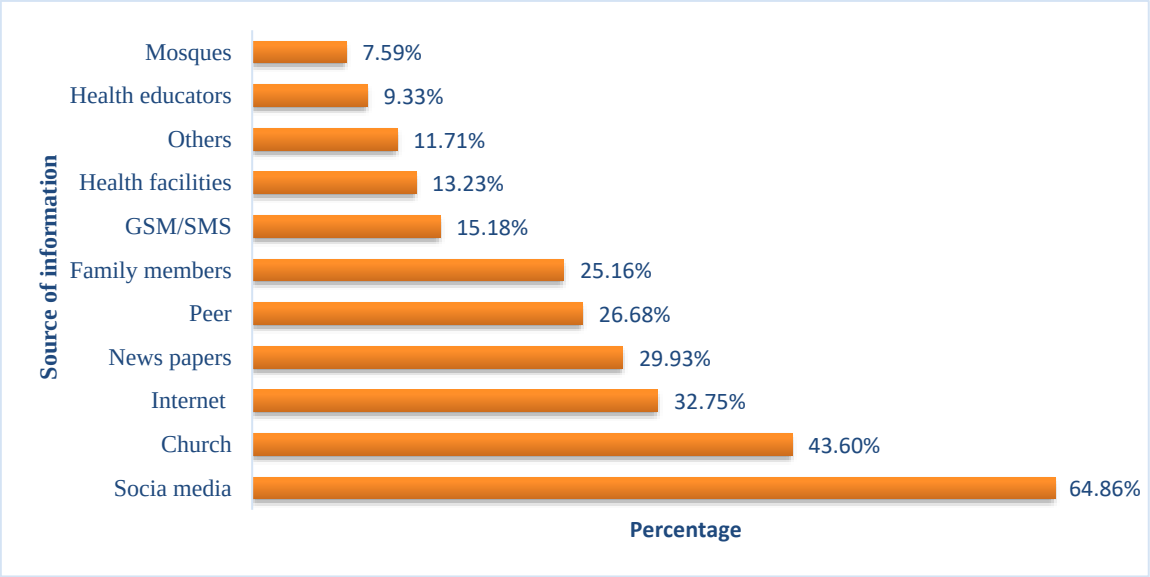

Figure 1. Sources of information before the arrival of the COVID-19 vaccine in the country

Figure 2 presents sources of information about COVID-19 after the vaccine has arrived or been introduced in the country. The vast majority of 394 (99.49%) of the respondents was aware about COVID-19, and 392 (98.99%) of them, had heard about the COVID-19 vaccine. Social media was again the top source of information, with more than half of 220 (55.56%) respondents having obtained information about the COVID-19 vaccine through social media, 209 (52.78%) had heard about it from the church, and 193 (48.74%), obtained such information via Internet platforms. Our findings are similar with the study by Puri, et al., (2020) who found that social media is an efficient means of disseminating information. Figure 2 illustrates other sources of information on the COVID-19 vaccine after the vaccine became available.

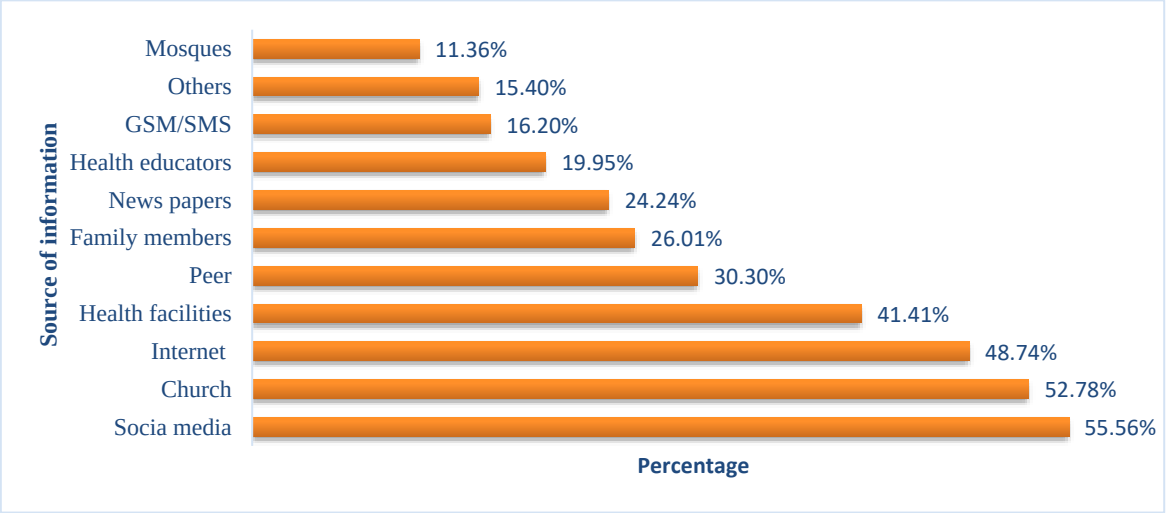

Figure 1. Sources of information after the arrival of the COVID-19 vaccine in the country

In this study, a higher percentage of people knew about the COVID-19 pandemic before and after vaccines became available in the country, 95.23% and 99.49%, respectively. It could perhaps be due to high levels of pandemic shocks around the world, and the area of study is not unique compared to the rest of the world. It may also be caused by the fact that the majority of respondents surveyed had a high level of education and probably knew and was aware of what was happening at that particular point in time. Studies indicate that respondents with a high level of education are more likely to be associated with health awareness (Abdel Wahed et al., 2020; Alahdal et al., 2020).

Table 3 in the appendix presents the findings of stated willingness to accept and pay for vaccines, namely inactivated, protein subunit, adenovirus vector, and mRNA vaccines. The results show majority of respondents surveyed had a higher acceptance rate for the Johnson & Johnson vaccine, followed by the inactivated vaccine. However, the stated willingness to accept these vaccines fell by 10% after the arrival of COVID-19 vaccines in the country. It could be due to fears of adverse health effects from those who reported being vaccinated in different parts of the country. We found that out of 461 respondents, 167 (36.23%) state they would be willing to accept or receive the Johnson & Johnson vaccine, which was to be provided free of charge, and 150 (32.54%) said they would to be willing to accept or receive the inactivated vaccine to protect against COVID-19. Following the launching of the COVID-19 vaccine in the country, which was in July 2021, willingness to accept Johnson & Johnson vaccine dropped to 106 (26.77%). We also found that only 98 (24.75%) respondents stated that they were willing to accept or receive an inactivated vaccine, and very few stated that are willing to accept protein subunit, adenovirus vector, and mRNA vaccines.

Our results show that about 122 (26.46%) of the respondents were willing to pay TZS17,960 (US$7.82) per dose for an inactivated vaccine, while about 179 (38.83%) were afraid of the Side effects and unwilling to pay for COVID-19 vaccine. Those willing to pay for the inactivated vaccine dropped to 49 (12.37%) after Johnson & Johnson's vaccine arrived in the

country. After the launch and the start of vaccination, about 145 (36.62%) of the respondents were not willing to pay for the COVID-19 vaccine because of fear of adverse health effects (Table 4 in Appendix).

Table 3. Willingness to accept and willingness to pay for the COVID-19 vaccine before vaccine availability and reasons for unwillingness to pay by households in Tanzania

	n	%	95% Confidence interval	
			Upper	Lower
Stated willingness to accept for **Inactivated vaccine**				
Yes	150	32.54	0.37	0.28
No	311	67.46	0.72	0.63
Stated willingness to accept for **Protein subunit?**				
Yes	89	19.43	0.23	0.17
No	368	80.57	0.84	0.76
Stated willingness to accept for **Adenovirus vector** vaccine				
Yes	111	24.08	0.28	0.20
No	350	75.92	0.80	0.72
Stated willingness to accept for **MRNA** vaccine				
Yes	86	18.66	0.22	0.15
No	375	81.34	0.85	0.78
Stated willingness to accept for **Johnson & Johnson** vaccine free of charge for COVID-19 protection.				
Yes	167	36.23	0.41	0.32
No	294	63.77	0.68	0.59
Willingness to pay (17, 960 TZS) for **Inactivated vaccine**				
Yes	122	26.46	0.30	022
No	339	73.54	0.77	0.69
Willingness to pay (15,480 TZS) for **Protein subunit** vaccine				
Yes	64	13.88	0.17	0.11
No	397	86.12	0.89	0.83
Willingness to pay (12,420 TZS) for **Adenovirus vector** vaccine				
Yes	90	19.52	0.23	0.16
No	371	80.48	0.84	0.77
Willingness to pay (17,480 TZS) for **MRNA** vaccine				
Yes	44	9.54	0.12	0.07
No	417	90.46	0.93	0.88
Reasons for unwillingness to pay *				
The government should provide all types recommended and pay for the vaccine	72	15.62	0.19	0.12
The vaccine is not important	77	16.70	0.20	0.13
I do not have enough money	67	14.53	0.18	0.11
Those who caused the virus must pay for it	26	5.64	0.08	0.04
Contrary to religious beliefs/immoral to pay for a vaccine	27	5.86	0.08	0.04
The benefits of avoiding the disease are not enough	21	4.56	0.06	0.03
Contrary to culture	13	2.82	0.04	0.01
I do not want to pay	78	16.99	0.20	0.14
Fear of adverse effects	179	38.83	0.43	0.34
Fear of inaccessibility of vaccines	35	7.59	0.10	0.05
Others	38	8.24	0.11	0.06

Note: * Multiple responses not allowed

Table 4. Willingness to accept and willingness to pay for the COVID-19 vaccine after vaccine availability and reasons for unwillingness to pay by households in Tanzania

	n	**%**	**95% Confidence interval**	
			Upper	**Lower**
Stated willingness to pay for **Inactivated vaccine**				
Yes	98	24.75	0.29	0.20
No	298	75.25	0.80	0.71
Stated willingness to pay for **Protein subunit vaccine**				
Yes	84	21.21	0.25	0.17
No	312	78.79	0.83	0.75
Stated willingness to pay for **Adenovirus vector vaccine**				
Yes	71	17.93	0.22	0.14
No	325	82.07	0.86	0.78
Stated willingness to pay for **MRNA** vaccine				
Yes	87	21.77	0.26	0.18
No	309	78.23	0.82	0.74
Stated willingness to pay for **Johnson & Johnson vaccine free of charge for COVID-19 protection**				
Yes	106	26.77	0.31	0.22
No	290	73.23	0.78	0.69
Willingness to pay (17, 960 TZS) for **Inactivated vaccine**				
Yes	49	12.37	0.16	0.09
No	347	87.63	0.91	0.84
Willingness to pay (15,480 TZS) for **Protein subunit vaccine**				
Yes	37	9.34	0.12	0.06
No	359	90.66	0.94	0.88
Willingness to pay (12,420 TZS) for **Adenovirus vector vaccine**				
Yes	33	8.33	0.11	0.05
No	363	91.67	0.95	0.89
Willingness to pay (17,480 TZS) for **MRNA** vaccine				
Yes	38	9.60	0.13	0.07
No	358	90.40	0.93	0.87
Reasons for unwillingness to pay *				
The government should provide all types recommended and pay for the vaccine	91	22.98	0.27	0.19
The vaccine is not important	69	17.42	0.21	0.14
I do not have enough money	34	8.59	0.11	0.06
Those who caused the virus must pay for it	7	1.77	0.031	0.005
Contrary to religious beliefs/immoral to pay for a vaccine	3	0.76	0.016	-0.001
The benefits of avoiding the disease are not enough	73	18.43	0.22	0.15
Contrary to culture	2	0.51	0.012	-0.002
I do not want to pay	34	8.59	0.11	0.06
Fear of adverse health effects	145	36.62	0.41	0.32
Fear of inaccessibility of vaccines	50	12.63	0.16	0.09
Others	76	19.24	0.23	0.15

Note: * Multiple responses not allowed

Table 5. Association between sociodemographic characteristics and willingness to pay for the COVID-19 vaccine before vaccine availability among households in Tanzania

Socio-demographic characteristics	**Willingness to pay TZS. 19, 960 for Inactivated vaccine for COVID-19 protection**					
			Model 1		***Model 2***	
	Yes *f* (%)	**No *f* (%)**	**Adj. odds ratio [95% CI]**	***p*-value**	**Adj. odds ratio [95% CI]**	***p*-value**
Age group (Years)						
18-39	42(26.09)	119(73.91)	1.06[0.53-2.14]	0.86	0.87[0.42-1.79]	0.70
40-59	64(29.36)	154(70.64)	1.53[0.80-2.90]	0.20	1.34[0.69-2.60]	0.38
≥ 60	16(19.51)	66(80.49)				
Sex						
Male	82(25.55)	239(74.45)	0.83[0.50-1.38]	0.47	0.75[0.44-1.27]	0.28
Female	40(28.57)	100(71.43)				
Marital status						
Single	21(38.18)	34(61.82)	2.68[0.89-8.07]	**0.08**	2.74[0.90-8.37]	**0.08**
Married	95(25.33)	280(74.67)	1.40[0.51-3.79]	0.51	1.45[0.52-4.00]	0.48
Others*	6(19.35)	25(80.65)				
Highest education level						
Primary school and below	39(25.0)	117(75.0)	0.98[0.61-1.57]	0.92	0.91[.56-1.49]	0.71
Secondary school and above	83(27.21)	222(72.79)				
Occupation						
Agriculture	21(23.86)	67(76.14)	0.57[0.29-1.11]	**0.09**	0.45[0.19-1.10]	**0.03**
Business	24(24.49)	74(75.51)	0.56[0.30-1.05]	**0.07**	0.43[0.18-1.01]	**0.01**
Employment	16(29.09)	39(70.91)	0.68[0.33-1.40]	0.30	0.52[0.20-1.33]	0.17
Both agriculture and business	25(21.19)	93(78.81)	0.47[0.25-0.88]	**0.02**	0.36[0.15-0.86]	**0.01**
Both agriculture and employment	14(40.00)	21(60.00)				
Both business and employment	14(35.00)	26(65.00)			0.75[0.28-2.01]	0.57
Agriculture, business and employment	8(29.63)	19(70.37)			0.60[0.20-1.82]	0.36
Average monthly income						
≤ TZS. 319,000	37(21.26)	137(78.74)			1.71[0.74-3.97]	0.21
TZS. 320,000 – TZS. 1,260,000	75(33.04)	152(66.96)			2.90[1.34-6.26]	**0.007**
≥ TZS. 1,261,000	10(16.67)	50(83.33)				
Constant			0.35[0.12-1.04]	**0.06**	0.25[0.06-1.00]	**0.05**
LR chi2			14.61		25.95	
Pseudo R2			0.0274		0.0487	

Note: * Widow/Divorced

Table 6. Association between sociodemographic characteristics and willingness to pay for the COVID-19 vaccine after vaccine availability among households in Tanzania

Socio-demographic characteristics	**Willingness to pay TZS. 19, 960 for Inactivated vaccine for COVID-19 protection**					
			Model 1		***Model 2***	
	Yes *f* (%)	**No *f* (%)**	**Adj. odds ratio [95% CI]**	***p*-value**	**Adj. odds ratio [95% CI]**	***p*-value**
Age group (Years)						
18-39	26(10.88)	213(89.12)	0.38[0.11-1.26]	0.11	0.37[0.11-1.26]	0.11
40-59	17(12.78)	116(87.22)	0.43[0.14-1.26]	0.12	0.41[0.13-1.24]	0.11
≥ 60	6(25)	18(75)				
Sex						
Male	40(12.70)	275(87.30)	1.38[0.55-3.44]	0.49	1.36[0.54-3.44]	0.52
Female	9(11.11)	72(88.89)				
Marital status						
Single	16(12.70)	110(87.30)	0.70[0.16-3.06]	0.64	0.58[0.13-2.60]	0.48
Married	28(11.34)	219(88.66)	0.37[0.10-1.37]	0.14	0.30[0.08-1.17]	**0.08**
Others*	5(21.74)	18(78.26)				
Highest education level						
Primary school and below	9(12.16)	65(87.84)	0.74[0.31-1.79]	0.51	0.83[0.34-2.03]	0.68
Secondary school and above	40(12.42)	282(87.58)				
Occupation						
Agriculture	3(13.04)	20(86.96)	0.73[0.20-2.67]	0.63	0.51[0.13-1.95]	0.32
Business	10(9.43)	96(90.57)	0.50[0.23-1.12]	**0.09**	0.36[0.15-0.86]	**0.02**
Employment	6(7.69)	72(92.31)	0.37[0.14-1.03]	**0.06**	0.27[0.09-0.79]	**0.01**
Both agriculture and business	5(8.62)	53(91.38)			0.32[0.11-0.96]	**0.04**
Both agriculture and employment	5(16.13)	26(83.87)			0.74[0.25-2.23]	0.59
Both business and employment	14(20.59)	54(79.41)				
Agriculture, business and employment	6(18.75)	26(81.25)				
Both business and employment	14(20.59)	54(79.41)				
Both agriculture, business and employment	6(18.75)	26(81.25)				
Average monthly income						
≤ TZS. 319,000	9(10.59)	76(89.41)				
TZS. 320,000 – TZS. 1,260,000	27(11.30)	212(88.70)				
≥ TZS. 1,261,000	13(18.06)	59(81.94)				
Constant			0.78[0.18-3.29]	0.73	1.32[0.28-6.16]	0.72
LR chi2			11.43		16.18	
Pseudo R2			0.0386		0.0546	

Note: * Widow/Divorced

4.1 Empirical Results and Willingness to Pay

Tables 5 and 6 show the result of the logit model, which includes Model 1 and Model 2. We examined determinants of the WTP for the COVID-19 vaccine before and after the vaccine arrived in the country. Based on insights from the data collected prior to the introduction of COVID-19, Model 2 was evaluated as the best choice, as shown in Table 5, because it has higher explanatory power (pseudo-R-square is higher) and LR chi-square is high. The results from Model 2 show that employment was positively and statistically significantly associated with the WTP for vaccines. Factors positively and statistically significantly influencing WTP for vaccines include farmers (p-value < 0.03), businessmen (p-value < 0.01), as well those engaged in both agriculture and business (p-value < 0.01), and unmarried respondents (p-value < 0.08). Single people or unmarried respondents, were about 3 times more willing to pay for the vaccine than married people before arrival of COVID-19 vaccines. Furthermore, we found that income significantly influences the WTP for the vaccine, showing that people with incomes between TZS 320,000 and TZS 1,260,000 are more likely to pay for an inactivated vaccine at a significant p-value < 0.01. It implies that WTP depends on people's ability to pay for vaccines. Our study is similar to Ruiz & Bell., (2021); and Wong et al. (2020), who reported that income is a strong indicator of intent to pay for the COVID-19 vaccine.

Table 6 show the results obtained from data collected after the arrival of COVID-19 vaccines in the country. The results show that employment positively and statistically significantly (p-value < 0.01) influences the WTP for vaccines and is thus a good predictor of the intention to pay for the COVID-19 vaccine. We also found that people who had business as their primary source of income were more likely to pay for an inactivated vaccine at a significant p-value < 0.02. Farmer and businessperson interaction factors positively and statistically significantly influence the WTP for vaccine at p-value < 0.04. We also found that married people were 30% more likely to pay for a vaccine than single people, making the results significantly at a p-value < 0.08 level of significant prior to the arrival of vaccines. This suggests that married people are likely to pay for vaccine to protect themselves and their families from COVID-19.

These results made it clear that before the vaccine arrived, many individuals were confident that the COVID-19 vaccine would prevent COVID-19 without significant side effects and acknowledged that it was a public health issue, the one vaccination required. However, after the arrival of the COVID-19 vaccines, people lost less confidence in the COVID-19 vaccine, which could be perhaps due to fears of side effects appearing in different parts of the country. Based on the above results on stated willingness to accept the vaccines, leaders could have expected such a response and found appropriate solutions before the COVID-19 vaccine became widespread (Wardman, 2020; Legge & Kim, 2021).

5. Conclusion

This study highlighted that social media was the top source of information about the COVID-19 vaccine, followed by religion. Occupation, particularly formal employment, business, and Agriculture-business interaction, have a positive and significant association

with the WTP for COVID-19 vaccines before and after its arrival in the county. On the other hand, people may be hesitant or unwilling to accept the COVID-19 vaccine because of fear of side effects caused by the vaccine. Additionally, the majority stated that they were willing to accept Johnson & Johnson vaccine that was to be offered prior to vaccine arrival and then offered free of charge after arrival in the country. It appears that people become willing to accept vaccine when there is no cost involved, case being in our areas of study. Therefore, we recommend that when such a pandemic-related health crisis occurs, the government may need to set up a health education program strategy so that the public is well informed about how the vaccines deliver their benefits to counter fears of side effects. If there are budget constraints in government hospitals, involving private and public hospitals could help fund COVID-19 vaccination, thus solving the problem of low-income people. The target should be farmers who engage in agriculture alone. Future research could expand this study and consider including multiple regions or countries to improve the generalizability of the results. We also encourage researchers to conduct follow-up studies to track changes in WTP and vaccine acceptance over time. Future studies should also consider incorporating qualitative methods, such as focus groups or interviews, to better understand the underlying reasons for WTP and vaccine hesitancy, when such a pandemic-related health crisis occurs.

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Competing Interests

The authors declare that they have no competing interests.

Ethics approval

This study was approved by Moshi Cooperative University with Ref. #: MoCU/UGPC/3/41 and expiration month of December 2022. The data was gathered in the study areas in Tanzania where no personal data or information was collected from the respondents.

Data availability statement

Data are available on request from the corresponding author

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