



A nationwide survey of the potential acceptance and determinants of COVID-19 vaccines in Ghana

**Emmanuel Lamptey¹,
Dorcas Serwaa¹,
Anthony Baffour Appiah²**

¹Institute of Life and Earth Sciences (Including Health and Agriculture), Pan African University, University of Ibadan, Ibadan, Nigeria; ²Ghana Field Epidemiology and Laboratory Training Program (GFELTP), School of Public Health, University of Ghana-Legon, Accra, Ghana

Received: February 12, 2021
 Accepted: May 29, 2021

Corresponding author: Emmanuel Lamptey, PhD
 Institute of Life and Earth Sciences (Including Health and Agriculture), Pan African University, University of Ibadan, Ibadan, Nigeria
 Tel: +234-8085737643, Fax: +234-8085737643
 E-mail: elamptey0364@stui.ui.edu.ng

No potential conflict of interest relevant to this article was reported.

Purpose: Safe and effective vaccine together with better treatment remains one of the strategic exist of the coronavirus disease 2019 (COVID-19) pandemic. As in many other countries worldwide, the government of Ghana has expressed its commitment to procuring globally approved and accepted vaccines. This preliminary study aims to analyses these factors that could impact the choice of the vaccine in Ghana.

Materials and Methods: This cross-sectional survey was conducted among 1,000 Ghanaian respondents from the 14th October to the 12th of December 2020. A structured questionnaire after a series of literature review and was transcribed unto google forms. Dataset was extracted using Excel ver. 2016 (Microsoft Corp., Redmond, WA, USA) and imported into IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics, cross-tabulations and logistic regression analyses were conducted at p-value <0.05.

Results: The results showed that 541 (54.1%) of the respondents would opt for the vaccines, 907 (90.7%) trusted the healthcare system and 388 (38.8%) had a high-risk perception of acquiring COVID-19. Our inferential analysis found that being married (adjusted odds ratio [aOR], 2.29; 95% confidence interval [CI], 1.10–4.78), salary worker (private: aOR, 2.24; 95% CI, 0.85–5.89; government: aOR, 42.58; 95% CI, 14.09–128.61), and high-risk perception (aOR, 5.35; 95% CI, 3.24–8.82) had a higher OR of accepting COVID-19 vaccine.

Conclusion: As the government of Ghana prepares to secure COVID-19 vaccines, it is important to understand the state of mind and determinants of COVID-19 vaccine acceptance in the general population. Policymakers and stakeholders should focus on evidence-based community messaging to improve uptake and break the transmission dynamics.

Keywords: COVID-19, Vaccine, Confidence, Risk behaviors



© Korean Vaccine Society.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Coronavirus disease 2019 (COVID-19) has affected all regions of the globe and Ghana a country in the West Coast of Africa is not an exception. As of 20th December 2020, the number of confirmed COVID-19 cases globally was 75,140,651 with 1,680,395 deaths [1], meanwhile Ghana had recorded 53,653 confirmed cases and 331 deaths [2]. World governments and international organizations have played vital roles in tracking the pandemic, advising on critical health issues, and distributing medical supplies amid the outbreak. The majority of the global population is still vulnerable to the COVID-19 and therefore safe and effective vaccine together with better treatment remain

one of the strategic exist of the pandemic [3]. This has opened the spigot of funding for research organization or laboratories around the globe to join the hunt for a vaccine at an astonishing pace and that kick off the record-breaking rush to develop a vaccine [4].

According to the World Health Organization (WHO), there were more than 50 COVID-19 vaccine candidates in clinical trials. Within November 2020, the big much-awaited breakthrough came when Pfizer/BioNTech developed its first vaccine with 95% effectiveness and others vaccines like Moderna which is 94.5% capable of protecting and the Oxford University Astra Zeneca vaccine whose clinical trials showed it stops 70% of people from developing COVID-19 were also equally in the race [3]. The U.S. Food and Drug Administration granted its first emergency use authorization for COVID-19 vaccines to the Pfizer-BioNTech candidature as well as Moderna's vaccine candidate. Similarly, some countries like Canada and the United Kingdom have authorized Pfizer-Bio-Tech vaccines and it is expected to be in circulation when emergence clearance is granted [5].

Prior to the emergence of these vaccines, in April 2020, WHO in partnership with scientists, businesses, and global health organizations launched the ACT (Access to COVID-19 Tools) accelerator to speed up COVID-19 vaccine responses. However, the success of these global vaccination efforts depends on public acceptance, and the unwillingness of the general population could cause vaccine hesitancy. Vaccine hesitancy is known to be triggered by several factors and this happens especially when new vaccines are being developed. Adverse health outcomes, misconceptions, lack of trust in the healthcare system, safety and efficacy, and inadequate knowledge are the few to mention [6]. In related review, vaccine hesitancy predictors include key factors such as the severity of the event, people's perceived risk of infection, personal consequences, and ethnicity [7]. These identified factors slow public responses to the virus causing increased anti-vaccination problems.

For instance, when the influenza A virus vaccines were first introduced, the acceptancy rate varied between 8% and 67% [8]. These rates differed from one country to the other, the United States and the United Kingdom recorded 64% and 56.1%, respectively for the H1N1 vaccine [9]. In Hong Kong, 50.5% of the studied population preferred to take the H7N9 vaccine during the outbreak in 2018 [10]. While in Beijing, China, 59.5% of the population were willing to accept the same vaccine [11]. A study done in the United Arab Emirates

reported vaccine safety (17%), side effects (35%), and multiple injections (28%) as critical factors in vaccine hesitancy [12]. In contrast, high efficacy, endorsement from credible health institutions like the World Health Organization and Centre for Disease Control, and history of vaccination influenced the acceptance of vaccines [12]. In a nutshell, the attributes of vaccine choice vary according to place, time, demographics, trust in established institutions, and even the behavioral nature of the community. More recent evidence suggests that accessibility of vaccination across the globe is becoming a challenge due to complex human behavior which changes over time and space; therefore, there robust and sustained efforts are needed to address the situation [13]. On December 20, 2020, the Government of Ghana expressed its commitment in the procuring of the COVID-19 vaccines ensuring that vaccines deployed in the country are safe and effective. In Ghana, to the best of our knowledge, no limited evidence exists on the potential acceptance rate of the COVID-19 vaccine and its determinants. This study determined the potential uptake of the COVID-19 vaccine and factors that could affect their choice in Ghana.

Materials and Methods

Study design

The cross-sectional survey was designed using Google Form platform and used a snowball sampling technique to study adult Ghanaian potential acceptance of COVID-19 vaccine. Study participants were recruited from communities across the 16 administrative regions of Ghana. All the regions at the time of the study have recorded COVID-19 cases. The web-based cross-sectional design made it possible to avoid physical contact as part of COVID-19 safety protocols while ensuring reliable data from large study population.

Sample size estimation

We estimated the minimum sample size using the Cochran formula [14] and based on the information from a previous study [15]; given that $Z=1.96$ (at 95% confidence interval [CI]), $p=0.67$ (potential COVID-19 vaccine acceptance rate), $q(1-p)=0.3.3$, and $e=0.05$ (margin of error), 327 participants were required. On assumption that 10% of people who received the link will not complete the survey, we estimated a minimum sample size of 360 participants for the analysis.

Data collection

A structured questionnaire was designed after series of literature review [15-18]. The questionnaire was drafted in English and in sectioned into sociodemographic characteristics, knowledge and perception towards COVID-19, trust in the health system, and participants’ willingness to accept the COVID-19 vaccine if it is available in the future. This was transcribed unto google forms (web-based questionnaire). The drafted questionnaire was pre-tested and co-vetted to ensure the relevant content and clarity, and to keep it simple and easy for participants. The study investigators shared the survey link via social media (Twitter, WhatsApp, Telegram channel) and through emails to their primary contacts (aged 18 and above) between 14th October to the 12th of December 2020. The primary participants were requested to share the survey link with their contacts. On receiving and clicking the link, participants got auto directed to the informed consent page, followed by the survey questionnaires.

Ethical considerations

According to the GHS-ERC (Ghana Health Service Ethics Review Committee) guidelines/standard operating procedures, research studies that may be considered for exemption are minimal risk research studies that conform to one or more of the following categories of research. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior except if information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, or reputation [19].

This study was online-based and self-administered, which posed no harm to our participants other than the psychological burden of responding to questions that are not different from the daily physiological burdens of life. Participants aged below 18 years were excluded because of their vulnerability as minors.

Statistical analysis

Dataset were extracted using Excel ver. 2016 (Microsoft Corp., Redmond, WA, USA) and imported into IBM SPSS ver. 22.0 (IBM Corp., Armonk, NY, USA) for management and analysis. Descriptive statistics were conducted to generate sum-

mary tables for study variables. A cross-tabulation analysis was performed to assess the distribution of intention to accept COVID-19 vaccine with sociodemographic characteristics of participants using chi-squared tests. We performed logistic regression analysis to estimate the odds ratios (OR) and their 95% CI. A two-tailed p-value <0.05 was considered statistically significant.

Results

The sociodemographic characteristics of the 1,000 survey participants are presented in Table 1. More of the study participants aged 18–25 years 428 (42.8%), were females 668 (66.8%), had never married 709 (70.9%), had attained junior high school 616 (61.6%) and an equal proportion of the par-

Table 1. Sociodemographic characteristics of the study population (n= 1,000)

Characteristic	No. (%)
Age (yr)	
18–25	428 (42.8)
26–35	388 (38.8)
36–45	129 (12.9)
>45	55 (5.5)
Gender	
Male	332 (33.2)
Female	668 (66.8)
Marital status	
Single	709 (70.9)
Separated/divorced/widowed	54 (5.4)
Married	237 (23.7)
Education	
Junior high school	72 (7.2)
Senior high school or some college	616 (61.6)
Bachelor’s degree	219 (21.9)
Postgraduate degree	93 (9.3)
Occupation	
Unemployed	372 (37.2)
Self-employed	111 (11.1)
Private worker	145 (14.5)
Government worker	372 (37.2)
Income level (per day)	
Not prefer to answer	377 (37.7)
Less than 2 USD or 12 GH¢	130 (13.0)
2–8 USD or 12–48 GH¢	345 (34.5)
8–32 USD or 48–192 GH¢	112 (11.2)
Above 32 USD or 192 GH¢	36 (3.6)

USD, US dollar; GH¢, Ghanaian Cedi.

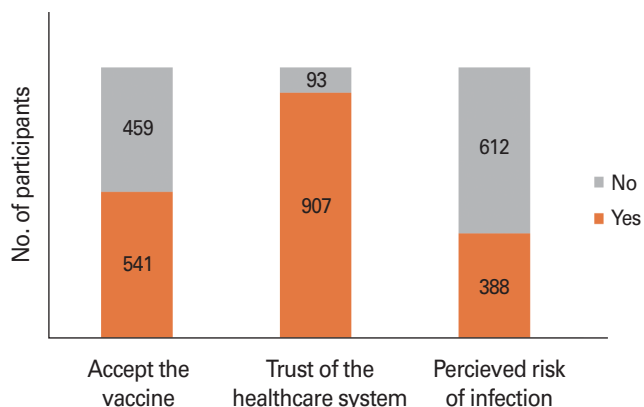


Fig. 1. Distribution of proportion of participants willing to accept the vaccine, trust the health care system, and having high perceived risk.

Participants were unemployed and government workers 372 (37.2%). A significant number of the participants preferred not to disclose their financial details (37.7%), while 345 (34.5%) of the participants earned 2–8 US dollar (USD) or 12–48 Ghanaian Cedi (GH¢) per day.

Of 1,000 participants, 541 (OR, 54.1%; 95% CI, 51–57) would opt for the vaccines if available, 907 (OR, 90.7%; 95% CI, 89–92) trusted the healthcare system and 399 (OR, 38.8%; 95% CI, 36–42) of the respondents reported to have a high risk of acquiring COVID-19 (Fig. 1).

The bivariate analysis to determine sociodemographic characteristics associated with the intent to uptake the COVID-19 vaccine is shown in Table 2. A significant proportion of participants aged 26–35 years 277 (71.7%), who were males 201 (60.5%) and were single 413 (58.3%) intended to accept the vaccine. There was a significant association between the intent to uptake COVID-19 vaccine and the sociodemographic characteristics of participants at $p < 0.05$ (except income level, $p = 0.058$).

All the sociodemographic variables were entered into both the bivariate and multivariate models of the logistic regression analysis as presented in Table 3. In the multivariate model, participants who were 36–45 years of age had lower odds of accepting the vaccine if available compared to those aged 18–25 years (adjusted odds ratio [aOR], 0.07; 95% CI, 0.02–0.24). Likewise, the OR of accepting a potential vaccine was lower in females relative to males (aOR, 0.54; 95% CI, 0.33–0.87). In addition, married participants had higher OR to accept the vaccine compared to the singles (aOR, 2.29; 95% CI, 1.10–4.78). Participants who had attained Bachelor’s degree had lower odds of participating in available COVID-19 vaccination (aOR, 0.28; 95% CI, 0.14–0.56). Also, government

Table 2. Bivariate associations between sociodemographic characteristics and intent to uptake COVID-19 vaccine among respondents (n=1,000)

Variable	“If vaccine against COVID-19 is available, I will take it.”		p-value
	Yes (n=541)	No (n=459)	
Age (yr)			<0.001
18–25	189 (44.2)	239 (55.8)	
26–35	277 (71.4)	111 (28.6)	
36–45	75 (58.1)	54 (41.9)	
>45	0	55 (100.0)	
Gender			0.004
Male	201 (60.5)	131 (39.5)	
Female	340 (50.9)	328 (49.1)	
Marital status			<0.001
Single	413 (58.3)	296 (41.7)	
Separated/divorced/widowed	0	54 (100.0)	
Married	128 (54.0)	109 (46.0)	
Education			<0.001
Junior high school	0	72 (100.0)	
High school or some college	339 (55.0)	277 (45.0)	
Bachelor’s degree	129 (58.9)	90 (41.1)	
Postgraduate degree	73 (54.1)	20 (21.5)	
Occupation			<0.001
Unemployed	188 (50.5)	84 (49.5)	
Self-employed	0	111 (100.0)	
Private worker	72 (49.7)	73 (50.3)	
Government worker	281 (75.5)	91 (24.5)	
Income level (per day)			0.058
Not prefer to answer	211 (56.0)	166 (44.0)	
Less than 2 USD or 12 GH¢	58 (44.6)	72 (55.4)	
2–8 USD or 12–48 GH¢	200 (58.0)	145 (42.0)	
8–32 USD or 48–192 GH¢	54 (48.2)	58 (51.8)	
Above 32 USD or 192 GH¢	18 (50.0)	18 (50.0)	

Values are presented as number (%).

COVID-19, coronavirus disease 2019; USD, US dollar; GH¢, Ghanaian Cedi.

workers had higher odds of accepting the vaccine (aOR, 42.58; 95% CI, 14.09–128.61). Moderate income earners (2–8 USD or 12–48 GH¢ and 8–32 USD or 48–192 GH¢ per day) had had lower odds to accept the vaccine compared to those who did not disclose their income (0.24 [95% CI, 0.11–0.54] and 0.23 [95% CI, 0.08–0.66], respectively).

The chi-square analysis depicted that 388 (39%) reported to have a high risk of acquiring COVID-19 infection while 315 (81.2%) agreed to accept the vaccine if available. All the participants (n=93) who mistrusted the healthcare system intended not to accept the COVID-19 vaccine if available. In the multivariate model adjusted for sociodemographic char-

Table 3. Logistic regression analysis for sociodemographic prediction of intent to uptake COVID-19 vaccine among respondents (n=1,000)

Variable	"Intended to uptake COVID-19 vaccine"			
	OR (95% CI)	p-value	aOR (95% CI)	p-value
Age (yr)				
18–25	1		1	
26–35	3.16 (2.36–4.22)	<0.001	1.65 (0.85–3.20)	0.137
36–45	1.76 (1.18–2.62)	0.006	0.07 (0.02–0.24)	<0.001
>45	-		-	
Gender				
Male	1		1	
Female	0.68 (0.52–0.88)	0.004	0.54 (0.33–0.87)	0.011
Marital status				
Single	1		1	
Separated/divorced/widowed	-		-	
Married	0.84 (0.63–1.13)	0.253	2.29 (1.10–4.78)	0.027
Education				
High school or some college	1		1	
Junior high school	-		-	
Bachelor's degree	1.17 (0.86–1.60)	0.322	0.28 (0.14–0.56)	<0.001
Postgraduate degree	2.98 (1.77–5.01)	<0.001	-	
Occupation				
Unemployed	1		1	
Self-employed	-		-	
Private worker	0.97 (0.66–1.42)	0.857	2.24 (0.85–5.89)	0.101
Government worker	3.02 (2.21–4.13)	<0.001	42.58 (14.09–128.61)	<0.001
Income level (per day)				
Not prefer to answer	1		1	
Less than 2 USD or 12 GH¢	0.63 (0.42–0.95)	0.026	0.98 (0.48–1.98)	0.952
2–8 USD or 12–48 GH¢	10.9 (0.81–1.46)	0.587	0.24 (0.11–0.54)	<0.001
8–32 USD or 48–192 GH¢	0.73 (0.48–1.12)	0.149	0.23 (0.08–0.66)	0.006
Above 32 USD or 192 GH¢	0.79 (0.40–1.56)	0.492	-	

COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio; USD, US dollar; GH¢, Ghanaian Cedi.

Table 4. Logistic regression analysis for factors potentially associated with the intention to receive coronavirus vaccine among respondents (n=1,000)

Variable	"If vaccine against COVID-19 is available, I will take it."						
	Yes (n=541)	No (n=459)	p-value	OR (95% CI)	p-value	aOR (95% CI) ^{a)}	p-value
Perceived risk			<0.001		<0.001		<0.001
Yes	315 (81.2)	73 (18.8)		7.37 (5.44–9.98)		5.35 (3.24–8.82)	
No	226 (36.9)	386 (63.1)		1			
Trust of the health system			<0.001				
Yes	541 (59.6)	366 (40.4)		Nil			
No	0	93 (100.0)		1			

COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio.

^{a)}Adjusted for age, gender, marital status, education, occupation, and income levels.

acteristics, the odds of accepting the COVID-19 vaccine was 5.35 folds among participants with high COVID-19 risk per- ception after adjusted for sociodemographic characteristics (95% CI, 3.24–8.82) (Table 4).

Discussion

We conducted a study of potential acceptance of a COVID-19 vaccine through a web-based self-administered questionnaire and collected responses from 1,000 individuals across the 16 administrative regions of Ghana. The results showed that an average number of the respondents would opt for the vaccines, the majority trusted the healthcare system and only a few had a high-risk perception of acquiring COVID-19. Lessons from polio vaccination campaigns have revealed that vaccine acceptance by communities was threatened by anti-vaccination movements, conspiracy theories, miscommunication, religious dogma, and rumors [20]. These same negativities may shadow the rollout of the COVID-19 vaccination. It was not therefore surprising to discover that a little above half (54.1%) of our respondents opted to accept COVID-19 vaccines in Ghana. Our finding is comparable to the 64.7% of respondents who intended to accept the COVID-19 vaccine in Saudi Arabia [18]. A similar study in the United States found that a high proportion (79%) of respondents had the desire to accept the COVID-19 vaccine [16]. Although more than half of the studied population opted for the vaccine, is relatively lower than the 90% universal acceptance rate and coverages for vaccines [17,20,21]. The differences in potential acceptance rates could be explained with vary exposure to demographic and socioeconomic factors linked with vaccine acceptance in these countries [8-10,15,17,20,21]. A documented evidence by the WHO identified three categorical drivers of vaccine uptake, in addition to an individual having relevant knowledge of the vaccines, including an enabling environment; social influences; and motivation [21]. It is evident therefore while promoting vaccination, in general, is useful in the context of the current pandemic, the acceptance, and uptake of COVID-19 vaccines present an unavoidable challenge. Efforts to address behavioral drivers of vaccine hesitancy may be vital to promote the COVID-19 vaccine in the general population.

Previous studies identified trust as an intrinsic and potentially modifiable component of successful uptake of a COVID-19 vaccine [10,15-17,21,22]. Although the vaccine potential acceptance rate was low, over 90% of the respondents trusted the healthcare system in Ghana. This implied that the respondents were willing to accept vaccines if healthcare system approves and provides relevant information on them. Nonetheless, the findings did not show that trust in the healthcare system is strongly associated with vaccine accep-

tance. Contrary to what was reported in similar studies in a global survey among 19 western countries [17]. The study found that trust in government by respondents is strongly associated with vaccine acceptance. However, the level of trust required to promote vaccine acceptance and uptake is a multifaceted approach [10,15-17,21,22]. For instance, a systematic study revealed that vaccine acceptance involves multiple levels of trust that include trust in the vaccine; the provider (the specific healthcare professionals); and trust in the health system [8]. Hence, planners and implementers of the COVID-19 vaccine in the present pandemic must address public trust in a multidimensional manner [8,21].

Our findings showed that only one-third (38.8%) of the respondent had a high risk of acquiring COVID-19 infection. This is inconsistent with the report of Serwaa et al. [23], who found 68.3% had a high risk of contracting the COVID-19 infection among Ghanaians. The lower risk perception in this study could be attributed to several factors. Ghana recorded a mild type of COVID-19 infection, with minimal secondary infection rate and lower-case fatality rate in addition to a drastic reduction in new COVID-19 cases as compared to the early stages of the outbreak [2]. Also, there is an increasing awareness and knowledge of COVID-19 transmissions, risk factors, and effectiveness of safety protocol [23-26]. Therefore, ones' perception or fear of contracting the virus could be relatively low.

Consistent with previous studies in the United States [15,16], Saudi Arabia [18], and Western countries [17], we found sociodemographic characteristics and high-risk perception as determinants of vaccine acceptance [2,4,6,8-12]. Our findings revealed that being married (2.29 folds), being a private salary worker (2.24 folds) or a government worker (42.58 folds), and having a high-risk perception (5.35 folds) had a higher odds of accepting COVID-19 vaccine as compared to their counterparts. While lower significant odds were observed among people aged 36-45 years (0.07 folds), being a female (0.54 folds), having a bachelor degree (0.28 folds), and earning 2-32 USD or 12-192 GHC (0.24 folds). The distribution of these sociodemographic determinants vary by country study was performed. This might be explained by the demographic and socio-cultural characteristics of the general population which differ across countries and continents.

The study had several limitations. Foremost, this a web-based cross-sectional study among 1,000 adult Ghanaians with reliable access to the internet, hence, views of people

with limited access to the internet and online health information resources, vulnerable populations of Ghanaian society, and illiterates were not captured in the study. Secondly, this study measured people's intentions at a point in time. However, the real intention might differ when the vaccine is available as intention varies over time and in the context of a dynamic society. Thirdly, due to the cross-sectional nature of the study, the researchers were unable to explore the motivation behind the acceptance or barriers behind the hesitancy of the COVID-19 vaccine. However, in the current COVID-19 outbreak situation in Ghana, this was the method scientifically safe and relevant to collect the data from a large population. Despite the above limitations, our study provides preliminary evidence in Ghana to demonstrate the population's intention to accept the COVID-19 vaccine. We expect that findings will stimulate further studies on community behavior factors for COVID-19 vaccine acceptance and uptake in Ghana and beyond.

In conclusion, as the Government of Ghana prepares to secure COVID-19 vaccines, it is important to understand the state of mind and determinants regarding the acceptance of the COVID-19 vaccine in the general population. Our study found 54.1% of studied participants from across the 16 administrative regions of Ghana would accept a COVID-19 vaccine. Furthermore, married individuals, private and government workers, and people with a high-risk perception had higher odds of accepting COVID-19 vaccines. Policymakers and stakeholders should focus on evidence-based community messaging to improve uptake and break the transmission dynamics.

ORCID

Emmanuel Lamptey <https://orcid.org/0000-0002-7822-7593>

Dorcas Serwaa <https://orcid.org/0000-0001-8583-4415>

Anthony Baffour Appiah <https://orcid.org/0000-0001-6559-8507>

References

1. World Health Organization. Attacks on health care in the context of COVID-19. Geneva: World Health Organization; 2020.
2. Ghana Health Service. COVID-19 updates. Accra: Ghana Health Service; 2020.
3. Gallagher J. Covid vaccine update: those that work - and the others on the way. BBC News. 2020 May 28.
4. Joseph A. 'A huge experiment': how the world made so much progress on a COVID-19 vaccine so fast. Boston (MA): STAT; 2020.
5. Herper M. FDA grants authorization to Moderna's Covid-19 vaccine, the second in the U.S. Boston (MA): STAT; 2020.
6. Setbon M, Raude J. Factors in vaccination intention against the pandemic influenza A/H1N1. *Eur J Public Health* 2010; 20:490-4.
7. Nguyen T, Henningsen KH, Brehaut JC, Hoe E, Wilson K. Acceptance of a pandemic influenza vaccine: a systematic review of surveys of the general public. *Infect Drug Resist* 2011;4:197-207.
8. Larson HJ, Clarke RM, Jarrett C, et al. Measuring trust in vaccination: a systematic review. *Hum Vaccin Immunother* 2018;14:1599-609.
9. Gidengil CA, Parker AM, Zikmund-Fisher BJ. Trends in risk perceptions and vaccination intentions: a longitudinal study of the first year of the H1N1 pandemic. *Am J Public Health* 2012;102:672-9.
10. Abbas KM, Kang GJ, Chen D, Werre SR, Marathe A. Demographics, perceptions, and socioeconomic factors affecting influenza vaccination among adults in the United States. *PeerJ* 2018;6:e5171.
11. Wu S, Su J, Yang P, et al. Willingness to accept a future influenza A(H7N9) vaccine in Beijing, China. *Vaccine* 2018; 36:491-7.
12. Alsuwaidi AR, Elbarazi I, Al-Hamad S, Aldhaheri R, Sheek-Hussein M, Narchi H. Vaccine hesitancy and its determinants among Arab parents: a cross-sectional survey in the United Arab Emirates. *Hum Vaccin Immunother* 2020;16: 3163-9.
13. Habersaat KB, Jackson C. Understanding vaccine acceptance and demand-and ways to increase them. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2020;63:32-9.
14. Bacchetti P, Wolf LE, Segal MR, McCulloch CE. Ethics and sample size. *Am J Epidemiol* 2005;161:105-10.
15. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. *EclinicalMedicine* 2020;26:100495.
16. Kreps S, Prasad S, Brownstein JS, et al. Factors associated with US adults' likelihood of accepting COVID-19 vaccination. *JAMA Netw Open* 2020;3:e2025594.
17. Lazarus JV, Ratzan SC, Palayew A, et al. A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med*

- 2021;27:225-8.
18. Al-Mohaithef M, Padhi BK. Determinants of COVID-19 vaccine acceptance in Saudi Arabia: a web-based national survey. *J Multidiscip Healthc* 2020;13:1657-63.
 19. Ghana Health Service Ethics Review Committee. Ghana Health Service Ethics Review Committee: standard operating procedures [Internet]. Accra: Ghana Health Service; 2015 [cited 2021 Feb 10]. Available from: https://www.ghanahealthservice.org/downloads/Standard_Operating_Procedures.pdf.
 20. Rahi M, Sharma A. Mass vaccination against COVID-19 may require replays of the polio vaccination drives. *EClinicalMedicine* 2020;25:100501.
 21. World Health Organization. Behavioural considerations for acceptance and uptake of COVID-19 vaccines. Geneva: World Health Organization; 2020.
 22. Wu S, Su J, Yang P, et al. Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China. *BMJ Open* 2017;7:e017459.
 23. Serwaa D, Lamptey E, Appiah AB, Senkyire EK, Ameyaw JK. Knowledge, risk perception and preparedness towards coronavirus disease-2019 (COVID-19) outbreak among Ghanaians: a quick online cross-sectional survey. *Pan Afr Med J* 2020;35(Suppl 2):44.
 24. Sarfo AK, Karuppannan S. Application of geospatial technologies in the COVID-19 fight of Ghana. *Trans Indian Natl Acad Eng* 2020;5:193-204.
 25. Afulani PA, Gyamerah AO, Nutor JJ, et al. Inadequate preparedness for response to COVID-19 is associated with stress and burnout among healthcare workers in Ghana. *PLoS One* 2021;16:e0250294.
 26. Bonful HA, Addo-Lartey A, Aheto JM, Ganle JK, Sarfo B, Aryeetey R. Limiting spread of COVID-19 in Ghana: compliance audit of selected transportation stations in the Greater Accra region of Ghana. *PLoS One* 2020;15:e0238971.