Napata College

Pharmacy program

Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among the general population in Sudan

A graduation project submitted to the Napata College in partial fulfillment of B.Sc. Degree in pharmacy

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B.Pharm, M.Pharm

2022

كلية نبتة

NAPATA COLLEGE

كلية نبتة

برنامج الصيدلة

المعتقدات والعوائق المرتبطة بالتطعيم ضد فيروس كورونا بين عموم سكان في السودان

بحث تكميلي لنيل درجة البكلاريوس في الصيدلة

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يناير 2022م

Declaration

I declare that the subject matter presented in this graduation project is original and has only been submitted to Napata College to obtain degree of B.S.c in pharmacy.

Dedication

To

Who lit up my life …...

And as a result got this stage ….

My father.

For who stayed up for me all her life ….

Even see me person has value and meaning….

My mother….

I dedicate this humble and simple work to them …….

To my brothers & sisters……

And all my friends

Acknowledgment

I would like to express my deep gratitude to **Dr. Ali Awad Allah Ali** our supervisor, for his in enthusiastic encouragement and useful critics of this research work. I would also like to thank Napata College family for them greet contribution in this work through providing all material needed.

المستخلص:

الخلفية: تردد اللقاح هو مسألة صحية عامة معقدة تشير إلى مخاوف بشأن سلامة التطعيم أو فعاليته أو الحاجة إليه. هناك فجوة كبيرة في المعلومات حول تردد اللقاح والمعتقدات والعقبات المرتبطة بالتطعيم ضد فيروس كورونا بين عموم السكان في السودان. لذلك هدفت هذه الدراسة إلى المساهمة في سد هذه الفجوة من خلال التحقيق في تصور ووعي السودانيين تجاه تناول لقاح كوفيد -19 وتحديد المعتقدات التي تقوم عليها.

المواد والطرق: تم استخدام استبيان مقطعي عبر الإنترنت وإدارته ذاتيًا لمسح المشاركين البالغين من السودان حول قبول لقاح كوفيد -19.

النتائج: بلغ مجموع المشاركين 369 (133 ذكور و236 إناث). كان القبول العام للقاحات كوفيد -19(64.4)٪ في السودان. وقد اظهرت النتائج القبول وعدم القبول بلقاح كوفيد-19كان متوقعًا من خلال نموذج الانحدار اللوجستي (0.641 * s + 0.147 الفئه العمرية * الجنس + 0.484 * المستوى التعليمي + 0.070 * المنطقة + 0.449 * المرض المزمن- 0.071 * درجة المعتقد (٪)). أظهر النموذج أن درجة الاعتقاد (٪) كانت ذات دلالة إحصائية مع القيمة الاحتمالية 0.210 و 0.617 و 0.307 و0.295 على التوالي. لم تكن مساحة المعيشة بقيمة 0.000001. العمر والجنس والمستوى التعليمي والمرض المزمن على الرغم من مساهمتهم في النموذج لم تكن ذات دلالة إحصائية (P = 0.885) وكانت المساهمة في النموذج بحد أدنى 0.070.

الخلاصة: لوحظ ارتفاع معدل انتشار الرفض والتردد بشأن التطعيم ضد COVID-19 في السودان في الدراسة. يبدو أن القلق بشأن سلامة اللقاح والمستوي التعليمي هما السبب الرئيسي لعدم الرغبة في قبول اللقاحات.

Abstract

Background: Vaccine hesitancy is a complex public health issue referring to concerns about the safety, efficacy or need for vaccination. There is a huge gap of information about the vaccine hesitancy, beliefs and barriers associated with COVID-19 vaccination among the general population in Sudan. Therefore, this study aimed to contribute to filling this gap by investigating the perception and awareness of Sudanese towards the intake of COVID-19 vaccine and determine the underpinning believes.

Materials and Methods: An online, cross-sectional, and self-administered questionnaire was instrumentalized to survey adult participants from Sudan on the acceptability of COVID-19 vaccine.

Results: Total of participants were 369, (133 were males and 236 were females). The public acceptability of COVID-19 vaccines was (64.4%) in Sudan. Vaccination ("Accept" and "Not accept") to COVID-19 vaccine was predicting through a logistic regression model ($Y=2.963+0.641*Agegroups+0.147*Gender+0.484*Educationallevel+0.070*Area+0.449*Chronic illness-0.071*Belief score (%)$). The model revealed that Belief score (%) was statistically significant with *p*-value of respectively 0.210, 0.617, 0.307and 0.295. The area of living was not value of 0.000001. Age, gender, education level and chronic illness despite their contribution to the model were not statistically significant (p=0.885) and contribution to the model was minimum with 0.070.

Conclusions: A high prevalence of refusal and hesitancy about COVID-19 vaccination in Sudanese population was observed in the study. The safety concern seemed to be the main reason for the unwillingness to accept vaccines.

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1. Introduction:

1.1 Coronavirus:

Coronavirus disease COVID-19 (the disease triggered by Severe Acute Respiratory Syndrome Coronavirus 2 (SARSCOV-2) was a rapidly expanding pandemic caused by a novel human coronavirus. In late December 2019, a novel coronavirus appeared in Wuhan, China, causing an outbreak [1]. After infecting and causing the death of thousands of persons in China, the virus has spread, reaching Italy and other European countries and the USA, with the number of confirmed new cases currently increasing every day [2]. The WHO declared it a pandemic

due to the widespread infectivity and high contagion rate.

First infections of COVID-19 in Sudan were detected among international travelers and returnees who arrived in the country between February and March 2020 [3]. Soon later, Sudan has suffered from the widespread of infections and the local dramatic development of the pandemic in lack of adherence among the public community and noncompliance of the individuals to the prevention measures that were promoted by the Ministry of Health [4].

There is a huge gap of information about the vaccine hesitancy, beliefs and barriers associated with COVID-19 vaccination among the general population in Sudan. Therefore, this study aimed to contribute to filling this gap by investigating the perception and awareness of Sudanese towards the intake of COVID-19 vaccine and determine the underpinning believes.

1.1.2 Prevalence and incidence:

As of 16 January 2022, over 323 million confirmed cases and over 5.5 million deaths have been reported worldwide. Despite a slowdown of the increase in case incidence at the global level, all regions reported an increase in the incidence of cases with the exception of the African Region, which reported a 27% decrease. The South East Asia Region reported the largest increase in new cases (145%), followed by the Eastern Mediterranean Region (68%), the Western Pacific Region (38%), the Region of the Americas (17%) and the European Region (10%). Deaths increased in the South-East Asia Region (12%) and Region of the Americas (7%), while remaining similar to the number reported in the other Regions [5].

1.1.3 SARS-CoV-2 variants:

All viruses, including SARS-CoV-2, the virus that causes COVID-19, change over time. Most changes have little to no impact on the virus' properties. However, some changes may affect the virus's properties, such as how easily it spreads, the associated disease severity, or the performance of vaccines, therapeutic medicines, diagnostic tools, or other public health and social measures. Five SARS-CoV-2 variants have been designated as variants of concern by the World Health Organization: the Alpha (United Kingdom, Sep-2020), Beta(South Africa, May-2020), Gamma (Brazil, Nov-2020), Delta(India, Oct-2020) , and Omicron variants (Multiple countries, Nov-2021) [6] .

1.1.4 Diagnosis:

Nucleic acid testing is the gold standard for the final diagnosis of COVID-2019 in non-invasive diagnosis. However, due to an inadequate supply of kits and complicated sampling methods, there are sure to be false negatives, which causes some patients to delay treatment and control measures, besides, nucleic acid testing can only make a positive diagnosis also recently, some researchers have proposed CT as a diagnosis standard for COVID-2019 to increase the detection rate. The advantage of CT is that it can make judgments quickly [7].

1.2 Literature review:

1.2.1 Vaccine:

Since there is no effective medical treatment for COVID-19 at present, the international collaborative efforts are more focused on developing a safe and effective vaccine against COVID-19[8]. There are several safe and effective vaccines that prevent people from getting seriously ill or dying from COVID-19. This is one part of managing COVID-19, in addition to the main preventive measures of keeping a safe distance from others and avoiding crowds, wearing a well-fitting mask covering your mouth and nose, keeping indoor spaces well ventilated, cleaning hands regularly and covering coughs and sneezes [9].

As of 12 January 2022, WHO has evaluated that the following vaccines against COVID-19 have met the necessary criteria for safety and efficacy: AstraZeneca/Oxford vaccine , Johnson and Johnson , Moderna , Pfizer/BionTech , Sinopharm , Sinovac , COVAXIN , Covovax and Nuvaxovid . Approved COVID-19 vaccines provide a high degree of protection against getting seriously ill and dying from the disease, although no vaccine is 100% protective [9]. On the 3rd of March, Sudan received the AstraZeneca vaccine through the COVAX alliance [10].

1.2.2 Who should get vaccinated:

All COVID-19 vaccines with WHO EUL are safe for most people 18 years and older, including those with pre-existing conditions of any kind, including auto-immune disorders. These conditions include: hypertension, diabetes, asthma, pulmonary, liver and kidney disease, as well as chronic infections that are stable and controlled [9].

1.2.3 Vaccine hesitancy:

Vaccine hesitancy was defined by the WHO Strategic Advisory Group of Experts (SAGE) as "delay in acceptance or refusal of vaccination despite availability of vaccination services" [11]. Vaccine acceptability is determined by three factors: confidence, convenience, and complacency [12]. Confidence is defined as the trust in the safety and effectiveness of the vaccine, trust in the delivery system as the healthcare system, and the trust in the policymakers [13]. Vaccination convenience refers to the relative ease of access to the vaccine that includes physical availability, affordability, and accessibility [14] and vaccine

complacency is associated with a low realized risk of the vaccine-preventable disease and hence more negative attitudes towards the vaccines [13]. Several determinants modify vaccination decisions and determine whether to refuse, delay, or accept some or all vaccines. These include contextual influences that arise from historical, socioeconomic, cultural, ecological, health system/institutional and political factors. [15] Concerns about the efficacy or safety, the country of manufacture of the vaccine, the anti-vaccine movements, and the belief of rushed vaccine development and production, besides rumors and misinformation, were important COVID-19 vaccination hesitancy causes. [16].

There are also individual and group influences that arise from the personal perception of the vaccine, beliefs, or attitudes toward vaccination, such as perceived efficacy or benefits of vaccines, safety concerns or side effects, and social/peer environment. Besides, specific issues directly related to the vaccine or vaccination like the introduction of a new vaccine or formulation or a new recommendation for a current vaccine, method of administration, development of the vaccination program, reliability and/or source of supply, schedule, cost, the strength of recommendations, knowledge base and/or attitude. Numerous COVID-19 vaccination studies have documented an association between some of these factors and the acceptance of the COVID-19 vaccine [17].

1.2.4 COVID-19 vaccine acceptance:

World Health Organization considers vaccine hesitancy as a significant threat to global health.

Reported COVID-19 vaccine acceptance rates varied worldwide [17]. But a recent global report on COVID-19 vaccine acceptance illustrated that nearly 30% of the investigated participants would refuse or hesitate to take a COVID-19 vaccine when it is available. [17]. The Middle East is among the regions with the lowest rates of vaccine acceptance globally [17]. As the vaccine development process progresses, it is crucial to boost the acceptance of the new vaccines. Developing effective COVID-19 vaccination strategies necessitate a proper understanding of the factors that would impact the decision of vaccination as these factors may change for individuals who accept and be determined to take the vaccine from those who do not [17].

Justification:

It has been reported that there was a little known about hesitancy to receive the COVID-19 vaccines. The COVID-19 vaccines are safe and effective, providing strong protection against serious illness and death and it is a huge step forward toward ending the pandemic. Failure to adhere to vaccination may lead to increased disease and lack of control of the pandemic for long periods.

Objectives:

General objectives:

To explore vaccine hesitancy: beliefs and barriers associated with COVID-19 vaccination among the general population in Sudan.

Specific objectives:

- To explore the level of COVID-19 vaccine hesitancy.
- To identify the beliefs of the general public.
- To identify the determining factors, motivators and barriers leading to the decision to receive vaccination or not.

2.1 Materials:

2.1.1 Study Design:

A cross-sectional descriptive study was conducted among Sudanese Population.

2.1.2 Study Duration:

The data collection was performed between August and October 2021.

2.1.3 Study Area:

The study targeted participants from the states of Sudan to attain results that would be generalizable across the country.

2.1.4 Study Population:

Study was conduct among Sudanese Population.

2.1.5 Sample Size:

Being a descriptive survey, the sample size was calculated as per Cochran's formula:

$N = Z^2 \, pq / \, e^2$

Z = value is obtained from Z table at a given value of precision, 1.96.

p = estimated proportion of the population which has the attribute in question; for our heterogeneous group of population, we assumed greater variability of 50%, so $p = 0.5$.

$q = 1 - p = 1 - 0.5 = 0.5$.

e = desired level of precision (ie, the margin of error) =5% = 0.05.

· Including these values in the formula

$N = 1.96^2 \times 0.5 \times 0.5/0.0 \, 5^2$

$N = 384.16$

Although the calculated sample size was 384, the authors could only obtain responses from 369 respondents.

2.1.6 Sampling Technique (s):

A validated, self-administered electronic questionnaire was distributed online through social networking sites, such as WhatsApp. The questionnaire consisted of questions in English alongside its Arabic translation. The forward and backward translations were done by independent bilingual experts. The link of the questionnaire was circulated through social media contacts throughout the Sudanese population (questionnaire in Supplementary File 1). The questions started with consent for voluntary participation and a declaration affirming age more than equal 18-years and not vaccinated for COVID-19 previously.

2.2 Inclusion Criteria:

Individuals aged 18 years and above who access to the Internet consented to participate.

2.2.1 Ethical Consideration:

2.2.2 Research ethics:

Ethical approval was obtained from Napata Collage. Verbal informed consent was obtained from all participants after explaining the purpose of the study.

2.2.3 Statistical consideration:

2.2 4 Statistical analysis:

For analysis of data, Statistical Package for Social Sciences software, version 23.0 (IBM SPSS Inc., Chicago, IL) and STATA 11 were used. Initially, all information gathered via questionnaire then coded into variables. Normality of data was tested using Kolmogorov-Smirnov test and Shapiro-Wilk test. Both descriptive and inferential statistics involving Pearson Chi Square Test, Fisher's exact Test and binary logistic regression were used to present the results. A p-value of less than 0.05 was considered statistically significant.

Score: Although the questionnaire used for assessing Belief toward COVID-19 vaccination in order to have a better assessment of overall belief domain was scored as; Agree=1marks and Disagree=0mark, reverse scoring was used for negatively quoted question this gives total score from 0 to 10 then transformed to percentages. The scores in belief domain was not normally distributed was expressed as median then were categorized as poor (less than median) and good (median and above).

3. Results:

3.1 Demographic characteristics:

Table 1 shows that total of participants were 369, more than half of the participants (66.1%) were aged 18–29 years and (64%) were female. About two-third (68.3%) obtained a university degree. The most numbers of participants were derived from urban regions (92.4%).Only (13%) declared a history of chronic disease.

Table 1: Demographic variables:

Demographic variables	Number	Percent
Age groups		
18-29 years	244	66.1%
30-39 years	87	23.6%
40-59 years	36	9.8%
60 years and more	2	0.5%
Gender		
Male	133	36%
Female	236	64%
Education level		
Primary	4	1.1%
Secondary	36	9.8%
University	252	68.3%
Postgraduate	77	20.9%
Area		
Urban	341	92.4%
Rural	28	7.6%
Chronic disease		
Yes	48	13%
No	321	87%
n=369		

3.2 Beliefs toward COVID-19 vaccination :

Table 2 illustrates total score for beliefs toward COVID-19 vaccine where good beliefs were (59.3%) and poor beliefs were (40.7%). Table 3 illustrates that the participants showed good beliefs toward COVID-19 vaccination regarding the safety (81.8%) and effectiveness (84.6%) , agreed that getting the vaccine is the best means of avoiding the complications of COVID-19 (73.4%) ,and taking the COVID-19 vaccine if available (71.3%) and participants showed poor beliefs toward COVID-19 vaccination concerned about the side effect of the COVID-19 vaccine (73.2%) , think about the vaccine is too costly (26.6%) , think about the vaccine will not stop the infection(62.6%) , think about don't need the vaccine because they follow all the precautionary measures (28.7%) , think about the COVID-19 vaccine is a conspiracy(31.4%) and think about don't need the vaccine because they are young and healthy(25.5%) .

Table 2: The beliefs score toward COVID-19 vaccine:

Belief score	Number	Percent
Poor	150	40.7%
Good	219	59.3%
Total	369	100%

Table 3: Participants showed good and poor beliefs toward COVID-19 vaccine :

Belief score	Agree	Disagree
Think about COVID-19 vaccine would be safe	302 (81.8%)	67 (18.2%)
Think about COVID-19 vaccine would be effective	312 (84.6%)	57 (15.4%)
Think about the best way to avoid the complications of COVID-19 is by being vaccinated	271 (73.4%)	98 (26.6%)
Think about taking the COVID-19 vaccine if available	263 (71.3%)	106 (28.7%)
Concerned about the side effect of the COVID-19 vaccine	270 (73.2%)	99 (26.8%)
Think about the vaccine is too costly	98 (26.6%)	271 (73.4%)
Think about the vaccine will not stop the infection	231 (62.6%)	138 (37.4%)
Think about don't need the vaccine because you follow all the precautionary measures	106 (28.7%)	263 (71.3%)
Think about the COVID-19 vaccine is a conspiracy	116 (31.4%)	253 (68.6%)
Think about don't need the vaccine because you are young and healthy	94 (25.5%)	275 (74.5%)

n=369

Table 4 illustrates there was an association between belief score with age group and educational level and there was no association between belief score with gender, area and chronic disease.

Table 4: Represent the association between variables and belief score:

By using Pearson Chi-Square Test P-vale and Fisher's Exact Test *P*-value .

Variables		Belief score		Pearson Chi-Square Test P-vale	Fisher's Exact Test P-vale
		Poor	Good		
Age groups	18-29 years	109	135		
		44.70%	55.30%		
	30-39 years	25	62		
		28.70%	71.30%		
	40-59 years	14	22		
		38.90%	61.10%		
	60 years and more	2	0		
		100.00%	0.00%	0.021**	0.015**
Gender	Male	51	82		
		38.30%	61.70%		
	Female	99	137		
		41.90%	58.10%	0.499*	0.286*
Education level	Primary	2	2		
		50.00%	50.00%		
	Secondary	21	15		
		58.30%	41.70%		
	University	103	149		
		40.90%	59.10%		
	Postgraduate	24	53		
		31.20%	68.80%	0.053*	0.043**
Area	Urban	135	206		
		39.60%	60.40%		
	Rural	15	13		
		53.60%	46.40%	0.148*	0.107*
Chronic disease	Yes	22	26		
		45.80%	54.20%		
	No	128	193		
		39.90%	60.10%	0.433*	0.264*

*.P value >0.05 that's considered as statistically insignificant.

**.P value <0.05 that's considered as statistically significant.

Table 5 illustrates belief of general public toward COVID-19 vaccine was predicted through a multiple linear regression model based on a set of six predictors. The regression (Belief of general public toward COVID-19 vaccine = 98.558+ 3.28*Age+ (-0.992)*Gender+1.623*Educational level+ (-3.743)* Area of living+ 1.391*Chronic illness + (-28.80) Accept taking the vaccine in any situation) model was statistically valid to predict the Belief of general public toward COVID-19 vaccine with F test (6, 362) = 33.946 and a p-value = 0.000. The combination of the 6 predictors account for r=0.600 to predict the Belief of general public toward COVID-19 vaccine. All the 6 predictors contribute, but Accept taking the vaccine in any situation were statistically significant P value 0.000001. The five other predictors contributing to the model were not statistically significant (p > 0.05).

Table 5: Represent belief of general public toward COVID-19 vaccine by using multiple linear regression models:

Multiple linear regression for prediction Belief score (%)							
	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Variables in equation	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	98.558	10.781		9.142	0.0000001	77.357	119.76
Age groups	3.28	1.541	0.097	2.128	0.034	0.249	6.31
Gender	-0.992	2.082	-0.02	-0.476	0.634	-5.086	3.103
Education level	1.623	1.708	0.041	0.95	0.343	-1.736	4.983
Area	-3.743	3.747	-0.042	-0.999	0.319	-11.112	3.627
Chronic disease	1.391	3.13	0.02	0.445	0.657	-4.763	7.546
Accept taking the vaccine in any situation	-28.805	2.093	-0.588	-13.761	0.000001	-32.921	-24.688
a Dependent Variable: Belief score							

Participants more contributed to be poor in belief about COVID-19 vaccine:

Younger age (18-39 years) participants more contributed to be poor in belief about COVID-19 vaccinations AOR: 1.544(CI95%: 0.637-3.744) times statistically insignificant with P value 0.366>0.05. Table 6

Female participants more contributed to be poor in belief about COVID-19 vaccinations: 1.262(CI95%: 0.756-2.109) times statistically insignificant with P value 0.374>0.05. Table 6

Lower educated (Primary and Secondary) participants more contributed to be poor in belief about COVID-19 vaccinations AOR: 1.592(CI95%: 0.717-3.531) times statistically insignificant with P value 0.253>0.05. Table 6

Participants from Rural areas more contributed to be poor in belief about COVID-19 vaccinations AOR: 1.668(CI95%: 0.674-4.127) times statistically insignificant with P value 0.268>0.05 .Table 6

Participants had chronic disease more contributed to be poor in belief about COVID-19 vaccinations AOR: 1.096(CI95%: 0.506-2.273) times statistically insignificant with P value 0.817>0.05. Table 6

Participants didn't have accept taking the vaccine in any situation more contributed to be poor in belief about COVID-19 vaccinations AOR: 9.886 (CI95%: 5.942-16.449) times statistically significant with P value 0.0000001<0.05 . Table 6

Belief ("Good" and "Poor") toward COVID-19 vaccination was predicting through a logistic regression model (Y=-5.077+0.435*Age groups+0.233*Gender+0.465*Educational level+0.512*Area+0.091*Chronic illness+2.291*Accept taking the vaccine in any situation). The model revealed that Accept taking the vaccine in any situation was statistically significant with a p-value of 0.0000001. Age, gender, education level and area of living despite their contribution to the model were not statistically significant with a p-value of respectively 0.336, 0.374, 0.253 and 0.268. The chronic illness was not statistically significant (p=0.817) and contribution to the model was minimum with 0.091. Table 6

Table 6: Represent binary logistic regression for prediction belief toward COVID-19 Vaccination.

Binary logistic regression for prediction belief toward COVID-19 Vaccination								
							95% C.I. for EXP(B)	
Variables in the Equation	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Age groups	0.435	0.452	0.926	1	0.336	1.544	0.637	3.744
Gender	0.233	0.262	0.791	1	0.374	1.262	0.756	2.109
Education level	0.465	0.407	1.306	1	0.253	1.592	0.717	3.531
Area	0.512	0.462	1.226	1	0.268	1.668	0.674	4.127
Chronic disease	0.091	0.394	0.054	1	0.817	1.096	0.506	2.373
Accept taking the vaccine in any situation	2.291	0.26	77.792	1	0.0000001	9.886	5.942	16.449
Constant	-5.077	1.092	21.609	1	0.000003	0.006		

3.3 COVID-19 vaccine acceptance:

COVID-19 vaccine acceptance in any situation was (64.4%) and refused it was(35.2%) as show in Table 7 , but some people were changed their mind or opinion and accepted vaccination after were refused it for the following reasons : (as show in Table 8) , if family or friends got vaccinated (9.2%) , if it was compulsory by the government (MOH) (22.3%) , if physician recommended it (22.3%) , if it was mandatory by job(23.8%) , if there is a way than injection(27.7%) and if more studies showed that the vaccine is safe and effective (59.2%) .

Table 7: Represent total score for acceptance taking the vaccine in any situation:

Accept taking the vaccine in any situation	Number	Percent
Yes	239	64.8%
No	130	35.2%
Total	369	100%

Table 8: Represent Reasons for accept the vaccination after refuse it:

Reasons for accept the vaccination after refuse it	Number	Percent
If my family or friends got vaccinated	12	9.2%
If it was compulsory by the government (MOH)	29	22.3%
If my physician recommended it to me	29	22.3%
If it was mandatory by my job	31	23.8%
If there is a way than injection	36	27.7%
If I know that more studies showed that the vaccine is safe and effective	77	59.2%
n=130		

Table 9 shows there was an association between accept taking the vaccine in any situation with educational level , participants without chronic disease and belief score but there was no association between accept taking the vaccine in any situation with age group , gender and area.

Table 9: Represent the association between variables and accept taking the vaccine in any situation: by using Pearson Chi-Square Test P-vale and Fisher's Exact Test P-value.

Variables		Accept taking the vaccine in any situation		Pearson Chi-Square Test P-vale	Fisher's Exact Test P-vale
		Yes	No		
Age groups	18-29 years	161	83		
		66.00%	34.00%		
	30-39 years	59	28		
		67.80%	32.20%		
	40-59 years	19	17		
		52.80%	47.20%		
	60 years and more	0	2		
		0.00%	100.00%	0.091*	0.095*
Gender	Male	84	49		
		63.20%	36.80%		
	Female	155	81		
		65.70%	34.30%	0.627*	0.354*
Education level	Primary	2	2		
		50.00%	50.00%		
	Secondary	16	20		
		44.40%	55.60%		
	University	166	86		
		65.90%	34.10%		
	Postgraduate	55	22		
		71.40%	28.60%	0.036**	0.031**
Area	Urban	223	118		
		65.40%	34.60%		
	Rural	16	12		
		57.10%	42.90%	0.379*	0.248*
Chronic disease	Yes	24	24		
		50.00%	50.00%		
	No	215	106		
		67.00%	33.00%	0.022**	0.018**
Belief score	Poor	54	96		
		36.00%	64.00%		
	Good	185	34		
		84.50%	15.50%	0.0000001**	0.0000001**

*.P value >0.05 that's considered as statistically insignificant.

**.P value <0.05 that's considered as statistically significant.

Accept taking the vaccine in any situation

Accept taking the vaccine in any situation; No; 130; 35%

Accept taking the vaccine in any situation; Yes; 239; 65%
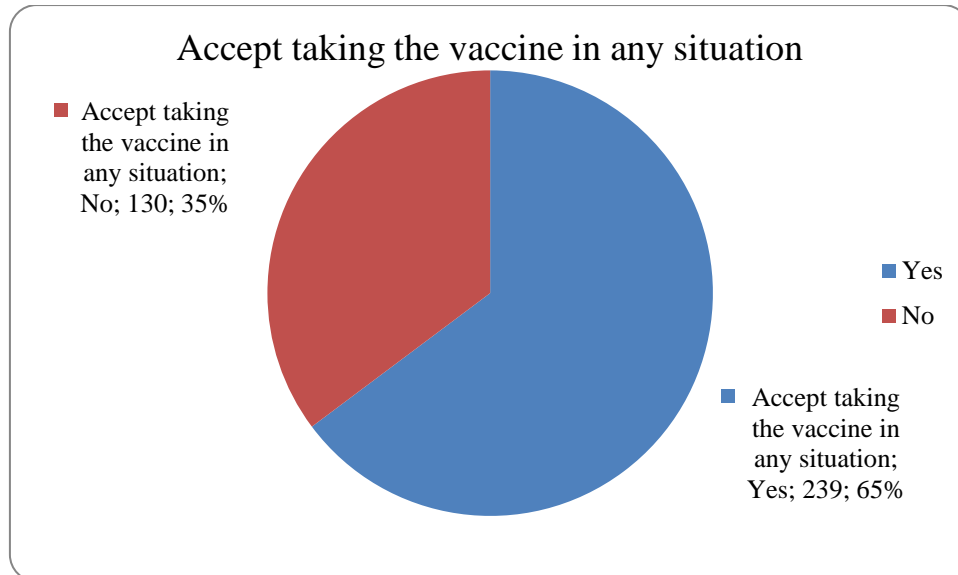
Yes
No

Figure 1: Represent response to accept taking the vaccine in any situation by participants:

Participants more contributed to refuse the vaccination:

Older age (40 years and more) participants more contributed to refuse the vaccination AOR: 1.898(CI95%: 0.698-5.164) times statistically insignificant with P value 0.210>0.05. Table 10

Male participants more contributed to refuse the vaccination AOR: 1.158(CI95%: 0.652-2.057) times statistically insignificant with P value 0.210>0.05 Table 10

Lower educated (Primary and Secondary) participants more contributed to refuse the vaccination AOR: 1.623(CI95%: 0.641-4.106) times statistically insignificant with P value 0.617>0.05 Table 10

Participants from rural areas more contributed to refuse the vaccination AOR: 1.073(CI95%: 0.415-2.774) times statistically insignificant with P value 0.307>0.05 Table 10

Participants had chronic disease more contributed to refuse the vaccination AOR: 1.567(CI95%: 0.676-3.633) times statistically insignificant with P value 0.885>0.05 Table 10

Participants had a lower belief score (%) more contributed to refuse the vaccination AOR: 0.931(CI95%: 0.917-0.946) times statistically significant with P value 0.000001<0.05 Table 10

Vaccination ("Accept" and "Not accept") to COVID-19 vaccine was predicting through a logistic regression model (Y=2.963+0.641*Age groups+0.147*Gender+0.484*Educational level+0.070*Area+0.449*Chronic illness-0.071*Belief score (%)). The model revealed that Belief score (%) was statistically significant with a p-value of 0.000001. Age, gender, education level and chronic illness despite their contribution to the model were not statistically significant with a p-value of respectively 0.210, 0.617, 0.307and 0.295. The area of living was not statistically significant (p=0.885) and contribution to the model was minimum with 0.070. Table 10

Table 10: Represent Participants more contributed to refuse the vaccination:

by using binary logistic regression for prediction accept taking the vaccine in any situation .

Binary logistic regression for prediction accept taking the vaccine in any situation								
							95% C.I. for EXP(B)	
Variables in the Equation	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Age groups	0.641	0.511	1.575	1	0.210	1.898	0.698	5.164
Gender	0.147	0.293	0.25	1	0.617	1.158	0.652	2.057
Education level	0.484	0.474	1.045	1	0.307	1.623	0.641	4.106
Area	0.070	0.485	0.021	1	0.885	1.073	0.415	2.774
Chronic disease	0.449	0.429	1.096	1	0.295	1.567	0.676	3.633
Belief score (%)	-0.071	0.008	84.365	1	0.000001	0.931	0.917	0.946
Constant	2.963	0.81	13.368	1	0.0003	19.356		

3.4 Barriers associated with COVID-19 vaccination:

Table 11 shows the barriers associated with acceptance of COVID-19 vaccination. The majority of vaccine refusers were concerned about side effects (70%). Approximately (56.2%) lack confidence in the effectiveness of vaccination, (46.9%) don't like needle, (29.2%) of the precipitants supported the conspiracy theory surrounding COVID-19 vaccine, whereas the remainder believed that vaccines are unnecessary because they are strongly compliant with personal hygiene practices and social distancing (23.1%) or because they consider themselves healthy and not at risk (18.5%) .

Table 11: Represent Reasons for refuse the vaccination.

Reasons for refuse the vaccination	Number	Percent
I don't need the vaccine because I'm young and healthy	24	18.5%
I don't need the vaccine because I do all the right things. I wash my hands and wear a mask and gloves	30	23.1%
COVID-19 vaccination is a conspiracy	38	29.2%
I don't like needles	61	46.9%
I don't believe that the vaccine will stop the infection	73	56.2%
I am concerned about the vaccine side effects	91	70%
n=130		

4.1 Discussion:

Although several studies are being conducted all around the world, this study observed that vaccine acceptance is 64.8%, which is lesser than the results obtained from similar studies conducted in the USA [11] Thunstrom et al 2020) reported that 80% of the general population accepted to get vaccinated, and another study conducted by [19] (Fu et al, 2021) in China, found that 72.5% of the health care workers accepted to get vaccinated. This study reported that vaccine acceptance among the participants was lower, but it is in alignment with the studies of South Africa (64%), Russia (54%), and France (59%) [20] IPSOS, 2020. Similarly, found that Saudi Arabia, COVID-19 vaccine acceptance was 67% [21].

The findings of the present study showed that COVID-19 vaccine acceptability has a statistically insignificant correlation with socio-demographic characteristics such as age, gender and area , and statistically significant with educational level and these findings are consistent with other studies conducted in the recent times in different countries, the socio-demographic factors were also found as significant factors for pandemic vaccine acceptability in the UK, France, Australia, the US, and Japan [22, 23, 24,25,26]. Also in Saudi Arabia, only age and marital status were found as significant factors in determining the willingness of accepting the COVID-19 vaccines [27].

Also account for our finding that people with chronic conditions more contributed to refuse the vaccination, unlike study was conducted in Hong Kong found that people with chronic conditions were significantly more likely to express vaccine acceptance [28].

The most significant reasons for acceptance of COVID-19 vaccination was beliefs . Previous studies on vaccine belief model was conducted had same results,   including the risk perception of vaccine safety and efficacy, vaccine is the best means of avoiding the complications of COVID-19 and side effects[29,30].

In our study, lack of confidence in the safety and effectiveness of vaccination were the main barriers preventing the acceptance of COVID-19 vaccination among the population. As stated by MacDonald [31], factors influencing hesitancy toward vaccination could be related to confidence, complacency, and/or convenience.

Vaccine acceptance may be affected by vaccine efficacy and side effects. The reported common side effects are generally mild to moderate and last for a few days. These include

injection site pain, fatigue, rigors, and fever, muscle and joints pains. Less commonly, a vaccine recipient may develop allergic reaction or anaphylaxis, and neurological side effects; however they are rarely reported (32). There is a rising concern particularly related to reported thrombo-embolic events, particularly after administration of AstraZeneca vaccine in Europe, but the European Medicines

Agency concluded that the benefits of the vaccine over weigh the potential risk of this rare side effect (33). In this context, Kaplan et al, (34) underlined that vaccine acceptance improved when vaccine efficacy exceeds 70%. Moreover, they addressed that minor side effects, such as a sore arm or fever lasting for a day did not affect vaccine acceptance, while major side effects in 1/100000 greatly affected vaccine acceptance. These side effects may vary according to the type of vaccine used in each country. Emerging evidence suggests that both exposure to misinformation about COVID-19 and public concerns over the safety of vaccines may be contributing to the observed decline in intentions to be vaccinated, and this highlights the need for measures to address public acceptability, trust and concern over the safety and benefit of approved vaccines (35, 36).

Moreover, another barrier to COVID-19 vaccination was participants who believed that there was a conspiracy behind COVID-19 vaccination, which has spread very rapidly around the world via social media platforms [37,38,39] .

Finally, the vaccine for COVID-19 availability is a critical step to face the COVID-19 Pandemic. But vaccine hesitancy represents a great threat to global health during this Pandemic and limits the power of health systems to control the COVID-19 pandemic. Hence, estimating the COVID-19 vaccine hesitancy represents a tool to design an action Plan to improve the vaccine acceptance.

4.2 Limitations of the Study:

We have used the online platform to collect information that may limit the representativeness of the sample, probably due to limited access to online participation.

4.3 Conclusions:

A high prevalence of refusal and hesitancy about COVID-19 vaccination in Sudanese population was observed in the study. This study observed the worries among the participants regarding the safety and efficacy of COVID-19 vaccines.

4.4 Recommendations:

The government must implement appropriate culturally accepted interventional vaccination educational campaigns to remove the beliefs, worries regarding the safety, efficacy, and vaccine side effects of COVID-19 vaccines, which will help to increase vaccine acceptance rates.

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List of abbreviations:

Abbreviations	Explanation
AOR	Adjusted Odds Ratio
CI	Confidence Interval
COVID-19	Corona Virus Disease of 2019
CT	Computerized Tomography
IPSOS, 2020	French pronunciation: [ip.sos]) (from "Institut de Publique Sondage d'Opinion Secteur") is a multinational market research and consulting firm with headquarters in Paris, France and 2020 ,a year in review .
MOH	Ministry of Health
P value	The probability that a particular statistical measure, such as the mean or standard deviation
SAGE	Strategic Advisory Group of Experts
SARSCOV-2	Severe Acute Respiratory Syndrome Coronavirus 2
UK	United Kingdom
USA	United States of America
WHO	World Health Organization
WHO EUL	WHO Emergency Use Listing Procedure

Questionnaire

We are a group of academic researchers conducting a research project on the," Beliefs and barriers towards COVID-19 vaccine acceptance",

This project aims to assess the beliefs the community people have towards the vaccine and the barriers due to which they are hesitant to take the vaccine.

The participants must be 18 years or older.

Your participation in this research project is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. The procedure involves filling a survey that will take approximately 5 minutes. Your responses will be confidential, and we do not collect identifying information such as your name, email address, or IP address. Please click the below options if you agree to participate.

- ○ Agree
- ○ Disagree

Age

- ○ 18-29
- ○ 30-39
- ○ 40-59
- ○ >60

Gender

- ○ Male
- ○ Female
-

Education level

- ○ Primary
- ○ Secondary
- ○ Graduate
- ○ Post-graduate

Location

- ○ Urban
- ○ Rural

Self-rated overall health

- ○ Excellent/very good
- ○ Good
- ○ Fair/poor

Do you have any chronic disease?

- ○ Yes

- ○ No

Beliefs toward safety of COVID-19 vaccination:

Do you think that the COVID-19 vaccine would be safe?

- ○ Yes
- ○ No
- ○ May be

Do you think that the COVID-19 vaccine would be effective?

- ○ Yes
- ○ No
- ○ May be

Do you think that the best way to avoid the complications of COVID-19 is by being vaccinated?

- ○ Yes
- ○ No
- ○ May be

If the COVID-19 vaccine is available, will you or did you take it?

- ○ Yes
- ○ No
- ○ May be

Are you concerned about the side effect of the COVID-19 vaccine?

- ○ Yes
- ○ No

Do you think the vaccine is too costly?

- ○ Yes
- ○ No

Do you believe that the vaccine will not stop the infection?

- ○ Yes
- ○ No

Do you think you do not need the vaccine because you follow all the precautionary measures?

- ○ Yes
- ○ No

Are you afraid of needles?

- ○ Yes
- ○ No

Do you think the COVID-19 vaccine is a conspiracy?

- ○ Yes

- ○ No

Do you think you do not need the vaccine because you are young and healthy?

- ○ Yes

- ○ No

Will you take the vaccine if it provided free of cost?

- ○ Yes

- ○ No

Will you take the vaccine if there is a way other than injection?

- ○ Yes

- ○ No

Will you deny taking the vaccine in any situation?

- ○ Yes

- ○ No

Participants' barriers associated with acceptance of COVID-19 vaccination

Tick the option/s

I am concerned about the vaccine's side effects.   (   )

I don't believe that the vaccine will stop the infection.   (   )

COVID-19 vaccination is a conspiracy.   (   )

I don't need the vaccine because I do all the right things. I wash my hands and wear a mask and gloves.   (%)

I don't need the vaccine because I'm young and healthy.   (   )

I don't like needles.   (   )

Other   (   )

Options to encourage future COVID-19 vaccination

Tick the option/s

If my physician recommended it to me   (%)

If I know that more studies showed that the vaccine is safe and effective (   )

If it was compulsory by the government (MOH).   (   )

If it was mandatory by my job   (   )

If my family or friends got vaccinated   (   )

If there is a way other than injection   (   )

I would not take it in anyway.   (   )

Other   (   )

We thank you for your time spent taking this survey.

Your response has been recorded.