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Assessment of COVID-19 Knowledge, Vaccination Rates and Seroprevalence among Female Sex Workers in Burkina Faso, 2022

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Abstract Introduction: Coronavirus 2019 originated in Wuhan, China. No country in the world has been spared. Several barrier measures had been taken at the national level to limit the spread of the disease. This study aimed to assess knowledge, vaccination rates, and seroprevalence of COVID-19 among Female sex workers (FSWs) in Burkina Faso. Methods: This was a cross-sectional study conducted from June to August 2022 in the five (5) main cities of Burkina Faso (Ouagadougou, Bobo-Dioulasso, Koudougou, Ouahigouya and Tenkodogo). The respondent-based sampling (RDS) method was used to recruit FSWs. Blood samples were taken to test for anti-SARS-CoV-2 antibodies (Ab using Enzyme-linked immunosortbent assay (ELISA) tests. Rapid diagnostic tests (RDTs) were also used to discriminate IgG and IgM antibodies. RDS Analysis software was used for weight calculation, and Stata 14.0 for data analysis. Generalized equation estimation was used to investigate possible factors associated with seroprevalence and knowledge of infection. Results: Of 1055 FSWs included, 49% [95% CI: 45.2 - 52.7%], 62.9% [95% CI: 59.2 - 66.5%], and 78.6% [95% CI: 75.6 - 81.3%] knew that the virus could be transmitted by blood, contact with an infected person and sweat respectively. Among the study population, 19.5% [95% CI: 16.7 - 22.6%] of FSWs were vaccinated. In addition, the seroprevalence of total anti-SARS-CoV-2 antibodies (Ab) was 98.6% [95% IC: 97.2% - 99.3%] among FSWs in Burkina Faso. According to the type of Ab, it was 93.6% [95% CI: 91.6 - 95.2] for Immunoglobulin G (IgG) and 4% [95% CI: 3.5 - 6.6] for Immunoglobulin M (IgM). No risk factors were identified as being associated with exposure to SARS-CoV-2 infection. Conclusions: This study results have shown that almost all FSWs in Burkina Faso carried anti-SARS-CoV-2 antibodies in August 2022, indicating high exposure to the virus during the first two years of the pandemic. However, further work is required to verify that the antibodies are protective (neutralizing antibodies).

Keywords: *Seroprevalence, COVID-19, FSWs, Burkina Faso*

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1. Introduction

Coronavirus 2019 disease (COVID-19) is a viral infection caused by the new coronavirus 2019 responsible for severe acute respiratory syndrome (SARS-CoV-2), the first cases of which were reported in Wuhan, China [1,2,3,4]. Internationally, 767,750,853 confirmed cases and 6,941,095 deaths were recorded as of June 7, 2023 [5]. During the same period, an estimated 13,396,086,098 vaccine doses were administered [6]. Burkina Faso has not been spared this pandemic. In Burkina Faso, as on August 19th, 2022, and according to the government information

service (SIG), 21,128 confirmed cases have been recorded, with 387 deaths [7]. Although this data concerns contact cases only, sick people and travellers who have undergone screening are not taken into account here.

To limit the spread of the virus measures like banning gatherings, social distancing, suspension of travel, closure of schools, markets, drinking establishments, and curfews were adopted [2,8]. All these measures have affected humanity, especially in terms of production and trade.

Sex workers are no exception. The measures mentioned above have had a more significant impact on specific populations, such as people without homes and, above all, FSWs [2,9]. FSWs are women who exchange their bodies for financial or material gain. This practice is exacerbated by women's economic vulnerability due to unemployment, underemployment, and poverty [2,8].

Sex work, by its very nature, would not allow the implementation of social distancing measures in the fight against the spread of coronavirus 2019 [2].

However, while compensatory measures have been adopted for people with socially accepted activities, such as public and private sector employees, FSWs have not benefited from support measures that could enable them to carry on their activities during this critical period [2,8,10]. The lack of support exposes them to poverty and maintaining their activities with customers. All of which could contribute to the spread of the disease. Similarly, there is a relationship between seniority in sex work, knowledge of coronavirus 2019, and adoption of barrier measures [2,8]. It has also been reported that the more sex workers are aware of the disease and its modes of transmission, the more they adopt barrier measures [1].

2. Material and Methods

Type and study period. This was a cross-sectional study conducted from June to August 2022.

Study sites. The study was carried out in Ouagadougou, Bobo-Dioulasso, Koudougou, Ouahigouya, and Tenkodogo. FSWs were recruited in collaboration with the associations Yerelon Plus in Ouagadougou, Yerelon in Bobo-Dioulasso, Acti-Plus in Koudougou, AMMIE (Appui moral, matériel et intellectuel à l'enfant) in Ouahigouya and AJVLS (Association des jeunes volontaires dans la lutte contre le Sida et la sauvegarde de l'environnement) in Tenkodogo, which were based in each of the above-mentioned towns. The choice of locations for recruiting participants met a minimum number of conditions. Each survey site was easily accessible by the study population and had at least four rooms: a waiting room, an eligibility room for the survey process, an interview and counseling room, and a blood sample collection and processing room. The samples testing for the detection of anti-Sarscov2 antibodies were performered at the biomedical research laboratory (LaReBio) within the Institut de recherche en sciences de la santé (IRSS).

Study population. To be included in this study, FSWs should be female by birth, be at least 15 years old, have sex work as their primary source of income during the last 12 months, have a study coupon (except for seeds recruited by the investigators), be able to give consent (e.g. not be drunk or drugged, be mentally normal) and be willing to participate in the study. However, not included in this work were all FSWs who had already participated in the present study and people with a coupon whose date had expired. However, this last criterion remains at the discretion of the site coordinator. FSWs suffering from mental incapacity or infirmity prevents them from understanding the study procedures.

A total of 1,055 FSWs were included, according to the calculation formula previously described by Cornfield in 1951 [11].

Sampling, participant recruitment, and data collection. FSWs were recruited using respondent-driven sampling as previously described [12]. Recruitment was carried out in collaboration with associations or non-governmental organizations offering HIV prevention services to FSWs. A structured questionnaire was used to gather information in the field. Data were processed and analyzed using RDS-Analysis and Stata 14.0 software.

Laboratory methods (sampling, serological tests). A few milliters of blood sample was taken from each FSWs willing to take part in the study. The blood sample was centrifuged and the serum was aliquoted and stored at -20°C. All samples from the 5 sites were transferred in Ouagadougou for the detection of anti-SARS-CoV-2 antibodies by ELISA using the WANTAI kit and rapid diagnostic tests (RDT). ELISA was used for the detection of the whole amount of antibodies (IgG + IgM). RDT was used for screening IgG et IgM.

Data processing and analysis. The analysis approach involved two aspects; one descriptive and the other explanatory. To this end, the sample weight in each of the five cities studied was calculated using the 2019 general population census data for women aged 15-49, which was 4,949,953 out of the total female population of 10,604,308, or 46.70% [13]. Thus, we considered the average prevalence of 2% of FSWs in the cities of Burkina Faso [14]. In addition, considering that each of the cities in the study contained 46.70% women of childbearing age, in line with the national average, Table 3 below shows the number of women of childbearing age in each city. RDS software was used to determine the weight of each participant, and Generalized Equation Estimation (GEE) was used to build the model designed to identify factors associated with the carriage of anti-SARS-CoV-2 antibodies. In fact, the GEE was an adaptation to the framework of the generalized linear model of two extensions of the linear model, either by replacing the assumption on the distribution by an assumption on its mean and variance (but we still estimate the parameters by least squares); or by taking into account a misspecification of the variance. We assumed that individuals in the same cluster were similar. That's why we used a hierarchical structure instead of an autoregressive one, which assumes that coupon recruitment takes place consecutively, i.e. coupon 1 recruits coupon 2 and so on. Poisson regression is used in rare events. But in our context, with this high seroprevalence, modified Poisson regression was used.

The command xtgee result [iweight=wave] if region==1, family(poisson) link(log) corr(exchangeable) eform was used to build the model [15,16]. Finally, we assessed the validity of the model using the estat wcorrelation command [15,16,17,18].

Ethical considerations. This protocol has been approved by the Burkina Faso Health Research Ethics Committee (CERS) and complies with the 1964 Declaration of Helsinki standards. Thus, measures were taken to ensure each participant's respect, dignity and freedom. The objectives of the study were clearly explained to the participants in an information note, and they voluntarily decided to take part in the study after signing the consent form, which the researcher or his representatives had already signed. This informed consent is explained in accessible French or, if necessary, in the participant's local language. Thus, the participant has the right to withdraw from the interview or any other stage of the study without fear or feeling threatened.

3. Results

Table 1 below describes the characteristics of the sample. Then, 51.7% participants are recruited in Ouagadougou city, 80% are vaccinated against COVID-19, 67.3% of FSWs have more than 1 kid, 43.8% had secondary level. Elsewhere, around 69% of FSWs were single, 56.1 are less of 25 years and 66.2% were unemployed.

Table 1. Sample characteristics

Characteristics	Number (N)	Percentage (%)
	Towns	
Ouagadougou	545	51.66
Bobo-Dioulasso	243	23.03
Koudougou	105	9.95
Ouahigouya	100	9.48
Tenkodogo	62	5.88
	Vaccinal status	
Vaccinated	844	80.00
Unvaccinated	208	19.71
No reply	3	0.29
	Number of kids	
Any kids	336	31.85
≥ 1 kids	710	67.30
≥ 6 kids	9	0.85
	Educational level	
Any level	191	18.10
Primary level	285	27.96
Secondary level	462	43.79
Universitary level	27	2.56
Other	80	7.58
	Current marital status	
Singles	723	68.53
Married	23	2.1
Divorced	271	25.69
Widows	38	3.60
	Age groups	
< 25 years	592	56.11
≥ 25 years	463	43.89
	Occupation	
Unemployment	698	66.16
Informal sector	201	19.05
Liberal profession	33	3.13
Students/pupils	15	1.42
Employed (Public or private)	6	0.57
Other	102	9.67

Table 2 shows attitudes or practices and knowledge of COVID-19 in the studied population. Then, 85/1% knew that SARS-CoV-2 can be transmitted by saliva and 78.6% believed that the virus can be contaminated through sweat. Similarly, for 62.9 % of them, SAR-CoV-2 can be transmitted by the infected person.; can transmitted

Table 2. Attitudes or practices and knowledge of COVID-19 among FSWs

Variables	Number (N)	Proportion (%)	95% CI
Attitudes or practices			
COVID-19 testing (Yes)	185	17.0	14.3 – 19.9
Covid-19 vaccination (Yes)	208	19.5	16.7 – 22.6
Use of bleach to decontaminate the bed after each client	384	34.3	30.8 – 38.1
Knowledge			
Transmission of SARS-CoV-2 by saliva (Yes)	866	85.1	82.4 – 87.5
Transmission of SARS-CoV-2 by sweat (Yes)	727	78.6	75.6 – 81.3
Transmission of SARS-CoV-2 by blood (Yes)	470	49.0	45.2 – 52.7
Transmission of SARS-CoV-2 by witchcraft (Yes)	121	12.1	9.8 – 14.7
Contamination by an already infected person (Yes)	626	62.9	59.2 – 66.5
Transmission of SARS-CoV-2 through sexual intercourse (Yes)	351	38.4	34.7 – 42.2
Contamination through sharing a common meal (Yes)	459	55.8	52.2 – 59.4
Manifestations of COVID-19 (Yes)	703	72.4	68.9 – 75. 6
COVID-19 is a fatal disease (Yes)	971	94.5	92.7 – 95.9
Unknowing carrier of SARS-CoV-2 (Yes)	626	62.9	59.2 – 66.5

Table 3 shows the immunization coverage of FSWs and their impressions of the COVID-19 vaccines administered in Burkina Faso. Only 19.5% of FSWs were vaccinated. Of vaccinated FSWs, 31.7% used Johson and Johnson vaccine. However, 80;5% of FSWs were unvaccinated, Then, 58.9% wished to be vaccinated and 53.6% didn't trust on COVID-19 vaccines.

Table 3. Vaccination coverage and impressions of FSWs of SARS-CoV-2 vaccine

Variables	Number (N)	Proportion	95% CI
Vaccinated FSWs	208	19.5	16.7 – 22.6
AstraZeneca	49	19.3	13.8 – 26.2
Johnson and Johnson	55	31.7	24.1 – 40.4
Sinovac	1	0.001	0.0002 – 0.01
Unknown	103	48.9	40.5 – 57.3
Unvaccinated FSWs	844	80.5	77.4 – 83.3
Unvaccinated FSWs wishing to be vaccinated	480	58.9	54.6 – 63.1
Unvaccinated FSWs wishing to be vaccinated	364	41.1	36.9 – 45.4
No trust in Covid-19 vaccines	205	53.6	46.8 – 60.2
Fear of side effects	48	18.0	13.2 – 24
Don't want the vaccine at all	111	28.5	22.9 – 34.8

From Table 4, the total anti-SARS-CoV-2 antibodies overall seroprevalence is 98.6% [95% CI: 97.2% - 99.3%]

without distinction, 93.6% [95% CI: 91.6% - 95.2%] for IgG and 4.9% [95% CI: 3.5% - 6.6%] for IgM.

Table 5 shows COVID-19 seroprevalences according to FSWs' sociodemographic and professional features in 5 BFA towns in 2022. Then, whatever the variable and the modality considered, the seroprevalence is greater than or equal to 93.5%.

Following the results of seroprevalences with sociodemographic and occupational characteristics, Table 6 gives seroprevalences according to behavioral factors and knowledge of the disease. Whatever the variable or modality considered, the seroprevalence is greater than or equal 96.9%.

Table 4. COVID-19 Seroprevalence among FSWs in 5 Burkina Faso cities in 2022

Variables	Number (N)	Seroprevalence (%)	95% CI (%)
IgG/IgM			
Positive	1041	98.6	97.2 – 99.3
Negative	14	1.4	0.7 – 2.8
IgG			
Negative	93	6.4	4.8 – 8.4
Positive	962	93.6	91.6 – 95.2
IgM			
Negative	997	95.1	93.3 – 96.5
Positive	58	4.9	3.5 – 6.6
Total	1055		

Table 5. Seroprevalences of total Ab according to sociodemographic and occupational characteristics among FSWs in 5 Burkina Faso cities in 2022

Variables	Number (N)	Positive cases	Seroprevalence(%)	95% CI
Towns		*P = 0.8045*		
Ouagadougou	545	537	98.5	96.6 – 99.3
Bobo-Dioulasso	243	241	99.1	94.8 – 99.9
Koudougou	105	104	98.8	91.9 – 99.8
Ouahigouya	100	99	97.6	84.6 – 99.7
Tenkodogo	62	60	97.4	88.8 – 99.4
Kids		*P= 0.6628*		
Any	336	332	98.2	94.6 – 99.4
Less than 1 kid	710	700	98.8	97.2 – 99.5
Six kids and more	9	9	100	NA
Years		*P = 0.9558*		
Less than 25 years	592	584	98.6	96.6 – 99.4
25 years and more	463	457	98.5	95.9 – 99.5
Marital status		*P = 0.2056*		
Singles	723	717	98.9	97.3 – 99.6
Marrieds	23	23	100	NA
Divorced	271	266	98.0	93.8 – 99.4
Widows	38	35	93.5	71.6 – 98.8
Education level		*P = 0.5688*		
Any	256	252	99.5	98.6 – 99.8
Primary	295	289	97.6	94.0 – 99.1
Secondary	462	458	98.5	95.5 – 99.5
Others	42	42	100	NA
Profession		*P = 0.9320*		
Unemployed	698	691	98.68	96.8 – 99.5
Liberal profession	33	32	99.4	95.5 – 99.9
Informal sector	201	198	98.0	91.1 – 99.6
Employed/Student	21	15	100	NA
Others	102	99	98.2	94.3 – 99.5
Vaccination		*P = 0.9614*		
Vaccinated	208	205	98.6	94.7 – 99.6
Unvaccinated	844	833	98.5	96.9 – 99.3

P= P-value

Table 6. Seroprevalences of anti-SARS-CoV-2 Ac according to behavioral characteristics and knowledge of COVID-19 among FSWs in 5 towns in Burkina Faso in 2022

Variables	Total	Positives cases	Seroprevalence	95% CI
Behavioral characteristics				
Alcohol consumption *P = 0.9492*				
Yes	641	632	98.5	96.7 – 99.3
No	414	409	98.6	95.5 – 99.6
Use of closed houses *P = 0.9513*				
Yes	382	377	98.5	95.1 – 99.6
No	671	662	98.6	96.9 – 99.4
Use of maquis and nightclubs *P = 0.3129*				
Yes	712	703	98.2	96.2 – 99.2
No	341	336	99.2	96.9 – 99.8
Number of customers /day *P = 0.5593*				
1 - 5 customers	762	750	98.3	96.6 – 99.1
6 - 10 customers	242	240	99.6	97.8 – 99.9
11-15 customers	51	51	100	NA
Disease knowledge				
Use of bleach *P = 0.6392*				
Yes	384	380	98.9	95.7 – 99.7
No	668	658	98.4	96.5 – 99.3
Contamination through saliva *P = 0.7421*				
Yes	866	855	98.6	97 – 99.3
No	110	109	97.7	85.6 – 99.7
Unknown	76	74	99.0	96.0 – 99.8
Contamination through sweat *P = 0.5873*				
Yes	727	717	98.5	96.8 – 99.3
No	184	182	97.8	90.4 – 99.5
Unknown	141	139	99.4	97.3 – 99.8
Contamination through blood *P = 0.4607*				
Yes	470	463	98.3	95.8 – 99.3
No	432	427	98.4	95.4 – 99.5
Unknown	150	148	99.6	98.2 – 99.9
Contamination through sexual intercourses *P = 0.9743*				
Yes	351	348	98.7	95.6 – 99.6
No	523	515	98.5	96.4 – 99.4
Unknown	178	175	98.4	92.6 – 99.7
Contamination by infected person *P = 0.3817*				
Yes	626	620	98.9	97.0 – 99.6
No	426	418	98.0	95.2 – 99.2
Contamination by meal *P = 0.9362*				
Yes	459	452	98.5	96.4 – 99.4
No	479	474	98.6	95.0 – 99.6
Unknown	114	112	98.9	95.4 – 99.7
Witchcraft contamination *P= 0.3708*				
Yes	121	121	100	NA
No	772	763	98.6	96.8 – 99.4
Unknown	159	154	97.5	92.3 – 99.21
Covid-19 maninfestations *P= 0.0077*				
Yes	703	693	98.1	96.2 – 99.1
No	349	345	99.6	98.9 – 99.9
Deadly disease *P = 0.9343*				
Yes	971	969	98.5	97.1 – 99.3
No	81	79	98.6	94.4 – 99.7
Covid-19 testing *P = 0.1313*				
Yes	185	181	96.9	90.3 – 99.0
No	867	857	98.9	97.5 – 99.5

Table 7. Search for factors associated with the prevalence of COVID-19 among FSWs in five cities in Burkina Faso

Variables	IRR	ES	z	P>|z|	95% CI
Customers/day					
1 to 5 customers	1	Reference			
6 to 10 customers	0.999	0.06	0.10	0.92	0.90 - 1.13
11 to 14 customers	1.006	0.24	0.05	0.96	0.63 - 1.62
15 Customers and more	.006	0.12	0.05	0.96	0.80 - 1.28
Saliva					
No	1	Reference			
Yes	0.997	0.09	-0.06	0.95	0.83 - 1.18
Unknown	0.988	0.14	-0.11	0.91	0.74 - 1.31
Blood					
No	1	Reference			
Yes	0.996	0.06	-0.06	0.95	0.88 - 1.13
Unknown	1.008	0.11	0.04	0.97	0.82 - 1.24
Sexual intercourses					
No	1	Reference			
Yes	1.009	0.1	0.13	0.90	0.89 - 1.14
Unknown	1.005	0 .1	0.02	0.99	0.84 - 1.20
Meal					
No	1	Reference			
Yes	0.996	0.06	-0.10	0.92	0.88 - 1.12
Unknown	0.977	0.1	-0.05	0.96	0.81 - 1.22
Infected person					
Yes	1	Reference			
No	0.987	0.05	-0.15	0.88	0.90 - 1.10

Identification of factors associated with the carriage of total anti-SARS-CoV-2 antibodies among FSWs in 2022. In this subchapter, this model was run to investigate possible factors associated with the carriage of total anti-SARS-CoV-2 antibodies.

The final model is obtained with the result (COVID-19) as the dependent variable. Any associated factor was notified. Table 7 gives the full associated factors analyzed.

4. Discussion

This study investigated knowledge, vaccination coverage, and cumulative seroprevalence of COVID-19 among FSWs in Burkina Faso. Most were single women (68.5%) and had at least one child (67.3%). Similarly, over 66% were unemployed. These three elements together give an idea of the level of economic fragility of FSWs. Other authors in Nigeria and Indonesia had already made the same observation, noting that FSWs mainly were single and unemployed [2,19]. In terms of knowledge, in 62.9% of cases, sex workers knew that COVID-19 could be transmitted by an infected person. In Nigeria, Avwioro and colleagues reported that FSWs refused to kiss their clients in 56.2% of cases [2]. The lattermeans they knew they were at risk of contracting the disease through physical contact with their clients. This situation is real and impressionnant when 62.9% of FSWs believed that the disease could be transmitted by saliva and that COVID-19 was fatal. For this reason, the longer sex workers had been in the sex trade, the more barrier measures they adopted to protect themselves. In 99.9% of cases, sex workers had adopted preventive measures such as wearing fascial masks during sexual relations [2,4,20].

However, if FSWs were so fearful of COVID-19, this contrasts with their reluctance to be vaccinated. Vaccination coverage among TS was only 19.5%. As a result, 80.5% of FSWs had not been vaccinated. Among those who had not been vaccinated, 41.1% did not want to be vaccinated. There were several reasons for this obstinacy. Some had no confidence in the vaccines that had been used. Others, on the other hand, were afraid of vaccine-induced side effects. Finally, the last group, without any explanation, didn't want any vaccines at all. Nevertheless, more than half (58.9%) wanted to be vaccinated if the opportunity arose since they knew that COVID-19 is a fatal disease [2,21,22].

COVID-19 is a contagious respiratory disease. In this study, the overall seroprevalence of the infection in FSWs was 98.6% (IgM + IgG), with IgG at 93.6% and IgM at 4.9%. This high overall seroprevalence explains why the disease is so widespread in FSWs and, by extension, in the general population. From 2019 to 2021, studies in Oman, Bangladesh and Brazil showed seroprevalences ranging from 5% to 22% of cases [23,24,25]. These differences in seroprevalence help to explain the cumulative nature of the data. Indeed, the longer the pandemic lasted, the greater the number of cases.

Moreover, recent cases of COVID-19 (IgM-positive cases) were minimal compared with the total number of cases reported in the FSW population. In addition, the seroprevalence of COVID-19 in 5 cities concerned ranged from 96.3% to 100%. We can, therefore, deduce that SARS-CoV-2 was present in all five towns. Indeed, due to long-distance travel, the disease follows the flow of populations in general and those of FSWs in particular in Burkina Faso. Also, the distribution of this seroprevalence did not vary according to the sociodemographic and behavioral characteristics of the FSWs. This showed that all their strata had been in contact with SARS-CoV-2, with seroprevalences in line with the cumulative seroprevalence, ranging from 97.4% to 100%. For this

reason, vaccination campaigns against coronavirus disease need to be stepped up, emphasizing raising awareness and compliance with barrier measures in the general population, particularly in the FSWs environment. What is the seroprevalence according to behavioral characteristics and knowledge of the disease?

Several factors could expose FSWs to exposure to the SARS-CoV-2 virus. These include behavioral characteristics and knowledge of the disease. However, the seroprevalences observed reflect the overall seroprevalence observed in this population. Consequently, it is unclear whether these behavioral characteristics affect the carriage of anti-SARS-CoV-2 antibodies in FSWs.

However, are any factors associated with the carriage of total anti-SARS-CoV-2 antibodies?

GEE is the model adapted to the RDS study to investigate factors associated with the carriage of total anti-SARS-CoV-2 antibodies. At the end of the model construction, no variable is associated with the carriage of total anti-SARS-CoV-2 antibodies among FSWs in Burkina Faso (P>0.05). This situation can be explained by the high seroprevalence of anti-SARS-CoV-2 antibodies, especially as contamination by virus-laden saliva droplets, the blood of infected subjects, and direct contact with an infected person had already been demonstrated by other authors [2] [26,27,28,29]. As a result, we find ourselves in a situation where a comparison between positive and negative cases is impossible, because the result of the population studied is like a single arm with more positive and rare negative cases.

Conclusions

This work has provided insight into knowledge, vaccination coverage, and seroprevalence of COVID-19 disease among FSWs in the five [5] main cities of Burkina Faso. This was made possible thanks to the involvement of associations such as Yerelon Plus in Ouagadougou, Yerelon in Bobo-Dioulasso, AMMIE in Ouahigouya, Acti-Plus in Koudougou and AJVLS in Tenkodogo, all of which already had extensive experience in providing health care to FSWs. The respondent-based sampling method was used to avoid any form of stigmatization of the population studied.

The study results showed that FSWs had a reasonably good knowledge of COVID-19. However, there was very little enthusiasm for vaccination, even though vast majority recognizing COVID-19 is a fatal disease that can be transmitted from person to person. This is why awareness-raising remains the key to combating the spread of this disease, which has almost reached all the FSWs strata concerned by this study.

The extent of COVID-19 disease reached almost 100%. This made it impossible to determine the factors associated with the expansion of the disease. Further studies are needed to identify the neutralizing antibodies that play a protective role.

This work had its limitations. These were the choice of carrying out the study in the five cities and choosing seeds through the associations. All of which could distort the randomized nature of the study.

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Conflict of Interest

The authors declare that there are no conflicts of interest associated with this manuscript.

References

[1] Tibubos AN, Otten D, Ernst M, Beutel ME. A Systematic Review on Sex- and Gender-Sensitive Research in Public Mental Health During the First Wave of the COVID-19 Crisis. *Front Psychiatry*. 17 sept 2021; 12: 712492.

[2] Avwioro G, Egwunyenga A, Adjekuko C, Mgbere O, Odibo E, Iyiola S, et al. Commercial Sex Work During Novel Coronavirus (SARS-CoV-2) Era in the Niger Delta Region: Relationships Between Knowledge, Preventive Practice, and Transmission Potential. I*nt J Womens Health*. 1 juin 2021; 13: 509‑23.

[3] Nolon AK, Ryvicker M, Glassberg H, Dubois A, Oluwasanmi O, Steier J. COVID-19 Sero- Prevalence and Risk Factors in a Sample of Community Health Center Employees in New York State. *J Occup Environ Med*. 1 janv 2022; 64(1): 86‑9.

[4] Benoit C, Unsworth R. COVID-19, Stigma, and the Ongoing Marginalization of Sex Workers and their Support Organizations. *Arch Sex Behav*. 22 nov 2021; 1‑12.

[5] Weekly epidemiological update on COVID-19 - 8 June 2023 [Internet]. [cité 12 juin 2023].

[6] WHO Coronavirus (COVID-19) Dashboard [Internet]. [cité 12 juin 2023].

[7] Cas de covid 19 Burkina Faso Août 2022 - Recherche Google [Internet]. [cité 22 août 2022].

[8] Mantell JE, Franks J, Lahuerta M, Omollo D, Zerbe A, Hawken M, et al. Life in the Balance: Young Female Sex Workers in Kenya Weigh the Risks of COVID-19 and HIV. *AIDS Behav. 2 janv 2021; 1‑8.*

[9] Alsaïdi I, De Sousa Santos F, Plard B, Janvier E, Tinland A, Hafni A, et al. Factors associated with SARS-CoV2 infection and care pathways among the most vulnerable populations living in Marseille: a case control study. *BMC Public Health*. 19 sept 2021; 21: 1704.

[10] Tan RKJ, Ho V, Sherqueshaa S, Dee W, Lim JM, Lo JJM, et al. The Impact of the Coronavirus Disease (COVID-19) on the Health and Social Needs of Sex Workers in Singapore. *Arch Sex Behav*. 2021;50(5):2017‑29.

[11] Cornfield J. The Determination of Sample Size. *Am J Public Health Nations Health*. juin 1951;41(6):654‑61.

[12] Lena Hipp EA. How to Implement Respondent-Driven Sampling in Practice: Insights from Surveying 24-Hour Migrant Home Care Workers. 2019.

[13] Rapport resultats definitifs RGPH 2019.pdf [Internet]. [cité 26 juill 2022].

[14] Vandepitte J, Lyerla R, Dallabetta G, Crabbé F, Alary M, Buvé A. Estimates of the number of female sex workers in different regions of the world. *Sexually Transmitted Infections*. 1 juin 2006;82(suppl 3):iii18‑25.

[15] Vrieze SI. Model selection and psychological theory: a discussion of the differences between the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). *Psychol Methods*. juin 2012;17(2):228‑43.

[16] Nguyen TH, Nguyen CX, Luu MQ, Nguyen AT, Bui DH, Pham DK, et al. Mathematical models to describe the growth curves of Vietnamese Ri chicken. Braz J Biol. 2021; 83: e249756.

[17] Shen CW, Chen YH. Model Selection for Generalized Estimating Equations Accommodating Dropout Missingness. *Biometrics*. 2012; 68(4): 1046‑54.

[18] Sen S, Cohen AS, Kim SH. Model Selection for Multilevel Mixture Rasch Models. *Appl Psychol Meas.* juin 2019; 43(4): 272‑89.

[19] Wirawan GBS, Wardhani BDK, Pradnyani PE, Nurhalina A, Sulaiman N, Sukmaningrum E, et al. Behavioral Changes, Adaptation, and Supports among Indonesian Female Sex Workers Facing Dual Risk of COVID-19 and HIV in a Pandemic. *Int J Environ Res Public Health*. 26 janv 2022; 19(3): 1361.

[20] COVID-19 : Facteurs de risque d'exposition des contacts à considérer lors des enquêtes épidémiologiques: 17.

[21] Liu NN, Tan JC, Li J, Li S, Cai Y, Wang H. COVID-19 Pandemic: Experiences in China and Implications for its Prevention and Treatment Worldwide. *Curr Cancer Drug Targets*. 2020; 20(6): 410‑6.

[22] Andrade SA de, de Souza DA, Torres AL, de Lima CFG, Ebram MC, Celano RMG, et al. Pathophysiology of COVID-19: Critical Role of Hemostasis. *Frontiers in Cellular and Infection Microbiology*.

[23] Santos CC, de M Lima FW, Magno L, Soares F, Ferraz D, Grangeiro A, et al. Seroprevalence of anti-SARS-CoV-2 antibodies and factors associated with infection among adolescent men who have sex with men and transgender women in Salvador, Brazil. *BMC Public Health*. 9 janv 2023; 23(1): 61.

[24] Khanam R, Islam S, Rahman S, Ahmed S, Islam A, Hasan T, et al. Sero-prevalence and risk factors for Severe Acute Respiratory Syndrome Coronavirus 2 infection in women and children in a rural district of Bangladesh: A cohort study. *J Glob Health*. 12:05030.

[25] Al-Abri SS, Al-Wahaibi A, Al-Kindi H, Kurup PJ, Al-Maqbali A, Al-Mayahi Z, et al. SARS-COV-2 antibody seroprevalence in the general population of Oman: results from four successive nationwide seroepidemiological surveys. *Int J Infect Dis* [Internet]. 30 sept 2021.

[26] SARS-CoV2 AND seroprevalence AND Female Sex Workers - *PMC - NCBI* [Internet]. [cité 10 août 2022].

[27] Etyang AO, Lucinde R, Karanja H, Kalu C, Mugo D, Nyagwange J, et al. Seroprevalence of Antibodies to Severe Acute Respiratory Syndrome Coronavirus 2 Among Healthcare Workers in Kenya. *Clin Infect Dis*. 29 janv 2022;74(2):288‑93.

[28] Aksoyalp ZŞ, Nemutlu-Samur D. Sex-related susceptibility in coronavirus disease 2019 (COVID-19): Proposed mechanisms. *Eur J Pharmacol*. 2 oct 2021;174548.

[29] Callander D, Thilani Singham Goodwin A, Duncan DT, Grov C, El-Sadr W, Grant M, et al. "What will we do if we get infected?" a qualitative interview-based study of the COVID-19 pandemic and its effects on the health and safety of sex workers in the United States. *SSM Qual Res Health*. 8 déc 2021; 100027.