The first line. Study on population of caregivers in contact with epidemic patients in the Sahel, the case of SARS-CoV-2

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Abstract

The health systems of countries in the South and the North have been directly affected by the COVID-19 pandemic. Healthcare workers have paid a high price. The aim of this study was to better describe the personnel who are on the front line when patients visit health care facilities and to analyze their risk factors for exposure, their perception of infection and the prevention practices implemented by these health care workers.

Methods A cross-sectional study was conducted over a 6-month period from October 2021 to March 2022 (i.e., at a distance from the index cases) among health care workers in 62 integrated health centers and five public urban hospitals in Niamey and Dosso. Information on socio-demographic characteristics, clinical symptoms, co-morbidities, knowledge and attitudes, and vaccination status was collected by means of a questionnaire. Blood samples were taken for serological analysis for each agent included.

Results: A total of 733 agents were included, mostly women (628, 85.67%) with a mean age of 40.5 years. Only 5.5% (40/733) of the workers reported having been in contact with a positive case of Covid-19. The most common method of protection was the use of alcohol and soap for hand hygiene. 76% of them reported having been vaccinated against the SARS-CoV2 virus. However, only 7.7% reported having used a Covid-19 diagnostic test in the last few months. IgM and IgG COVID-19 serologies were positive in 1.2% and 92.2% of the health care workers, respectively, during the survey period.

Conclusion: In Niger, frontline health workers have been widely exposed to SARS CoV-2, but most of them don't think so. As a result, in their daily practice, they make poor use of means to prevent and control COVID-19 infection and rarely use diagnostic tests in case of illness. Vaccination was widely accepted by these staff, according to their statements.

Introduction

The COVID-19 pandemic has had an impact on the world of work, particularly in health care settings. Healthcare workers (HCPs) have experienced profound changes in their working conditions. However, they often had few resources and information at their disposal, especially at the beginning of the pandemic (1).

In the South, structures such as health centers were at the forefront of receiving patients. Given the banality of the clinical signs of the disease, patients with COVID-19 did not stand out from other consultations. The protective attitude had to be extended to all patients received. The Ministry of Health organized a rapid response and mobilized a significant amount of resources to fight the pandemic. However, the provision of protective equipment to peripheral health structures was a lengthy process, and health care workers were ill-equipped for a number of weeks or even months. Respirators were purchased to treat severe cases. Biological diagnostics were organized for the whole country.

In countries like Niger, doctors were able to follow the evolution of knowledge through specialized media on the Internet, but ultimately it was nurses, caregivers and maintenance staff who were on the front lines of the epidemic, with little information available to them most of the time. How did they react? What

resources did they really have at their disposal and how did they make use of them? (2)? These questions are crucial to anticipate other, potentially more deadly epidemics. And to learn from this difficult period.

Niger, like other countries in the world, has been confronted with the SARS-CoV-2 disease (COVID-19) pandemic (officially since 19 March 2020), and all the regions of the country have been affected by the pandemic (3). However, it seems to have been relatively spared by the epidemic in terms of mortality. In December 2002, a total of 9,506 cases were recorded, including 315 deaths. This represents 0.039% of the total population. However, several seroprevalence studies conducted in the subregion showed that this number of infected people was greatly underestimated compared with the number of reported cases (3, 4, 5). Frontline workers were then largely exposed to positive individuals early in the epidemic. They paid a heavy price, with 184 deaths out of a total of 1059 confirmed cases in the first few months of the epidemic and 17.4% of the total number of reported deaths (3). According to the number of cases reported, Niamey, the country's capital, was the epicentre of the pandemic. It accounted for more than 70% of the confirmed cases (7).

The aim of this study was to describe the characteristics of health workers directly or indirectly involved in managing patients with COVID-19 in primary care structures, as well as their access to personal protective equipment, including vaccination. A serological study was carried out to correlate these profiles with SARS-CoV-2 positivity. This was done regardless of the origin of the positivity, infection or vaccination.

PATIENTS, MATERIALS and METHODS

Framework and study period

The study was carried out in integrated health centers in Niamey and Dosso and in regional hospitals. It took the form of a cross-sectional survey. The surveys took place from 20 December to 22 February 2022 in Niamey and from 31 December 2021 to 10 January 2022 in Dosso. Healthcare workers of all ages, sexes and professional profiles in contact with patients and fluids who agreed to answer the questionnaire were the target population of this study.

Sampling strategy

The minimum sample size was calculated globally to ensure an accuracy of +/- 5% of the results obtained. A non-response and invalid questionnaire rate of 10% was maintained. A total of 384 people were expected to answer the questionnaire correctly, so 422 people had to be interviewed, the number of people enrolled was increased to 733, which was retained to allow for subgroup analyses. In Niamey and Dosso, a sample of 633 and 100 respectively was included. The number of agents working in the health facility was used to calculate the number of agents to be registered by structure. Within each health facility, the selection of agents was random.

Data and samples collected

Sociodemographic characteristics (sex, age, occupation, etc.), adherence to protective measures, use of the COVID-19 diagnostic test for oneself, signs suggestive of COVID-19 in the last six months, co-morbidities and vaccination status were collected by means of a questionnaire.

From all participants, a 2 ml blood sample was collected in a dry tube. The samples were sent to the laboratory in the best conditions in accordance with the recommendations of the laboratory.

Serological techniques

Both rapid diagnostic tests (TDRs) and ELISA were used to detect anti-SARS CoV-2 IgM and IgG antibodies. At the dispensaries, samples were first analyzed using STANDARD™ Q Covid-19 IgM/IgG Combo Test cassettes (REF/Q-NCOV-01C). All samples were then laboratory ELISA tested using Invitrogen Human SARS-COV-2 Spike Ig Total ELISA Kit (BMS2323TEN) according to the manufacturer's recommendations.
Anti-SARS-CoV-2 antibody positivity was interpreted according to the vaccination status of the individual. In vaccinated individuals, the presence of antibodies was considered indicative of vaccination. In unvaccinated individuals, antibodies were considered indicative of SARS-CoV-2 infection.

Analyzes of epidemiological data

Data were collected by questionnaire, stored in an anonymized database and analysis using R software version3.6.1.
The seroprevalence of COVID-19 among health workers in the target health facilities was described in terms of socio-demographic characteristics, clinical signs compatible with COVID-19 (last 6 months), history of diagnosis of COVID-19 (documented). Secondly, the knowledge, perceptions, attitudes and practices of health professionals regarding COVID-19 and how to prevent it were assessed.

The descriptive analyses and the analyses of attitudes and practices with regard to COVID-19 were focused on all respondents and the results are presented as percentages. Analyses of risk factors for SARS-CoV-2 infection focused only on unvaccinated individuals, using the presence or absence of IgM and/or IgG antibodies as the dependent variable. The risk factors associated with positive serology were determined using logistic regression. The logistic regression was first unadjusted and then adjusted. Univariate analysis was performed to select variables to be included in the model using the chi2 test with a $p<0.2$ cut-off for selection. Interactions between variables were assessed. Confounding variables and associations were expressed as odd ratios (ORs). 95% confidence intervals (CI) were used. A p-value < 0.05 was considered significant.

Ethical considerations

This research was conducted in accordance with the norms and standards of the Helsinki declaration of October 2013. The personal data recorded and analyzed complies with the recommendations of the National Agency for the Protection of Personal Caracter Data of Niger, under Law 2019-71 of December 24, 2019 amending Law 2017-28 of May 03, 2017. Its implementing decree is N°2020-309 of April 20, 2020.

The protocol was approved by the National Ethics Committee for Health Research (CNERS) of Niger (deliberation order No. 067/2021/CNERS of 28.10.2021). Informed written consent was obtained from all health professionals involved in the study. An identification number was assigned to all agents enrolled at the study site. Only anonymize personal data were stored to ensure data confidentiality.

Information and Consent

Information note

Health care staff in the departments included in this study were informed about the study's procedures. They were provided with clear and appropriate information regarding the objectives of the study, the nature, the procedures (questionnaire, sampling), the risks, the benefits of the study, the management of data confidentiality and their right to refuse to participate in the study. This information was provided by the field study implementation team through an information note prior to the administration of the questionnaire and the blood sample.

Informed consent

Informed consent was obtained from all healthcare professionals willing to participate in the study before any procedures were performed as part of the study by a trained member of the study team. Each participant has been informed that participation in the study is voluntary and that they are free to withdraw from the study without justification at any time, without consequences and without affecting their professional responsibilities. He also requested permission to take the samples necessary for the study, to use the epidemiological data for the purposes of the study, to transfer the samples concerning him outside the country for further analysis and to retain samples for future research purposes.

Risks and benefits

This survey imposed minimal risk on the participants, involving the collection of a small amount of blood. As an advantage, it has made it possible to adapt the vaccination protocol according to Covid history and serological status.

Confidentiality

All precautions were implemented to preserve the confidentiality of the data collected from the health workers entering the study. All subjects who participated in the study were assigned an identification number by the team for the labeling of questionnaires and clinical samples. The link between this identification number and the individuals was maintained by the investigation team and was not disclosed elsewhere. When sharing data with organizations or any agency or institution, they have considered only the study identification number and not identifiable information.

Availability of data and materials

Our data does not involve DNA sequence, RNA sequence, genome assembly, protein sequence or genetic variation data. Rather, epidemiological data (socio-demographic characteristics, risk factors, history of illness and vaccination) and laboratory data (SARS-CoV-2 serology) were collected during the implementation of this research. They are entered into a database and form part of the information held by the Ministry of Public Health. These data are available upon reasonable request. If anyone would like to have access to the data from this study, they should contact Dr. Hamidou Lazoumar Ramatoulaye. His e-mail is: lramatoulaye@yahoo.fr, Phone: +227 96134073.

RESULTS

Study population

A total of 733 caregivers were included in this study **(Tables 1 and 2).**

Table 1: Socio-demographic characteristics, knowledge and sars-cov 2 serology

Characteristics	total (%)	nbr + (%)	P value	Characteristics	total (%)	nbr + (%)	P value
Region			0.043	**Vaccinated**			0.258
Dosso	100 (13.6%)	100		No	178 (24.3%)	162 (91.0%)	
Niamey	633 (86.4%)	608 (96.1%)		Yes	555 (75.7%)	519 (93.5%)	
District				**Vaccine**			
I	122 (16.6%)			AstraZeneca	116 (21%)	110 (94.8%)	
II	172 (23.5%)			Johnson and Johnson	127 (22.8%)	1 (100.0%)	
III	101 (13.8%)			Sinopharm	312 (56.2%)	115 (91.3%)	
IV	170 (23.19%)			N-Miss	178	162	
V	68 (9.3%)			**Dose**			0.394
Dosso	100 (13.64%)			1st dose	140 (25.4%)	129 (92.1%)	
Gender			0.410	2nd dose	412 (74.6%)	388 (94.2%)	
Female	628 (85.7%)	608 (96.8%)		N-Miss	181	164	
Male	105 (14.3%)	100 (95.2%)		**Reason for not vaccinated**			0.562
Marital status			0.473	Needs more informations	49 (27.4%)	45 (91.8%)	
Currently married	573 (78.2%)	552 (96.3%)		Fear of vaccine side effects	98 (54.7%)	87 (88.8%)	
Not currently married	160 (21.8%)	156 (97.5%)		Not convinced by efficacy	9 (5.0%)	9 (100.0%)	
Age trance			0.902	Vaccine not offered	14 (7.8%)	14 (100.0%)	
18-39 years	343 (46.8%)	331 (96.5%)		Others	9 (5.0%)	8 (88.9%)	
40 and over	390 (53.2%)	377 (96.7%)		N-Miss	554	518	

Function			0.798	**Wearing a mask in the ward**			
Nurses	323 (44.1%)	311 (96.3%)		Not always	433 (59.1%)	404 (93.3%)	0.615
Laboratory staff	34 (4.6%)	32 (94.1%)		Always	300 (40.9%)	277 (92.3%)	
Midwife	111 (15.1%)	108 (97.3%)		**Wearing a mask outside the ward**			0.620
Others	265 (36.2%)	257 (97.0%)		Not always	596 (81.4%)	596 (81.4)	
Pregnancy			0.774	Always	136 (18.6%)	135 (18.4)	
No	335 (91.3%)	321 (95.8%)		**Wearing a mask at time of collect**			0.878
Yes	32 (8.7%)	31 (96.9%)		No	374 (51.0%)	348 (51.10.0%)	
N-miss	366			Yes	359 (49.0%)	333 (48.90%)	
Medical ATCDs			0.238	**Wearing a mask / colleagues**			
No	476 (64.9%)	457 (96.0%)		Yes almost all	175 (23.9%)	159 (90.9%)	0.226
Yes	257 (35.1%)	251 (97.7%)		No all	558 (76.1%)	522 (93.5%)	
Clinical signs				**Patient wearing a mask**			
arthrosis	2			Yes almost all	139 (19.0%)	126 (90.6%)	0.249
headache	2			No all	594 (81.0%)	555 (93.4%)	
abdominal pain	4			**Has already taken Covid-test**			
fever	1			No	676 (92.2%)	629 (93.0%)	0.607
goiter	1			Yes	57 (7.8%)	52 (91.2%)	
hemorroïds	1			**Respect for hygiene rules**			0.908
infection	7			Not always	245 (33.4%)	228 (93.1%)	

gastric ulcer	52			Always	488 (66.6%)	453 (92.8%)	
Signs of Covid_19			0.726	**Alcohol use for hands**			
No	596 (81.3%)	575 (96.5%)		No always	305 (41.6%)	283 (92.8%)	0.916
Yes	137 (18.7%)	133 (97.1%)		Always	428 (58.4%)	398 (93.0%)	
Contact with Covid-19+			0.918	**Soap use for hands**			
No	693 (94.5%)	644 (92.9%)		Not always	280 (38.2%)	261 (93.2%)	0.798
Yes	40 (5.5%)	37 (92.5%)		Always	453 (61.8%)	420 (92.7%)	
Trained on Covid-19				**Consult a doctor when sick**			0.414
No	260 (35.5%)			No	67 (100.0%)	59 (88.1%)	
Yes	473 (64.5%)			Yes	143 (100.0%)	131 (91.6%)	
				N-Miss	523	491	

Table 2 : Socio-demographic and clinical characteristics of participants in Dosso and Niamey

	Dosso			Niamey			Total
Gender	**F**	**H**	**tot**	**F**	**H**	**tot**	
Total	**90**	**11**	**101**	**540**	**94**	**634**	**735**
Class of age							
20-29	23		23	111	29	140	163
29-49	55	6	61	324	39	363	424
>50	12	5	17	103	24	127	144
N-miss				2	2	4	4
Vaccinated							
20-29	52%		52%	59%	62%	59%	58%
29-49	65%	83%	67%	81%	85%	82%	79%
>50	33%	100%	53%	88%	88%	88%	84%
total	58%	91%	61%	78%	78%	78%	76%
Type of job (Nbr)							
administrative staff				12	2	14	14
ward aide				3	1	4	4
welfare assistance	1		1	11	3	14	15
nurse	60	6	66	223	36	259	325
lab technician	9		9	22	3	25	34
medical doctor	4	1	5	4	2	6	11
maid	8	2	10	102	13	115	125
Nutritionist				13	4	17	17
cashier	1	1	2	6	2	8	10
midwife	4		4	106	1	107	111
other	3	1	4	30	25	55	59
trainee				8	2	10	10
Comorbidities (%)							
Diabetes	1,11%	9,09%	1,98%	10,93%	0%	9,31%	8,30%
Cancer	0%	0%	0%	0,74%	0%	0,63%	0,54%
heart problem	3,33%	0%	2,97%	0,37%	0%	0,32%	0,68%

hypertension	16,67%	0%	14,85%	14,63%	0%	12,46%	12,79%
asthma	17,78%	0%	15,84%	3,89%	1,06%	3,47%	5,17%
pulmonary problem	7,78%	0%	6,93%	0,37%	0%	0,32%	1,22%
hepatic problem	1,11%	9,09%	1,98%	0,19%	0%	0,16%	0,41%
hematology problem	7,78%	0%	6,93%	1,30%	0%	1,10%	1,90%
pregnacy	8,89%	0%	7,92%	4,26%	0%	3,63%	4,35%
HIV	1,11%	0%	0,99%	0,00%	0%	0,00%	0,14%
Marital status							
single	10		10	56	31	87	97
divorced	1		1	17	1	18	19
married	64	10	74	439	61	500	574
widow	15	1	16	28	1	29	45
vaccinated							
single	60,0%		60,0%	57,1%	67,7%	60,9%	60,8%
divorced	100,0%		100,0%	88,2%	100,0%	88,9%	89,5%
married	62,5%	90,0%	66,2%	80,2%	82,0%	80,4%	78,6%
widow	33,3%	100,0%	37,5%	78,6%	100,0%	79,3%	64,4%
total	57,8%	90,9%	61,4%	78,0%	77,7%	77,9%	75,6%

Most of them came from health structures in Niamey (86.4%), the rest from Dosso, 139 km from the capital. In Niamey, health workers from communes II and IV (25.5% and 9.3% respectively) were the most represented of the five communes.

Females were most represented in this study (85.7%). More than half of the staff were over 40 years old (53.2%). Nurses represented 44.1% of the total staff surveyed, followed by other paramedical staff (36.2%), midwives (15.1%) and laboratory staff (4.6%). Most of the women were nurses (44.9%), cleaners (17%) and midwives (17%). The men were nurses (40%), cleaners (14%) or had other functions. No clear difference emerged according to the age group of those employed, depending on where they worked.

A significant proportion had pre-existing comorbidities (257, 35%). These could potentially expose them to a severe form of Covid-19. The most common of these comorbidities were high blood pressure (12.79%), diabetes (8.30%) and asthma (5.17%). At the time of enrolment, 10% of the 317 women under the age of 40 were pregnant. Interestingly, 50% of laboratory technicians and administrative staff reported at least one comorbidity. This was followed by paramedics (40%).

Signs consistent with COVID-19 occurred in 18.7% of the health workers. At enrolment, 14.8% and 20.9% of people in Dosso and Niamey, respectively, had signs potentially associated with COVID. There was no

significant difference according to age. These signs were more common in women than in men (15.5 % vs. 9 %, 21.3 % vs. 5.3 % in Dosso and Niamey, respectively). They were also more frequent in patients with no co-morbidities **(Table 3)** and in those who reported being in personal contact with COVID+ patients. However, despite this evidence, only 57 caregivers (7.77%) performed a COVID-19 diagnostic test at least once since the beginning of the epidemic.

Table 3 : Factors associated with the presence of signs of Covid-19 at enrolment

	Dosso				Niamey				Total	
signs of covid	**no**	**yes**	**total**	**% pos**	**no**	**yes**	**total**	**% pos**	**Nbr**	**% pos**
Age										
20-29	20	3	23	13%	119	21	140	15%	163	15%
29-49	51	10	61	16%	288	75	363	21%	424	20%
>50	15	2	17	12%	101	26	127	20%	144	19%
ATCD+										
no	36	11	47	23%	162	48	210	23%	257	23%
yes	50	4	54	7%	350	74	424	17%	478	16%
Gender										
Female	76	14	90	16%	423	117	540	22%	630	21%
Male	10	1	11	9%	89	5	94	5%	105	6%
vaccine										
no	34	5	39	13%	115	25	140	18%	179	17%
yes	52	10	62	16%	397	97	494	20%	556	19%
Total	86	15	101	15%	512	122	634	19%	735	19%

This low use of diagnostic testing was not correlated with employment, age, sex of the participant or use of other protective measures. On the contrary, it may be related to a very low perception of risk related to COVID, as only 5.5% of the participants thought they had been in contact with infected patients. Logistic regression analysis to determine the variables influencing the use of the Covid-19 test showed that age group of persons over 50 (P=0.01), married (p=0.03), widowed (p=0.04), occupation as a laboratory technician (p=0.03), and preventive measures such as wearing a mask (p=0.02) and contact with a Covid-19 patient (6.5*10e-5) are factors significantly influencing the use of the Covid-19 test **(Table 4).**

Table 4 : Variables influencing the use of the Covid-19 test

	Test Covid-19			
Variables	n(%)	OR	IC	p
Male	105(14,32)	0,6	[0,21-1,69]	0,33
Class of age				
29-49 ans	426(58,12)	4,9	[1,51-16,44]	0,008
>50	172(23,47)	5,8	[1,5-22,61]	0,01
Marital status				
Divorced	19(2,59)	0,2	[0,01-1,59]	0,11
Married	573(78,17)	0,4	[0,13-0,94]	0,03
widower	45(6,14)	0,2	[0,02-0,98]	0,04
Profession				
Nurse	323(44,07)	1,5	[0,75-3,11]	0,23
Laborantin	34(4,64)	3,4	[1,01-10,55]	0,03
Midwife	111(15,14)	1,1	[0,41-2,72]	0,91
Antécédents				
Asthma	33(4,50)	1,8	[0,60-5,28]	0,29
Autres antécédents	8(1,09)	6,4	[1,27-32,29]	0,02
Diabetes	37(5,05)	1,5	[0,48-4,85]	0,47
HTA	63(8,59)	1,5	[0,57-3,70]	0,42
Wearing a mask	359(48,98)	2,1	[1,12-4,05]	0,02
Patient does not wear a mash every day	594(81,04)	1,6	[0,71-3,54]	0,25
Contact with a Covid-19 patient	40(5,46)	5,2	[2,32-11,72]	6,5*10e-5
Respect for hand hygiene always	488(66,58)	1	[0,53-1,92]	0,96

Which protections?

Equipment for the prevention and control of COVID-19 infection was used very inconsistently by healthcare workers. (Table II). Only 66.6% (488/733) of the participants stated that they always complied with the hygiene measures against COVID-19 **(Table 1 and 5)**.

Table 5 : Use of safety procedures

	Dosso				Niamey				Total	%
	F	H	total	%	F	H	Total	%		
Total	90	11	101		540	94	634		735	
other staff wearing mask in ward										
almost none	28	2	30	**0,297**	11		11	**0,0174**	41	**6%**
sometime	48	8	56	**0,5545**	391	71	462	**0,7287**	518	**70%**
yes almost ever	14	1	15	**0,1485**	138	23	161	**0,2539**	176	**24%**
patient wearing a mask in ward										
almost none	45	3	48	**48%**	12	1	13	**2%**	61	8%
sometime	45	7	52	**51%**	412	70	482	**76%**	534	73%
yes almost ever		1	1	**1%**	116	23	139	**22%**	140	19%
wearing a mask in ward										
No	9		9	**9%**	6	4	10	**2%**	19	**3%**
rarely	15		15	**15%**	8		8	**1%**	23	**3%**
sometime	19	4	23	**23%**	111	27	138	**22%**	161	**22%**
frequently	25	5	30	**30%**	178	22	200	**32%**	230	**31%**
ever	22	2	24	**24%**	237	41	278	**44%**	302	**41%**
wearing mask outside ward										
No	45	2	47	**47%**	64	10	74	**12%**	121	**16%**
rarely	14	3	17	**17%**	24	4	28	**4%**	45	**6%**
sometime	15	2	17	**17%**	229	35	264	**42%**	281	**38%**
frequently	11	2	13	**13%**	115	22	137	**22%**	150	**20%**
ever	5	2	7	**7%**	107	23	130	**21%**	137	**19%**
respects of hygien rules										
no answer	2		2	**2%**	1	1	2	**0%**	4	**1%**
no	4		4	**4%**	2	1	3	**0%**	7	**1%**
sometime	11	2	13	**13%**	18	7	25	**4%**	38	**5%**

most of time	13	4	17	**17%**	144	36	180	**28%**	197	**27%**
ever	60	5	65	**64%**	375	49	424	**67%**	489	**67%**
hand washing										
No	19	1	20	**20%**	8	2	10	**2%**	30	**4%**
sometime	46	6	52	**51%**	44	12	56	**9%**	108	**15%**
yes ever	25	4	29	**29%**	487	79	566	**89%**	595	**81%**
hand washing with alcool										
no answer	4	1	5	**5%**	15	7	22	**3%**	27	**4%**
no	2	1	3	**3%**	2	1	3	**0%**	6	**1%**
sometime	5	1	6	**6%**	36	11	47	**7%**	53	**7%**
most of time	16	3	19	**19%**	171	30	201	**32%**	220	**30%**
ever	63	5	68	**67%**	316	45	361	**57%**	429	**58%**
hand washing with soap										
no answer	1	1	2	**2%**	7	3	10	**2%**	12	**2%**
no				**0%**	4		4	**1%**	4	**1%**
sometime	4		4	**4%**	22	7	29	**5%**	33	**4%**
most of time	14	5	19	**19%**	175	37	212	**33%**	231	**31%**
ever	71	5	76	**75%**	332	47	379	**60%**	455	**62%**

The use of alcohol and soap for hand cleaning was reported by 58% and 61% of participants, respectively. During the present study, 59% of them stated that they didn't wear a mask in the ward and only 49% of them really wore a mask during the registration process of the study. At the same time, 81% said that patients didn't wear masks during consultations and 76% said that their own colleagues didn't wear masks. No significant differences in awareness and use of protection were found between men and women or by age.

Most participants reported having been vaccinated against COVID (75.7%, 555). Of these, 74.6% (412/555) had received two doses. Sinopharm vaccines were the most commonly used, followed by Johnson & Johnson vaccines. Among those who had not been vaccinated, 49% (87/178) of the participants said that they had not done so because they were afraid of the side effects of the vaccine and 25.2% (45/178) needed more time to decide (Table 1). A proportion of women were less vaccinated than men, i.e. those living in rural areas (57%) or living alone (widow or single) (Table 2). The youngest participants were also the least vaccinated (on average 58%) and the oldest were the most vaccinated (on average 84%) (Table 2). Analysis of factors associated with Covid-19 vaccination among health workers showed that age over

50 years (p=0.001), married status (p=0.002), laboratory technician (p=0.003) and midwife (p=0.002) were statistically associated with vaccination.

Serological prevalence and risk factors

In this study, 708 or 96.58% of health workers were positive for COVID-19 serology (96.1% in Niamey and 100% in Dosso). No statistical difference in age, sex, employment, presence of clinical signs of Covid-19 or marital status was observed because of this high rate. Most nurses (90.4%), midwives (87.4%) and laboratory workers (76.5%) had had SARS-CoV-2 infection. There was no significant difference between having clinical symptoms and having anti-SARS-CoV-2.

In fact, 48.90% of those who wore a mask at the time of sampling, 92.3% of those who always wore a mask at the health center and 94.8% of those who always complied with hygiene measures had positive SARS-CoV-2 serologies (Table 5). This situation reflects the idea that contamination may have occurred outside the facility, in a community setting, and most importantly, that the study took place after the virus had spread in the community.

Risk factor analysis was performed only on 178 (24.28%) unvaccinated individuals. Among them, the rates of positive serology for IgM and IgG were 1.12% and 91.01%, respectively.

Factors associated with positive serology in unvaccinated health workers were: age group (OR 3.84 CI95% [1.16 50.40]), history of tuberculosis (OR 3.45 CI95% [0.85, 24.3]) and marital status with higher risk for unmarried (7.56, CI95% [1.40, 141]). After adjustment for age, district and employment, safety equipment, employment, type of health structures, etc. were not found to be a risk factor in either Niamey or Dosso **(Table 6).**

Table 6: Factors associated with positive serology among unvaccinated health personnel in health facilities in Niamey and Dosso.

Characteristics	N	Unajusted	Ajusted for age and district.	Ajusted for age, district, function.
		OR (95%-CI)	OR (95%-CI)	OR (95%-CI)
District	178			
Dosso				
Niamey		0.00	-	-
Age	178			
18-39 years		—		
40 et +		1.16 (0.40, 3.84)		
Gender	178			
Female		—		
Male		0.58 (0.17, 2.67)	0.74 (0.21, 3.44)	0.60 (0.15, 3.00)
Marital statuts	178			
married		—		
Not married		**7.50 (1.46, 137)**	**7.74 (1.46, 143)**	**7.56 (1.40, 141)**
Function	178			
Nurses		—		
Laboratory satff		0.51 (0.10, 3.79)	0.35 (0.06, 2.86)	
Midwide		0.66 (0.18, 2.75)	0.88 (0.23, 3.70)	
Others		1.05 (0.28, 4.29)	1.08 (0.27, 4.85)	
Medical ATCDs	178			
No		—		
Yes		3.70 (0.99, 24.1)	2.91 (0.75, 19.2)	3.45 (0.85, 24.3)
Contact with a person with Covid-19	178			
No		—		
Yes		0.68 (0.11, 13.1)	0.76 (0.12, 15.0)	0.71 (0.11, 14.0)

Wearing a mask in the ward	178			
Not Always		—		
Always		0.95 (0.34, 2.93)	1.29 (0.45, 3.99)	1.22 (0.42, 3.82)
Wearing a mask outside the ward	177			
Not Always		—		
Always		1.60 (0.42, 10.6)	1.97 (0.51, 13.1)	1.82 (0.46, 12.2)
Wearing a mask during enrolment	178			
No		—		
Yes		0.74 (0.25, 2.08)	0.83 (0.28, 2.36)	0.76 (0.24, 2.27)
Wearing a mask by other agents	178			
Not Almost		—		
Yes Almost all		0.92 (0.30, 3.44)	1.28 (0.41, 4.83)	1.21 (0.38, 4.62)
Respect the hygiene rules	178			
Not Always		—		
Always		1.17 (0.38, 3.31)	1.22 (0.39, 3.52)	1.31 (0.41, 3.95)
Use of alcohol for hands	178			
Not Always		—		
Always		0.94 (0.31, 2.67)	0.86 (0.28, 2.46)	0.94 (0.29, 2.91)
Use of soap for hands	178			
Not always		—		
Always		0.84 (0.25, 2.42)	0.77 (0.23, 2.27)	0.82 (0.24, 2.52)

DISCUSSION

This cross-sectional observational study was carried out during the second wave of the COVID-19 pandemic in Niger. Caregivers were selected in the capital and in rural areas. The structures studied were

mainly first-line dispensaries. They provide primary health care with rudimentary equipment, curative consultations, vaccinations, antenatal consultations and maternity care (8).

Who is in first line ?

The study population was representative of staff in this type of primary health care facility. The majority were women (85.7%). More than half were over 40 years old (53.2%). Nurses accounted for 44% of total staff. Among them, 96% in Niamey and 100.0% in Dosso had anti-SARS-CoV-2 antibodies, which is in agreement with other studies in Niger, such as in Maradi with 85.4% anti-SARS-CoV-2 seroprevalence among staff (18). However, this is much higher than in other published studies, i.e. 19.7% in Kenya (16), 33% in RDC (17), 15.7% by TDR and 43.5% by ELISA in 2021 in Lubumbashi, Democratic Republic of Congo. A large proportion of these positive serologies could be attributed to vaccinated individuals. 75% of them reported having been vaccinated. No correlation with age, sex or function was found for this high level of positivity.

What practices according to the type of staff and their motivation?

Overall, less than half of the staff regularly use the means to prevent and control COVID-19 infection in their workplaces. This is despite the fact that the Ministry of Health has provided this equipment. No use was made of simple strategies such as hand washing with soap or alcohol. Training to reduce the risk of transmission to health workers or patients was also provided to dispensary staff and patients (19). This poor use of protection could be due to ignorance, carelessness or lack of time due to workload, as has been reported in Morocco (20) and Niger (10). However, an important factor could be the belief of most caregivers that they have never been in contact with COVID patients, which is also correlated with a very low use of diagnostic tests available in pharmacies and therefore a misperception of risk. Indeed, a very low perception of risk among caregivers seems to be an important factor in the low compliance with prevention advice, such as mask use, hand washing or vaccination. At the same time, this perception could explain the low use of diagnostic tests for patients and, therefore, the low number of cases reported by the Ministry of Health.

To limit the transmission of SARS-CoV-2 virus within health care facilities and the community, measures must be taken to raise awareness and strengthen the protection of health care workers.

Why this low utilization of diagnosis test?

The study period included the cold season in Niger. This is associated with many respiratory diseases. However, although 91.2% of unvaccinated individuals tested positive after this period, only 7.8% of health workers reported using a COVID diagnostic test during this period. Only one case of COVID was documented with a test among the 733 people enrolled. Irrespective of their co-morbidities, these data show that the use of COVID-19 diagnostic tools by healthcare workers is very low. Interestingly, most of the caregivers reported not having been exposed to COVID-19. This low uptake could be due to stigma, denial and neglect. According to Yolande and others in Brazzaville, it could also be due to fear of the results, which is the main reason for refusal of voluntary screening. There is therefore an urgent need to raise awareness among health care workers and to draw their attention to their individual risk factors (21).

Sources of knowledge also seem to be a pitfall for these workers, especially in remote areas, as they were in need of more information about COVID. New educational strategies should be developed for them, especially through the use of smartphones, which are widely available in Africa, even in remote areas.

Relations to vaccination

Since March 2002, the Ministry of Health has conducted several vaccination campaigns against the SARS-CoV-2 virus, targeting health workers, military personnel and the elderly (23). However, some mistrust of the efficacy, safety and security of these vaccines has arisen among the population, including health workers, as a result of the implementation of vaccination. This may be one of the factors that has had a negative impact on vaccination compliance in the general population.

In this study, more than 75% of the study population reported that they had been vaccinated and had received two doses. However, in another study, only 42% of health workers were found to be vaccinated (10). These results, based on self-declaration, could therefore be questioned. The Sinopharm vaccine was the first to be introduced in the country. It was followed by the Johnson & Johnson vaccine, thanks to the Chinese embassy.
Overall, fear of side effects, uncertainty, lack of reliable information, fear of the vaccine and lack of confidence are the main reasons for refusing to vaccinate against COVID-19 (10,27,28). Vaccination rates were much lower in rural areas, especially among women, which may be related to false reports claiming that vaccinated women's fertility decreased. This has been observed in many countries where the medical profession has been poor at supporting vaccination campaigns. In fact, by the end of 2021, only 27 per cent of health workers in Africa will have been fully vaccinated against COVID-19. This means that the majority of health workers in Africa are still unvaccinated and remain dangerously exposed to severe forms of COVID-19 (24). According to the WHO, this is one of the main reasons for the severe shortage of health workers in Africa, which has a negative impact on access to health services. To date, many countries have less than one health worker per 1000 people, and the disease will drastically reduce this number (25). In Niger, for example, 184 health workers will have died from COVID-19 by December 2022. Awareness-raising campaigns and training are urgently needed to encourage health workers to change their behavior to improve acceptance of control measures such as vaccination.

CONCLUSION

The majority of frontline health workers in peripheral health structures have been exposed to the SARS CoV-2 virus. It is not clear whether this was in a professional or private setting. A large proportion of these workers have been vaccinated, but this is a matter of some concern, and the effectiveness of the vaccine may be questionable. On the other hand, tools for the prevention and control of COVID-19 infection are not used on a regular basis by health care workers. It should also be noted that there is very little recourse to diagnosis by healthcare workers themselves, reflecting a mistrust of the "screen and treat" strategy, which needs to be better understood, researched and documented. Better risk analysis and adaptation of messages to these workers regarding control measures are needed to reduce the impact of the COVID-19 epidemic among these workers and the population attending health facilities. These results raise the

question of what could be a key factor in a future epidemic, namely the awareness of health care workers about the risks they face.

LIMITS

The main limitation of this study is the declarative aspect of the survey. Social or professional pressure may have led people to change their answers to make things look better, or not to report not having vaccinated. It was also not always possible to confirm the vaccination status through the records. These biases may vary according to the type of structure (public/private), its size (from hospital to health center), the function of the person (qualified/unqualified) or their status (individual contractor/contracted).

Declarations

Conflicts of interest:

No conflict of interest has been declared by the authors.

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Author contributions :

RJ, HLR, FL, RAM, SB participated in the conception and design of the study,

MAM, HLR, RJ, FL participated in the data analysis,

ZA FAA, AKAZ, II, BAS, GIO, AS, AM, DSB, CD, AD collected the field data,

KDI, FCSC, MSAN participated in the serological analyzes of samples in the laboratory,

HLR, RJ, MAM, KDI, FL contributed to the writing of the text,

HLR, RJ, FL, KDI, MAM, SHS, critically revised the manuscript.

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