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## RESEARCH ARTICLE

### Risk Factors Associated with COVID-19 Infections among Healthcare Workers in Eswatini: A Cross-Sectional Study

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#### Abstract:

##### Background:

The coronavirus disease 2019 (COVID-19) pandemic has spread with alarming speed, infecting millions globally, including Eswatini. Despite the institutionalization of measures by the Ministry of Health (MoH) to fight the pandemic, the cumulative number of people infected with COVID-19 has kept increasing daily. We sought to assess risk factors for COVID-19 infections among Health care workers (HCWs) in selected health facilities of the Lubombo region of Eswatini.

##### Methods:

A cross-sectional design and systematic stratified sampling were used to select the participants.

##### Results:

The study enrolled 333 HCWs, with the majority (201, 60.4%) being females, and the participants' mean age was 33 years. The study showed that not having an isolation arrangement in a health facility for people suspected to have COVID-19 presents risk to HCWs for COVID-19 (Crude Odds Ratio (COR) = 2.5, 95%CI: 1.0–6.2,  $p = 0.50$ ; Adjusted Odds Ratio (AOR) = 3.0, 95% confidence interval (CI) 1.0–8.7,  $p = 0.038$ ). Likewise, HCWs who rarely followed infection prevention and control (IPC) measures were at higher risk of COVID-19 infection than those who followed such measures (COR = 4.2, 95%CI: 1.1–17.2,  $p = 0.041$ ; AOR = 6.5, 95%CI: 1.4–30.0,  $p = 0.016$ ), and HCWs exposed to a colleague diagnosed with COVID-19 were at higher risk of being infected themselves (AOR = 11.4; 95%CI: 0.9–135.7;  $p = 0.054$ ).

##### Conclusion:

An active COVID-19 symptoms screening, triage and isolation arrangement for suspected COVID-19 clients for all clients entering the facility increases protection of HCWs from COVID-19. Reinforcement of all infection prevention and control measures to prevent exposures from infected patients and colleagues is essential.

**Keywords:** Health care worker, Risk factors, COVID-19, Eswatini, Prevention, Patients, Pandemic.

#### Article History

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## 1. INTRODUCTION

Since the first reported case of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Wuhan, China, the spread of COVID-19 has been alarming, infecting millions globally.

Health Care workers (HCWs), as frontline essential workers, are particularly at increased risk of nosocomial infec-

tions, of which there are a number of associated factors [1 - 6]. These factors include the effective implementation of infection prevention and control (IPC) measures, the availability and use of personal protective equipment (PPE), HCWs close interactions with infected persons, sociodemographic factors, vulnerability of individual HCWs (pre-existing medical conditions, such as diabetes mellitus and cardiovascular diseases, respiratory conditions) places them at risk of being infected with the virus [2 - 4].

It is reported that the infection rate of HCWs varies between 3 and 17% in accordance with history and degree of

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exposure and presence of symptoms [5 - 9]. The loss of lives of several thousands of HCWs all over the world to this disease due to ever evolving guidance on COVID-19 transmission causes a lag between the evidence, knowledge and implementation and this is not only a public health crisis, but also a tragedy to the world and a barrier to infection control and fighting against the disease [10].

Clinical management of patients while implementing adequate IPC measures during the COVID-19 pandemic is still challenging in low- and middle-income countries (LMICs), and it is an ongoing agenda for HCWs in healthcare settings. COVID-19 infection among HCWs may not only be a function of health facilities but also from community and pre-symptomatic contacts. They can also acquire COVID-19 from patients, colleagues, family members, friends, and social events [10, 11]. This study is aimed to assess risk factors of COVID-19 in the local context, which includes barriers and missed opportunities in; Practices (handwashing/sanitizing), Inadequate Training and Knowledge on infection prevention and control (IPC), improper use of PPE, availability and consistency in the use of PPE, history of a diagnosed patient, colleague and family member of HCWs, pre-existing medical conditions, as well as sociodemographic factors to understand the risk factors for COVID-19 infection in a regional health system.

## 2. MATERIALS AND METHODS

### 2.1. Study Design and Approach

The design was a cross sectional study of health care workers in selected health facilities in the Lubombo region. Two groups of HCWs were selected for assessment; 1) HCWs working in health facilities that had registered a COVID-19 HCW case and 2) HCWs who tested positive for COVID-19 by real-time reverse transcription polymerase chain reaction (r-RT PCR) on a nasopharyngeal swab as of 19<sup>th</sup> July to 30<sup>th</sup> August 2020. Participants who consented to enroll were interviewed on risk factors for COVID-19 infection.

### 2.2. Study Population and Setting

This study was carried out among HCWs in the Lubombo region of Eswatini at seven [7] health facilities that had registered COVID-19 cases among HCWs (medical doctors, nurses, and allied workers). The target sample was proportionally allocated based on the number of HCWs in each of these facilities.

### 2.3. Sampling Procedure and Sample Size Calculation

Both systematic stratified sampling and convenience sampling were employed to select participants. The sample size was calculated using Power Analysis and Sample Size (PASS) 2008 software [11] based on the following assumptions; a response distribution of 50%, which gives the largest sample size, at 95% confidence interval, allowing a 5% margin of error and a statistical power of 80%. A contingency of 10% was added to the calculated minimum sample size to account for potential non-response.

### 2.4. Data Collection

HCWs completed an offline survey that was carried out through (Research Electronic Data Capture) REDcap<sup>®</sup>, version 8.10, Vanderbilt University, Nashville, Tennessee, USA was used for data collection [12], which is a browser-based, metadata-driven Electronic Data Capture (EDC) software and workflow methodology for designing clinical and translational research databases and projects, developed by Vanderbilt University [13]. The electronic study data were password protected in an encrypted database, hosted and managed at University Research Co., LLC (URC).

### 2.5. Data Analysis

Data were analyzed using STATA 15 (Stata Corp 2017) statistical software package created in 1985 (Release 15; College Station, TX, USA: StataCorp developed by William Gould) [14, 15]. The continuous variables were described as means (standard deviations) and medians (interquartile ranges), while the categorical variables were presented as counts (frequencies or percentages). Binary logistic regression was used to determine associations between the two groups, with the outcome variable being diagnosed with a COVID-19 laboratory-confirmed result and the independent variables being sex, age, cadre, department (isolation or non-isolation ward), pre-existing medical conditions and history of exposure to COVID-19-infected patients, colleagues, and family members. An odds ratio at a 95%CI was also computed to show the strength of the association between the outcome and independent variables, and a *p*-value <0.05 was considered to indicate statistically significant associations between the independent and dependent variables.

## 3. RESULTS

A total of 333 (HCWs) were enrolled as study participants (132 males (39.6%) and 201 females (60.4%)). Their mean age was  $36.4 \pm 9.9$  years. Age was initially divided into 6 age bands and more than two-thirds of the HCWs (66.4%) fell below the 40-year age bracket. More than 80% of HCWs worked in a facility where there was an isolation ward/designated space, 267 (80.2%) and 71 (21.3%) worked in isolation ward/designated spaces within their facilities.

### 3.1. Sociodemographic Factors Associated COVID-19-Positive

Out of the 333 participants, 22 (6.6%) COVID-19-positive confirmed (13 females (6.5%) versus nine males (6.8%)). Thirteen HCWs (50.1%) aged  $\geq 40$  years were COVID-19-positive, similar to those aged 40 years and below. While only 25 (7.5) HCWs reported a history of smoking, 3 (12.2%) of those were COVID-19-positive and had a history of smoking. While none of the doctors had ever been tested positive for COVID-19, 11 (9.9%) of the nurses and 11 (5.2%) of the allied workers tested positive for COVID-19. Four (4) (5.2%) of the HCWs who worked in facilities with an isolation ward/designated space had been contracted COVID-19-compared with 6 (8.3%) of those working in an isolation ward/designated space.

**Table 1. Sociodemographic factors and COVID-19 test results.**

Risk Factor	n (%)	Negative	Positive	Odds of being COVID-19 Positive			p-value
		n (%)	n (%)	COR (95%CI)	p-value	AOR (95%CI)	
<b>Total participants</b>	<b>333 (100.0)</b>	<b>311 (93.4)</b>	<b>22 (6.6)</b>				
<b>Sex</b>							
Male	132 (39.6)	123 (93.2)	9 (6.8)	1.1 (0.4–2.6)	0.13	1.1 (0.4–2.9)	0.780
Female	201 (60.4)	188 (93.5)	13 (6.5)	REF	REF	REF	REF
<b>Age</b>							
<40 years	221 (66.4)	212 (96.2)	9 (4.1)	REF	REF	REF	REF
≥40 years	112 (33.6)	99 (88.4)	13 (11.6)	3.1 (1.3–7.5)	0.012 *	3.6 (1.4–9.0)	0.006 *
<b>History of Smoking</b>							
Yes	25 (7.5)	22 (88.0)	3 (12.0)	2.1 (0.5–7.6)	0.269	1.3 (0.1–16.0)	0.861
No	308 (92.5)	289 (93.8)	19 (6.2)	REF	REF	REF	REF
<b>Cadre</b>							
Medical Doctor	10 (3.0)	10 (100.0)	0 (0.0)	0.0 (0.0)	0.992	0.00 (0.00)	0.999
Nurse	111 (33.3)	100 (90.1)	11 (9.9)	2.0 (0.8–4.8)	0.116	2.2 (0.9–5.6)	0.084
Allied worker	212 (63.7)	201 (94.8)	11 (5.2)	REF	REF	REF	REF
<b>HCWs working in a facility with an isolation ward/designated space</b>							
Yes	267 (80.2)	253 (94.8)	14 (5.2)	REF	REF	REF	REF
No	66 (19.8)	58 (87.9)	8 (12.1)	2.5 (1.0–6.2)	0.050	3.0 (1.0–8.7)	0.038 *
<b>Working in an isolation ward/designated space</b>							
Yes	71 (21.3)	66 (91.7)	6 (8.3)	1.4 (0.5–3.7)	0.507	2.0 (0.6–6.2)	0.236
No	262 (78.7)	245 (93.9)	16 (6.1)	REF	REF	REF	REF

\* Statistical significant association where p<0.05; AOR, adjusted odds ratio; COR, crude odds ratio; COVID-19, coronavirus disease 2019.

HCWs who were ≥40 years had 3.6 folds higher chances (AOR 95%CI: 1.4-9.0) of being infected with COVID-19 than those that are <40 years. In addition, HCWs working in facilities without an isolation ward/designated space were 3.1 times more likely (AOR 95%CI: 1.0-8.7) of being infected with COVID-19 than those working in facilities with an isolation ward/designated space, in terms of the AOR. Even though they were not statistically significant at 0.05 level (0.05<p<0.1) subject to the small sample size, nurses appeared 2.2 more likely (AOR 95%CI: 0.9–5.6) of being infected with COVID-19 compared to allied workers (Table 1).

**3.2. Infection Prevention Practices Associated with being COVID-19 Positive**

The findings show that there was a larger proportion of HCWs in the age group <40 years (211, 95.5%) having good IPC practices compared to those in the age group 40+ years (100, 89.3%). Additionally, HCWs 40+ years were more likely of having poor IPC practices towards COVID-19 [AOR 0.3; 95%CI: 0.2-0.9] p=0.037\*. Likewise, nurses were more likely to have poor IPC practices towards COVID-19 [AOR: 4.6; 95%CI: 1.0-20.2] p=0.045\* compared to allied workers, and both showed a statistically significant association (Table 2).

**Table 2. Prevention practices associated with being COVID-19 positive.**

Characteristics	Total	X±SD (95%CI)	IPC Practices score	IPC	Poor IPC Practices	Good IPC Practices	Odds of having poor IPC Practices			p-value
							n (%)	n (%)	n (%)	
<b>Total participants</b>	<b>333 (100.0)</b>									
<b>Sex</b>										
Male	132 (39.6)	20.5±4.7 (13.0-25.0)		12 (9.1)	120 (90.9)	0.5 (0.2-1.2)	0.145	0.5 (0.2- 1.3)	0.179	
Female	201 (60.4)	21.0±4.2 (13.0-25.0)		10 (5.0)	191 (95.0)	REF	REF	REF	REF	
<b>Age</b>										
<40 years	221(66.4)	21.0±4.1 (6.0-25.0)		10 (4.5)	211 (95.5)	REF	REF	REF	REF	
≥40 years	112 (33.6)	20.4±5.0 (7.0-25.0)		12 (10.7)	100 (89.3)	0.3 (0.2-0.9)	0.037*	0.3 (0.2-0.9)	0.037*	
<b>Smoker</b>										
Yes	25 (7.5)	20.1±5.2 (6.0-25.0)		3 (12.0)	22 (88.0)	0.5 (0.1- 1.8)	0.269		0.294	
No	308 (92.5)	20.9±4.4 (7.0-25.0)		19 (6.2)	289 (93.8)	REF	REF	REF	REF	
<b>Cadre</b>										
Medical Doctor	10 (3.0)	23.6±1.2 (22.0-25.0)		0 (0.0)	10 (100.0)	(0.0)	0.994	(0.0)	0.994	
Nurse	111 (33.3)	21.7±3.4 (9.0-25.0)		2 (1.8)	109 (98.2)	5.7 (1.3- 24.7)	0.021*	4.6 (1.0-20.2)	0.045*	

(Table 2) contd.....

Characteristics	Total	X±SD (95%CI) Practices score	IPC	Poor IPC Practices	Good IPC Practices	Odds of having poor IPC Practices			p-value
						n (%)	n (%)	n (%)	
Allied worker	212 (63.7)	20.2±4.8 (6.0-25.0)		20 (9.4)	192 (90.6)	REF	REF	REF	REF
<b>Working in an isolation ward/ designated space</b>									
Yes	72 (21.6)	22.6±2.9 (9.0-25.0)		1 (1.4)	71 (22.8)	6.2 (0.8-47.0)	0.077	5.6 (0.7- 44.1)	0.102
No	261 (78.4)	20.3±4.6 (6.0-25.0)		21 (8.1)	240 (91.9)	REF		REF	

\* Statistical significant association where p<0.05; AOR, adjusted odds ratio; COR, crude odds ratio; COVID-19, coronavirus disease 2019.

**Table 3. Participants with pre-existing conditions.**

Age	Total	Obesity			Cancer			Diabetes			HIV			Heart disease			Asthma (requiring medication)					
<i>n (%)</i>																						
	<b>333 (100.0)</b>	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U			
<40	221(66.4)	46 (20.8)	163 (73.8)	12 (5.4)	3 (1.4)	212 (96.0)	6 (2.7)	12 (5.4)	207 (93.7)	2 (0.9)	51 (23.1)	167 (75.6)	3 (1.4)	9 (4.1)	207 (93.7)	5 (2.3)	18 (8.1)	203 (91.9)	0 (0.0)			
≥40	112 (33.6)	30 (26.8)	75 (67.0)	7 (6.3)	8 (7.1)	103 (92.0)	1 (0.9)	17 (15.2)	94 (83.9)	1 (0.9)	28 (25.0)	82 (73.2)	2 (1.8)	15 (13.4)	97 (86.6)	0 (0.0)	12 (10.7)	99 (88.4)	1 (0.9)			
Age	Total	Chronic disease asthma			lung (non-disease)			Chronic liver disorder			Chronic hematological disorder			Chronic neurological impairment/disease			Organ or bone marrow recipient			Other pre-existing condition(s)		
<i>n (%)</i>																						
	<b>333 (100.0)</b>	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U	Y	N	U			
<40	221(66.4)	2 (0.9)	219 (99.1)	0 (0.0)	1 (0.5)	220 (99.6)	0 (0.0)	3 (1.4)	218 (98.6)	0 (0.0)	2 (0.9)	219 (99.1)	0 (0.0)	0 (0.0)	221 (100.0)	0 (0.0)	13 (5.9)	203 (91.9)	5 (2.3)			
≥40	112 (33.6)	2 (1.8)	109 (97.3)	1 (0.89)	2 (1.8)	110 (98.2)	0 (0.0)	1 (0.9)	110 (98.2)	1 (0.9)	3 (2.7)	108 (96.4)	1 (0.9)	1 (0.9)	111 (99.1)	0 (0.0)	24 (21.4)	88 (78.6)	0 (0.0)			

Y, Yes; N, no; U, Unknown.

**3.3. Pre-existing Conditions**

Selected underlying pre-existing medical conditions were assessed to ascertain if the HCWs with those conditions were at increased risk of being infected with COVID-19. Comparing the HCWs in the two age bands revealed that a greater proportion of the HCWs in the 40+ year age band had cancer (8, 7.1%), obesity (30, 26.8%), diabetes (17, 15.2%), heart disease (15, 13.4%), and asthma (requiring medication) (12, 10.7%), were organ or bone marrow recipients (1, 0.9%), or had other pre-existing conditions (24, 21.4%) compared to 3 (1.4%), 46 (20.8%), 12 (5.4%), 9 (4.1%), 18 (8.1%), 0 (0.0%), and 13 (5.9%) HCWs in the <40-year age band, respectively (Table 3).

**3.4. History of Exposure Associated with Being COVID-19 Positive**

The findings on the history of exposure being associated

with COVID-19-positive showed that HCWs (1, 5.6%) who tested positive for COVID-19 but did not know if there was a suspected COVID-19 patient in their department were more likely to be infected with COVID-19 (AOR = 2.4; 95%CI: 0.6–9.1) compared to those who were confident that there was no infected patient in their department. In addition, the HCWs who did not know whether they had a diagnosed colleague in their department were likely 11.4 more folds at risk of being infected with COVID-19 (AOR 95%CI: 0.9–135.7; *p* = 0.054) compared to those who were confident that they had none (border line significant). The HCWs (2, 0.6%) who did not know whether they had a suspected infected family member before screening for COVID-19 were more likely of being infected with COVID-19 (AOR = 4.2, 95%CI: 0.4–38.1), even though there was no statistically significant association (*p*> 0.05) (Table 4).

**Table 4. History of exposures associated with being COVID-19.**

Risk factor	n (%)	Negative	Positive	Odds of being COVID-19 Positive			p-value
		n(%)	n(%)	COR (95% CI)	p-value	AOR (95% CI)	
<b>Total participants</b>	<b>333 (100.0)</b>	<b>311 (93.4)</b>	<b>22 (6.6)</b>				
<b>Was there a suspected patient in the department before screening for COVID-19?</b>							
Yes	144 (43.2)	131 (91.0)	13 (9.0)	1.3 ((0.9-1.9)		0.205	1.6 (0.9-2.8)
No	171 (51.4)	163 (95.3)	8 (4.7)	REF		REF	REF
Unknown	18 (5.4)	17 (94.4)	1 (5.6)	0.8 (0.4-2.0)		0.724	2.4 (0.6- 9.1)
<b>Was there a diagnosed patient in the department?</b>							

(Table 4) contd....

Risk factor	n (%)	Negative	Positive	Odds of being COVID-19 Positive			p-value
		n(%)	n(%)	COR (95% CI)	p-value	AOR (95% CI)	
Yes	98 (29.4)	87 (88.8)	11 (11.2)	1.1 (0.7- 1.7)	0.648	0.8 (0.5- 1.5)	0.555
No	206 (61.9)	196 (95.1)	10 (4.9)	REF	REF	REF	REF
Unknown	29 (8.7)	28 (96.6)	1 (3.4)	0.7 (0.4- 1.4)	0.362	0.4 (0.1- 1.1)	0.077
<b>Was there a suspected colleague in the department before screening for COVID-19?</b>							
Yes	153 (45.9)	142 (92.8)	11 (7.2)	1.0 (0.7-1.5)	0.846	0.9 (0.5-1.7)	0.824
No	169 (50.8)	158 (93.5)	11 (6.5)	REF	REF	REF	REF
Unknown	11 (3.3)	11 (100.0)	0 (0.0)	0.5 (0.2-1.4)	0.181	0.1 (0.3-0.7)	0.023*
<b>Was there a diagnosed colleague in the department?</b>							
Yes	130 (39.0)	119 (91.5)	11 (8.5)	1.0 (0.7-1.5)	0.874	0.9 (0.5- 1.7)	0.825
No	193 (58.0)	182 (94.3)	11 (5.7)	REF	REF	REF	REF
Unknown	10 (3.0)	10 (100.0)	0 (0.0)	0.8 (0.3- 2.3)	0.657	11.4 (0.9- 135.7)	0.054
<b>Was there a suspected family member in your family before screening for COVID-19?</b>							
Yes	34 (10.2)	29 (85.3)	5 (14.7)	0.8 (0.4-1.5)	0.494	1.0 (0.4- 2.4)	0.985
No	297 (89.2)	281 (94.6)	16 (5.4)	REF	REF	REF	REF
Unknown	2 (0.6)	1 (50.0)	1 (50.0)	3.4 (0.4-28.6)	0.261	4.2 (0.4- 38.1)	0.203
<b>Was there a diagnosed family member in your family?</b>							
Yes	20 (6.0)	18 (90.0)	2 (10.0)	0.6 (0.2- 1.4)	0.232	0.6 (0.2-2.0)	0.458
No	313 (94.0)	293 (93.6)	20 (6.4)	REF	REF	REF	REF

\* Statistical significant association where  $p < 0.05$ ; AOR, adjusted odds ratio; COR, crude odds ratio; COVID-19, coronavirus disease 2019.

#### 4. DISCUSSION

The mean age for HCWs in this study was 36.4 years which is in agreement with Khamis *et al.* (2020) and this is an age that is close to the average national community age [16, 17]. From the 22 HCWs that were infected, a majority (13) of them were female, which is also consistent with reports from other studies [18, 19] but in contrast with results reported by Khamis *et al.* (2020) [16].

Our findings showed that HCWs aged 40 years and above were more likely of being infected with COVID-19 than those with age less than 40 years. This can be attributed to several reasons, as shown in Table 2. HCWs who are 40+ have a higher chance of having poor IPC practices, placing them at a higher risk of being infected with the virus. This suggests that HCWs who do not adequately adhere to IPC, such as consistent use of personal protective equipment (PPE), which includes masks, face shield, gloves and gowns as per the standard operating procedures. The findings are in line with the findings from other studies [20].

Moreover, a higher proportion of the health care workers, 40+ years age group are either diabetic (30, 26.8%) or have heart disease (15, 13.4%), cancer (8, 7.1%), or bone marrow diseases (1, 0.9%), including 24 (21.4%) with either having hypertension, ovarian cysts, gout, or ulcers, thereby, implying the need to sensitize this group about their extra risk. Individuals with certain underlying conditions are reported to be at increased risk for severe illness from the virus that causes COVID-19 [4, 6]. More caution and mentorship training and supportive supervision are necessary for this group. The results are agreeable with other studies [4, 21, 22], which shows that individuals who have pre-existing conditions are at high risk of being infected with COVID-19.

This study also showed that nurses are more likely to being less compliant to IPC practices than both allied workers and doctors, AOR=4.6(1.0-20.2) P=0.045\*. This finding is contrary

to findings for Gwendolyn *et al.* that reported that doctors, as a group, are less consistently compliant to IPC when compared to nurses. The qualitative study showed that the perceived entitlement to professional independence by senior doctors is their major contributor to how they choose to practice IPC, and that although doctors are aware of the importance of IPC, for many it is not their highest priority [23].

It was also observed that not having an isolation arrangement for people suspected to have COVID-19 presents a risk of COVID-19 infection for HCWs. The findings are consistent with other studies showing that isolation rooms/designated spaces play an important role in preventing nosocomial transmission of COVID-19 [24]. It is important that all health facilities should provide active triage and isolation of all COVID-19 symptom-showing patients when they come to the facility to avoid transmissions in health settings as one way of increasing sensitivity to precautions. Having an isolation room/designated space may also have a positive psychological effect on the HCWs, and it may assist them with being more alert to or cautious of the adherence to infection control precautions when caring for patients with or suspected to have COVID-19. These findings are in agreement with other studies [20].

Even though not statistically significant, 130 (39.0%) HCWs who were exposed to diagnosed colleagues were more likely of being infected with COVID-19, and 11 (8.5%) HCWs in the same department tested positive for COVID-19. Likewise, those who did not know if there were any COVID-19 suspected and diagnosed colleagues in their departments were at higher chance of being infected with the virus even though it was not statistically significant and if adherence to IPC is ignored, these can be infected [2]. Some HCWs maybe in contact with another infected colleague, particularly during 'break' times, whereby HCWs at certain times are not compliant with social distancing and universal

masking when eating [21]. Transmissions could also be through asymptomatic or pre-symptomatic colleagues. HCWs who had their own colleagues or patients in the early stages of unsuspected infections, when viral loads are high [25].

In addition, the study findings have also shown that HCWs who are not aware of their family member's COVID-19 status are likely at a higher chance of being infected even though it was not a statistically significant. A significant source of infection among HCWs, almost a fifth (22.7%) might have been infected by family members. These findings are in agreement with those reported by Shoari *et al.* [26]. It is important to note that the study analyzed observational local data and the results are not suitable for generalizing.

## 5. LIMITATIONS

While this study contributes to the evidence base of the risk factors of COVID-19 infections among HCWs in Eswatini, it has limitations [27]. The study was of a cross-sectional design and, hence, cause-effect relationships can't be established. The study data were collected through structured questionnaires with closed-ended questions, which provides limited answer options. However, to mitigate the potential impact of this limitation, the study had some questions and responses relevant for assessing the risk factors for COVID-19 in the local context, as well as validating risk factors stated in the literature. The design was adopted due to the limited timeframe of the study, and large amounts of information were collected from a large number of participants in a short period of time. The cross-sectional design was also relatively cost-effective. The responses to closed ended questions were easy to code and to statistically analyze, with limited effect on the validity and reliability of the results.

## CONCLUSION

It is important to isolate individuals that are suspects of COVID-19 infection and those who are infected to help break the chain of transmission in health facilities. HCWs are at a high risk of acquiring COVID-19 in the workplace. In order to prevent hospital-acquired infections in the hospital among HCWs, infection control measures for COVID-19 that apply to the community, such as social distancing and universal masking, must be meticulously applied.

The findings of the study cannot be generalized, and authors recommend that this study be repeated in the other regions of Eswatini, and that a surveillance system be established to routinely test HCWs using antibody tests to quantify the true prevalence of COVID-19 among HCWs in Eswatini.

## AUTHORS' CONTRIBUTIONS

SMH, ZPN-K, HB, and LLD were involved in conceptualization, study design, and software, SMH, ZPN-K were further involved in data analysis, data curation and writing original draft preparation. All authors were involved in writing, reviewing and editing of manuscript. All authors read and agreed to the published version of the manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPANTS

Ethical approval for this study was obtained from the Eswatini National Health Research Review Board (ENHRRB) (reference # SHR277/2020) prior to commencement. Permission was also sought from the MoH and the facility managers for access to the health facilities and facility HCWs. Confidentiality of participants was maintained all through the study process as data was collected and held anonymously. In addition participation was voluntary and non-compensated.

## HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

## CONSENT FOR PUBLICATION

The participation in this study was voluntary and confidentiality of the patients was maintained. Informed consent was obtained from all the participants.

## STANDARDS OF REPORTING

STROBE guidelines and methodologies were followed in this study.

## AVAILABILITY OF DATA AND MATERIALS

The support data of the study findings are available from DOI 10.5281/zenodo.5595244.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest financial or otherwise.

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