# Individual-Level Factors associated with Perceived COVID-19 Risk among Health Care Workers in South Africa

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*Article*

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**Abstract:** The global SARS-Cov-2 which caused the coronavirus disease 2019 (COVID-19) pandemic has had a significant impact over the last 3.5 years, especially among healthcare workers (HCWs) who were constantly in the forefront of the pandemic. Due to the nature of their work, HCWs faced a potential risk of exposure. Therefore, this study investigated the individual-level factors associated with perceived COVID-19 risk among South African HCWs. We used an analytical cross-sectional study design to analyse data from the *South African Health Care workers' response to the Coronavirus (COVID-19) pandemic* online survey conducted by the Human Sciences Research Council across the nine provinces in South Africa, from 11th April to 7th May 2020. In this study, only data (n= 5 579) with non-missing values for COVID-19 risk and individual-level factors (age, gender, educational level, occupational category, and race) was analysed. Univariate and Multivariate binomial logistic regression analyses were conducted. The crude and adjusted odds ratio and p-value ≤ 0.05, were used to describe the association between the individual-level factors and perceived COVID-19 risk, from low-medium to high. The binomial logistic regression was used to assess the factors associated with high perceived risk. Perceived COVID-19 risk among HCWs in South Africa was significantly associated with age, race, educational level and occupational category. Being 60 years and older, being "White", having a Master's and Doctorate degrees and being a healthcare worker other than a nurse practitioner and medical practitioner, all had higher odds of having high perceived COVID-19 risk. The findings may be used to guide policies and programs aimed at mitigating the impacts of COVID-19 and other similar pandemics.

**Keywords:** coronavirus disease; healthcare workers; individual-level; perceived risk; South Africa

## 1. Introduction

For over two years, the entire world was involved in a fierce battle against SARS-CoV-2 that causes coronavirus disease (COVID-19), which has been one of the greatest threats to public health in this present day and age [1]. Health care workers (HCWs) constitute the backbone of the healthcare system and are on the front lines delivering healthcare services. Therefore, when an infectious disease breaks, the healthcare community is often severely burdened [1]. Complications from COVID-19 have caused a number of HCWs to die in the line of duty, and their infection rate is unprecedented

in modern history [2]. According to the WHO, between the period of January 2020 to May 2021, there were 115 500 deaths worldwide, with estimates ranging from 80 000 to 180 000, based on the estimated 135 million HCWs in the world [2]. Numerous studies involving nurses have revealed a direct connection between mental health issues and perceived risk [3–6]. Scholars in education and psychology have identified risk perception as an essential element in influencing behaviour [7–10]. To this end, the probability of infection during a pandemic will often be influenced by how at risk people perceive themselves to be, wherein, the greater the perceived risk, the more likelihood to adhere to protective measures put in place [7,13]. Therefore, to develop and implement effective communication strategies, it is crucial to collect empirical data on HCWs' impressions of COVID-19 risk.

Some studies have shown that HCWs who were over 60 and infected with COVID-19 were more likely than their younger counterparts to be hospitalized, with significant mortality risk associated with COVID-19 complications [14–16]. Furthermore, racial differences in COVID-19 risk were noted among HCWs [14,15,17–19]. Additionally, studies revealed a strong correlation between occupational category and COVID-19 risk perception, with nursing-related occupations, and medical professions having higher COVID-19 risk perception scores than their counterparts in other occupational categories in the healthcare setting. [14,15,18,20–24,26,27,35]. However, there was no definite consensus among researchers on gender differences and COVID-19 risk among HCWs [15,19,21,28–30]. Despite knowing that HCWs are more at risk of contracting SARS-Cov-2, information regarding their individual-level factors and COVID-19 risk perception is rather elusive, particularly in South Africa. When it comes to HCWs, studies concentrated mostly on the general population and/or general socio-demographic characteristics [14,15,18,20–26,31–35]. HCWs employed in various healthcare settings are more likely to contract COVID-19 than the general population due to the nature of their work. As a result, their COVID-19 risk perception may differ, particularly when aggregated by individual-level factors, and thus their engagement in preventative behaviours may differ from that of the general public as well. Therefore, this study aims to fill those research gaps by determining the individual-level factors associated with perceived COVID-19 risk among HCWs in South Africa.

## 2. Materials and Methods

Secondary analysis of data from the HCWs survey conducted by the Human Sciences Research Council (HSRC) was conducted. The online survey was conducted using a structured questionnaire from 11th April to 7th May 2020, involving all HCWs aged 18 years and older across the nine provinces of South Africa. The HCWs included medical and nursing practitioners as well as other categories of HCWs. The methodology of the original study is described elsewhere [36,37]. The exposure and primary outcome variables with complete datasets regarding COVID-19 risk and individual-level factors (age, gender, educational level, occupational category, and race) relevant to this current study were extracted from the HSRC HCW survey dataset (n= 5,579).

The primary outcome variable was perceived COVID-19 risk based on the question, "*how would you rate your personal risk of contracting COVID-19 in the workplace*?" with the following options: 1 = extremely high risk, 2 = high risk, 3 = moderate risk, 4 = low risk, 5 = very low risk. These responses were further recoded into two categories namely 1 = low-medium risk (very low risk, low risk and moderate), 2 = high risk (high risk and extremely high risk), based on other studies that measured perception of risk among HCWs [20,28,38].

The exposure variables were individual-level factors which included: age group in years (18-29, 30-39, 40-49, 50-58, 60-69, 70 and older); gender groups (male, female, transgender, intersex, and prefer not to say), these gender groups were regrouped into three categories [male, female, and other (transgender, intersex, and prefer not to say)]; occupational category (medical practitioner, nurse practitioner, allied health workers, other HCWs); level of education (diploma(s)/occupational certificate(s), bachelor's degree, honours/post-graduate diploma, master's degree, specialist qualification, doctorate); location (Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West, Western Cape); population group according to Statistics

South Africa's [39] designations (Black African, White, Coloured Indian/Asian, Other, prefer not to say), these were regrouped to five categories [Black African, White, Colored, Indian/Asian, Other (Other, prefer not to say)].

The HSRC HCW online survey was approved by the HSRC Research Ethics Committee (No REC 5/03/20: COVID-19 study). The copy of the dataset used in this study was provided to the researchers digitally and was destroyed upon completion of the study. With the use of secondary data, there was no physical harm or risk involved in the data collection for this study. This study was part of a Masters of Public Health degree and ethics waiver approval was obtained from the University of Johannesburg, Health Research Ethics Committee (HREC) (No REC-1527-2022) to analyse the secondary data from the HSRC HCW online survey.

The statistical analysis was conducted by restricting the sample size according to the study outcome of perceived COVID-19 risk among HCWs. The variables were weighted by using the STATA command for survey studies [41,42]. The Chi-Square test with an alpha of less than or equal to 5% was used to measure whether the association between variables was statistically significant. Binomial logistic regression was used to assess the factors associated with high perceived risk at the univariate (crude OR) and multivariate (adjusted OR) levels. Only variables that were significant (p-value of $\leq 0.05$ and 95% confidence interval (CI) not overlapping zero (0)) at 20% from the univariate analysis were used in the multivariate analysis to determine significant associations between perceived COVID-19 risk and individual-level characteristics. Perceived COVID-19 risk was classified as "low-moderate risk" and "high risk", indicating the strength of the associations between the exposure variables and the outcome variable. "Low-moderate" was used as the base reference comparison. The Akaike's information criterion and Bayesian information criterion and likelihood ratios tests were used to choose the best predicting risk factor model. These three tests were used to establish the best risk factors that described "perceived COVID-19 risk among health care workers in South Africa". All the analysis were conducted using STATA version 17 (College Station, TX, USA).

## 3. Results

### 3.1. Background Characteristics of the Study Sample

Table 1 above presents the characteristics of the study sample of HCWs who participated in this study. Female participants constituted 69.9% (3 899) and White participants 50.4% (2 810). 29.7% (1 659) were 30-39 years, 40.0% (2 233) were medical practitioners, and 29.8% (1 664) had Bachelor's degrees. The highest proportion of participants by province were from Gauteng 32.6% (1 821).

**Table 1.** Characteristics of the study sample (n = 5579).

| Variables | Total |
|---|---|
| | **n (%)** |
| **HCWs Age Group** | |
| 18-29 Years | 913 (16.4) |
| 30-39 Years | 1659 (29.7) |
| 40-49 Years | 1451 (26.0) |
| 50-59 years | 936 (16.8) |
| 60-69 Years; 70 years and Older | 620 (11.1) |
| **Gender of HCWs** | |
| Female | 3899 (69.9) |
| Male | 1654 (29.7) |
| Other (transgender, intersex, prefer not to say) | 26 (0.5) |
| **HCWs Professional category** | |
| Nurse practitioner (all the categories under nurse practitioner) | 1263 (22.6) |
| Medical practitioner (all the specialities under medical practitioner, medical student) | 2233 (40.0) |

| | |
|---|---|
| Other HCW (all the categories under allied health care worker, other health care practitioner) | 2083 (37.3) |
| **HCWs Level of Education** | |
| Diploma(s)/occupational certificate(s) | 990 (17.8) |
| Bachelor's degree | 1664 (29.8) |
| Honour's/post-graduate diploma | 992 (17.8) |
| Master's degree | 834 (15.0) |
| Specialist qualification | 872 (16.0) |
| Doctorate | 227 (4.1) |
| **HCWs Province** | |
| Eastern Cape | 410 (7.4) |
| Free State | 194 (3.5) |
| Gauteng | 1821 (32.6) |
| KwaZulu-Natal | 1043 (18.7) |
| Limpopo | 139 (2.5) |
| Mpumalanga | 155 (2.8) |
| Northern Cape | 87 (1.6) |
| North West | 181 (3.2) |
| Western Cape | 1549 (27.8) |
| **HCWs Population group** | |
| Black African | 1224 (21.9) |
| White | 2810 (50.4) |
| Coloured | 532 (9.5) |
| Indian/Asian | 669 (12.0) |
| Other (other, prefer not to say) | 345 (6.2) |

*3.2. Perceived COVID-19 risk frequency among the participants*

Table 2 above shows the perception of COVID-19 risk by individual level factors among HCWs in South Africa. Among the HCWs, 4 732 (84.8%) had Low-Moderate risk perception of COVID-19, while 847 (15.2 %,) reported High COVID-19 perceived risk. Low-Medium risk COVID-19 perception was reported by 1 134 (89.8%) of all nurse practitioners, 1 969 (88.2%) by medical practitioners and 1 629 (78.2%) by other HWC category. 129 (10.2%) nurse practitioners, 264 (11.8%) medical practitioners and 454 (21.8%) other HCWs reported high COVID-19 risk perceptions.

**Table 2.** COVID-19 risk perception by individual level factors.

| | Perceived Risk of COVID-19 infection among HCWs | | |
|---|---|---|---|
| | **Low-Moderate risk, n (%)** | **High risk, n (%)** | **Total** |
| **Overall** | 4732 (84.8) | 847 (15.2) | 5579 |
| **Gender (p< 0.000)** | | | |
| Female | 3271 (83.9) | 628 (16.1) | 3899 |
| Male | 1439 (87.0) | 215 (13.0) | 1654 |
| Others | 22 (84.6) | 4 (15.4) | 26 |
| **Professional category (p< 0.000)** | | | |
| Nurse Practitioner | 1134 (89.8) | 129 (10.2) | 1263 |
| Medical practitioner | 1969 (88.2) | 264 (11.8) | 2233 |
| Other HCWs | 1629 (78.2) | 454 (21.8) | 2083 |

In the univariate binomial logistic regression analysis, as shown in Table 3 above, the age group 70 years and older had 3.49 [cOR 3.49, 95% CI (2.18-5.58), *p*< 0.001] higher odds of having high perceived COVID-19 risk when compared to the 18-29 years age group. The age group 60-69 and 50-59 years had 2.71 [cOR 2.71, 95% CI (2.03-3.62), *p*< 0.001] and 1.58 [cOR 1.58, 95% CI (1.21-2.08), *p*< 0.001] higher odds of having high perceived COVID-19 risk, respectively, when compared to the 18-29 years age group. When compared to the female gender, males had 22% [cOR 0.78, 95% CI (0.66-0.92), *p*< 0.003] lower odds of having higher perceived COVID-19 risk. "Other" HCWs had 2.45 [cOR 2.45, 95% CI (1.99-3.02), *p*< 0.001] higher odds of having high perceived COVID-19 risk when compared to the nurse practitioners. Almost all the educational levels (except the Bachelor's and the Doctorate degrees), had higher odds of perceiving themselves as at high risk of COVID-19, when compared to the Diploma(s)/Occupational certificate(s) category. White respondents had 3.09 [cOR 3.09, 95% CI (2.46-3.87), *p*< 0.001] higher odds of having high perceived COVID-19 risk when compared to the Black African respondents. Also those HCWs identified as "Other" had 2.02 [cOR 2.02, 95% CI (1.40 - 2.90), *p*< 0.001] higher odds of perceived COVID-19 risk when compared to the Black African respondents.

**Table 3.** Univariate binomial logistic regression analysis and Multivariate binomial logistic regression: Healthcare workers individual-level factors associated with perceived COVID-19 risk.

| Characteristics | Unadjusted logistic regression model | | Adjusted logistic regression model | |
|---|---|---|---|---|
| | cOR(95% CI) | p value | aOR(95% CI) | p value |
| *HCWs Age Group* | | | | |
| 18-29 Years | Ref | | Ref | |
| 30-39 years | 1.33(1.04-1.71) | 0.026 | 1.40(1.08-1.83) | 0.012 |
| 40–49 years | 1.37(1.06-1.77) | 0.016 | 1.38(1.05-1.82) | 0.023 |
| 50-59 years | 1.58(1.21-2.08) | 0.001 | 1.49(1.10-2.00) | 0.009 |
| 60-69 years | 2.71(2.03-3.62) | <0.001 | 2.48(1.79-3.42) | <0.001 |
| Older than 70 years | 3.49(2.18-5.58) | <0.001 | 3.78(2.25-6.34) | <0.001 |
| *Gender of HCWs* | | | | |
| Female | Ref | | Ref | |
| Male | 0.78(0.66-0.92) | 0.003 | 0.82(0.67-1.00) | 0.049 |
| Other | 0.95(0.33-2.76) | 0.920 | 0.84(0.28-2.54) | 0.759 |
| *HCWs Professional category* | | | | |
| Nurse practitioner (all the categories under nurse practitioner) | Ref | | Ref | |
| Medical practitioner (all the specialities under medical practitioner + medical student) | 1.18(0.94-1.47) | 0.148 | 0.89(0.68-1.16) | 0.380 |
| Other HCW (all the categories under Allied health care workers + other Health care practitioner) | 2.45(1.99-3.02) | <0.001 | 2.03(1.60-2.57) | <0.001 |
| *HCWs Level of Education* | | | | |
| Diploma(s)/Occupational certificate(s) | Ref | | Ref | |
| Bachelor's degree | 1.33(1.02-1.73) | 0.035 | 1.14(0.86-1.52) | 0.356 |
| Honours /Post Grad Diploma | 1.98(1.50-2.60) | <0.001 | 1.39(1.03-1.86) | 0.029 |
| Master's degree | 3.79(2.90-4.94) | <0.001 | 2.53(1.90-3.37) | <0.001 |
| Specialist qualification | 1.46(1.09-1.96) | 0.012 | 1.44(1.04-1.99) | 0.029 |
| Doctorate | 4.15(2.90-5.95) | <0.001 | 2.85(1.93-4.21) | <0.001 |
| *HCWs Population Group* | | | | |
| Black African | Ref | | Ref | |
| White | 3.09(2.46-3.87) | <0.001 | 2.32(1.83-2.96) | <0.001 |
| Coloured | 1.15(0.80-1.66) | 0.436 | 1.17(0.81-1.70) | 0.407 |
| Indian/Asian | 1.17(0.83-1.63) | 0.370 | 1.03(0.73-1.45) | 0.884 |

| | | | | |
|---|---|---|---|---|
| Other | 2.02(1.40-2.90) | <0.001 | 1.62(1.10-2.38) | 0.015 |

HCWs, healthcare workers; Ref, reference; cOR, crude odds ratio; aOR, adjusted odds ratio.

In the multivariate binomial logistic regression analysis, as shown by Table 3 above, the odds of having high COVID-19 perceived risk were 3.78 [aOR 3.78, 95% CI (2.25-6.34), $p<0.001$] and 2.48 [aOR 2.48, 95% CI (1.79-3.42), $p<0.001$] times higher among respondents who were 70 years and older and the 60-69 years age group, respectively, when compared to those who were 18-29 years old. High COVID-19 perception risk odds were 2.03 times higher [aOR 2.03, 95% CI (1.60-2.57), $p<0.001$] among the "Other" HCWs category when compared to the nurse practitioners. When compared to the Diploma(s)/Occupational certificate(s), the odds of having high COVID-19 perceived risk among the Master's degree and Doctorate degree levels of education of HCWs were 2.53 [aOR 2.53, 95% CI (1.90-3.37), p<0.001] and 2.85 [aOR 2.85, 95% CI (1.93-4.21), p<0.001] times higher, respectively. The odds of having high COVID-19 perceived risk were 2.32 [aOR 2.32, 95% CI (1.83-2.96), p<0.001] times higher for White HCWs, when compared to the Black African HCWs.

## 4. Discussion

The study was aimed at determining the association between individual-level factors and perceived COVID-19 risk among HCWs in South Africa. Individual-level factors such as older age, White race, having educational qualifications at Master's and Doctorate degrees and being a HCW other than a nurse or medical practitioner were significantly associated with perceived COVID-19 risk among HCWs in South Africa during April-May 2020.

### 4.1. Demographics of the study sample

The sample comprised a higher proportion of females than males, which is consistent with most previous studies reviewed [43–46]. It may be hypothesized based on these findings that most of the healthcare workforce is dominated by females or that females HCWs are more likely to take the time to respond to these surveys. This sample also comprised of more White participants than any other race, particularly medical practitioners and those who were categorized as Other HCWs. This could be attributed to the racial disparities in the South African study context - particularly because the study was online and participation required specific gadgets and access to the internet, which HCWs of other races might not have been privileged to have at the time of the study. It is well documented that White South Africans are often the most privileged of races in South Africa [47–50]. Therefore, having the data collected online, might have had a bearing in having more White participants in the study.

### 4.2. Overall COVID-19 risk perception among healthcare workers in South Africa

This study found that majority of the HCWs (84.8%) had low-moderate perceived COVID-19 risk. This outcome is not surprising, taking into consideration that during data collection (11th April to 7th May 2020), South Africa had just instituted its first national lockdown, there were very few numbers of cases and deaths (compared to the second and third waves), COVID-19 recovery rates were high, and HCWs and South Africa's population in general did not know the devastating effects the pandemic would later have [51,52]. This is in line with the underpinnings of risk perception as people's subjective assessments of the outcomes that may possibly follow pandemics or disasters are likely to be affected, in part, by time [53–55]. Furthermore, even with past pandemics like H1N1 influenza and Ebola, their earlier episodes were not predictive or understood well by many, even HCWs [56,57]. However, later, their perceptions changed [56,57]. Hence it is most likely that had the data been collected during or after the second wave, perceptions would have changed and more HCWs would probably have perceived themselves to be at higher risk of COVID-19, as evident in studies carried out after this study [14,15,18,21,23,26,27].

### 4.3. Age and perceived COVID-19 risk

This study found that HCWs who are 60 years and older, perceive themselves to be at high risk more than younger HCWs. This finding is consistent with other studies [28,58–60]. This might be due to the fact that age is a known risk factor for more serious consequences of an illness - including COVID-19 [28,31,61,62].

### 4.4. Gender and perceived COVID-19 risk

Gender was not a significant factor associated with perceived COVID-19 risk in this study. This is despite that gender differences are a known phenomenon in self-reported emotional experiences and in health and wellbeing [64]. Therefore, this is inconsistent with other studies among HCWs and the general population that reported that women generally evaluate their COVID-19-specific risk more highly than men, even in different dimensions of risk perception [31,42,64–66], while some other studies found that females reported high COVID-19 risk perception as compared to males [64,67–72]. These observed inconsistencies may be once again attributed to the period of data collection for this study, which was early, before the pandemic picked and hence the differences in gender may have not been appreciated, as reported in the later researches mentioned herein.

### 4.5. Professional category and perceived COVID-19 risk

Higher odds (2.03) of having high perceived risk among HCWs categorised as "Other" was observed in this study. This could be explained in relation to the inclusion of allied health workers in the category (which include dentists, pharmacists, radiographers, physiotherapist and administrative staff among others), who also worked closely to patients due to the nature of their jobs, but not mostly at bedside as nurse and medical practitioners do. On another note, the issue of differences in professional category can further be explained by findings of Richards *et al* [73], who reported that administrative staff (at medium and high level administration) believed that COVID-19 would soon be eradicated and that treatments would be more effective, yet had stronger concerns about it than other professional categories like nurses and medical practitioners. Neville *et al* [74] explained that this might be because managers manage the concerns they have about COVID-19 by engaging thoughts of COVID-19 being over more quickly and effectiveness of treatments, and/or may be due to misalignment of descriptive and injunctive norms between perceptions of what is likely to be effective in the context of COVID-19 versus perceptions about what should be done. A further explanation could be the lack of general practices to establish a common identification with the broader group of HCWs. Hence, administrative workers may have taken their positions as a lesser part of the larger collective of HCWs and thereby retained a potentially more individual identity, which could explain their differing perceptions as compared to other HCWs [75,76].

Furthermore, the inconsistencies between the professional categories' perceptions cannot be explained without noting the time factor of the data collection of the study, that is, the early stages of the pandemic during which data was collected, before the second and third waves had occurred. When the effects of the pandemic became more evident, prolonged exposure and spending a maximum time with the patients would become the most fearful experience. This is evident in studies carried out after this study, which found out that nurses, medical practitioners and other HCWs who are in constant or direct contact with patients perceived themselves as high risk [14,15,18,21,23,26,27]. In Deressa *et al* [20], Saleem *et al* [24] and Kang *et al* [22], nurses were even reported to have severe anxiety and fear of contracting COVID-19 when handling COVID-19 patients as compared to other HCWs.

### 4.6. Educational level and perceived COVID-19 risk

Having a higher educational level at Master's degree and Doctorate degree was found by this current study to be significantly associated with high COVID-19 risk perception when compared to those with Diploma(s)/Occupational certificate(s). These findings are consistent with other studies that found that having a higher level of education was associated with higher COVID-19 risk

perception scores than having a lower educational level [6,28,77]. A study by Glazer [78] postulated that lower levels of education are associated with lower education and awareness on COVID-19. In addition, Asnakew and Kerebih Asrese [77] reported that lower education levels among HCWs and those working at lower administrative levels had low COVID-19 perception risk and they were barriers to compliance with COVID-19 preventative measures.

### 4.7. Population group and perceived COVID-19 risk

Ethnicity also had some significant association with COVID-19 risk perception in this study. White HCWs had higher odds (2.32) of perceiving themselves as at high risk of COVID-19 risk than Black African HCWs. These findings can be partly explained by the dominance of the White population in the sample, possibly as a result of the racial disparities in the South African population in general, as explained earlier when discussing the demographics on the study participants in this study. On the other hand, differences in risks of COVID-19 and their impacts among HCWs are reported to vary by race as a result of varied racial/ethnic composition of HCWs across occupations, settings and localities [14,44]. However, the findings from this study seem to be in contrast with the findings by Nino *et al* [79] who reported that compared to Whites, Black people and other marginalised racial and ethnic groups, were most likely to perceive themselves as being at high risk of COVID-19. The findings by Nino *et al* [79] are in agreement with the findings by Phaswana-Mafuya *et al* [80], who reported high rates of COVID-19 hospitalisation in Black African females compared to Coloureds, Indians and Whites (6.7% (95% CI 6.0 - 7.4), 6.3% (95% CI 5.5 - 7.2) and 4% (95% CI 3.5 - 4.5), respectively. A range of studies in other settings reported a greater impact of COVID-19 in other races compared to Whites [15,17,18,65]. Hence the dominance of White HCWs in this study's sample could be the explanation of their high perception of COVID-19 risk when compared with Black Africans.

### 4.8. Strengths and limitations of the study

This study presented some major strengths and some limitations. The first strength of the study is that it utilised a relatively big sample size of HCWs, and all major professional categories were represented in the sample. The second strength of the study is that it utilised data gathered from an online survey which, despite a hard lockdown in South Africa, gave real time responses from the HCWs while the COVID-19 pandemic was unfolding. One major limitation of this study is the timing of the study's data collection which was done during the first wave of the pandemic, wherein lot of effects and consequences had not yet been realized by the HCWs. Therefore, there is a possibility that had the study been undertaken during or after the second wave in South Africa, the results could have been different. Another limitation is the unequal representation of participants by race, which might have influenced the outcome of particular variables of the study. Hence, findings from this study only reflect perceptions of COVID-19 during the first wave in South Africa. This shortfall of the study can be linked to the other limitation of the study, which is the online survey methodology, which might have had elements of bias towards those HCWs who had readily available electronic devices and access to internet and had the time and motivation to respond to the questionnaires. It also needs to be noted that causality could not be established given the cross-sectional nature of the study. Caution must be exercised in terms of generalizability of the findings of this study as the sample was not representative of the entire population of HCWs. However, the larger sample size counteracts this limitation.

### 5. Conclusion

The study found significant associations between individual-level characteristics with perceived COVID-19 risk among South African HCWs. Being of older age, being White, having higher educational qualifications and being a HCW other than a nurse or medical practitioner were found to be significantly associated with perceived COVID-19 risk among HCWs in South Africa. Hence these individual-level factors can be an important yardstick for targeted preventative and control

measures during pandemics similar to COVID-19; these people are more likely to adhere to all preventative and control measures put in place. On the other hand, individual-level factors like younger age, occupational categories like nurse practitioners, "Black" races and other races except "Whites", having educational qualifications lower than Master's degree, need to be targeted the most during pandemics like COVID-19 for their low-moderate risk perception. This is because low risk has been associated with poor adherence to preventative and control measures during pandemics. To this end, this study provides important insights into the role of individual-level factors on perceived COVID-19 risk and has elucidated how risk perception is important in informing or influencing one's adherence to measures put in place. In doing so, we have identified factors that are associated with risk perception, which can help devise and strengthen preventative measures.

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