Spatial analysis of perceived health system capability and actual health system capacity for COVID-19 in South Africa

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Abstract

People's confidence on the health system capability in managing COVID-19 outbreak can determine public support, risk perceptions and compliance behaviours during the pandemic. Therefore, this paper investigated people's perception on health system capability using online survey data and current state of health system capacity to deal with COVID-19 pandemic at different spatial areas across the country. Simple and multiple logistic regression models were used to examine the factors associated with perception of the health system's capability to manage the COVID-19 pandemic at a national level and within each province. Spatial comparative analysis was conducted on perception of health system capability and density indicators of health system capacity. Findings showed South Africans had low confidence on health system capability with only two in five (40.7%) reporting that they thought that the country's health system was able to manage the COVID-19 pandemic. Sex and knowledge on COVID-19 were significantly associated with the perception of the health system's capability to manage the pandemic at the national level and in four of the nine provinces. Overall, the findings of this study clearly highlights the challenges on the country's health system both perceived or real that needed to be addressed as part of the preparation for the COVID-19 pandemic. Timeous implementation of a countrywide National Health Insurance (NHI) system is now more critical than ever in improving health care outcomes of the South African population even beyond the existence of the COVID-19 epidemic.

Introduction

Coronavirus Disease 2019 (COVID-19) is a novel coronavirus caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2). This novel coronavirus first emerged as a causative agent that led to a respiratory disease outbreak in December 2019 in Wuhan, China (Jernberg 2020). South Africa recorded its first confirmed case of COVID-19 on March 5 2020. Since then the number of confirmed cases have grown exponentially as there are currently (as of first week of July 2020) more than 200 000 confirmed cases across the country. Health system capability and capacity to deal with this COVID-19 pandemic has been under pressure and scrutiny globally. Clinically, the COVID-19 disease is characterised by a dry cough, fever, fatigue and shortness of breath. In severe cases, patients present with severe respiratory illness such as a pneumonia or acute respiratory distress syndrome (ARDS) which could both lead to death (Zhang et al. 2020). According to recent presentation made to South African Members of Parliament by the Director General of the National Department Health, there is a total of 119 416 hospital beds available from both private and public hospitals across South Africa (du Toit and Cowan 2020; van der Hever 2020). There are also 3 318 Intensive Care Unit (ICU) beds available, but it is projected that ICU beds could exceed 14 700 at the highest peak of COVID-19 infection. With regard to ventilators, the public healthcare system and private healthcare system currently has a total of 3 216 ventilators. It is estimated that at highest peak of COVID-19 outbreak, 7 000 ventilators will be required to deal with the virus, a shortage of 3 784 (du Toit and Cowan 2020).

In South Africa, inequalities exist in access to health services between public and private sectors, as well as within the public sector itself, especially between urban and rural areas (Rosero-Bixby 2004; Benatar 2013; Hu et al. 2013; Guerrero et al. 2013; Mansour 2016; Burger and Christian 2018; Robin et al. 2018). The public healthcare system supports around 84% of uninsured population while the private sector only deals with 16% of the people with medical aids across the country, even though its annual per capita healthcare expenditure is almost 10 times more than the public sector's (Benatar 2013). Those who can afford medical insurance are predominantly white and those who cannot are black African. These inequalities seen in health care access in South Africa are indicative of the racial segregation policies carried over into the present from the apartheid government (Gradin 2019). The COVID-19

outbreak has dramatically highlighted the necessity for a more integrated healthcare system (Nkonki and Fonn 2020). The COVID-19 pandemic presents significant opportunity for the National Health Insurance (NHI) to be piloted in real-time. In March 2020, the Competition Commission has published a COVID-19 block exemption for the health sector for promoting better coordination, sharing of information and standardisation of practice across the entire healthcare sector as well as promoting agreements between the National Department of Health and the private healthcare sector (DTI 2020). Spatial accessibility of healthcare facilities is also important factor in the fight against COVID-19 outbreak. Spatial accessibility is often concerned with the complex relationship between the spatial separation of the population and the supply of healthcare facilities and thus has a strong underlying geographic component (Black et al. 2004; Mokhele et al. 2012; Munoz and Källestål 2012; Khashoggi and Murad, 2020). Spatial accessibility is regarded as a primary deciding factor of access to healthcare and healthcare utilization (Siegel et al. 2016; Ma et al. 2018).

In addition, people's confidence on the healthcare system in managing COVID-19 outbreak is also crucial in managing the outbreak. For instance, in India, it was reported that some people escaped hospitals or quarantine and this had been alluded mainly to the confidence deficit in the public health system in many parts of the country (Chetterje 2020). Therefore, this paper explores South Africans' perceptions of the country's health system capability to manage COVID-19. It further assesses the country's current health system capacity in the various geographic areas and draws comparisons with perceptions of the health system capability to manage COVID-19 pandemic.

Materials And Methods

Data

This paper utilised data from Human Sciences Research Council (HSRC) COVID-19 online survey conducted from 27 March 2020 to 2 April 2020 in South Africa. The survey was open to all adult people (18 years and older) residing in South Africa, regardless of race, sex or nationality. The self-administered structured questionnaire (48 items) included socio- demographic, knowledge and infection control measures regarding COVID-19, risk of contracting COVID-19, perception of health system capability, hygiene practices, preparedness for self-isolation/quarantine, preparedness for lockdown and the use of social media in accessing information on COVID-19. The survey alerts were distributed on a data-free messaging platform, were distributed via various social media platforms, were posted on the HSRC organisational website and broadcasted on radio and TV stations. Ethics approval was received from the HSRC Research Ethics Committee (REC); (REC 5/03/20).

Measures

Socio-demographic variables used were sex, age, employment, knowledge score (continuous variable), risk perception and self-isolation or quarantine possibility. These were age group in years (18-29, 30-39, 40-49, 50-59, 60+), sex (male or female), race (Black African, Coloured, White, Indian/Asian), employment status (employed full time, employed informal/part time, student, unemployed, self-employed), and dwelling type (formal dwelling or informal dwelling). Knowledge score was developed from six knowledge variables about COVID-19, which were four variables on knowledge about transmission (COVID-19 is spread by direct contact with the virus from: (Select all that apply)) with options being (infected people coughing/sneezing, pets, touching face after being in contact with infected person, contact in public gathering with infected person, contaminated surfaces and I don't know); one variable on knowledge about incubation (After how long will an infected person show signs of being sick?) with

options being (immediately, after 1-2 days, after 2-14 days, after 15-20 days, and I don't know); and one variable on knowledge about symptoms (Which of the following best describes the symptoms of COVID-19: (Select all that apply)) with options being (shortness of breath, body pain, sweating, headaches, coughs, sneezing, red-itchy eyes, runny nose, fever, and I don't know). Respondents were assigned a value of 1 for each of the four transmission modes identified, for correct identification of the incubation period of 2-14 days and for correct identification of fever, cough and shortness of breath as the main symptoms. The final knowledge sum score ranged from 0 to 6. For risk perception, self-perceived risk of contracting coronavirus was assessed using the question "How do you rate your personal risk of contracting COVID-19?" with response options being 1=very high risk, 2=high risk, 3=moderate risk, 4=low risk and 5= very low risk. These responses were recoded into 1=low risk (very low risk, and low risk), 2=moderate risk and 3=high risk (very high risk and high risk). For perception of self-isolation or quarantine possibility, this was assessed using the question "Do you think you may end up in a situation of self-isolation or quarantine?" with response options being 1=yes, 2=no and 3=don't know. These responses were recoded into 0=no (no and don't know) and 1=yes (yes). The primary outcome variable, perception on health system capability in dealing with COVID-19, was assessed using the following question "Do you feel each of the following are able to manage the South African COVID-19 outbreak? SA health system" with options being 1=yes, 2=no and 3=don't know. These were dichotomised into 0=no (no and don't know) and 1=yes (yes) for logistic regression models.

Statistical analysis

Data was analysed using Stata version 15.0 (Stata Corp 2017). The data were benchmarked using Statistics South Africa 2019's mid-year adult population estimates for generalisability of the findings. Differences in estimates between the socio-demographic variables were compared using Chi-squared tests with a statistical significance level of $p < 0.05$. Logistic regression was performed to determine factors associated with the perception that the country's health system was capable to manage the COVID-19 outbreak. This was done at both national level and at provincial level to determine differences across provinces. Race group and dwelling type were excluded from the logistic regression analyses due to small cell sizes for Indian/Asian and Coloured communities in some provinces, namely the Northern Cape, Limpopo and Mpumalanga. A significance level of $p < 0.05$ was used.

Spatial analysis

For spatial density indicators, secondary data for the numbers of hospitals, hospital beds and ICU beds was gathered from various sources (Naidoo et al 2013; Makombo 2016; Stats SA 2019; van der Hever 2020). For population, 2019 population estimates from Statistics South Africa (Stats SA) were considered (Stats SA 2019). Spatial density indicators were developed to determine number of hospitals, hospital beds and ICU beds per given population across various provinces using ArcGIS 10. For spatial comparative analysis across perception of health system capability maps and density indicators of health system capacity maps, the graduated colour symbology and equal interval classification method was done using five classes for all maps. The COVID-19 hospitals earmarked by the national government were also geocoded and mapped for spatial analysis of their distribution and geographic accessibility.

Results

Demographics of respondents

The study sample from the online survey comprised 53 488 respondents. After benchmarking, females constituted 53.9% and Black Africans accounted for 76.4% followed by Whites at 10.8%. In terms of age composition, 29.9%

were 18-29 years old followed by those aged between 30 and 39 years old (25.7%).

Perception of health system capability in managing COVID-19

Table 1 highlights people’s perceptions towards health system capability to manage COVID- 19 outbreak across different socio-demographic variables and provinces. Overall, two in five South Africans (40.7%) reported that they thought that the country’s health system was able to manage the COVID-19 outbreak. The perception of health system capability to manage COVID-19 varied significantly across all socio-demographic variables ($p < 0.01$ for age and $p < 0.001$ for all other variables). Males had a significantly higher prevalence of perceiving the health system as capable than females. The elderly (70 years and older) had the lowest confidence on the health system’s capability (29.0%). Black Africans had the highest confidence on the health system’s capability (46.9%) while White participants had lowest (13.4%).

Those employed part-time or informally had the highest confidence (44.8%) on health system capability and self-employed adults had the lowest (34.4%). The perception of health system capability was less prevalent among those who thought they were at moderate and high risk of contracting COVID-19 (around 38% each) and among those who thought they might end up in self-isolation or quarantine (34.1%). People residing in informal dwellings had a higher confidence on the health system’s capability (55.7%) than those who lived in formal dwelling (40.0%).

Table 1 People’s confidence on health system capability in managing COVID-19 pandemic

Socio-demographics	Total	%	95% CI	p value
Sex				
Male	15 476	44.4	[42.3-46.5]	<0.001
Female	33 721	37.6	[36.0-39.1]	
Age group				
18-29	8 794	43.0	[40.8-45.2]	<0.01
30-39	13 074	39.6	[37.5-41.7]	
40-49	13 089	40.7	[38.3-43.2]	
50-59	10 683	43.0	[39.8-46.3]	
60-69	5 887	40.7	[35.8-45.9]	
70+	1 864	29.0	[19.0-41.5]	
Race				
Black African	7 883	46.9	[45.2-48.5]	<0.001
Coloured	4 376	30.1	[28.3-31.9]	
White	36 322	13.4	[12.8-14.1]	
Indian/Asian	3 878	17.8	[16.1-19.6]	
Employment				
Employed full time	28 204	40.0	[38.4-41.6]	<0.001
Employed informal/part time	3 774	44.8	[40.3-49.3]	
Student	2 932	43.3	[39.6-47.0]	
Unemployed	8 131	43.4	[39.7-47.2]	
Self employed	10 339	34.4	[30.1-39.0]	
Risk perception				
Low	22 917	44.7	[42.9-46.6]	<0.001
Moderate	21 110	38.1	[35.8-40.4]	
High	9 458	38.3	[35.6-41.0]	
Self-isolation/quarantine possibility				
Yes	24 546	34.1	[32.3-36.0]	<0.001
No	11 593	50.9	[48.3-53.4]	
I don't know	17 264	40.2	[37.9-42.6]	
Dwelling type				
Formal dwelling	52 878	40.0	[38.7-41.3]	<0.001
Informal dwelling	59955.7	[49.6-61.6]		
Province				
Eastern Cape	2 462	39.0	[34.7-43.6]	<0.001
Free State	1 254	52.1	[46.2-58.0]	
Gauteng	24 543	39.2	[37.7-40.7]	
KwaZulu-Natal	6 399	39.8	[36.9-42.7]	
Limpopo	1 020	48.8	[42.1-55.6]	
Mpumalanga	95740.0	[33.9-46.4]		
North West	97152.4	[44.9-59.8]		
Northern Cape	47847.2	[39.0-55.6]		
Western Cape	15 404	30.8	[29.1-32.5]	
Total	53 488	40.7	[39.4-42.0]	

Fig. 1 highlights that Western Cape had the lowest percentage (30.8%) of people who felt that the national health system was capable of dealing with COVID-19. Gauteng and Eastern Cape were under the second lowest category of 35.2% to 39.4%. North West and Free State had the highest percentages of people (more than half each) who had

confidence in the health system's capability in managing COVID-19 outbreak. These were followed by Limpopo with 48.8% of people having confidence on the country's health system to deal with COVID-19 pandemic.

In the national sample, age (compared with 18-29 years: 60 years and older, OR=0.76, 95% CI: [0.59-0.99]), being female (OR=0.75 [0.67-0.83]), employment status (compared with full time employed: Unemployed, OR=1.21 [1.02-1.44] and self employed, OR=0.78 [0.64-0.96]), knowledge score (OR=0.89 [0.85-0.93]), risk perception (compared with low risk perception: moderate, OR=0.82 [0.72-0.93]), and perception of self-isolation or quarantine possibility (OR=0.65 [0.58-0.72]) were significantly associated with the perception that the health system was capable of managing the COVID-19 outbreak (Table 2).

In the Eastern Cape, perception of self-isolation or quarantine possibility (OR=0.54 [0.37-0.8]) and age 40-49 years (OR=0.53 [0.31-0.91] compared to 18-29 years) were significantly associated with decreased odds of perceiving that the health system was capable. In the Free State, female gender (OR=0.61 [0.37-0.99]) and knowledge score (OR=0.68 [0.55-0.85]) were significantly associated with decreased odds of perceiving that the health system was capable while age 30-39 years (OR=2.12 [1.05-4.28] compared to 18-29 years) was significantly associated with increased odds of this perception. In Gauteng province, female gender (OR=0.78 [0.69-0.89]), knowledge score (OR=0.88 [0.83-0.94]) and moderate risk perception (OR=0.81 [0.7-0.93] compared to low risk perception) were significantly associated with decreased odds of the perception. In KwaZulu-Natal, knowledge score (OR=0.9 [0.82-0.99]) and moderate risk perception (OR=0.75 [0.56-1.0] compared to low risk perception) were significantly associated with decreased odds of perception. In Limpopo being self-employed (OR=0.33 [0.13-0.81] compared with being in full time employment) was significantly associated with decreased odds of perception. In the North West, female gender (OR=0.36 [0.2-0.67]) and perception of self-isolation or quarantine possibility (OR=0.41 [0.23-0.72]) was significantly associated with decreased odds of perception. In the Western Cape, female gender (OR=0.77 [0.65-0.92]), 60 years and older (OR=0.49 [0.35-0.68] compared to 18-29 years), being self-employed (OR=0.74 [0.56-0.97] compared to being in full time employment), knowledge score (OR=0.86 [0.8-0.93]) and perception of self-isolation or quarantine possibility (OR=0.69 [0.58-0.81]) were significantly associated with decreased odds of perceiving that the health system was capable of managing the COVID-19 pandemic.

Table 2 Logistic regression showing factors associated with people's perception of health system's capability on managing COVID-19 by province

	National	EC	FS	GP	KZN	LP	MP	NW	NC	WC
Socio-demographics	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
Sex										
Male	Ref	ref	ref	Ref	ref	ref	ref	ref	ref	ref
Female	0.75*	0.96	0.61*	0.78*	0.94	0.61	0.8	0.36*	0.6	0.77*
Age group										
18-29	Ref	ref	ref	Ref	ref	ref	ref	ref	ref	ref
30-39	0.92	0.88	2.12*	0.88	0.76	1.33	1.1	0.73	0.9	0.8
40-49	0.97	0.53*	1.21	1.09	0.98	0.95	2.1	0.75	1	0.8
50-59	1.07	1.13	2.07	1.08	0.85	1.01	3	0.73	1.4	0.81
60+	0.76*	1.14	2.37	0.76	0.67	1.26	0.4	0.45	0.9	0.49*
Employment status										
Employed full time	Ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Employed informally/part time	1.21	1.2	0.55	1.21	1.4	0.62	1.5	1.35	3.5	1.31
Student	1.07	0.82	0.81	1.24	1.04	0.71	2	1.16	0.7	1.22
Unemployed	1.21*	0.9	0.84	1.16	1.32	0.76	2.4	1.7	2	1.17

Self employed Knowledge	0.78*	0.75	0.54	0.85	0.76	0.33*	1	1.03	2	0.74*
Knowledge score	0.89*	0.89	0.68*	0.88*	0.9*	0.99	0.9	1.04	0.8	0.86*
Risk perception										
Low	Ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Moderate	0.82*	1.02	0.62	0.81*	0.75*	0.73	0.8	0.97	0.5	0.94
High	0.87	0.94	0.59	0.9	0.82	0.64	0.9	0.9	0.5	0.95
Self-isolation quarantine possibility or										
No	Ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Yes	0.65*	0.54*	0.9	0.6*	0.86	0.76	0.6	0.41*	0.6	0.69*

*p < 0.05; EC=Eastern Cape; FS=Free State; GP=Gauteng; KZN=KwaZulu-Natal; LP=Limpopo; MP=Mpumalanga; NW=North West; NC=Northern Cape; WC=Western Cape

Health system capacity

Table 3 shows secondary data on total population, hospitals, hospital beds, and ICU beds by province. Gauteng, the most populated (smallest by geographic area) province had the highest number of hospitals, however these were mainly private hospitals (83) compared to 39 public hospitals. There were more Hospital beds in public hospitals than in private hospitals whereas the opposite was the case with regard to ICU beds across the country.

Table 3 Population, hospitals, hospital beds, and ICUs beds by province

Province	Total population	Public hospitals	Private hospitals	Total hospitals	Public hospital beds	Private hospitals beds	Total hospital beds	Public ICU beds	Private ICU beds	Total ICU beds
Eastern Cape	6 712 276	91	17	108	13 200	1 723	14 923	93	110	203
Free State	2 887 465	34	13	47	4 798	2 337	7 135	109	114	223
Gauteng	15 176 116	39	83	122	16 656	14 278	30 934	330	1 132	1 462
KwaZulu-Natal	11 289 086	77	12	89	22 048	4 514	26 562	273	305	578
Limpopo	5 982 584	42	10	52	7 745	600	8 345	34	28	62
Mpumalanga	4 592 187	33	13	46	4 745	1 252	5 997	25	63	88
North West	4 027 160	22	14	36	5 132	1 685	6 817	54	87	141
Northern Cape	1 263 875	16	2	18	1 523	293	1816	21	27	48
Western Cape	6 844 272	53	39	92	12 241	4 385	16 626	222	291	513
RSA	58 775 021	407	203	610	85 362	31 067	119 155	1 178	2 140	3 318

Data sources: Naidoo et al. (2013); Makombo (2016); Stats SA (2019); van der Heveer (2020)

Fig. 2 shows the results from the spatial density analysis of hospitals and hospital beds per population. KwaZulu-Natal, Gauteng, Limpopo and North West had the lowest number of hospitals per 100 000 people with 0.79, 0.80, 0.87 and 0.89 respectively (Figure 2a). All the remaining provinces had more than one hospital per 100 000 people. Free State had the highest with 1.63 hospitals per 100 000 people. Gauteng had the highest number of hospital beds, followed by Western Cape, KwaZulu-Natal and Eastern Cape with more than 10 000 hospital beds in their hospitals. Mpumalanga, Limpopo and Northern Cape had the lowest number of hospital beds per 10 000 people (Figure 2b). Gauteng, which was among those with the lowest number of hospitals per 100 000 people, fell under the second highest category with 20 hospital beds per 10 000 people. Free State, KwaZulu-Natal and Western Cape had the highest number of hospital beds per 10 000 people with 25, 24 and 24 respectively. Figure 2b also shows broad spatial distribution of private and public hospitals across different provinces.

With regard to the number of ICU beds per 10 000 people, Limpopo and Mpumalanga fell under the lowest category of 0.10 to 0.28 ICU beds per 10 000 people (Fig. 3a). Only Gauteng, followed by Free State and Western Cape, had the highest ICU beds per 10 000 people. Fig. 3a further depicts the spatial distribution of hospitals earmarked to attend to COVID-19 patients. Almost all provinces, except Gauteng, seems to have unbalanced location of the COVID-19 hospitals. The authors are not aware of the factors that were considered when selecting the current COVID-19 hospitals. From a geographic point of view, it appears that the hospitals in each province are often located in some major cities which are not necessarily centrally located within their province. Therefore, these hospitals are not easily accessible to a large proportion of a province's population, especially if the patients will be transported by road. Hence, at least two hospitals per province could have resolved the skewness of this spatial distribution. KwaZulu-Natal in particular has all three COVID-19 hospitals around Pietermaritzburg, which raises some spatial concern in terms of physical accessibility of these COVID-19 hospitals. For the vulnerable population, the elderly, a similar pattern was noticed, with the exception of the Eastern Cape, which ranked in the second lowest category of numbers of ICU beds per 10 000 people but had one of the lowest numbers of ICU beds per 10 000 elderly people. Limpopo, Mpumalanga and the Eastern Cape had between 1.17 and 3.24 ICU beds per 10 000 elderly people (Fig. 3b).

Discussion

Our study findings shows that, overall, people reported having low confidence in the South African health system, with only two out of five people indicating they thought the health system would manage to deal with COVID-19 pandemic. In similar studies conducted in Denmark and Finland, respondents reported high rates of confidence in their health systems to deal with COVID-19 with 86% and 78% respectively (Norrestad 2020a; 2020b).. Black Africans, those employed part-time or informally and informal dwellers had higher confidence in health system capability while Whites, self-employed and those residing in formal dwellings had lower confidence in health system capability to deal with COVID-19. This demonstrates clear divisions based on socio-economic status, geolocation as well as some racial differences in peoples' perceptions. The majority of the Black Africans rely on the public health system almost exclusively therefore this increased confidence could well be due to the fact that they would not have alternative options in terms of access to health care, traditional forms of treatments aside. The lower confidence shown here by White respondents could be directed at the public health system and not the private which is usually very well resourced. The majority of Whites have access to medical insurance and therefore private medical care.

Also concerning is that, the elderly (70 years and above), those who perceived themselves at high risk of contracting COVID-19 and those who thought they might end up in self-isolation or quarantine had lowest confidence in health system capability to manage COVID-19 pandemic. People in older age groups are among those that are classified as highly vulnerable to COVID-19 pandemic around the world both in terms of infections and fatalities (WHO 2020).

Sex and knowledge on COVID-19 were significantly associated with the perception of the health system's capability to manage the pandemic at the national level and in four of the nine provinces. Females were less likely to have confidence on health system's capability to manage COVID-19 outbreak than their male counterparts. The finding that men have more confidence in the health care system is surprising since previous studies reported that men generally access health care services much less than women do (van Heerden et al. 2015). It is possible that women lacking confidence in the health system's capability could be associated with how they perceive the quality thereof. Future research would need to examine perceptions of health system's capability together with the quality. Age and self-isolation or quarantine possibility key at national level and in three provinces while employment and risk perception were significant predictors at national level and in two provinces. The vulnerable group, elderly (60 years

and older), were key determinant of people's confidence on health system capability to deal with COVID-19 pandemic at national level and in Western Cape. People's risk perceptions (which are influenced by age and degree of perceived vulnerability) and knowledge about a public health problem often result in lower confidence in managing the problem.

Spatial accessibility has been previously reported to represent an important barrier to accessing healthcare services (Munoz and Källestål 2012). Spatial accessibility of COVID-19 hospitals in our findings raises some concerns regarding the readiness to deal with COVID-19 pandemic, especially considering that patients might have to be transported through roads. These could be addressed by at least adding extra temporary hospitals earmarked for COVID-19 in each province with one COVID-19 hospital. Provinces have already started setting up this additional health care facilities in preparation for the expected surge in the number of cases and the potential need for hospitalisation across the country. Mostly rural provinces such as the Eastern Cape and KwaZulu-Natal should also receive special context specific planning for the provision which addresses challenges such as long distances between villages and available hospitals as well as poor road infrastructure. These extra hospitals should be allocated based on the geographic location and population distribution as well as the emerging trends of the pandemic whereby the number of cases and epicentres have been shifting since the outbreak of COVID-19. The Western Cape Province initially only had one COVID-19 earmarked hospital in the early stages of the epidemic when our study was conducted. This later changed dramatically with now the province being regarded as the epicentre for the epidemic with leading number of confirmed cases and number of deaths, and this has had to be revisited and more hospitals being allocated as well as temporary hospitals being setup at the International Convention Centre for the fight against the COVID-19 pandemic. Other provinces with big urban metros such as the Eastern Cape, Gauteng and KwaZulu-Natal had to also readjust their plans as they all initially had three hospitals each that were earmarked for the response.

Our study finding shows that number of hospitals per population and number of hospital beds per population across the country are generally lower compared to some international statistics from both public and private hospitals such as in Canada, Italy and Japan (Wilson et al. 2018). The current national average of 5.6 ICU beds per 100 000 in South Africa is slightly lower compared to those of some European countries such as the United Kingdom (6.6), France (9.7) and Italy (12.5). Turkey and Germany had one of the highest reported numbers with 46 and 29.2 ICU beds per 100 000 population (WHO 2020). As indicated earlier, the country currently has lower ICU beds available compared to the number of ICU beds that may be required (3318 vs 14 700) at the highest peak of COVID-19 infection (du Toit and Cowan 2020). This means that there are currently on average 0.56 ICU beds per 10 000 people across the country. At the highest peak, worst case scenario, national average of 2.50 ICU beds per 10 000 people will be required. If we take this into account, this means that there is a lot to be done in all provinces to reach the required national average. In particular, urgent attention is needed to increase the ICU beds numbers in Eastern Cape, KwaZulu-Natal, Western Cape and Gauteng as they are currently at around 0.30, 0.51, 0.75 and 0.96 ICU beds per 10 000 people respectively. These four provinces require urgent attention as they are currently leading with confirmed cases of COVID-19 pandemic.

Findings from this paper shows that there were some similarities between people's perceptions on healthcare systems capability and the actual health systems capacity to deal with COVID-19 pandemic in some provinces. For instance, Free State was predominantly at upper band in terms of proportions of people who had confidence on the health systems capability and the actual health system capability to deal with the pandemic. Eastern Cape on the other hand was at the lower end with regard to people's confidence in health systems capability and health system capacity. Eastern Cape appeared at upper bound only on number of hospital per 100 000 and number of hospital

beds per 10 000 population. Surprisingly, Western Cape had the lowest score on people's confidence on health system capability in managing COVID-19, yet it was among the top for almost all density indicators of health systems capacity except for the density on number of ICU beds per 10 000 elderly people where it was in the middle of the range. Western Cape also had the highest significant proportion of elderly people based on the online survey results. In addition, results showed that the elderly (60 years and above) was significant predictor of people's confidence in health system capability (OR = 0.49, $p < 0.05$). This might have attributed to the lowest confidence on health system capability in this province. Although North West and Limpopo had the highest proportions of people who felt that the health system was capable to deal with COVID-19 outbreak, they were among the lowest in all health system capacity indicators.

The outbreak of the COVID-19 epidemic showed and demonstrated the urgency and the importance of the NHI implementation, especially in addressing the inequity access to healthcare that exists between private and public health care. The COVID-19 pandemic has laid bare the health disparities that exists between different communities that exists in the country due to historical structural systems brought about by both colonialism and Apartheid race based special planning and service provision. The NHI is now more than ever our only hope in correcting the mistakes of the past. This outbreak provides the first and best opportunity for South Africa to reengineer the country's health system to be united and integrated as much as possible between the public and the private health care systems. The COVID-19 block exemption for the health sector is an important step towards the testing the implementation of NHI. The government and all role players in the country should embrace this opportunity and make it real by ensuring that all systems that are necessary for the NHI implementation are put in place and expanded upon.

This study does have some limitations. One of the main limitations was that there was no clarity on the online questionnaire on whether South African health system included both private and public sector. So there might be underestimation or overestimation on the people's confidence on health system capability to deal with COVID-19 depending on how they understood and experience the health system. Respondents may also have been responding on their perceptions of the public health care system regardless of whether they utilise those services or not. Other than the above mentioned limitations, findings from this paper gives a rough picture of what are people's perception on the South African health system capability and the current state of health system capacity to deal with COVID-19 outbreak at provincial and national levels across the country.

Conclusion

To the best of our knowledge this paper was the first to investigated perception of the South African health system capability and its actual health system capacity to respond to the COVID-19 pandemic and its subsequent spread. Overall, most people reported having low confidence in the health system's capability in managing COVID-19 outbreak and that may be due to having the wrong perceptions or may be due to prior bad experiences in their interaction with health care facilities and services. Sex and knowledge on COVID-19 were significantly associated with the perception of the health system's capability to manage the pandemic at the national level and in four of the nine provinces. Females were less likely to have confidence on health system's capability to manage COVID-19 outbreak than their male counterparts. Overall, the findings of this study clearly highlights the challenges on the country's health system both perceived or real that needed to be addressed as part of the preparation for the COVID-19 pandemic. Urgent policy interventions and implementations are recommended for continued increase in the number of ICU beds across the country with particular focus in Western Cape, Eastern Cape, KwaZulu-Natal and

Gauteng. Timeous implementation of a countrywide NHI system is now more critical than ever in improving health care outcomes of the South African population even beyond the existence of the COVID-19 epidemic

Declarations

Consent

Informed consents were obtained from participants before participants proceeded to the online survey questions. Participants were informed that their participation was voluntary and that they could withdraw from the online survey at any time should they wish so.

Author Contributions SPR conceived the study and TM conceptualised the paper. TM and RS conducted the analysis and interpreted the results. TM drafted the manuscript. TM, RS, SS, GWS, SD, TMa, IN, WP, ND, SJ, SP, KZ, MMo, MM, SPR contributed to interpreting the results and editing the manuscript. All authors read and approved the final manuscript before submission.

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Figures

Figure 1

Percentage of people who indicated they believe that the health system was able to manage the COVID-19 outbreak

Figure 2

Hospital and hospital beds densities, Left: a) number of hospitals per 100 000 people and right: b) number of hospital beds per 10 000 people

Figure 3

ICU beds densities, Left: a) number of ICU beds per 10 000 people and Right: b) number of ICU beds per 10 000 elderly people