Physicians Availability and Associated Factors at Ministries of Health Facilities in Sudan in 2019

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Abstract

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Background: In 2006, Sudan was not considered as a country with a critical shortage of human resources for health (HRH). Nevertheless, 12 years later, with the substantial changes in Sudan socioeconomic environment, the HRH situation looks less promising. Physicians' density was estimated to be 0.314 per 1000 population in Sudan, even though Sudan produces many physicians. By 2009, an average of 2485 medical doctors were graduating annually from medical schools in the country. However, in 2005, it was estimated that over 60% of Sudanese physicians' practice outside the country, and Anecdotal reports suggest that physicians' coverage and distribution is inadequate, but the full extent of the problem has not been determined.

Methods: Quantitative and qualitative primary data was collected from a representative sample of 491 health facilities and critical informants from different HRH stakeholders at the federal and state levels in January 2019. Physicians' availability was determined according to minimum standards at each level of health facility set by the Federal Ministry of Health (FMOH). Factors associated with low vs. high physicians' availability were assessed using logistic regression.

Results: Of the facilities surveyed, 41% did not have a single physician providing services, and only 15% of the facilities had a number of physicians that met or exceeded FMOH minimum standards. Statistically significant associations were found between low physicians' availability and health facility location outside Khartoum state (OR 7.7, 95% CI 4.9 – 12), facilities in rural areas (OR 4.5, 95% CI 2.9-6.8), secondary level compared to tertiary level facilities (OR 3.2, 95% CI 1.3-8.4) and facilities perceived not fit to provide services compared to facilities perceived fit to provide services (OR 3.9, 95% CI 1.3-8.4). Statistically significant associations were also seen between physicians' availability and the presence of public schools, private schools, and private hospitals in the facility area.

Discussion: We found low physicians' availability in government health facilities, especially outside Khartoum, in rural areas, and PHC facilitates. Physicians availability was associated with facilities fitness to provide services and availability of schools and private hospitals in the area. The potential for utilizing expansion of specialization opportunities across Sudan as a means to retain physicians should be explored and generating better data would help design an evidence-based physician retention strategy to guide FMOH retentions efforts.

Introduction and Rationale:

The severe shortage of health workers across the world is a critical challenge to the achievement of health and development goals. The crisis is impairing health systems capability to provide essential services and embedding adequate response to security threats and emergencies.[1] With broader aspirations to attain Universal Health Coverage (UHC), bridging the gap in health services providers is crucial.[2]

In 2006 Sudan was not considered as a country with a critical shortage of human resources for health (HRH).[3] Nevertheless, 12 years later, and with the substantial changes in Sudan socioeconomic environment, the HRH situation looks less promising. Health workers density is approximately 1.9 for 100,000 population and physicians' coverage and, distribution is hard to be determined.[4,5] The last available estimate is from 2008, where physician's density was estimated to be 0.314 per 1000 population.[5] There are wide geographical disparities with about 70% of health personnel working in urban settings; of these, 38% are in the capital of Khartoum. Around 67% of the health workers are working at secondary and tertiary health facilities opposed to only 33% in PHC settings, which dramatically weakens the country's ability to achieve its strategic objectives of extending UHC.[4]

This shortage in HRH generally and in medical physicians more precisely is unique in the light of the increasing number of students joining the medical colleges around Sudan. Medical education in Sudan expanded from 3 schools in 1978 to 33 by 2014.[6,7] This number is quite considerable compared to the availability of medical education in Sub - Saharan Africa and the Middle East where there were 127 and 142 Medical Schools by 2014.[8]

The 2004 -2013 HRH projection plan estimated 6965 graduates in the years 2011-2013 and surplus of 6008 doctors during the ten years plan. Medical Physicians graduation has exceeded the 2004- 2014 projections as, by 2009, an average of 2485 medical doctor were graduating per year.[4] Nevertheless, migration and brain drain seems to consume the physicians produced in Sudan at an unprecedented pace.

In 2005 it was estimated that over 60% of Sudanese physicians' practice outside the country and about 26% of medical graduates are estimated to be lost to migration every year.[9] A 2018 study found that more than one-third of new graduating physicians taking the Medical Licensing Examination intended to emigrate immediately and another 30% within two years.[10] Physicians migration phenomenon was exacerbated by the advent of licensed active physicians' recruitment agencies. From 2008 to 2011 about 4000 physicians applied for work in Saudi Arabia through these agencies.[9]

Although there are HRH strategic plans for Sudan, clear policies to address physicians' migration are deficient. Stakeholders seem to lack consensus about the effects of medical migration and whether it should be combated. Also, the Sudanese Government leans towards encouraging migration.[9,11]

FMOH is pursuing increasing specialist in 9 fields (Cardiology, Neurology, Orthopedics, Urology, Ophthalmology, Endoscopy, Intensive Care for Neonatology, Diagnostic Radiology, and Anesthesiology), availability in through "The project of localization of micro-specialties and retention of specialists" started in 2014. The project considers a specialization covers a state if one specialist is providing services, and 80% of the specialization requirements are present in the state. Despite the modest goal, the project was

only able to report 100% coverage in three states only, i.e., Khartoum, Gazira, and the Red Sea. While in states like South Kurdufan and Central and East Darfur, coverage rates are 44%.[12]

Absence of reliable data on HR availability in Sudan impedes addressing the problem. The HRH Strategic Plan states that appropriate situation analysis, e.g., conduction of survey on health workforce distribution is needed for reaching FMOH targets.[4]

Several players interact during the different phases of HRH training and production in Sudan. These include FMOH which is responsible for setting policies, strategic direction and plans, Ministry of Higher Education as the primary producers of HRH, Sudan Medical Specialization Board (SMSB) which manages and delivers specialty programs and, the Medical Specialization Council (MSC) which ensures that the medical schools in Sudan are comparable to the international and regional standards.[4,5,13,14]

With the secession of the South and the instabilities it presents, a changing socioeconomic landscape and an influx of refugees, Sudan's health system is facing intense challenges. Sudan produces large numbers of physicians compared to other countries in Africa; however, a large number of medical graduates migrate to other countries. Now more than ever, identifying modalities to combat health workforce migration while applying innovative strategies for health workforce retention is crucial to ensure a responsive health system capable of providing consistent quality health services especially with the ongoing current FMOH plan to achieve UHC through the Primary Health (PHC).[15]

General Objective:

To determine the availability of physicians in SMOH health facilities in Sudan and the factors associated with high vs. low physicians' availability and to examine the health system ability to fill arising vacancies.

Specific Objectives:

- To determine the availability of physicians in SMOH facilities in Sudan by:
    - Tertiary, secondary and, PHC levels
    - Khartoum vs. Outside Khartoum and Urban vs. Rural settings
    - Health facility fitness to provide service (does the respondent perceive the facility to be qualified to provide the health services that should be delivered adequately), cleanliness level, and maintenance level
    - Availability of public schools, private schools, and private hospitals in the area
- To determine the factors associated with high vs. low physicians' availability.
- To examine the health system ability to respond and fill arising vacancies.

Methods:

Sampling:

The study employed a mixed method design with a survey sent to health facilities and key informant interviews. The surveys used stratified random sampling with a sample of 504 health facilities out of 2773 SMOH facilities where health services were designed to be provided by physicians. We calculated a sample size of 197 hospitals and 307 health centers to provide 80% power to obtain statistically significant differences with physician vacancy 10% in health facilities in Khartoum and 20% outside Khartoum and a margin of error of 5%.

For the key informant interviews, purposive sampling was used to select knowledgeable respondents from the different HRH stakeholders across the health system governance, management, and service delivery levels. Interviews requests were sent to 12 key informants nevertheless, interviews were completed with 9 informants only, including, FMOH Undersecretary, Head of HRH Department, Deputy Director - Hospital Affairs Department -FMOH, Director - SMSB, Deputy Director – SMC, Director of Curative Medicine – SMOH, Kasala , Director of Curative Medicine- SMOH, Northern State, and HRH Director – SMOH, West Darfur.

The study was presented to FMOH Ethics Review Boards for approval, and verbal informed consent was obtained before the interviews.

Data collectors were assigned from different SMOHs. The questionnaire was filled through onsite or phone interviews. For more detail on the questionnaire and semi-structured interview guide, refer to Annex – 1, 2 and 3.

Data Management and Analysis:

The proportion of filled physicians' post in the responding health facilities was calculated. The denominator for calculating vacancy proportion per facility was determined using FMOH "Description and Specifications of Health Services and Health Units Document." Summary for denominator determination is detailed in Annex 4. Health facilities were grouped into four categories according to physicians' availability proportion, i.e., facilities with no physicians' providing services, facilities with less than half of the minimum standard met, facilities with half or more of minimum standard met, and facilities that meet or exceed the minimum standard. Distribution of physicians’ vacancy and the facility managers estimates of the average time required to fill physicians’ vacancies categories was examined according to the selected characteristic.

Association between the different characteristics of the health facilities and the areas at which the health facilities are located in, and physician availability (high or low) and, the average time required to fill physicians' vacancies were examined using a logistic regression model. Details on the determination of cut off points for the logistic regression model can be found in annex 5.

For the qualitative data, interviews were analyzed manually, and themes were derived empirically through repetition, constant comparisons, identifying metaphors and analogies and, cutting and sorting.

Results:

Survey Results

Out of a total desired sample of 504 health facilities, 491 facilities managers filled out the questionnaire, giving a response rate of 97%. Table 2 provides a summary of the distribution of the selected characteristics of the responding facilities. Approximately one-third of the responding health facilities were located in Khartoum state, four-fifths were PHC level facilities and, slightly less than three-quarters were in rural areas. The majority of the responding health facilities (nine out of ten) were in areas served by a public school, while only around one-third were in areas served by a private school and, about a quarter were in areas served by a private hospital.

Around half of the responding facilities were considered to be well maintained and fit to provide services. The percentages of facilities that were perceived fit to provide services and have good cleanliness level were higher in Khartoum state.

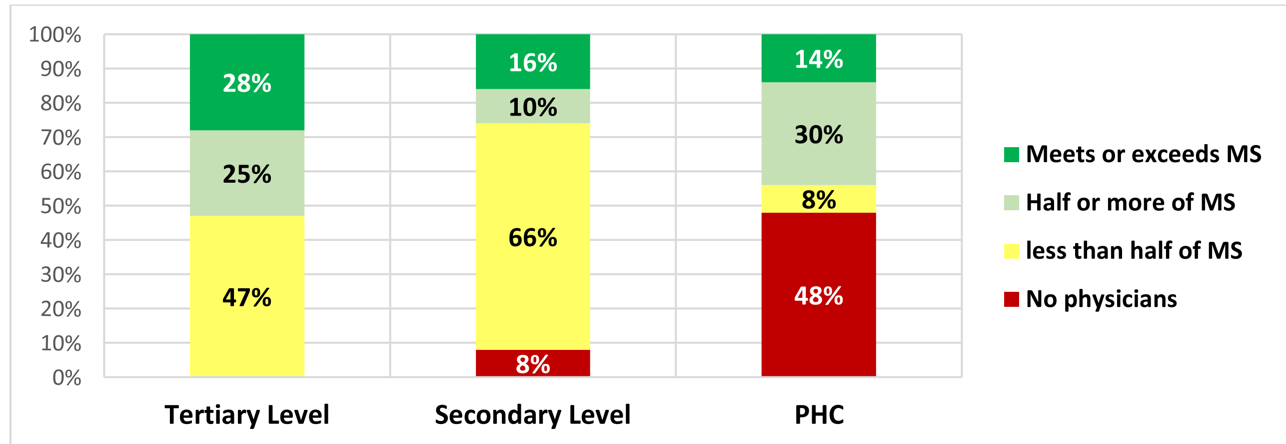
Table2: Health Facilities Distribution by the Selected Characteristics

Characteristics		Total Sample		Khartoum		Other 17 States	
		n	(%)	n	(%)	n	(%)
Khartoum Vs. Other 17 Sates		491	100	141	0	350	71
Health Services Level	PHC	409	83	115	82	384	84
	Secondary	50	10	11	8	39	11
	Tertiary	32	7	15	11	17	5
Area Type	Urban	145	29	81	42	64	18
	Rural	345	71	59	57	286	82
Public School in the Area	Yes	443	90	116	82	327	93
	No	36	7	20	14	16	5
Private School in the Area	Yes	152	31	80	57	72	21
	No	315	64	50	36	265	76
Private Hospital in the Area	Yes	118	24	62	44	56	16
	No	365	74	78	55	287	82
Maintenance Level	Good	235	47	70	50	165	47
	Average	141	29	28	20	43	31
	Poor	114	23	43	31	71	20
Cleanliness Level	Good	342	70	114	81	228	65
	Average	111	23	22	16	89	25
	Poor	36	7	5	4	31	9
Fitness to Provide Services	Fit	256	52	90	64	166	47
	Average	140	29	43	31	97	28
	Not Fit	60	14	8	6	60	17

Compared to the minimum standard of physicians required by health facilities, 41% of the responding facilities had no physicians providing services, 28% had half or more, 16% had less than half and, 15% had a number of physicians that meets or exceeds FMOH minimum standard.

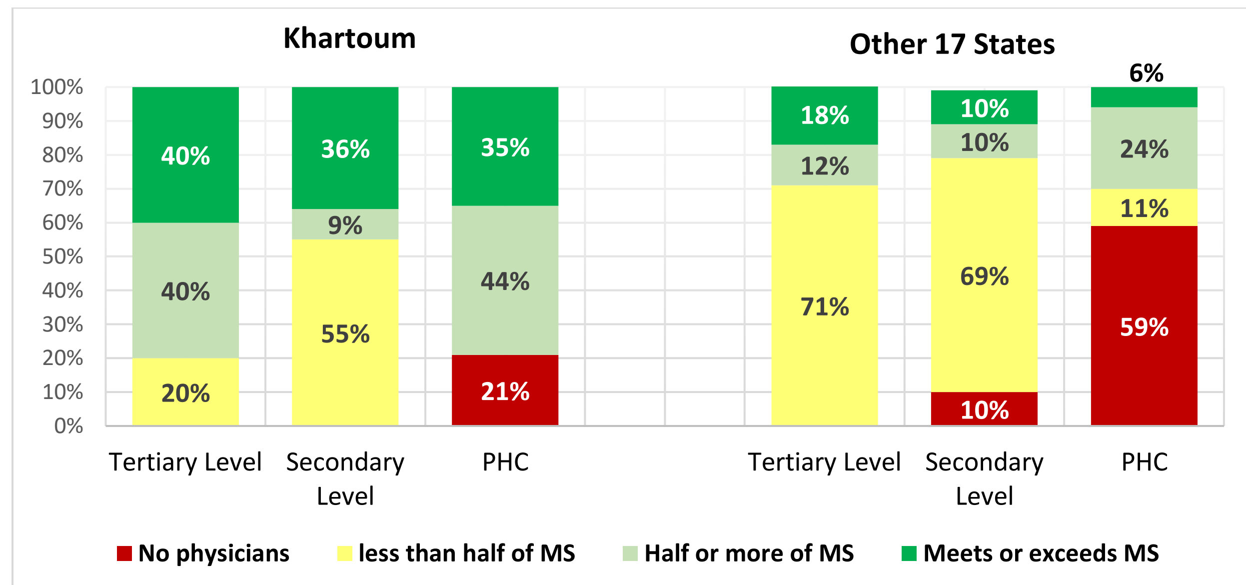
As shown in Figure 1, when physicians' availability was examined by health service level, slightly less than half of the PHC facilities had no physicians providing services while all tertiary level facility had physicians providing services. About two-thirds of the secondary level health facilities had less than half of FMOH minimum standard of physicians.

Figure 1: Physicians' Availability of Minimum Standards (MS)- By Health Services Level (Total Sample)



Examining the data in Khartoum vs. other 17 states, not a single secondary or tertiary level facility in Khartoum, had no physicians providing services (see Figure 2). More than three-quarters of the tertiary health facilities in Khartoum were equally distributed between meeting or exceeding minimum standards or having more than half of the minimum standard of physicians while slightly less than three-quarters of the tertiary health facilities in the other 17 states had less than half the minimum standard.

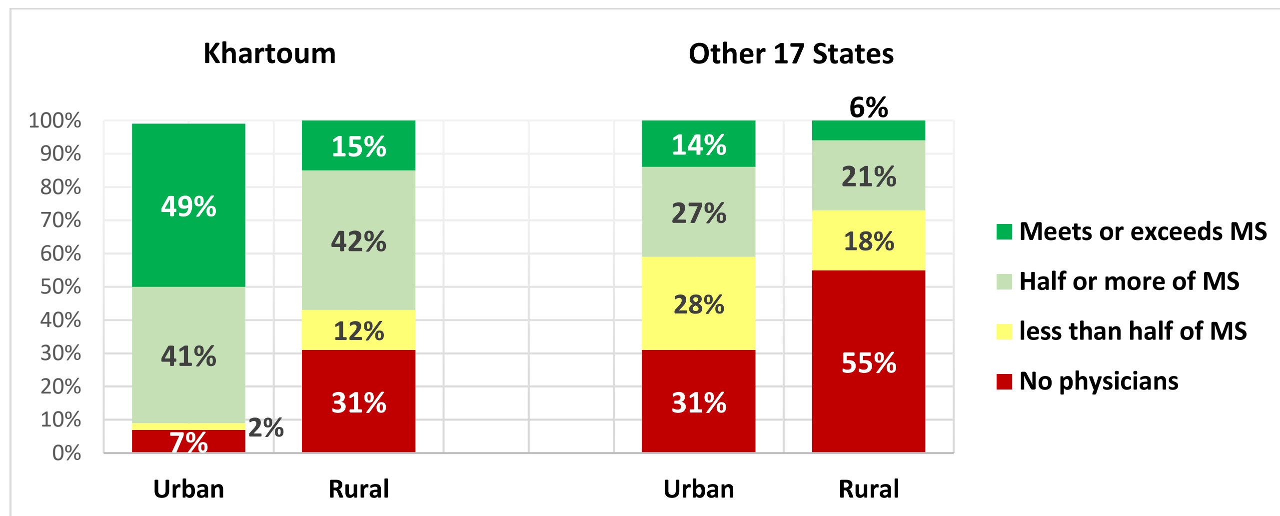
Figure (2): Physicians' Availability of Minimum Standards (MS) – By Health Services Level in Khartoum state Compared to the Other 17 States



When physicians availability was examined by whether the facility is located in Khartoum State or not (Figure 3), Khartoum demonstrated higher physicians availability with more than one-third of the facilities meeting or exceeding the minimum standard, and around two-fifths of the facilities had half or more of the minimum standard. On the other hand, half of the facilities outside Khartoum had no

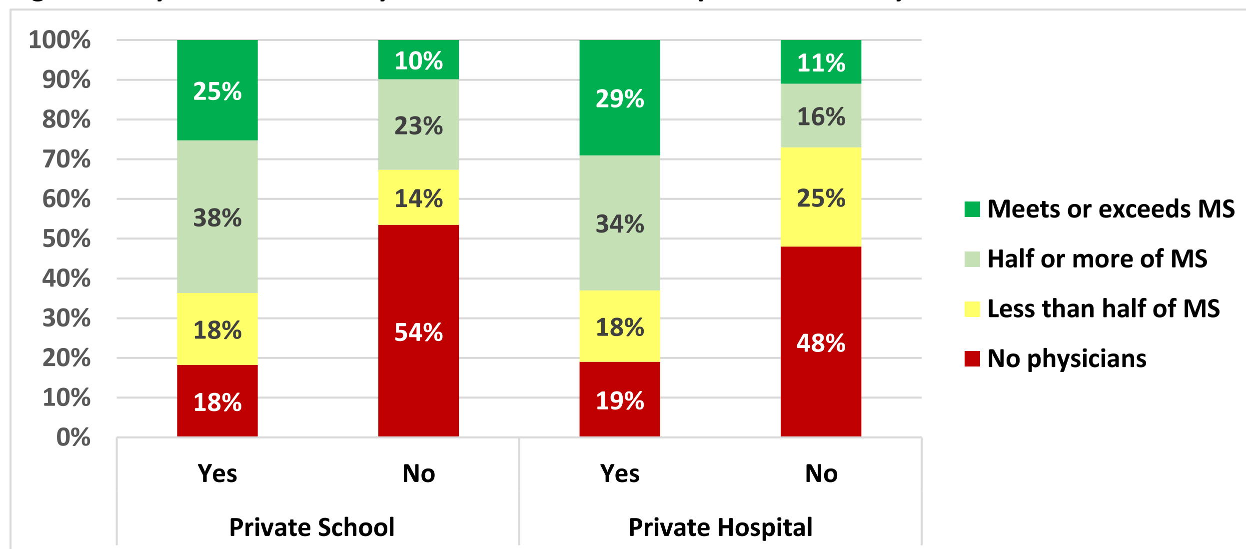
physicians providing services. Also, facilities in rural areas demonstrated lower physicians availability, where half of the facilities in rural areas had no physician providing services. Similarly, as Figure 3 details health facilities in rural areas continued to demonstrate lower physicians' availability even after segregating the data by Khartoum or the other 17 states.

Figure 3: Physicians' Availability of Minimum Standards (MS) – Urban vs. Rural Areas in Khartoum Compared to the Other 17 States



Facilities located in areas served by a public school showed lower physicians availability compared to facilities located in areas not served by a public school and areas served by a private school (Figure 4). Moreover, areas served by private schools and private hospitals have higher rates of physicians' availability.

Figure 4: Physicians Availability- Private Schools and Hospitals Availability in the Area



Physicians availability varied among the different levels of perceived facility fitness to provide services. Approximately three-quarters of the health facilities perceived not fit to provide services had no single physician. Health facilities with different levels and cleanliness level showed less variation in physicians availability distribution. Summary of physicians' availability according to the different health facilities characteristics are found in Table 3.

Table 3: Physician Availability by the selected Facility Characteristics										
Characteristics		**Physicians Availability**								
		No physicians available		**Less than half of MS**		**Half or more of MS**		**Meets or exceeds MS**		
		n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
State	**Khartoum**	24	17	9	6	58	41	40	35
	Other	176	50	70	20	78	22	26	7
Area Type	**Urban**	26	18	20	14	50	34	49	34
	Rural	174	50	59	17	86	25	26	8
Public School in the Area	**Yes**	192	43	68	15	120	27	63	14
	No	5	14	8	22	14	39	9	25
Private School in the Area	**Yes**	28	8	28	18	58	38	38	25
	No	169	54	45	14	71	23	30	10
Private Hospital in the Area	**Yes**	23	19	21	18	40	34	34	29
	No	174	48	57	25	93	16	41	11
Maintenance Level	**Good**	82	35	48	20	64	27	33	17
	Average	68	48	20	14	39	27	14	10
	Poor	49	43	11	10	33	29	21	18
Cleanliness Level	**Good**	137	40	54	16	96	28	55	16
	Average	48	43	17	15	30	27	16	14
	Poor	14	39	7	19	10	28	5	14
Fitness to Provide Services	**Fit**	88	34	75	18	45	29	48	19
	Average	59	42	17	12	46	33	18	13
	Not Fit	50	74	5	7	10	15	3	4

As seen in Table 4, several statistically significant associations emerged between the selected health facilities and, location characteristics, and physicians' availability. The largest statically significant odds ratio was for low physicians' availability (number of physicians less than 50% of FMOH minimum standard per facility type) in health facilities outside of Khartoum compared to facilities in Khartoum (OR 7.7, 95% CI 4.9 – 12). Also, the odds of low physicians' availability in secondary level hospitals was 3.2 times the odds of low physicians' availability in tertiary level hospitals (95% CI 1.3-8.4). The odds of having low physicians' availability in health facilities perceived not fit to provide services was 3.9 times the odds of having low physicians' availability in those perceived fit (95% CI 1.3-8.4). The odds of low physicians' availability in rural areas was 4.5 times the odds of having low physicians' availability in urban areas (95% CI 2.9-6.8). Facilities located in areas not served by a private school had 3.6 times the odds of having low physicians' availability compared to facilities located in areas served by a private school (95% CI 2.4-5.5). Health facilities located in areas not served by a private hospital had 2.9 the odds of having low physicians' availability compared to health facilities located in areas served by a private hospital (95% CI 1.9-4.5).

A statically significant negative association emerged between the availability of public school in the area and low physicians' availability. Contrary to the other factors examined health facilities located in areas served by a public school had 0.4 the odds of low physicians' availability compared to health facilities in areas not served by a public school (95% CI 0.2-0.8).

When the data for Khartoum and the other 17 states were examined separately, the statistically significant associations between availability of physicians' in health facilities in Khartoum and the different characteristics did not persist except for the higher odds of low physicians' availability associated with working in rural areas. Nevertheless, the statistically significant relationships between physicians' availability and whether health facilities are perceived fit to provide services or not, the presence of a private school and a private hospital in the area in addition to the association with facilities location (urban or rural) persisted in health facilities outside Khartoum.

Table 4: Association between Physicians Availability Facilities and Area Characteristics:										
Dependent Variable: Physicians Availability Low (less than 50% of FMOH minimum standard per facility type) Vs. High (50% or more of FMOH minimum standard per facility type).										
Independent Variable	**Base Comparison**	**Overall**			**Khartoum**			**Outside Khartoum**		
		P value	**OR**	**95% CI**	**P value**	**OR**	**95% CI**	**P value**	**OR**	**95% CI**
State	Other vs. Khartoum state	<0.001	7.7	4.9 - 12						
Area Type	Rural vs. Urban	<0.001	4.5	2.9-6.8	<0.001	6.7	2.8-17.3	< 0.05	1.8	1.03-3
Health Services Level	PHC vs. Tertiary	0.347	1.4	0.7-2.9	0.938	1.1	0.3-4.9	0.894	0.9	0.3-2.6
	Secondary vs. Tertiary	< 0.05	3.2	1.3-8.4	0.076	4.8	0.9-31	0.470	1.6	0.4-6
Maintenance Level	Average vs. Good	0.178	1.3	0.9-2	0.477	1.5	0.5- 4	0.889	1.03	0.6- 1.8
	Poor vs. Good	0.636	0.9	0.6-1.4	0.156	1.9	0.8-4.7	0.471	0.8	0.4-1.5
Cleanliness Level	Average vs. Good	0.6168	1.1	0.7-1.7	0.923	0.94	0.3- 2.7	0.428	0.8	0.5-1.4
	Poor vs Good	0.7751	1.1	0.6-2.3	0.850	0.8	0.04- 5.7	0.395	0.7	0.3-1.6
Fitness to Provide Services	Average vs. Fit	0.657	1.1	0.7-1.7	0.894	1.1	0.4-2.5	0.996	0.99	0.6-1.7
	Not Fit vs. Fit	<0.001	3.9	2-7.8	0.337	2.1	0.4- 9.3	<0.01	3.04	1.4-7.6
Public School in the area	No Vs. Yes	< 0.05	0.4	0.2-0.8	0.125	0.3	0.04 -1.1	0.913	0.9	0.3-3
Private School in the Area	No vs. Yes	<0.001	3.6	2.4-5.5	0.173	1.7	0.3- 1.3	<0.001	2.5	1.5- 4.3
Private Hospital in the area	No vs. Yes	<0.001	2.9	1.9-4.5	0.518	1.3	0.6-3	<0.01	2.2	1.2-4

The average time required to fill physicians' vacancies varied between less than 3 months for 41% of responding facilities, 1 year or more for 34%. More than one-third of the PHC facilities reported that less than 3 months is needed compared to around half the tertiary level hospitals. In Khartoum, more than half of the arising vacancies took less than 3 months to be filled compared to less than one-third in the other 17 States. More than half of the health facilities located in urban areas took less than 3 months to fill vacancies compared to less than one-third of facilities in rural areas. Health facilities in areas where there is a public school did not show marked variation in the average time required to fill physicians' vacancies. On the other hand, more than half the health facilities in areas where there is a private school and in areas where there is a private hospital reported that it takes less than 3 months to fill physicians' vacancies. More details can be found in Table in Annex 6.

Examining the association between the average time required to fill physicians' Vacancies and facilities location characteristics, several statistically significant associations emerged. Facilities outside Khartoum had 3.5 times the odds of taking long average time (7 months or more) to fill vacancies compared facilities in Khartoum (95% CI 2.1- 5.4). Health facilities in rural areas had 2.5 the odds of taking a long average time compared to facilities in urban (95% CI 1.6-3.9). Health facilities with average maintenance level had 1.7 the odds of taking a long average time to fill vacancies compared facilities with good maintenance levels (95% CI 1.04-2.6). Association between average time to fill vacancies has also emerged with the presence of public schools, private schools, and, private hospitals in the area. More details can be found in Table 2 in Annex 6.

Interview responses:

The responses of most of the interviewees formulated three two themes namely (1) physicians' availability situation in Sudan and causes of low physicians' availability and (2) ongoing efforts to improve physicians' availability.

Physicians Availability and Vacancies Length:

Federal informants agreed that there is low availability of physicians in SMOH facilities in Sudan and knew well that it varied between Khartoum and the other states and between urban and rural areas. Nevertheless, they raised concerns that with no robust data, these perceptions remain to be informed guestimates that rely on reports that are not comprehensive nor accurate.

At the state level, informants perception about physician's availability varied with some states reporting low availability in areas that are considered geographically remote or less accessible, e.g., Northern State, while others highlighted very low physicians' availability in all of the states in addition to very high turnover rates, e.g., West Darfur. Also, informants argued that the increase in the number of medical graduates is not materializing as increased availability of physicians.

Key informants attributed low physicians' availability to several push factors including low wages, absence of or poor-quality accommodation and less optimal work environments, i.e., inadequate facilities qualification to provide services in term of infrastructure, availability of allied health workers and equipment. They emphasized that the availability of educational services and amenities for physicians' families shape physicians' willingness to serve in an area. Further, informants added that in some states, security concerns reduce physicians' willingness to serve. Also, our informants stated that high demand for health workers and physicians from other countries; for example, Saudi Arabia is draining large numbers of physicians that are looking for a better economic situation.

Further, informants added that physicians' inclination to pursue specialization pathways contributes to their migration or concentration in Khartoum to be able to work in environments equipped to support their clinical competencies development. One respondent emphasized this by saying

"No doctor, or a very minimum number, want to sit in a clinic in the middle of nowhere. Doctors need to continuously move and develop professionally."

Several informants indicated that a substantial number of physicians' posts that are officially open or planned by FMOH and SMOH are either not created or not financed in the first place. Respondents shared that because of the economic climate, the Ministry of Labor keeps firm regulations that limit the creation of new jobs to accommodate the needed number of physicians. Besides, although some jobs might exist and financed, the states could decide to channel the funding to other areas. One respondent stated that

"Sudan is expanding health facilities and increasing the production of health workers, but the problem is in the labor market or the economic capacity to create decent jobs so we can distribute these workers to these health facilities."

Informants stated that there was no systematic way to report and follow up on vacancies and emphasized that states proactiveness to fill the vacant posts is essential in determining vacancy length. Also, one informant stated that having health professionals as decision-makers at the state government improves states' response and the follow up for filling arising vacancies.

Efforts to improve physicians' availability:

Informants agreed that there are continuing efforts to address low physicians' availability and high turnover through the provision of monitory and non-monitory incentives; nevertheless, we found no consistent vision regarding these efforts. Respondents believed that although some efforts have improved the situation of physicians' availability, they were not able to reach their target. They shared that the efforts to attract and retain physicians suffered from limited budgets, varying political commitment, and fragmentation. One informant stated that despite the multisectoral nature of the reasons behind low physicians' availability, there is weak coordination within the health sector and with the other concerned sectors.

"FMOH or the NHIF might try to move the agenda, but other sectors that are directly responsible might not see it as a priority or are unwilling to commit or engage in the discussion itself."

One key informant mentioned that although the government of Sudan does not oppose physicians' migration, a better stance on physicians' migration management is needed. Potential of expanding specialization opportunities within and outs side Khartoum to retain and better distribute physicians should be explored.

Also, respondents emphasized that the overall economic situation of the country significantly hampered these efforts since the programs that relied on providing additional top-ups to hire and retain physicians suffered from currency devolution which meant that the planned top ups lost their value and capacity to attract physicians.

Additional systematic factors that respondents suggested might limit the success of the initiatives included unclear roles and responsibilities between that federal and state level, the concentration of specialization opportunities in Khartoum, and unclear physicians' career pathways. Key informants have stated that although in a decentralized system like Sudan jobs are a state responsibility, the federal level is still playing a significant role in contracting and availing physicians. Also, informants agreed that states' commitment to avail budgets and the needed environment of physicians to work or additional agreed upon incentives is not consistent. One respondent attributed this inconsistency to variation in political commitment across time, between the federal and state level and between states, saying *"States are less faithful."*

Regarding the concentration of specialization opportunities in Khartoum, for a physician to start their specialization pathway, they have to register in the SMSB and serve in accredited facilities that are mostly concentrated in Khartoum. One informant stated that although SMSB is contemplating expanding into the states, nevertheless this decision can only be taken by state-level authorities. Expanding specialization opportunities was a promising solution mentioned by 5 out of the 9 informants interviewed. Informants also said that because physicians training posts are at the federal level while civil service jobs are at the state level, physicians are not part of a continuous carrier pathway which puts them in a state of instability.
"Doctors find themselves getting hired and fired from civil service jobs many times," said one informant. Key informants also shared that this instability is further magnified by the fact that physicians must stay on long waiting lists before being able to secure these jobs.

Discussion:

The study revealed that there is a marked shortage of physicians in Sudan with a substantial number of health facilities not served by a single physician. Also, there are marked variations in physicians' distribution in Khartoum vs. the other states, between urban and rural areas, between the different levels of health facilities, local conditions of health facilities and, availability of schools and private hospitals in areas at which the facilities are located. The study also revealed that the most important factors for determining physicians availability in a health facility are presence of the facility in Khartoum or the other states, urban or rural area type, perceived level of fitness to provide health services and health facility level followed by presence of public schools, private schools and private hospitals in the area.

The inadequate coverage pattern is not unique to Sudan and comparable to many developing countries in sub-Saharan Africa.[16,17] Sudan does not seem to benefit from the high level of physician production compared to some other countries with high physicians' production. For example, in Eygpt, there is an overall excess of physicians, even after allowing for migration.[18] Our informants suggested that the poor work environment, lack of or poor accommodation and availability of educational services and amenities for the physicians' families in addition to physicians desire to pursue specialization profoundly influence physicians' work preferences. These are not factors limited to Sudan; similar push factors influence the availability of health workers in many developing countries.[19,20,21,22]

Association of low physicians' availability with facilities being outside Khartoum and in rural areas reflects that overall area development and affluence highly influences physicians' work preference. This explanation can be further supported by the positive association between low physicians' availability and the presence or absence of private schools and hospitals in the area. Although these associations are independent, the availability of private schools and hospitals indicates a better socio-economic development status in the area that reflects as purchasing power for private education and health services. Area development also translates into better living conditions, and private hospitals availability can provide additional revenues for physicians, which commonly influence physicians' work location preference.[19,22,23]

Our finding of low physicians' availability in the PHC level did not translate to a statistically significant difference with secondary or tertiary levels. This may be attributed to the cut-off point selected for determining whether the facility has high or low physicians' availability. Another explanation might be the presence of Model Health Centers (MHCs) that operate in Khartoum State, which are characterized by high numbers of physicians that exceeds FMOH standards for PHC facilities. These MHCs might have

skewed the Khartoum data on PHC level physician availability. MHCs are not part of the standard FMOH facilities definitions; hence, more information is needed about how this health services model was developed and why the facilities retain physicians. The statistically significant association of low physicians' availability in secondary level compared to tertiary level can be attributed to physicians' tendency to work in facilities that support progress in specialization pathway. Studies showed that health workers availability is influenced by aspirations for career development, skill enhancement, and training.[19]

Informants interviewed believed that expanding specialization could potentially improve physicians' availability. Also, a study by Nurelhuda et al. showed that offering scholarships to train abroad, advancing the standards of health facilities and providing on-site supervision encourages young physicians to serve in the states. According to Nurelhuda et al., physicians were willing to trade off US$ 608, US$ 333, and US$ 325 of their salaries for these factors, respectively.[10] Also, Snow, Rachel C et al. concluded that service in rural areas would be more appealing if it were linked to career advancement through training.[17] Therefore, expanding the specialization program might encourage young and mid-level physicians at least to delay early migration decision, especially with the substantial difference between junior and specialized physicians' salaries in some of the migration hotspots like Saudi Arabia.

The quality of public education might explain the odd negative association between low physicians' availability and the facilities located in areas served by a public school. Although education provision has expanded in Sudan, nevertheless its quality deteriorated.[24] There is an increasing preference for private education in Sudan as in many developing countries, due to inadequate public spending.[25] In Sudan, the education sector receives 2.2 of the GDP compared to 4.5% and 4% of the GDP in the Middle East and North Africa.[26]

Informants report that the number of physicians' jobs supplied by the Ministry of Labor is not adequate to meet SMOH facilities needs impede attributing physicians' shortage in Sudan solely to physicians' personal preferences. It indicates that systematic factors influence physicians' shortage in Sudan, whether economic, political, or health system related.

Distribution and associations of the average time needed to fill physicians' vacancies are comparable to physicians' availability patterns. Respondents linked variation in the time needed to fill vacancies to the proactiveness of SMOH teams. This might explain how maintenance level is associated with the average time required to fill vacancies since proactive teams are more likely to try to maintain health facilities. Nevertheless, lack of a systematic process for physicians' recruitment, probably outweighs of health proactiveness.

Study Limitations:

With a cross-sectional design, the ability to establish causation and determine association with high accuracy is limited. Despite randomization, the large sample size and use of logistic regression, other non-measured variables could still influence the results. Our estimates of FMOH standards might have misclassified some health facilities regarding the FMOH standard number of physicians per facility type

Non-response Bias: We collaborated with SMOH staff for data collection to ensure facilities collaboration and minimize non-response.

With our large sample size and high response rate from facilities, the quantitative component findings are likely generalizable to health facilities throughout Sudan. Nevertheless, given Sudan's unique social,

political and economic attributes that are neither comparable with characteristics of countries in sub-Saharan Africa or the Middle East and North Africa, there is limited ability to generalize the study findings to these regions. Also, since the interviews did not include practicing physicians, views from key stakeholders should be interpreted carefully and need to be further assessed through concept mapping studies that examine Sudanese physicians' perspectives.

Volatile political situation limiting data collection completion: The volatile political situation of Sudan hampered the data collection. There were wide demonstrations and physicians' strikes; hence, we were not able to complete the questioners and KII in several facilities.

Conclusion and Recommendations:

This study characterized the magnitude of physicians' shortage and maldistribution in Sudan and some of the causes associated with the shortage. The causes behind physicians' shortage and maldistribution in Sudan are multifaceted and need to be addressed through short- and long-term multi-level intervention packages.

There is a clear need for a policy on physicians' migration and retention in Sudan. Most importantly, having reliable data is crucial for developing a robust retention policy. Strengthening facility-level data on physicians' availability and vacancies status, conducting physicians' concepts mapping and taking physicians' perspectives into account and, establishing a database on physicians' migration is essential to guide FMOH physicians' retention efforts. Better data would help design an evidence-based, coherent physicians retention strategy to guide FMOH short- and long-term physicians retentions efforts. Potential for utilizing expansion of specialization opportunities across Sudan as a means to retain physicians is one option that should be explored. Finally, advocating for an intersectoral – all government - response to address the factors influencing physicians' availability is essential.

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