



INTEGRATING ORAL HEALTH INTO GLOBAL HEALTH

Challenges and opportunities for Sudan
Oral Health Care system





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Acronyms

DMFT:	Decayed, Missing, and Filled Teeth
FMoH:	Federal Ministry of Health
LIC:	Low Income Country
HCS:	Health Care System
MoE:	Ministry of Education
MoF:	Ministry of Finance
NCD:	Non-Communicable Disease
OOP:	Out-Of-Pocket
PHC:	Primary Health Care
SDG:	Sustainable Development Goal
SHIF:	Social Health Insurance Fund
SMoH:	State Ministry of Health
UHC:	Universal Health Coverage
WHA:	World Health Assembly
WHO:	World Health Organization

Foreword

Worldwide oral diseases remain the leading causes of ill health among people. It is estimated that oral diseases affect nearly 3.5 billion people and that treatments for oral health conditions are expensive and usually not part of Universal Health Coverage (UHC). In addition to socio-economic determinants, oral disease is extremely related to lifestyle factors which are linked to most non-communicable diseases as well as protective factors such as appropriate oral hygiene or exposure to fluoride. Oral conditions' impact in terms of function's impairment, pain, suffering, and quality of life can be severe.

This Khartoum Office of the Italian Agency for International Cooperation (AICS), together with the Ministry of Health of the Red Sea State, planned and developed a survey aimed at assessing the main aspects of the Oral Health Care System (HCS). The analysis was developed in the Red Sea capital city, Port Sudan. In line of the outcomes of the 74th World Health Assembly, this report is an important tool in raising awareness and providing some inputs to address oral health as key component of global health in the Republic of Sudan.

Improvements in the primary health care sector require numerous harmonized and sustained measures, with special regard to the distinct and different needs of the Sudanese population. Reaching this objective will require a strong commitment among stakeholders at all levels: federal, state, district, and community levels, jointly with oral health care professionals. We hope this report will motivate organizations and key leaders to work on behalf of the Sudanese population and to take the important and necessary next steps to improve oral health, enhance access to oral health care, and reduce oral health disparities.

The study method aims to evaluate the main challenges faced by public dental providers to meet the population's health demand. Additionally, the assessment can provide useful insights and recommendations to frame targeted interventions in improving the alignment between Federal and State level authorities regarding dental care. This study is primarily driven toward the analysis of Sudanese governance, financing, human resource, training, care delivery, and health information system (HIS). Moreover, the population's oral health needs are investigated with the support of demand and supply analysis tools, developed by a joint bilateral effort with local oral health authorities and implemented in Port Sudan's public dental clinics.

I would like to express my sincere appreciation to all those who participate in the realization of this study.

Michele Morana
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AICS Khartoum Office

Executive summary

Oral health services in the Republic of Sudan are extensively covered by public and private providers. The Ministry of Health (MoH) collaborates with the National Health Insurance Fund (NHIF) to offer a comprehensive health benefit package, including free basic dental treatments and oral primary prevention services. Overall, the MoH and NHIF, as public provider and primary purchaser, show mutual accountability and common intents in providing long-term sustainable access to dental care for the entire population.

However, systematic barriers and challenges are being faced on a daily basis, weakening care delivery and raising cost-services without bettering the population's oral health outcomes.

First, the National Health Strategy Plan (NHSP) 2024-2021 provides a brief mention regarding oral health initiatives, basically calling attention to the integration of oral health into global health and strengthening UHC including oral health services at primary care level. Nevertheless, the Federal policy does not match with State level interventions. Also, the 2017 Oral Health Policy Plan, previously not considered in the NHSP, has not been endorsed yet, thus creating a gap in the political long-term agenda, and possible mismatch between Federal and State guidelines.

Second, the greatest extent of health care provision is offered by the private sector. While services are provided at the public level, MoH expenditure for dental services is under %1, meaning, most of the beneficiaries prefer rather to access the private sector or to skip dental care overall. Dental services at primary care level are distributed across the country preferring urban to rural area, even though rural dwellers represent the %70 of the Sudanese population. Secondary and tertiary level facilities offering dental care are rare and located in major cities. Overall, dental equipment is often insufficient and lacks routine maintenance due to high cost. Consumables are generally scarce as well. This endemic dearth of basic dental instruments in public services can largely hinder several clinical activities. Facilities performance is also considered low, due to a deficient management system.

Third, the number of dental providers is insufficient, distributed according to facilities location. Salaries under the MoH are very low and perceived as discouraging by the personnel, thus boosting the attrition rate and migration from public to private. However, to level out, budget allocation at facility level encompasses bonuses for health professionals.

Despite being generally underestimated, oral health encompasses a crucial role in the family medicine approach fostered by AICS within the Dictorna programme. Additionally, there is often not enough research available to support for national oral interventions. In line with the 74th WHO WHA resolution, this project aims to promote the integration of oral health into global health, spreading awareness on the relevance of oral

health as a determinant of overall health and on considering oral diseases as NCDs, which merit harmonized horizontal approaches in line with other chronic conditions and with a family medicine approach.

Therefore, the Italian Agency for International Cooperation (AICS), together with the Ministry of Health of the Red Sea State, planned and developed a survey aimed at assessing the principal aspects of the oral Health Care System (HCS). The analysis was developed in the Red Sea capital city, Port Sudan.

The study method aims to evaluate the main challenges faced by public dental providers to meet the population's health demand. Additionally, the assessment can provide useful insights and recommendations to frame targeted interventions in improving the alignment between Federal and State level authorities regarding dental care.

This study is primarily driven toward the analysis of Sudanese governance, financing, human resource, training, care delivery, and health information system (HIS). Moreover, the population's oral health needs are investigated with the support of demand and supply analysis tools, developed by a joint bilateral effort with local oral health authorities and implemented in Port Sudan's public dental clinics.



Key findings

Governance and policy

- 🦷 In the Republic of Sudan the Oral Health Care System governance is divided across a Federal-State multi-level pyramid system, separating regulatory power from care delivery. Although there is vertical demarcation developed through a top-down system, jurisdictional powers among stakeholders' levels appear blurred. A Federal univocal policy direction regarding oral health care is also lacking.
- 🦷 A National Oral Health Policy document was drafted in 2017 but still not endorsed. There is no clear alignment between the ongoing Sudan National Health Sector Policy strategy 2024-2021 and State level oral health care interventions. Oral health promotion and primary prevention programmes seem to be missing.

Care delivery

- 🦷 The Ministry of Health works in close collaboration with the National Health Insurance Fund to provide a comprehensive oral health benefit package through accredited Ministry of Health facilities.
- 🦷 The total number of Ministry of Health facilities accredited with the National Health Insurance Fund reached 3,578 units in 2020.
- 🦷 Khartoum State includes more than %45 of total Ministry of Health facilities accredited with the National Health Insurance Fund.
- 🦷 Screening, diagnostic, and therapeutic services are provided in both primary health centers and hospitals as secondary care, where major surgical, rehabilitative, and subspecialized tertiary care is provided mainly at larger public hospitals including teaching hospitals, private hospitals, and in specialized centers. Sudan has 358 PHCs providing dental care, 160 dental departments between secondary and tertiary care facilities, and 8 specialized hospitals.
- 🦷 Fragile patients' categories such as medically compromised, children, disabilities, elderly, or pregnant women are not clearly addressed by the Federal policy plan, neither by dedicated facilities.

Personnel

- ☞ According to the Sudan Medical Council, the overall number of dentists registered in 2019 was 8,964 (May 2019) and 519 specialists. 532 providers (0.12:10,000), divided between general dentists and specialists, are contracted by the MoH.
- ☞ The average salary of a MoH employee is between 12,000 and 23,000 SDGs per month, whereas private professionals can get more than 90,000 SDGs. Public-private career split is very common.
- ☞ It is estimated that Sudan has lost almost %60 of its physicians due to outward migration.
- ☞ Dental allied health professionals are underrepresented. The Federal authority's dataset accounted 213 dental assistant/therapist in 2020 and the last WHO dataset 86 dental laboratory technicians.

Oral disease burden

- ☞ 52.4 % of Khartoum children aging from 5-3 are affected by early childhood caries, mean dmft 2.3. One in two -12year-old children suffers from tooth decay or had experiences caries.
- ☞ Mean Periodontal Index (PI) is 1.8, ranging between 1.5 – 0.1 among 39-10 years old. Population sub-groups, such as pregnant women, have a high prevalence of periodontal disease (%24), also associated with decreasing gestational age. According to local authorities there were no registered cases of Noma (necrotizing ulcerative stomatitis) in the past 5 years.
- ☞ According to IARC, in Sudan the overall number of lip and oral cavity cancers registered (2020) was 564.
- ☞ Percentage of traumatic dental injuries among school children aged 12-9 years in Khartoum state was found to be %48.9.
- ☞ In Sudan approximately about %40 of HIV cases has oral lesions, main age group affected is 40 - 30.
- ☞ Cleft lip and palate prevalence in Sudan is 0.9 per 1,000 children.

Training system

- Universities offering dental programs in Sudan are 33, plus 9 that are currently under approval.
- Ministry of Education is not able to meet students' internship demand. Two to three thousand students from dental programs are currently waiting to enter their housemanship after being graduated.
- A Continuous Medical Education system for dentists is defined by the Federal Ministry of Health, but not monitored.
- There are few Dental Hygienist and Dental Assistant programs across the country. Khartoum university is the only school providing a Dental Hygienist program.
- Postgraduate programs are offered by the Ministry of Education and by the Ministry of Health through the Sudan Medical Specialization Board. They last 3 to 4 years. Main post graduate courses are: oral surgery, restorative dentistry, prosthodontics, periodontics, paediatric dentistry, orthodontics, oral pathology, dental public health. PhD programmes are also offered.

Health Information System (HIS)

- The patients' registration process in Ministry of Health hospitals and primary health centers is mainly paper based and prone to systematic errors. Beside insurance ID, the relevant services performed are indicated in accordance with the classification system of the National Health Insurance Fund service package.
- The classification of oral conditions in the Sudan aggregate registration system includes nine diagnostic codes. The current ICD codes exclude hard tissues conditions and disorders of tooth development and eruption.

Financing

- The Republic of Sudan has an out-of-pocket model and low national health insurance. Per capita total Current Health Expenditure is 58.8 US\$. The %36 of OOP is spent at the primary health care centres. The %40.8 is spent at general hospitals.

- ☞ The spending on dental care practices is little more than %1 of total national health care expenditure.
- ☞ The full reimbursements for dental care increased from 12,263,459 SDG in 2018 to 27,807,200 in 2020.

Health Benefit Package

- ☞ The National Health Insurance Fund is affiliated to Ministry of Social Security and Development and it acts both as purchaser for the Ministry of Health and provider.
- ☞ The National Health Insurance Fund covers almost %81.6 of the total population (34,249,066). Poor and vulnerable groups represent the %71 of total subscribers.
- ☞ The package of services totally covered provided are: medical consultation, scaling, diagnostic services (i.e. x-ray, CT scan, etc.), extractions, surgical procedures, filling.

Key findings from Port Sudan health need assessment

Dental infrastructures and personnel

- ☞ Considering only the Ministry of Health providers that are accredited with the National Health Insurance Fund, Port Sudan dental facility:population ratio is 0.16:10,000. Currently in Port Sudan there are eight public dental facilities: two general hospitals with dedicated wards, one specialized hospital, and five primary health centers. When including private dental centers, the ratio increases to 0.34:10,000. Dental chairs population ratio is 0.36:10,000.
- ☞ Public dental facilities do not have any communication means except personal mobile phones. Excluding patients paying out-of-pocket, patients' registration and claims management is only paper based.
- ☞ There are no X-rays and radiographic instruments of any kind, including orthopantomography and computed tomography (CT) scans, in primary health centers. Only Port Sudan Dental Hospital has an x-ray machinery, but it is out of service. Specimen testing is outsourced to Khartoum's anatomic pathology laboratories, 670 km away.

- ☞ Facilities suffer frequent lack of electricity and sporadic water shortage. Secondary electric back-up sources are often deficient.
- ☞ Facilities do not provide official guidelines for medical waste management. Biological risk due to improper medical waste storage appeared to be underestimated.
- ☞ In Ministry of Health dental facilities, the staff is composed by dentists and dental assistants. Total number of dentists working in was 0.34:10,000) 17) and dental assistants 0.26:10,000) 13).

Dental services

- ☞ Only two between hospitals/primary health centers can provide all the dental services covered by the health benefit package. Overall, dental clinics limit dental equipment according to the type of services they provide (and vice versa). Performance indicators are not studied at facility level.

Access

- ☞ The %73 of patients intercepted by the survey in Port Sudan dental facilities were women, mean age 36 years. The %92 was from urban areas. The %89 of the surveyed population affirmed difficulty in making financial ends meet. Only %12 of the population was under 18. Almost %45 of the patients accessing Ministry of Health dental facilities attended secondary schools.
- ☞ The economic barriers to dental care appeared not to be relevant. Among the patients interviewed, almost 1 out of 10 admitted to forgoing or postponing dental care due to economic reasons. About %8 gave up essential goods because of the cost of dental treatment. Average out-of-pocket annual expense on dental care per year was 4500 SDG.
- ☞ The %50 of the surveyed population received dental care during the previous 6 months and %10 were receiving dental care for the first time. Dental consultation/advise appeared to be the main reason of visiting a dentist (%80).
- ☞ The %15 of the interviewers suffered any form of delay in receiving care, while travel time to reach dental facility is less than 30 minutes on average.

Patient safety and satisfaction

- ☞ According to the survey, participants showed high satisfaction related to communication with dental providers. The treatment options, decisions regarding patients care and patients' empowerment were positively perceived.
- ☞ The patients' feedback was rarely considered. Respondents from the survey were positively impressed by dental care safety, high quality, and good continuity of care.

Recommendation

- ☞ Encouraging Federal level efforts to integrate oral health into UHC focusing on strengthening the essential oral health services and the basic package of oral care and boosting oral health workforce addressing population health needs and the social determinants of health.
- ☞ Embracing the 74th WHO WHA resolution on oral health considering oral health as an integral part of general health.
- ☞ Promoting school-based oral health promotion and primary prevention programmes.
- ☞ Introducing a clear surveillance plan of oral diseases identifying available data on oral health conditions, access to care, intervention strategies, and workforce infrastructure.
- ☞ Implementing an effective medical coding and claims management system.
- ☞ Investing on task-shifting from dentist to allied health professionals and extending allied health professional scope of work and training programmes.
- ☞ Defining and implementing dental clinics guidelines regarding infection control, medical waste, staffing, maintenance, and equipment stock out management.
- ☞ Expanding hospitals/primary health centers accreditation with the National Health Insurance Fund to other State agencies and stakeholders (i.e., Armed Forces, Ministry of Interior, etc.).
- ☞ Simplifying oral care delivery introducing more cost-effective dental equipment such as mobile dental units.

Introduction to the study and methodology

Overview

Recently the Republic of Sudan has experience months of profound change. Since the 2019 revolution, the ferment of civil society and the desire for change has led towards progressive developments within the welfare state. Strengthening the national HCS seems to be one of the crossroads.

According to the Sudan National Health Sector Policy (SNHSP) 2024-2021, population health demand is considered one of the main drivers of the National health sector reform process. Political resettlement and 2019's fervent rebirth have matched demand to a cultural change. Quoting the SNHSP 2024-2021 «health demand is very well reflected in the slogan of the national revolution of Freedom, Peace, and Equity”(1). The national government associates the slogan with the concept of Universal Health Coverage (UHC) – Sustainable Development Goal (SDG) target 3.8. In fact, it aims at “guaranteeing the access to necessary services while providing protection against financial risk”. Timely access to health services, a mix of promotion, prevention, treatment, and rehabilitation cannot be achieved, amongst the population without a well-functioning Health Financing System (HFS) (1).

UHC is reached when population's health needs are fulfilled accessing health care services without incurring the risk of financial hardship. Meanwhile, access to care is the chance or capacity to do both things together. Therefore, UHC cannot be achieved without universal access, but the two are not the same.

Three access dimensions:

- ☞ Physical accessibility. The availability of good health services within reasonable reach of those who need them and of opening hours, appointment systems and other aspects of service organization and delivery that allow people to obtain the services when they need them;
- ☞ Financial affordability. People's ability to pay for services without financial hardship. It takes into account not only the price of the health services but also indirect and opportunity costs (e.g. the costs of transportation to and from facilities and of taking time away from work). Affordability is influenced by the wider health financing system and by household income;
- ☞ Acceptability. People's willingness to seek services. Acceptability is low when patients perceive services to be ineffective or when social and cultural factors such as language or the age, sex, ethnicity, or religion of the health provider discourage them from seeking services.

Services must be physically accessible, financially affordable, and acceptable to patients if universal health coverage is to be attained(2).

Over the last decade, the push for UHC has gained traction of a considerable energy also in the Republic of Sudan, becoming a prime concern area in reaching the SDGs by 2030. Country health care system performance evaluation draws important progress in key areas such as coverage vaccination rate (tuberculosis, poliomyelitis, diphtheria), ARTs for HIV, and most prevalent communicable disease (3)

However, Non-Communicable Diseases (NCDs) remains the first cause of death in Sudan, accounting for %73. Main factors are ischemic heart disease, accounting for %16.17, stroke %11.6, cancers %20, COPD %5.8, and diabetes mellitus %2.74 of all deaths. Despite these numbers, NCDs escalation has not always been faced with effective mitigation strategies. Nonetheless, SNHSP is strongly moving toward an integrated approach, firmly focused on chronic diseases management through targeted interventions that encompass all HCS building blocks, an approach currently lacking in the system and limited by endemic barriers.

UHC and Oral Health

Although UHC (SDG target 3.8) has consistently been referred as “North Star” of the HCS reform process, oral health has been largely absent from the UHC discussion, and limited progress has been made in addressing oral diseases, around the world for over the last twenty years.

Dental services are usually relegated to the sidelines of UHC. In fact, the World Bank’s UHC Study Series, which documents and analyses Low-Income Countries’ paths towards UHC, tends to omit oral health from its monitoring of benefit packages(4).

However, thanks to years of advocacy and lobbying made by prominent entities like the WHO Oral Health Department, the World Dental Federation, State level representatives, civil society organizations, and universities, oral health gained new relevance and has been revaluated as a key component within UHC. As a result, on May 26th 2021, the 74th WHO World Health Assembly (WHA) ratified the resolution proposed on January 2021 on Oral Health having considered the report by the Director General titled “Achieving better oral health as part of the universal health coverage and noncommunicable disease agendas towards 2030”. The resolution is historic for oral health disease management. In fact, it urges member States to address key risk factors of oral diseases shared with other NCDs, such as high intake of free sugars, tobacco use and harmful use of alcohol, and to enhance the capacities of oral health professionals. It also recommends a shift from the traditional curative approach towards a preventive approach that includes promotion of oral health within the

family, schools, and workplaces, and includes timely, comprehensive, and inclusive care within the primary health-care system. It clearly emerged that oral health should be firmly embedded within the NCDs agenda and that oral health care interventions should be included in UHC programmes.

Oral health integration with global health and UHC is justified by oral disease burden and social impact. Worldwide more than 3.5 billion people suffer from oral diseases, without any notable improvement of the situation between 1990 and 2017. Untreated dental caries in permanent teeth is the single most prevalent condition globally, affecting 2.3 billion people. Severe periodontal disease, a major cause of total tooth loss, is estimated to affect 267 million people, particularly older people. Cancers of the lip and oral cavity are among the top 15 most common cancers worldwide, with over 500,000 cases and nearly 180,000 deaths each year. Noma, a necrotizing disease starting in the mouth and fatal for 90% of children affected, is a marker of extreme poverty (5). The burden of oral diseases demonstrates significant inequalities, disproportionately affecting marginalized populations and those of lower economic status. Inequalities are found, as with other NCDs, throughout the life course and across populations in low-, middle- and high-income countries. With limited resources for prevention and control, low- and middle-income countries face the highest burden of oral diseases (6).

Despite oral diseases high prevalence and distribution, it might be said that oral health is still a neglected area of global health that could contribute to the achievement of UHC, through its integration in the system (5). Moreover, UHC can help frame policy dialogue to address weak and fragmented primary oral health services, and address substantial out-of-pocket (OOP) expenses associated with oral health care in many countries, which in turn would help to achieve UHC (7).

The Republic of Sudan, as Low Income Country (LIC), faces limits related to the so-called “westernised dentistry approach”: the current treatment-dominated and increasingly technology-focused system of oral health care is trapped in an interventionist cycle that does not tackle the underlying causes of diseases nor meet the needs of a large proportion of the population (8). Dentistry is often unavailable, unaffordable, and underappreciated for most of these populations, particularly the poorest population quintiles and rural dwellers. Rather than being isolated and separated from mainstream HCS, dentistry needs to be more integrated with primary care services. Dental care systems should focus more on promoting and maintaining oral health and achieving greater oral health equity, especially at primary health care (PHC) level.

The primary oral health care approach empowers health promotion and oral disease prevention and favours health equity. It includes various domains such as risk assessment, oral health evaluation, preventive intervention, communication, and education as well as interprofessional collaborative practice(9).

Family Medicine and Oral Health in Sudan

AICS's Dictorna programme aims at fostering UHC by shifting from the disease to the person with the disease amongst of the changes of health systems toward PHC.

Through the HCS's decentralization process, Sudan's States are mandated to progressively entitles districts to a capillary work of healthcare capacity and capability improvement, thus increasing access to affordable care through punctual investments at the community level.

Family practice is a person-focused model, far from disease-focused approach. The rationale is built on the health of individual persons and populations segments, not on specific pathologies, their diagnoses, and management (10). A second key element of family medicine is the comprehensiveness of care, particularly providing integrated health promotion, disease prevention, curative care, rehabilitation, and physical, psychological, and social support to individuals.

Social determinants of health, such as a country's political condition, economy, social and cultural characteristics, disease burden and individual epidemiology are important dynamics for developing appropriate health care strategies and to establish resource allocation criteria (11).

Given these assumptions, no standardized model of family medicine can be used as a reference since each country has its peculiarities, and family medicine is more likely to succeed when based on specific considerations about country's local features.

Empirical evidence suggests that without a proper understanding of HCS's demand and supply baselines, many countries go through initial implementation struggles, such as preparing treatment protocols, developing an essential package for health services and essential medicine lists, making family patient folders for the families, etc. It is only when the health policy objective became achieving UHC, including primary care reform, that the multi-disciplinary family care approach proved successful, such as Egypt, Bahrain, Jordan and Islamic Republic of Iran (10).

Data on resources (such as diagnostic material, dental equipment, and supplies, which can be extremely hard to provide to dental clinics), the extent of professionals training, the organization and funding of health services, the roles, responsibilities and availability of other health professionals, must be gathered or it could hinder the implementation process.

Conceptual framework

Due to its endemic fragility, the Republic of Sudan is currently fronting several diverse challenges within the health sector. Countrywide there is a lack of political commitment and resources, which are major limits. The integration of oral health with other NCDs management is scarce. Average Sudanese citizens have low access to dental care, and large population segments suffer from a lack of essential oral health care coverage, especially the poorest quintiles. Also, there are no Federal or State level policy programs to plan and deliver evidence-based cost-effective interventions. The accuracy of sporadic vertical projects is low, yet are more common than cross-sectoral and horizontal multidepartment collaborations. Highly retentive populations, such as school-based children, are not addressed with primary prevention initiatives. Moreover, a dentist-centred model excluding PHC and shift tasking through mid-level providers, such as dental therapists and hygienists, is not prioritized. Dental Health Information System is deficient and frequently ineffective. Also there are no performance evaluation systems in place.

Given these premises, the Minister of Health of Red Sea State, in collaboration with the local Oral Health Directorate, and the Italian Agency for Development and Cooperation (AICS), conducted an assessment of oral HCS at the Federal level with a focus on oral health demand and the public delivery system in the capital of the Red Sea State, Port Sudan, including urban and suburban areas. To promote a population's health needs assessment as a core value of family medicine toward PHC and UHC, this study aims to shed light on the main challenges of Sudanese oral HCS to provide key recommendations. Moreover, it intends to describe the overall framework of the National oral health system of care, following the WHO six building blocks: Governance, Information, Financing, Human Resources for Health, Medicine and Medical Technology, and Service delivery (12). Key topics highlight some areas according to the global and country context and characteristics that exert high burden on the health system.

As of the current evidence, no specific study has been produced on oral health needs of the Sudanese population. A family medicine approach, following a population health management-based model, is deemed appropriate to encompass Sudan's major oral health dynamics. This approach provides a deeper understanding of both demand and supply, focusing on: accessibility to oral health care services, perceived oral health status, oral diseases main risk factors prevalence, quality of care, patients' engagement in therapeutic path, economic barriers, and per capita healthcare expenditure for dental care, as well as public oral health facilities assessment throughout qualitative indicators (13).

Methodology

Study methodology allows a two-level understanding of the Sudanese Oral HCS. Following a top-down approach, the authors initially approached eminent country experts and key actors from the oral health sector. As presented in section one, qualitative interviews have been conducted with the academic sector, particularly the Khartoum University, the NHIF, the Oral Health Directorate of Khartoum and Red Sea State, and the curative medicine department at the Federal Ministry of Health (FMoH).

The University of Khartoum provided crucial information about dental training system, university distribution, and personnel retention, as well as the main hurdles faced within the academic sector. FMoH and the Oral Health Directorates of Red Sea and Khartoum State provided important insights regarding oral health governance, current and future policy directions, the dental services delivery system, and personnel distribution in the public sector.

NHIF furnished key data regarding health information system, dental care services claims' management, coding, pricing of dental health services, and reimbursement schemes.

Section two focuses on a need assessment for the population's oral health.

The study was conducted in the city of Port Sudan, capital of the Red Sea State. Methodologies are based on demand and supply analysis, each framed in dedicated questionnaires.

As many public health authorities worldwide have developed, demand analysis for population health needs assessments cover to communities' health priorities and needs using patients' questionnaires, while a supply analysis form was created for dental care facilities evaluation.

Demand analysis

A population's health care needs awareness and population empowerment is crucial for effective health care delivery plan and services' design (14). According to the Oxford dictionary, "Need" is defined as "circumstances in which something is necessary". Therefore, to catch population health needs, public health authorities worldwide have developed tools that are able to assess entire communities' health priorities and needs.

Community health needs assessment tools can be summarized as public health instruments measuring disease burden, population needs' patterns, health priorities, population segments in higher need, planning

and designing interventions, setting health interventions implementation framework and KPIs for monitoring and evaluation (14).

Needs can also be assessed and addressed using an individual's illness impact, disability degree attributed to specific disease, and patients' perspective (15). Therefore, the role of demand analysis and health needs (also considering perceived needs) has gained attention among national healthcare authorities and assumed great importance, also in terms of scarce resources allocation plans and new population based healthcare strategy programs development (17)(16). Medical branches in which health need assessments are investigated are growing (20)(19)(18).

Therefore, the authors have hereby presented an oral health demand analysis framework developed following the 1997 conceptual framework from the WHO International Collaborative Study of Oral Health Outcomes (ICS II)(21). The 1997 WHO conceptual framework is an expanded version of the 1973 Andersen and Newman model for evaluating the utilization of health care(22). As reported by Varenne et al, this model assumes that a person's use of health services is a function of predisposing, enabling, and need factors(23).

1. Predisposing characteristics: gender, marital status, educational level, occupation, length of time in the community, and health beliefs (attitudes, values, knowledge of dental care delivery services);
2. Enabling resources refer to attributes specific to the individual or the community (e.g. income, social network, access to a regular source of care);
3. Need variables reflect illness levels that require the use of services. Needs can be perceived by the individual and are influenced by cultural beliefs and values (e.g. perceived health status, disease severity, limitation of activity).

Therefore, as a result of available international scientific literature, the authors selected appropriate demand analysis tools, in accordance with the aforementioned three categories. Main contributions came from the WHO oral health methodology framework study, the European Patient Forum survey, the Oral Health Workforce Research Center, and peer-reviewed publications focused on oral health demand analysis surveys, particularly from the African region (27)(26)(25)(24)(23). Accordingly, the authors defined a set of independent variables for individual factors and possible barriers in accessing dental care services that may influence utilization of oral health care services. Variables regarding both socio-demographic and health beliefs factors, which can be either modifiable (e.g. education, marital status, or health attitudes such as perceived general health status and seriousness of oral disease, the importance of oral health, or benefits of brushing) or non-modifiable (e.g.

age or sex), and enabling characteristics, which refer to specific attributes of the individual or the community in which the individual lives (e.g. level of income, provenance, family size), and need factors, that reflect the perceived need for oral health care (patient's perceptions of illness, impairment of quality of life) or the self-assessment of health status, have been included from the WHO International Collaborative Study of Oral Health Outcomes (ICS II) and from the Oral health surveys: basic methods - 5th edition(28) . Health inequalities and access barriers met by patients have been analysed in terms of affordability, availability, accessibility, adequacy, and appropriateness of dental care, by adapting the Oral Health Workforce Research Center survey methods 2019 and the European Patients Forum survey 29) 2016).

The overall objective of this survey is to identify potential challenges or good practices in the area of access to oral healthcare for patients and to assess population oral health care needs. Results will inform policy makers and ensure that responses to health challenges will be developed with consideration of the specific needs of patients with oral health conditions. The complete version of the demand analysis questionnaire form is presented in Annex 1.

Supply analysis

The health facility assessment form for dental care services in Port Sudan has been developed from the WHO Harmonized Health Facility Assessment 2021 (HHFA) combined questionnaire form (core + additional) represents a resource package for conducting standardized health facility surveys (30).

This framework enables a comprehensive external review of the availability of health facility services and the systems that facilities have in place to deliver services at required standards of quality, and the effectiveness of the services. Availability, quality, and effectiveness of health services are integral to UHC and contribute to achieving SDGs. The health facility assessment framework can support health sector reviews, planning and policymaking, and enable evidence-based decision-making for strengthening health services(31).

The HHFA, from which this framework has been built, relies upon the USAID/WHO Service Availability and Readiness Assessment (SARA) and incorporates components of other key global health facility surveys and indicator lists (32). It is based on global service standards and uses standardized variables, questionnaires, and data collection methodologies. Standardization of indicators and data collection promotes alignment of health facility survey approaches and enables comparability of results over time and across geographic areas.

A module is defined as a set of questions (in questionnaire format) and aims to collect information for a defined set of indicators. Main modules selected are the following:

1. Diagnostic and treatment procedures;
2. Staffing and staff management;
3. Facility level resources and safety practices;
4. Conditions for infection prevention and control;
5. Health financing and accounting;
6. Expenditure;
7. Individual patient records/chart and identifiers;
8. Service and infrastructures;
9. Outpatient dental services

From module 1 to 8 authors selected indicators in accordance with study's objectives. However, since dental services (as dental treatments) are not included in the HHFA, a quick literature review has been done to build module 9 "Outpatient dental service". It refers to common dental services and main dental care materials. The full questionnaire is presented in Annex 2.

Supply analysis

Both questionnaires have been completed through face-to-face field interviews. Patients in hospital setting have been interviewed by local medical advisors enrolled for the execution of the study. Interviewers were fluent in the local language (Arabic) and in English. Prior to field work, they received an intensive training program. Data from facilities for the supply analysis have been collected with the support of local medical directors. Red Sea State Federal authorities provided authorizations and the local Oral Health Directorate provided a comprehensive facility list, including all public providers. Authors used JMP SAS version 15 for descriptive statistics.

Health Care System overview

The Republic of Sudan is in northeast Africa and is its 3rd largest country in the African continent. More than 42 million people live in 1,861,484 sq. Km, out of which around %70 in rural areas. Life expectancy is 65 years. Internally, there are 2.2 million displaced people, whereas refugees from neighbouring countries amount to roughly 2 million. Population growth rate is %2.4 and the fertility rate is %5.2. Almost %36 of the population is below poverty line (33). The Republic of Sudan's HDI is 0.507, positioned at 170 out of 189 countries and territories, placing the country in a low human development category (34). The adjusted net national income per capita (current US\$) in 2018 was 764 US\$(35).

According to the Institute of Health Metrics and Evaluation (IHME), communicable diseases' burden is %19, NCDs %73, and injuries 36) %7). OOP expenditure is %69 and the density of health workforce is 0.5 physicians and 0.7 nurses and midwives per 1,000 population (33) (2020). Health service coverage in the country is considered limited and poorly distributed. About %40 of total primary care centers are not considered as optimally functioning, mainly due to personnel shortage and poor infrastructures. Moreover, physical accessibility to health facilities varies from State to State. The national average is 1:6,816, whereas WHO suggests 1:5,000. It is estimated that %25 of the population has no access to health facilities due to geographical boundaries, poverty, social barriers, or internal conflicts. Financial and socioeconomic factors contribute to limiting access to health services. Patients from higher income quintiles benefit from health care almost ten times more frequently than those in the lower income ones. Health workers are deficient in number and categories, and although over %70 of the population resides in rural areas, %70 of health workers work in urban areas, and %38 of them in the capital Khartoum.

In Sudan health care services are divided across three levels. MoH is the primary provider and multiple services providers ranging from public to private entities complete the setting. PHC is the base of the system and provided solely by the MoH (with few exceptions including international cooperation and private sector) at Federal and State level. More than %70 of healthcare expenditure is dedicated to hospitals, while PHC gets less than %6 out of it. Out of the hospitals funding, %37 goes in salaries and %28 in medicines. Therefore, despite the differences in funding among the services levels, the overall amount remains limited. PHC covers %93 of population but there are deep discrepancies from one State to another and between urban and rural settings. Urban areas benefit from outpatient service %25 more than rural dwellers and insured population use health care services 1.5 more than non-insured.

A national project for improving PHC services expansion is ongoing, but it has no obvious impact on PHC indicators. According to records, by end of %60 ,2016 of PHC facilities were providing the minimum PHC package. However, a survey showed only one third of the funded facilities were functioning in 2015 and there

was a high staff turnover despite projects' investments on their training and education. Further emphasis on monitoring and evaluation at all health system levels, facilities functionality, service process and quality are needed.

Oral health is considered a key element of general health and WHO defines oral diseases as “The most common NCD and affect people throughout their lifetime, causing pain, discomfort, disfigurement and even death”(37). In middle-low-income countries (MLIC) they cost %5 of overall Health Care Expenditure (HCE) and %20 of out-of-pockets health expenditure, an expense that soars in absence of a public coverage system. Social determinants of health have a huge impact on oral diseases and consistent differences may be found among different social strata and across different territories.

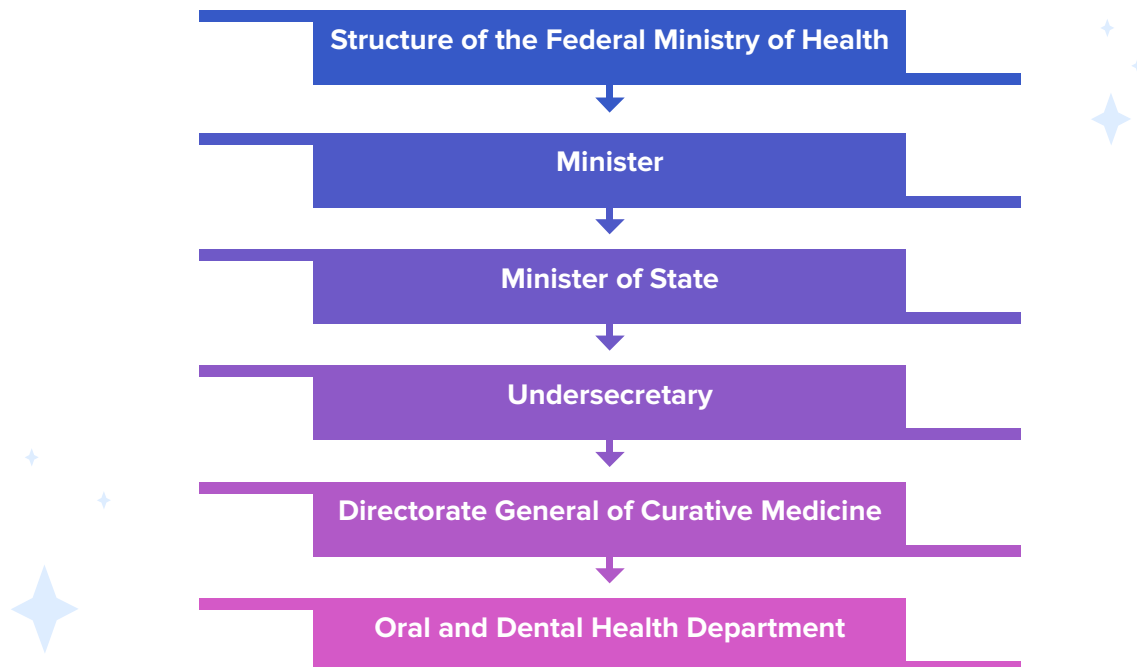
Oral health is a key indicator of overall health, well-being, and quality of life. It encompasses a range of diseases and conditions that include dental caries, periodontal (gum) disease, tooth loss, oral cancer, oral manifestations of HIV and AIDS, oro-dental trauma, Noma, and birth defects such as cleft lip and palate (38). The Global Burden of Disease Study 2017 estimated that oral diseases affect 3.5 billion people worldwide. According to the International Agency for Research on Cancer, cancers of the lip and oral cavity are among the top 15 most common cancers worldwide, with nearly 180,000 deaths each year and almost 380,000 new cases (40) (39). Moreover, the impact of oral diseases on quality of life is huge: in adults they can, in the worst cases, lead to malnutrition and social isolation. In children they are the most common cause of pain-related sleep disturbance and retarded growth (41).

Most oral diseases and conditions share modifiable risk factors with the leading NCDs (cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes). These risk factors include tobacco use, alcohol consumption and unhealthy diets high in free sugars, all of which are increasing at the global level. There is a proven relationship between oral and general health. It is reported, for example, that diabetes mellitus is linked with the development and progression of periodontitis. Moreover, there is a causal link between high consumption of sugars and diabetes, obesity and dental caries (38). Poor diet, one high in sugars is one of the main causes of tooth decay; tobacco use is implicated in the causation of periodontal disease; and abuse of alcohol is harmful. Tobacco and alcohol use are also strongly implicated in the development of oral and oropharyngeal cancer. People with lower socio-economic status suffer disproportionately from oral diseases and the resulting health, quality of life and economic impacts (43) (42) (41). Many of these causes of disease lie outside the direct influence of health professionals, so it is imperative to adopt an integrated approach to tackle the combined burden of oral diseases and other NCDs, by addressing common modifiable risk factors and social determinants of health.

According to Ribat National University, Sudan, “Despite the generally high standards of living enjoyed by some of Sudanese, not all adults experience a maintainable level of oral health”. Cost barriers related to dental cares is a common problem worldwide and also in Sudan where usually dental care is covered out-of-pocket in more than the %70 of cases (44).

Governance

The health system in Sudan as per the Constitution (2006), Local Governance Act (2003) and Public Health Law (2008) is directed toward decentralization with the three levels of governance (Federal, State, District). The structure of the dental HCS provides a division that underlies both Federal and State management. The Federal Department of Health holds regulatory powers, providing guidelines and policies, whereas State health departments are responsible for implementing care through a system divided between primary care and hospital care in collaboration or otherwise with the NHIF. Nevertheless, stakeholders’ jurisdictional limits appear blurred.



Although there is vertical demarcation developed through a top-down system, no clear distinction of the role and responsibility of each health system levels is clearly defined, implying a possible conflict of interests throughout health system levels. This condition may jeopardize the system's harmony and accountability of lower levels with above higher ones. As a result, the health system looks fragmented, where each layer works in silos, embedding deep failure in health system management and health care services performance.

Federal and State Policies

The development of a National Health Policy and Strategic Directions is government-led, encompassing crucial and extensive inputs from multiple initiatives developed by Sudanese public health professionals and experts. Federal and State level partners with relevant stakeholders in 2018-2017 participated in the definition of the Sudan National Health Sector Policy strategy 2024-2021.

It intended to intercept and discuss all main challenges and bottlenecks that currently hinder the overall HCS performance. Major areas of interest have been defined, such as human resources, service delivery, health financing, medical supplies, and technology. Through the Sudan National Health Sector Policy strategy 2024-2021, the FMoH aims to address the roots of health problems in Sudan by working in collaboration with all sectors and with participatory approaches. Moreover, the successful implementation of this policy is contingent on ownership and high political commitment by diverse levels of the government and the effective engagement of all stakeholders.

Dental public health experts from the steering committee group defined the following oral health initiatives:

1. Addressing of oral healthcare governance gaps and suggest emergency interventions such as considering oral healthcare as a part of PHC directorate to achieve UHC outcomes;
2. To develop M&E framework for monitoring of oral health outcomes;
3. Establish a system to generate oral health information for analysis and evident based decision making;
4. Strengthen and enhance intra/multi sectorial collaboration and networking, beside a clear roles and responsibilities of Oral Health Directorate.

Policy initiatives appear comprehensive and holistic. Also, although being clearly mentioned the linkage between oral health, PHC, and UHC, no details have been considered in relation to strategy implementations or objectives.

Nonetheless, it is not clear if policy's initiatives are aligned to ongoing Federal or State level oral health policies. In fact, an oral Federal health policy implementation plan seems to be missing from the overall scenario. As so, it can be hard to align a long-term strategy plan to current initiatives.

Despite this, a National Oral Health Policy was drafted in 2017 by a task force that included several public health experts in addition to policy experts. Desk reviews and situation analyses were performed and the FMoH was called to concede the consensus. However, the final policy document has not been endorsed, apparently competing with other health priorities.

Delivery System

Oral health services in Sudan are offered through different providers: governmental, State (police, army, MoH), private providers, NGOs, civil society, and universities.

A classic three layers scheme is in place: primary, secondary, tertiary health care. PHC acts as first encounter and gatekeeper for patients and includes dispensaries, PHC units, and health centers, the latter forms the referral point from the lower facilities. PHC centers usually provide essential care as stated since the 2003, when FMoH introduced a health care service package including child vaccination, reproductive health, childhood immunization (IMCI), management of common diseases, and an essential drug list. This line of care is almost entirely provided by the public sector, since %90 of PHCs are under the MoH. Only a small part of PHCs is equipped with dental units (e.g., Khartoum State has the highest percentage thanks to 167 dental clinics at primary care level).

On the other hand, private and public sector join forces to provide secondary and tertiary care. Private is mainly centred in urban setting. Screening, diagnostic, and therapeutic services are provided in both health centers and hospitals as secondary care, where major surgical, rehabilitative, and subspecialized tertiary care is provided mainly at larger public hospitals including teaching hospitals, private hospitals, and in specialized centers.

Patients with special needs are not clearly addressed by the Federal policy plan, neither by dedicated facilities. Dental services directed towards special needs populations medically compromised, children, disabilities, elderly, or pregnant women, are generally mentioned by the Federal policy plan, which is not implemented locally. Also, oral health services tend to stand alone, not being integrated with other health services (e.g., NCDs, maternal and child health programmes).

Important preventive and screening programmes at the Federal level are absent (e.g., oral cancer control programme, oral school health programme). Only in Khartoum State few programs for the early detection of oral cancer, early detection of hypertension in dental services, diabetic patients, pregnant women, and patients with disabilities are currently offered. Moreover, since 2006 the Khartoum State offers a program of health promotion and primary prevention through mobile dental clinics.

Personnel

The distribution of health workers in Sudan has been considered “scattered” by the Sudan National Health Sector Policy strategy 2024-2021. Number and type of health workers differ from one State to another. Despite over %70 of the population residing in rural areas, %70 of health workers are in urban ones, thus serving about %30 of the total country population. Additionally, %38 of health workers practice in the capital, Khartoum, including %62 of all specialists’ and %58 of technicians. Moreover, %67 of health providers practice in in secondary and tertiary facilities, whereas only %33 in PHCs (45). According to the Statistical report 2017, there are 25.5 doctors per 100,000 persons and 33.5 nurses per 100,000 persons. This makes Sudan falling within critical shortage zone based on WHO threshold of 23 health workers per 10,000 populations.

Despite the introduction of a law for a compulsory one year placement, the lack of enforcement discourages its implementation (46). In addition, the rural environment is usually considered hostile for the medical profession. Therefore, despite economic incentives, the scarcity of management, service delivery organization, equipment and facilities vacancy have an adverse impact on health workers.

Regarding dental care, until the end of World War II, government health services in Sudan did not have any dentists. In 1954, the number of dentists and dental workers gradually increased, reaching 18 providers, 10 of them in Khartoum, and 2 dental technicians. In 1967 there were about 25 dentists distributed in three cities (Khartoum - Bahri - Omdurman). The largest number of dentists were concentrated in Khartoum, keeping dental assistants outside the capital.

Currently, very little data is published or publicly available about oral health providers in Sudan, as well as the type of services provided.

The last data published on the WHO database from 2015 describes a dentist ratio of 1:5,000 (overall number 8.116), compared with approximately 1:2,000 in most industrialized countries (47).

Year (latest publication)	Dentists per 10,000 population	Dentists (number)	Dental Assistants and Therapists	Dental Prosthetic Technicians (number)
2015	2.086	8116	-	-
2004	0.232	701	295	86

Table 1: Global Health Observatory. WHO. 2021

Although there has been an increase in the overall number of oral health professionals, with a progressive increase of dentists, the total number of mid-level providers such as dental assistants, dental therapists, and dental prosthetic technicians still remains low (47).

On the other hand, according to the Sudanese medical council the overall number of dentists registered in 2019 seemed a bit higher compared to WHO dataset: 8,964 (May 2019) and 519 specialists. However, only 532 providers (0.12:10,000), divided between general dentists and specialists, are contracted by the MoH. Although they work as public providers, no data is available regarding their daily activities as private clinicians. Also, distribution looks scattered and with the highest concentration in Khartoum. Both dental laboratory technicians and dental assistants' numbers appear to be scarce. Unfortunately, their number is not always officially recorded.

	State	Population	Dentists	Specialists	Dental assistant	Private clinics	PHCs	N° of departments	Dental Hospitals
1	Blue Nile	1080743	5	1	6	2	8	6	-
2	White Nile	2410260	14	-	7	16	14	9	-
3	Sennar	1847458	12	1	8	-	5	2	-

	State	Population	Dentists	Specialists	Dental assistant	Private clinics	PHCs	N° of departments	Dental Hospitals
4	South Kordofan	1458228	2	-	6	14	4	9	-
5	West Kordofan	1197830	5	1	7	-	5	6	-
6	North Kordofan	2551899	12	1	8	7	34	6	-
7	South Darfur	4071749	7	1	8	10	18	1	-
8	North Darfur	2296068	7	2	17	10	6	18	-
9	West Darfur	1000564	6	-	4	5	6	1	-
10	East Darfur	1148442	2	1	2	-	4	1	-
11	Central Darfur	724546	2	-	2	1	5	1	-
12	Kordofan	4926555	88	7	74	31	24	44	2
13	Nile	1472257	8	1	6	12	21	6	-
14	Northern	913533	7	-	30	12	6	27	-
15	Gedaref	2108468	9	1	6	16	3	10	-
16	Kassala	2438808	8	1	22	9	21	8	-
17	Khartoum	7687547	235	70	-	491	164	4	1

	State	Population	Dentists	Specialists	Dental assistant	Private clinics	PHCs	N° of departments	Dental Hospitals
18	Red Sea	1447787	21	2	3	10	10	6	-
TOTAL		40.782.742	444	88	213	646	358	160	8

Table 2: Dental facilities and personnel distribution. FMOH, March 2020.

Economic differences can be found in the average salary received by public and private providers. Although the hospital and academy environment may offer a better ground for improving theoretical and clinical skills, more than %90 of graduating oral health professionals favour the private practice.

The average salaries in the public sector are usually very low. In fact, employees of the MoH earn between 12,000 and 23,000 SDGs per month, whereas private professionals can get more than 90,000 SDGs. Therefore, public-private career split is very common.

Dental allied professionals

Dental allied professionals provide oral health promotion, oral primary prevention, and basic dental services, usually in decentralized and remote areas not covered by dentists.

This category is composed of different professional figures: i.e., dental assistant, dental hygienist, and dental therapist.

Allied dental professionals are often called dental auxiliaries. In partnership with dentists, dental auxiliaries increasingly provide care in community settings such as schools, nursing homes, community health centers, and health centers. According to their competencies and regulation allied dental professionals can perform examinations, preventive services, local anaesthesia, restorations, and extractions, with or without the indirect supervision of dentists.

The WHO strongly recommends dental therapist for under-resourced environment on the African continent

(49)(48). In Sudan according to the current legislation, only oral hygienists and dental assistants are legally authorized to practice. However, their competencies are very limited and well-defined. In fact, dental assistants are responsible for supporting and facilitating dentists' daily procedures, yet in Sudan it is well known that dental assistants also cover, without any exception, several dentists' activities, without possessing a proper formal preparation. Their presence is subdued to contingent HCS providers scarcity. On the other hand, dental hygienist, officially introduced in 2018, can only provide primary prevention through scaling, root planning, and oral health promotion.

Allied dental professionals competencies can be expanded by increasing the scope of duties they are statutorily allowed to perform, decreasing dentist supervision requirements, or developing opportunities for mid-level professionals to benefit the entire service delivery process (50).

Health professionals' retention

Despite the progressive uprising number of the health workforce, human resource deficiency still remains of major concern (45). Outbound trained professionals is one of the main issues, as well as the scarce human resources management and misdistribution of existing doctors. It is estimated that Sudan has lost almost %60 of its physicians due to outward migration (51). According to the Federal authorities, the tendency is to emigrate due to economic reasons, usually to Gulf countries: Saudi Arabia, Kuwait, and United Arab Emirates.

The burden of oral disease in Sudan

While there are many forms of oral disease each one with different signs and symptoms, a relatively small number has the greatest burden of disability at population level. Fortunately, cost-effective interventions exist to prevent and treat these highly prevalent diseases. According to WHO priorities in the African region, seven oral diseases and conditions represent the largest part of the oral disease burden. They are all widespread and most are either preventable or treatable in their early stages:

- 1) Tooth decay and cavities (dental caries);
- 2) Gum (periodontal) diseases;
- 3) Oral cancers;
- 4) Oral manifestations of HIV and AIDS;
- 5) Noma;
- 6) Oro-facial trauma from accidents and violence;
- 7) Cleft lip and palate.

Caries experience

Most of the available evidence on dental caries in Sudan is from Khartoum state, with only a few studies reporting on the burden from Gezira state and other rural areas. Caries severity seems to be on the decline, although high caries experience remains a challenge (52). One in every two -12-year-old schoolchildren (DMFT 0.5) reported an impact on their daily life activities as a result of being affected by a carious tooth and caries experience and severity tend to increase with age (53). Early childhood caries is common among ages 5-3 pre-school children in Khartoum State, %52.4 of the children are affected. The mean dmft was 54) 2.3).

Periodontal disease

Periodontal disease is a chronic or acute inflammatory process of the soft tissues that surround the teeth characterized by their progressive degradation. Poor oral hygiene, increasing age, smoking, low educational level, ethnicity, and economic status have been reported as risk factors for periodontal disease (55). In Sudan the prevalence of periodontal disease is lower than in Iran, but higher than Ethiopia, with a mean Periodontal Index (PI) of 1.8 and a range of 1.5 – 0.1 among 39-10 years old. Population sub-groups, such as pregnant women, have a high prevalence of periodontal disease (%24.0), also associated with decreasing gestational age (56).

Oro-pharyngeal cancer

Oro-pharyngeal cancers are tumours (malignant growths) on any part of the mouth or throat. Sudan's National Cancer Registry (NCR) published cancer incidence in Sudan for the period of 2013-2009. The number of registered oral cancer cases at the national hospital which treats all cancers in the Sudan is at a rate of 920 per year, comprising %9 of the cancers reported annually (57). In another review of 14,922 cancer cases registered at the Sudan Cancer Registry from 12.6 ,1985-1970 % were related to the oral cavity (58). A survey in Khartoum state reported that oral cancer was the 2nd most common cancer following breast and prostate in females and males respectively, representing %9.4 of all cancers (59). Usually low survival rates and high mortality rate are related to oral cancer due to delayed presentation, delayed referral and delayed treatment (60). According to WHO, the overall number of cancers registered in 2020 was 27,382 and 564 were between lip and oral cavity (61).

Oral manifestation of HIV and AIDS

Prevalence of HIV in Sudan is %0.2 of the overall population (62). Among HIV-infected patients globally, the prevalence of oral manifestations of HIV and AIDS is estimated to be 38) % 60–50). From a survey conducted in Omdurman, approximately about %40 of HIV cases had oral lesions. The main age group affected by oral lesion is 40 - 30. Mortality due to oral lesions in HIV patients is rare. There is no specific dental clinic for HIV patient in Sudan (National Oral Health Policy 2018, oral Health Directorate, FMOH).

Noma

Noma, a severe type of oral gangrene, is a neglected disease of poverty that remains a major public health problem in some poor African countries. However, it is believed to not be common in Sudan. In the past 5 years, there were no registered cases at the only referral dental hospital in Sudan (Khartoum State OHD).

Oral-facial trauma

While all age groups are affected, oro-facial injuries are relatively common in children, affecting about one in five. Studies in -13–11year-old Africans have reported prevalence ranging between %9.8 and 38) %19.1). Similarly, in Sudan, the percentage of traumatic dental injuries among school children age 12-9 years in Khartoum state was found to be 63) %48.9).

Cleft lip and palate

Cleft lip and palate is the most common congenital facial anomaly in children. It can affect appearance, speech, hearing, growth, psychosocial wellbeing, and social integration. The prevalence in Sudan is 0.9 per 1,000 children. More girls than boys are affected, with a ratio of 10:3. A hospital-based study showed the following distribution of cases: %54 had cleft lip with cleft palate, %30 had only cleft palate and the remaining %16 had cleft lip alone (64).

Non-Communicable diseases (NCDs) and oral health

Most common oral diseases and NCDs are closely linked and share common risk factors such as unhealthy diet, poor nutrition, use of tobacco and harmful consumption of alcohol. Interventions against oral diseases and NCDs must therefore become integrated. In addition, oral health problems are more severe among people with diabetes, HIV infected people often have oral lesions that affect their quality of life because of dry mouth, and people with sugar-rich dietary habits, and poor nutrition.

The WHO typically refers to four major risk factors for NCDs: poor diet, physical inactivity, tobacco use, and harmful alcohol use(65).

Regarding oral diseases, tooth decay is a multifactorial aetiology disease. It is linked to several factors. To name a few: age, dietary patterns, and oral hygiene practices. Also, risk factors like smoking, excessive alcohol consumption, low socioeconomic status, stress levels, diabetes mellitus type 2, presence of certain pathogens like *P. gingivalis*, *T. forsythia* and *A. Actinomyces comitans* can contribute to periodontitis (66). Socio determinants factors have consistently been demonstrated by epidemiological surveys. Thus, both these conditions (NCDs and oral diseases), are largely caused by a cluster of risk factors that belong to the same basket. Therefore, integrated actions to tackle them might produce a double benefit, filling two needs with one deed.

Diet in Sudan is mostly affected by socio-economic conditions and food availability. Episodes of malnutrition in early childhood, along with calcium, phosphate and vitamin A, C and D deficiencies, can increase ones susceptibility to dental caries through three mechanisms: defects in tooth formation (odontogenesis), the delayed eruption of teeth, and alterations in the salivary glands (67). In the Republic of Sudan, rates of malnutrition have remained high for the past 25 years, putting the country in the status of constant emergency, and reflecting

the limited progress that has been made. The WHO 2015 Health Profile estimates the prevalence of various conditions due to malnutrition in children under 5 years of age and shows that %2.2 of the population under study is underweight, %16.4 is wasting, %5.3 is in severe wasting and %35.0 is stunting (3).

HIV/AIDS is a second main risk factor for developing grave oral diseases. Despite the fact that oral lesions have decreased by more than %30 since the introduction of HAART, HIV/AIDS patients are prone to develop a diversified series of oral lesions, i.e., candidiasis, salivary gland disease, sarcoma, Kaposi's sarcoma, and oral hairy leucoplakia (68). In 2019 HIV incidence in Sudan accounted to more than 3,500 new cases and 46,000 people were living with HIV (69).

Cigarette smoking is a well-established risk factor for periodontal disease and is the strongest factor for oral cancer. Research evidence suggests that smokers have a higher tendency for problems such as teeth and bone loss and gingival recession compared to non-smokers, and to the formation of periodontal pockets, which increase the probability to suffer from more severe periodontal disease.

Moreover, in Sudan a smokeless of tobacco product called Toombak is very common. It is used as a form of snuff-dipping process or Suffa. It has the shape of a small ball (4-2 cm), commonly placed inside the lip (between lips and gums), and slowly sucked for 10 to 15 minutes. The process can be repeated about 20 time per day on average (70).

Clear evidence regarding Toombak prevalence direct correlation with oral cancer is scarce. According to Idris A M et al 1994, in Sudan over %40 of male population were Toombak users and among a cluster of 62 oral cancer patients, 50 had lesions directly correlated to Toombak use (71). Therefore, even if epidemiological data are currently missing, Toombak remains a risk factor for oral cancer, and possibly a very dangerous one.

Alcohol consumption when combined with tobacco use can exponentially impact oral cancer risk. However, Sudan is an alcohol-free country where data about alcohol use is simply not available. Nevertheless, recently the Federal Government decided to remove apostasy law and alcohol ban, after more than 30 years of Islamist rule, allowing non-Muslims to drink alcohol. Most probably this change of direction will support data collection and epidemiological study reducing stigma around alcohol consumption.

Oral hygiene

In many developing countries, natural methods of tooth cleaning using chewing sticks (miswak or siwāk in Arabic), prepared from the twigs, stems or roots of a variety of plant species are still being practiced due to their availability, low cost, and simplicity. In Sudan the *Salvadora persica* plant is quite common, which belongs to the Salvadoraceae family, that also has a wide geographic distribution ranging from Rajasthan (India), Nepal, and Malaysia in the east through Pakistan, Iran, Iraq, Saudi Arabia, and Egypt to Mauritania in the west. In Africa, they are found in North Africa, Ethiopia, and Central Africa to Southwestern Africa. In terms of oral hygiene, *Salvadora persica* has been reported to be antibacterial, antifungal, anticariogenic, and antiplaque (72). However, even if traditional miswak utilization remains popular, toothbrush and toothpaste use are very common as well.

Traditional medicine

Traditional medical practices are progressively disappearing from Sudan. Health education and legal restrictions are pushing traditional medicine to society's edge. Nevertheless, in some decentralized areas, especially rural ones, traditional healers still find fertile ground to practice.

Concerning dental care, traditional practices can be addressed to both adults and children. For example, a previously common practice was the uvulectomy (uvula removal). This practice was used for cases of chronic diarrhea (children) or abscesses (adult) and it is performed by traditional healers using a sharp hook, previously cleaned with salt and ash. A little piece of wood is utilized as mouth depressor. Despite the cultural and health significance of the practice, it is now strongly discouraged. In fact, it can lead to catastrophic complications, such as haemorrhage, anaemia, septicaemia, tetanus, HIV infection, or even death.

Moreover, when young children would present forms of oral pain that stimulated thumbsucking, a traditional practice was to remove frontal teeth or reduce their shape with metal instruments. Thus, according to local tradition, discouraging thumb sucking and reducing the risk of any oral diseases' transmission.

Additionally, in children with recurrent vomiting, a practice is reported that uses the application of manual strength to expand the baby's palate, apparently reducing the spasm of vomiting. To perform it, adults can use their thumb, covered with ash, to lift the baby up, and using baby's weight to express pressure on the palate, so inducing its expansion.

Another practice for adults is treating gingivitis with little incisions of the infected tissues, stimulating bleeding, followed by mouthwash with salty water as antiseptic. Toombak or garlic are also commonly use as painkillers.

Training system

Health workforce production in Sudan is crucial. It has been underlined in the 2016 - 2012 National strategic plan with the purpose of developing human resource plans and guidelines in all levels and areas of the health system in a wide-ranging tactic (73). Overall, training and production of the health workforce in Sudan has increased consistently in the last 20 years. This has been the results of the soaring number of medical schools, in both public and private sectors (public %55 and private %45). Health workers are around 100,000, split between 20 different professions (73). Male and Female distribution is mostly equal and age structure favours young professionals (74). The Ministry of Higher Education oversees pre-service training and production of health workers throughout public universities with medical and health science facilities, and roughly 250 allied health cadre>s schools and institutes. The Medical Council is delegated with registration and licensing of doctors, pharmacists, and dentists. Civil service under FMOH is the main employer in addition to the army, police, universities, and health insurance fund. Private sector staff accounts for %9, considering that dual practice is very common.

Universities offering dental programs in Sudan are mostly concentrated in major cities. Their total number is 33, plus 9 that are currently under approval, and their distribution within States is divided as described below.

State	No. of private schools	No. of Governmental school	Total No. of Schools
Khartoum	21	5	26
North Kordofan	0	1	1
Northern	0	0	0
Kassala	0	0	0
Blue Nile	0	0	0
North Darfur	0	0	0
South Darfur	0	0	0

State	No. of private schools	No. of Governmental school	Total No. of Schools
South Kordofan	21	5	26
Al Gezira	1	2	3
White Nile	0	0	0
River Nile	0	1	1
Red Sea	1	1	2
Gadaref	0	0	0
Sennar	0	0	0
West Darfur	0	0	0
Central Darfur	0	0	0
East Darfur	0	0	0
West Kordofan	0	0	0

Table 3: Sudan dental school distribution. Khartoum University



Figure 1: Dental universities distribution

Usually, dental universities also provide dental services. Moreover, they can be accredited with the local State MoH. When matching the requirements, university hospitals can furnish dental services in agreement with the national health system according to the limits defined by the NHIF. Hospital staff is divided between those employed by the university and those by the State MoH of reference. Public salaries are commonly low and university authorities might provide financial incentives for MoH staff to reduce attrition rate.

Students from dental universities after graduation are required to attend a probation period in a MoH hospital, during which they are temporary registered under the medical council. Once the so-called housemanship (or internship) is finished, they can obtain their permanent registration. Unfortunately, due to lack of university medical facilities, many students can wait up to 2 years before entering the program. According to FMOH estimates, roughly two to three thousand students are currently in attendance. Thus, even if public universities can provide students scholarships or facilitate accommodation, they cannot expand the training offered due to infrastructural limits or the endemic lack of professors.

According to the FMOH, a system of continuous medical education through seminars and workshop has been defined. However, it is not supported by a monitoring system.

Academy of health science

The Academy of Health Science offers courses for all nursing and paramedical sciences. In contrast to dental laboratory technicians who can obtain a certificate after secondary school, allied dental professionals such as dental assistants and dental hygienists require a university diploma.

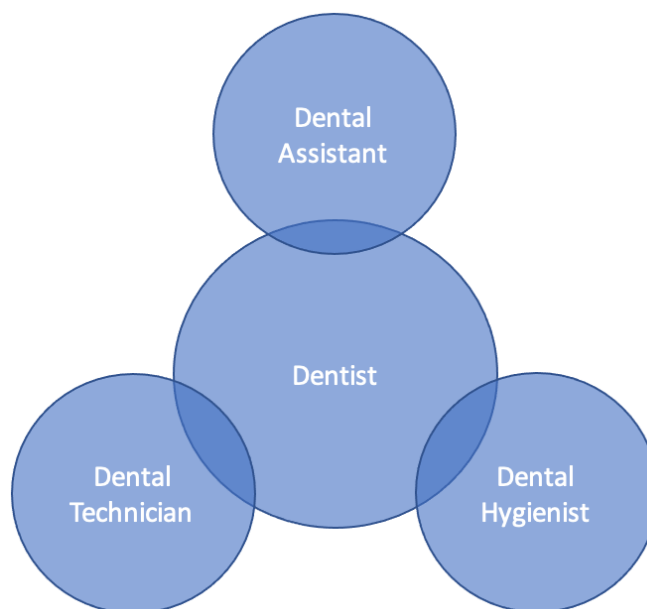


Figure 2: Dental team in Sudan

Dental Assistant and Dental Hygienists

Overall, dental assistant training is scarce in Sudan. Two schools can be found in the Khartoum State, graduating only few dozens of students per year. Data from other States are not published and cannot support the hypothesis that other schools are providing similar training programs. On the other hand, Khartoum University introduced in 2018 the figure of the dental hygienist and a dedicated university program.

The Dental Hygienist and Dental Assistant programs are delivered in 6 semesters to be completed in 3

academic years. Currently, three batches are registered for each program. The number of enrolled students for the hygienist and assistant programs are 140 and 125, respectively.

Role of Dental Hygienist	Role of Dental Assistant
Patient screening procedures: such as assessment of oral health conditions, review of the health history, oral cancer screening, head and neck inspection, dental charting and taking blood pressure and pulse	Assisting the dentist during a variety of treatment procedures
Taking and developing dental radiographs (x-rays)	Taking and developing dental radiographs (x-rays)
Teaching patients and communities appropriate oral hygiene strategies to maintain oral health; (e.g., tooth brushing, flossing and nutritional counselling)	Teaching patient appropriate oral hygiene strategies to maintain oral health; (e.g., tooth brushing, flossing and nutritional counselling)
Administering local anaesthetic	
Place temporary dressings and re-cement crowns	
Applying preventive materials to the teeth (e.g., sealants and fluorides)	

Table 4: Roles of Dental Hygienist and Dental Assistant. University of Khartoum

Postgraduate programs

Postgraduate programs are offered by the Ministry of Education (MoE) and by the MoH through the Sudan Medical Specialization Board (SMSB). They appear slightly the same and require both clinical practice and frontal lessons and assure students can obtain dental specializations that are nationally recognized. Formally, SMSB courses allow to obtain a Medical Doctorate (MD), whereas MoE programmes are canonical post-graduate programmes. Nevertheless, clinical skills and preparation by the end of the two academic lines are supposed to be equal. Both MoE and SMSB might also offer PhD programs, according to ongoing research streams.

Ministry of Education (3 years)	Sudan Medical Specialization Board (4 years)
Oral Surgery	Maxillofacial surgery
Restorative Dentistry	Periodontics
Prosthodontics	Dental public health
Periodontics	Pedodontics
Paediatric Dentistry	
Orthodontics	
Oral Pathology	
Dental Public Health	

Table 5: Postgraduate programs under MoE and MoH. FMOH

Health Information System

Dental care service claims transmission is included under the MoH management in collaboration with the NHIF.

K00	Disorders of tooth development and eruption
K05	Gingivitis and periodontal diseases
K07	Dentofacial anomalies [including malocclusion]
K10	Other diseases of jaws
K11	Diseases of salivary glands
K12	Stomatitis and related lesions
K13	Disease of lip
K13.1	Disease of cheek
K14	Disease of tongue
C14	Malignant neoplasm of other and ill-defined sites in the lip, oral cavity, and pharynx

Table 6: Sudan ICD 10 Dental Diagnosis Codes. FMOH, 2020

The classification of oral conditions in the Sudanese aggregate registration system includes nine diagnostic codes. ICD codes consider predominantly soft tissue lesions and exclude disorders of tooth development and eruption. Dental pathologies such as pulpitis, dental fractures, or injuries secondary to caries, are not included in the list and therefore not reported in the canonical annual reports. Therefore, it is not possible to trace back through the diagnostic codes the pathologies of hard dental tissues, which are the most prevalent pathologies of the oral cavity.

Patients' registration at facility level is usually paper based and many differences can be found from one facility system to another. At the hospital level patients are treated in dental clinics, differently from other chronic patients, and do not have individual charts. Hence, the patients' histories are not recorded.

The registration process in MoH hospitals or at PHC level includes the division between patients covered by NHIF and those not covered (OOP patients). Patients enrolled under the NHIF are usually registered on logbooks. Beside insurance ID specifics, relevant services performed are indicated in accordance with the classification system of the NHIF service package. OOP patients are usually recorded separately with similar criteria. Hospitals/primary health centers admissions are registered according to patients' symptoms. Nonetheless, both often differ from the ICD diagnosis codes used for the monthly hospitals/primary health centers report, which is then transmitted to the MoH. ICD codes are then applied secondary to internal reporting, introducing a substantial variability and possible fragmentation of data collection and transmission. Furthermore, data collection and transmission are mainly paper based and prone to systematic errors.

Hospitals/primary health centres OOP patients' services are registered and transmitted according to a dedicated intranet system, reducing variability, and assuring a better accuracy.

Financing

Like most African countries, the Republic of Sudan follows the out-of-pocket model and minimal national health insurance to some extent which benefits the wealthier populations. The increase in expenditure rose from %64 in 2008 to %69.31 in 2018. Per capita total Current Health Expenditure (CHE) of Sudan amounts to 58.8 US\$. Over %36 of OOP is spent at the primary health care centres, mainly for paying user fees and medicine costs, while %40.8 is spent at general hospitals. Over %16 is paid at the physician's private clinics and other %0.17 at specialised hospitals. The spending on dental care practices is little more than 75) %1).

High private expenditure might result in gross disparities, with spending highly skewed towards those who can actually afford it (76). A prevalent private expenditure can give rise to deterioration of public health care, especially in areas with lower per-capita income, usually also lacking public financial resources and managerial capacities. Other models like extensive Beveridge once in LIC can be effective to cover gaps. In fact, this system might assure a better distribution of services, particularly when fostering a PHC model, centred on health promotion, primary, and secondary prevention (77).

Financing Revenues	Amount USD	Percent	Amount SDG	Per Capita \$US
Public Revenues	594,291,998	24.06%	14,144,149,560	14.16
Central government schemes	163,506,941.89	6.62%	3,891,465,217.01	3.89
State/regional/local government schemes	193,702,269.59	7.84%	4,610,114,016.28	4.61
Social health insurance schemes	164,231,229.87	6.65%	3,908,703,271.00	3.91
Other Public	72,851,556.98	2.95%	1,733,867,056.03	1.74
Private Revenues	1,712,022,465	69.31%	40,746,134,674	40.78
Household funds	1,710,145,794.74	69.23%	40,701,469,914.88	40.73
Other Private funds	1,876,670.55	0.08%	44,664,759.03	0.04
Rest of the World	163,860,085.10	6.63%	3,899,870,025.33	3.90
Rest of the World	163,860,085.10	6.63%	3,899,870,025.33	3.90
Total CHE	2,470,174,549	100%	58,790,154,259.56	58.84
Capital Expenditure	98,611,647.67		2,346,957,214.58	2.35
THE	2,568,786,196		61,137,111,474	61.2

Table 7: Health Financing Revenues 2018. FMOH

In high-income countries, the cost of dental services covers a substantial portion of total private spending. The risk of financial hardship is, in fact, very high where access to care looks more feasible.

Providers of Health Services	Amount SDG	Percent	Amount \$US	Per Capita
Providers of Ambulatory Health Care	25,130,437,494.5	42.7%	1,055,900,735.1	25.1
Offices of Medical Specialists	7,000,652,825.4	11.9%	294,145,076.7	7.0
Dental Practices	7,853,690.0	0.0%	329,987.0	0.0
PHC Health Centers	14,173,888,397.4	24.1%	595,541,529.3	14.2
Other Medical Practices	3,948,042,581.7	6.7%	165,884,142.1	4.0
Providers of ancillary services	580,262,581.0	1.0%	24,380,780.7	0.6

Table 8: Health Care Provider 2018. FMOH

On the other hand, in countries where financial hardship due to high OOP is prevalent, dental care expenditure appears to be moderate. In fact, dental care is usually considered needless. Therefore, the poorest population quintiles tend to forgo dental care, not considering them essential. Under these circumstance, dental care is not a source of financial hardship for poor households because poor households are more likely to experience unmet needs for dental care (79)(78).

Health Benefit package

The Sudanese Health Benefit package is proposed by the Sudanese NHIF. The NHIF is a governmental organization funded in 1994. It is the main public health insurance institution that operates throughout the country, regulating and providing a mandatory Social Health Insurance. The social insurance coverage has firstly been addressed to government employees, and then gradually mixed (voluntary, involuntary). The enrolment is for the population is now compulsory.

NHIF is affiliated to Ministry of Social Security and Development and it acts both as purchaser for the MoH and provider.

The NHIF covers almost %81.6 of the total population (34,249,066). Poor and vulnerable groups represent the %71 of total subscribers. In some villages, where there are no current censuses of the dwellers, and where many of them perform informal work or have low unregistered incomes, the districts authorities can appoint local leaders to carry out supervisory work. These representatives are recognized in their role by the community and are mandated to identify family units in state of need. By doing so, such families can be included in official lists as low-income households and benefit from Zakat support or other forms of SHI payment exemption.

The populations covered are usually entire households. Family units might include a family head, parents (non-working and non-pensioners), wife*/husband, non-married daughters, and male sons up to 18 years (students are include until 25 years).

Sector	Payment	Source of financing
Formal (public-private)	%10 of fixed salary (%4 employee and %6 employer)	MoF
Self-employed	Flat rate for family	Syndicates Associations Unions
Poor families	Flat rate for families	Zakat NGOs MoF
Pensioners	Flat rate for families	MoF NHIF

Table 9: Premiums by sectors. NHIF

The Republic of Sudan has seen a true financial instability during the 2020-2019 biennium. Accordingly, social insurance premiums, mainly due to inflection trends, can have a different impact on family units' financial sustainability.

Once beneficiaries are enrolled and have obtained a health insurance card, they are eligible to access services across different States (regardless of the place of residence or card issuance). NHIF's Benefit package is comprehensive and provided to all beneficiaries without distinction.

Medical services

The general health benefit package includes an extensive group of service: 1) medical consultations (CHWs, MA, MWs, GP & Specialist); 2) laboratory investigations (routine, chemical, serology, haematology, etc.); 3) diagnostic investigations like radiology and Imaging diagnostic services (X- rays, U/S, MRI, CT, etc.); 4) surgical operations such general surgery, ENT, GIT, orthopaedics, ophthalmology, urology, obstetric & gynaecological, cardiovascular, dermatology, etc.); other services such as physiotherapy, dental services, respiratory tract, hearing, cardiovascular, nephrology, psychiatric, eye care, etc.

Dental services included	Dental services exempted
Medical consultation: dentist, GP and medical assistants	Root canal treatments
Treatment of infection	Fixed prosthetics
Scaling	Removable prosthetics
Diagnostic services (X Ray, CT scan, etc.)	Orthodontics
Extraction	Implanting
Surgical procedures	
Filling	

Table 10: Dental health benefit package. NHIF

MoH facilities number accredited with the NHIF, and the total attendees, have been steadily increasing since 2016. Number of facilities raised from 2,083 to 3,578, while annual attendees from 14,967,113 to 22,455,772.

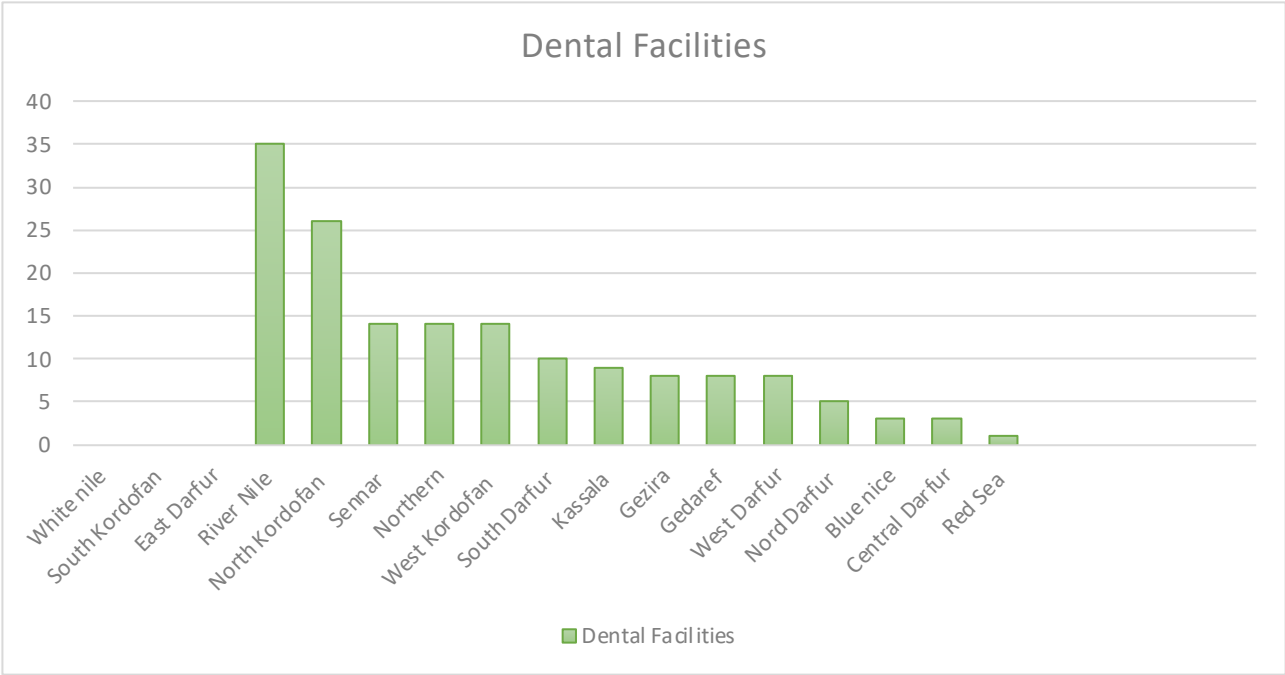


Table 11: Total number of facilities providing dental services covered by the NHIF. NHIF

As seen in the table, few States seem to be uncovered. More importantly, Khartoum State includes more than %45 of total MoH facilities.

The reimbursement system from NHIF to MoH facilities is based on monthly instalments. According to claims amount, funds are defined and then allocated. At the facility level, reimbursements are divided according to predefined percentages. Health professionals receive the %40 ,%40 goes for equipment, utilities, etc, while %20 left is kept at State level.

The progressive increase of dental service provision might afflict the financial sustainability of the sector. Only in

the first quarter of 2021 the number of benefits was reached compared to the whole 2020. Although the number of services covered by the insurance appears to be growing, in proportion to the number of beneficiaries, the system remains deficient, and the services are not easily available to the population. According to the Director of General Directorate of Health Services, National Health Insurance Fund, Dr. Wael Ahmed Fakihammed, the major challenges the system faces are due to a shortage of dental staff (highly concentrated in urban areas), to weak setting of dental departments in the public sector (including infrastructure and equipment), and to the escalation of dental services costs.

Some possible answers to current hurdles might come from moving towards UHC through joint plans and collaboration with MoH and other partners, improving access to healthcare and addressing health inequalities while focusing on vulnerable groups, enhancing financial sustainability through cost containment and additional sources of funding, overcoming fragmentation in healthcare finance, and shifting towards strategic purchasing.

State	2018			2019			2020			1st Q 2021		
	No. of Visits	Total cost	Average Cost	No. of Visits	Total cost	Average Cost	No. of Visits	Total cost	Average Cost	No. of Visits	Total cost	Average Cost
Khartoum	0	0	0	137,408	8,450,291	61	57,564	4,587,779.00	80	14,121	7,967,757	564
Sinnar	8,137	767,063	94	7,084	1,164,692	164	9,567	1,942,290.00	203	1,970	682,540	346
Gezira	51,375	146,991	3	41,689	222,122	5	31,402	3,053,961.00	97	6,818	2,154,823	316
Gedaref	11,294	91,579	8	10,282	141,528	14	8,021	522,591.00	65	2,246	214,819	96
Red Sea	6,363	115,355	18	15,621	630,311	40	10,394	514,093.30	49	10,348	1,289,757	125
River Nile	42,979	3,467,652	81	37,495	3,200,902	85	34,738	4,240,116.50	122	19,255	2,875,313	149
White Nile	44104	1817695	41	51708	4720407	91	12,066	1,153,372.00	96	-	-	0
North Darfur	4737	110835	23	2691	80715	30	3,949	177,140.00	45	636	63,600	100
Blue Nile	20,528	880,123	43	13,861	490,505	35	11,286	783,077.00	69	2,870	275,262	96
West Darfur	7837	205979	26	12568	832556.25	66	8,477	719,938.50	85	112	15,924	142
North Kordofan	25,723	1,806,703	70	27,694	2,682,066	97	14,937	1,460,937.60	98	4,503	3,338,154	741
Northern	14,675	289,176	20	12,175	373,845	31	9,890	571,570.00	58	2,135	333,390	156
Kassala	17,252	692,044	40	3,825	339,636	89	12,866	1,576,061.00	122	3,375	896,383	266
South Kordofan	7,483	578,390	77	10,280	947,084	92	8,796	1,117,252.00	127	2,035	795,407	391
South Darfur	18,248	575,840	32	31,531	1,212,285	38	31,029	2,570,738.00	83	12,050	1,229,223	102
West Kordofan	4,244	63,660	15	5,318	58,860	11	10,098	1,304,960.00	129	2,605	260,500	100
Central Darfur	6,253	477,961	76	6,377	813,347	128	4,853	1,177,800.00	243	1,272	256,195	201
East Darfur	4,104	176,414	43	840	25,200	30	5,488	333,523.37	61	1,199	440,375	367
Total	295,336	12,263,459	41.52	428,447	26,386,352	61.59	285,421	27,807,200	97.43	87,556	23,089,422	263.73

Table 12: Utilization and cost of dental services (2021 - 2018). NHIF

Medicine and Technologies

The dental profession is in a continuous development in terms of materials, drugs, and equipment. The supply and monitoring of dental material and devices needs effective regulation and follow-up.

Key aspects of the Sudanese medical technologies market are the need for improving the current organizational structure with respect to medical devices, including the need for appropriate dedicated personnel focusing solely on the area of medical devices. Other problems identified include the lack of a health technology management system, shortcomings in various aspects of the procurement process including the lack of a systematic approach to needs analysis so that at times medical devices are placed without the specialized personnel required to operate them resulting in the devices not being used for provision of services. In addition, inadequate attention is paid to budgeting and financing so that there is lack of funds to operate and service the devices after they have been purchased. Apart from this, there is inadequate attention paid to the selection of the medical device so that an inappropriate device is purchased for the institution(80).

The Republic of Sudan depends solely on imported drugs. The current share of local manufacturing in production of essential medicines in Sudan is only 81) %5).

Although the drug coverage is still low in MoH facilities (82), aggravated and accentuated by the COVID19-pandemic, the country is currently experiencing multiple crises, including drug shortage (83).

The NHIF, in accordance with the MoH, defined a drug list of which items costs are %75 covered. However, mainly because of extreme currency inflation and lack of price control due to market privatization, drug price skyrocketed, making them unaffordable for many.

Given this unsatisfactory situation, in line with the 74th WHO WHA resolution, Sudan's government is now tasked with developing a long-awaited global strategy, action plan and monitoring framework for oral health. A central point of attention is the development of "Best Buys for Oral Health" to prioritize effective interventions to promote good oral health.

Best Buys for Oral Health address key features such as: prioritization, as what are appropriate public health and clinical interventions to effectively promote oral health; cost-effectiveness-analysis, or which oral health interventions should be included in an essential package for oral care; what extent prioritized interventions differ between different geographic regions and macroeconomic context; and how can Best Buys for Oral Health be implemented in country-level policy process (LMICs, HICs).

Port Sudan overview and assessment of the dental health care system

Socio-Demographic status in Port Sudan

Port Sudan (Būr Sūdān) is a port city located in eastern Sudan, it is the capital of the Red Sea State, and it is its main seaport. Estimates regarding the population of Port Sudan today vary considerably. According to the UN World Urbanization Prospects, Port Sudan's 2021 population is about 84) 493.366). This estimate represents the urban agglomeration of Port Sudan, which typically includes Port Sudan's population in addition to adjacent suburban areas. It represents roughly the %28.6 of the population of Red Sea State, with %29.5 of its households and %71.7 of its urban population. Port Sudan is a multi-ethnic city. Northern Sudanese and other minorities, including Egyptians, Yemenis, Indians, Syrians, and Greeks, as well as Fallata and Hawsa from West Africa, have been residents from the start. An increasing number of Beja have also taken up residence in the city. The three main Beja groups are the Bishariyyin, the Amar'ar/Atmaan and the Hadendowa. Other groups include Beni Amer and Rashaida from Eastern Sudan, IDPs from Southern Sudan, the Nuba Mountains and Darfur and refugees from Eritrea and Ethiopia (85).

The health needs of the fast-expanding population of Port Sudan have not been matched by local health services. According to current evidence, to date the best health facilities are in Deim Madina and Transis, while the poorest such as Baghdad and Atbay are the ones lacking the most. International organizations such as Oxfam, Emergency, AICS, and AISPO currently support the health delivery system (85). Dental services are not exempt from this poor distribution and scarcity of territorial coverage.

Dental Health Care Facilities

N°	State MoH Dental Hospitals	MoH Dental Clinics at Health Centers	Private Dental Centers
1	Port Sudan Dental Hospital	Ahmed Gasim H.C.	Sea Ports Corporation Hospital
2	Taqadoun Rural Hospital	Dar Es Salaam H.C.	Police Hospital
3	Al Wihda Rural Hospital	Abu Bakar As Sideeq H.C.	Military Hospital
4		Al Thawra East H.C.	Loading and Discharge Labors Hospital

N°	State MoH Dental Hospitals	MoH Dental Clinics at Health Centers	Private Dental Centers
5		Omar Ibn Al Khattab H.C.	Parout Clinic
6			An Noor H.C.
7			Um Al Qurrah H.C.
8			Air Defense H.C.
9			Judiciary Medical Complex

Table 13: Dental facilities lists. Red Sea MoH

The overall offer of dental facilities in Port Sudan is a mix of private and public centers. Public facilities are divided between general or specialized hospitals and primary health centers. Moreover, Port Sudan can benefit from the presence of nine Private Dental Centers, under the management of other ministries (Ministry of Defence, Ministry of interior, and private). In Private Dental Centers patients have free access, however, only those entitled to specific insurance coverages (Ministry of Defence, Ministry of interior, etc) are provided with the dental services packages and lower co-payments. Otherwise, patients can pay OOP according to the national price list. Beside private dental centers, Port Sudan also hosts 13 private dental cabinets.

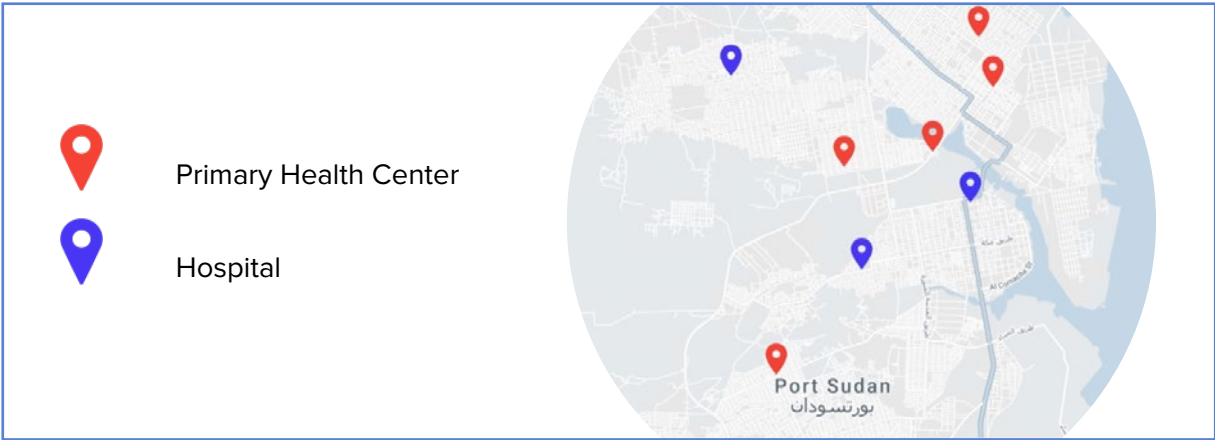


Figure 3: Port Sudan MoH Dental Facilities distribution

As described by the map, dental clinics are mainly based in central-north of Port Sudan. The facility population ratio is 0.16:10,000, considering only MoH providers accredited with the NHIF. When including Private Dental Centers the ratio increases to 0.34:10,000. Overall, it appears that the number of facilities and their distribution do not particularly match population oral health need.

Costs of dental care is quite similar when comparing NHIF reimbursements and OOP hospital price list.

Nonetheless, the national currency has sharply declined due to rising inflation (more than %342 in March 2021) had an impact on dental care price value. In fact, dental care treatments prices are fixed to 2020 monetary value. Therefore, hospital reimbursements appear unbalanced, devaluing hospitals/primary health centers purchasing power.

Service type	Price (SDG)	Service type	Price (SDG)
Examination	40	Medical certificate	158
Normal extraction	380	Specialist visit	188
Wisdom tooth extraction	478	Gum cleaning	308
Glass ionomer filling	238	Stitch removal	58
Temporary filling	408	Composite filling	618
Definitive filling (amalgam)	478	Age estimation (forensic)	158
Other filling	100	Minor surgery	2008
Front root canal treatment	608	Medium surgery	4008
Back root canal treatment	648	Major surgery	6008

Table 14: Dental service type pricing list for OOP patients

N°	Service type	Price (SDG)
1	Normal extraction	306
2	Wisdom tooth extraction	472
3	Temporary filling	400
4	Definitive filling	472
5	Partial scaling and root planning	306
6	Complete scaling and root planning	613

Table 15: Dental service type pricing list (reimbursement) for insured (NHIF) patients

Results from Demand Analysis in Port Sudan

Results from the field survey came from data collection conducted between May 14th 2021 – June 14th 2021. Data about oral health demand was gathered from 142 individuals within the eight public dental facilities currently operating in the city of Port Sudan.

Table 16 illustrates the socio-economic characteristics of the population surveyed. %73 were women. Mean age 36 (C.I. %92 .(33.4 – 38.9 were from urban areas, while %40 attended primary school. %68 are currently married, whereas %28 single. In terms of household size, %26 of them had +5 children and +5 %78 people per household. %89 of the surveyed population affirmed difficulty in making financial ends meet. Only %12 of the population surveyed was under 18. Also, about %45 of attendants have completed at least a secondary education level. Higher education level is correlated to higher household income. The secondary education net enrolment rate in Sudan is 86) %39.5), showing that population with lower education level was partially skimmed from dental care delivery.





Table 16: Patients' social status

Health Status

Almost %75 of the total population surveyed suffered from pain or discomfort related to oral health. However, both teeth and gum health were generally perceived by patients as good or average. Oral dental hygiene habits show the use of toothbrush and miswak, even combined, and toothpaste. Also, dental hygiene devices are usually correctly maintained and changed every 3-2 months.

Toothache or sensitive teeth has been referred as most common oral problem by 7 out of 10 respondents. Difficulty in biting and difficulty in chewing food are the most frequent discomfort as well as interrupted sleep due to oral pain.

Generic risk factor related to daily habits and diet showed not to be very relevant. Soft drinks, sweet and candies are consumed daily only by %3.5 and %7 of the surveyed population, while tea and coffee with sugar are highly consumed, respectively by %50 and %25 of the total. On the other hand, only %4.2 of the respondents affirmed

to consume fresh fruit daily.

None of the participants are used to consuming alcohol, and just %2 admitted to smoking or chewing tobacco daily.

During the past 12 months, did your teeth or mouth cause any pain or discomfort?

Yes		No		Don't know		No answer	
105	%74	37	%26	0	0	0	0

How would you describe the state of your teeth?

Excellent		Very good		Good		Average		Poor		Very poor		Don't know	
2	1.4%	5	3.5%	75	53%	46	32%	11	8%	3	2%	0	0

How would you describe the state of your gums?

Excellent		Very good		Good		Average		Poor		Very poor		Don't know	
4	2.8%	6	4%	124	87%	3	2%	4	3%	1	0.7%	0	0

How often do you clean your teeth?

Never		Once a month		3–2 times a month		Once a week		6–2 times a week		Once a day		Twice or more a day	
2	1%	0	0	2	1%	0	0	0	0	47	33%	91	64%

How frequently do you change your device (e.g. toothbrush or one of the previous)?

Once every 2 or 3 months		Once every 6 months		Once a year		Never		Other	
115	81%	0	0	0	0	2	1.4%	25	18%

Do you use toothpaste to clean your teeth?

Yes				No			
115		81%		27		19%	

Have you experienced the following symptoms related to your oral health in the last 6 months?

Toothache or sensitive teeth		Stained or disordered teeth		Broken or missing teeth		Crooked teeth		Bleeding gums		Loose teeth		None	
99	70%	15	11%	28	20%	11	8%	7	5%	5	4%	19	13%

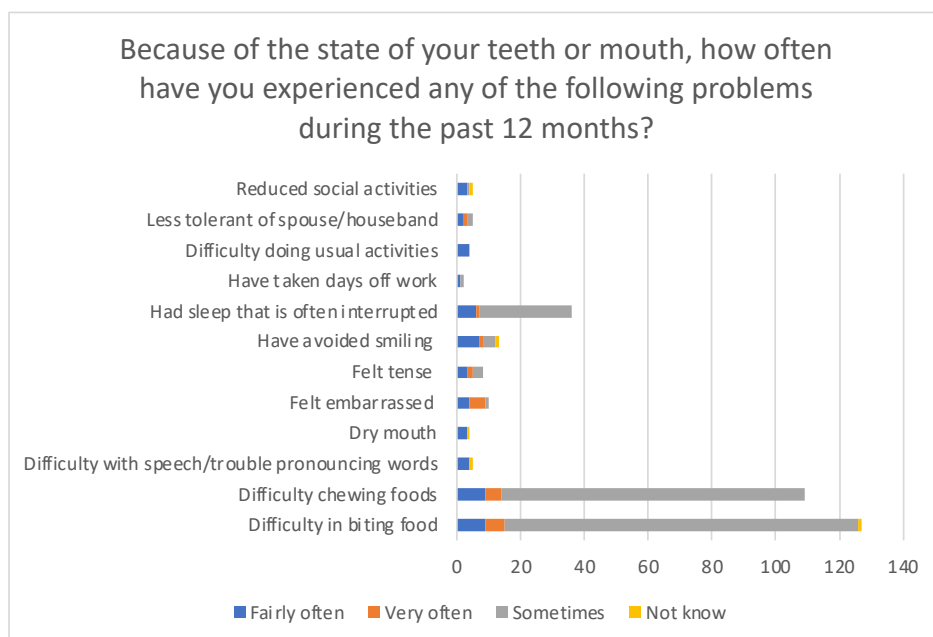


Table 18: Oral health related problems

How often do you eat or drink any of the following foods, even in small quantities?	Several times a day	Every day	Several times a week	Once a week	Several times a month	Seldom or never
Fresh fruit	0.7	4.2	14.8	10.6	24.6	44.4
Biscuits, cakes, cream cakes	1.4	27.5	12.0	2.8	7.0	49.3
Sweet pies, buns	0.0	4.2	5.6	3.5	5.6	81.0
Jam or honey	0.0	2.1	5.6	6.3	14.1	71.1

How often do you eat or drink any of the following foods, even in small quantities?	Several times a day	Every day	Several times a week	Once a week	Several times a month	Seldom or never
Chewing gum containing sugar	0.7	9.2	6.3	7.0	9.2	66.9
Sweets/candy	1.4	7.0	6.3	4.2	11.3	69.0
Lemonade, Coca Cola, or other soft drinks	1.4	3.5	6.3	7.0	9.9	71.8
Tea with sugar	22.5	50.0	2.1	1.4	2.1	21.8
Coffee with sugar	38.7	26.8	2.1	3.5	0.0	26.8

Table 19: Oral health dietary risk factors

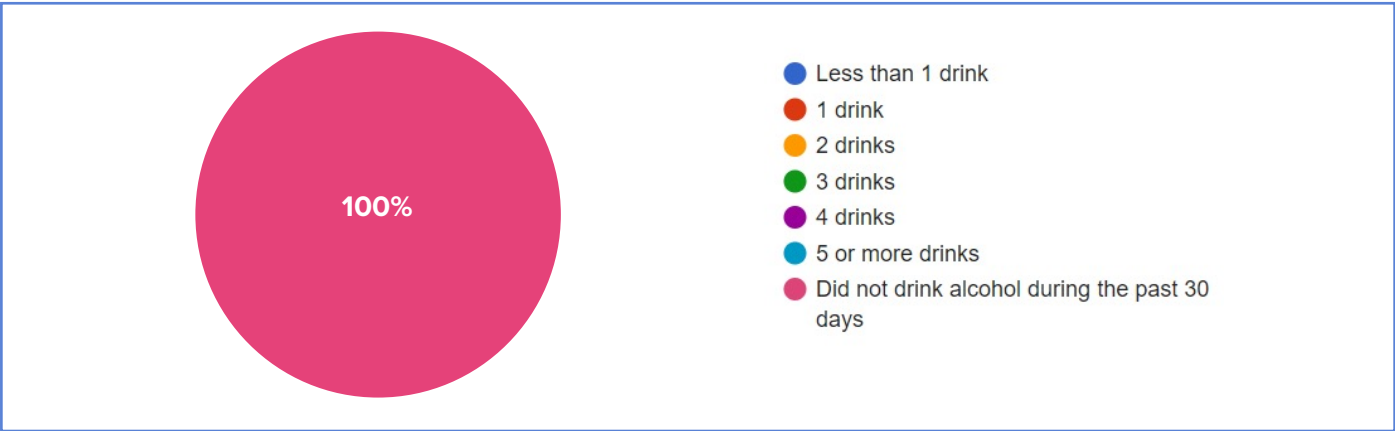


Table 20: Oral health lifestyle risk factors

Affordability

Economic barriers to dental care appear not to be relevant. Given the premises that dental care is frequently considered a commodity and skipped due to high cost in LIC, only almost 1 out 10 admitted to forgoing or postponing dental care due to economic reasons. About %8 gave up essential goods (house, food, clothes) because of the cost of dental treatment. Also, a very small portion spends more than 4,500 SDG on dental care per year.

Have you ever had to forego or postpone dental treatment for economic reasons?

Yes		No	
115	88.5%	15	11.5%

Have you ever had to give up essential goods (house, food, clothes) because of the cost of dental treatment?

Yes		No	
10	7.8%	118	92.2%

On average, how much do you spend per year on dental care (mark the closest one)?

4500 SDG or less		9000 SDG		18000 SDG		36000 SDG or more	
116	92.8%	5	4%	2	1.6%	2	1.6%

Do you benefit from any exemptions in paying for dental care (public insurance, private insurance, donation such as NGO or private entities)?

Yes		No	
131	92.3%	11	7.7%

How long is it since you last saw a dentist?

Less than 6 months		12–6 months		More than 1 year but less than 2 years		2 years or more but less than 5 years		5 years or more		Never received dental care	
67	47.5%	22	15.6%	11	7.8%	21	14.9%	5	3.5%	15	10.6%

Table 21: Dental care economic barriers

Availability and accessibility

Among the surveyed population, almost %50 received dental care from dental visits during the previous 6 months and only %10 were receiving dental care for the first time. Dental consultation/advise is the main reason of visiting a dentist (%80). Only %15 of the interviewers suffered any form of delay in receiving care, while travel time to reach dental facility is less than 30 minutes on average.

How long is it since you last saw a dentist?

Less than 6 months		12–6 months		More than 1 year but less than 2 years		2 years or more but less than 5 years		5 years or more		Never received dental care	
67	47.5%	22	15.6%	11	7.8%	21	14.9%	5	3.5%	15	10.6%

What is the reason of your visit to the dentist today?

Consultation/ advise		Pain or trouble with teeth, gums, or mouth		Treatment/ follow-up treatment		Routine check-up/ treatment		Other	
116	81.7%	14	9.9%	2	1.4%	4	4.2%	4	2.8%

Over the past 12 months, have you experienced a significant delay in accessing dental care due to lack of providers, service malfunctioning, or long waiting list?

Yes		No	
18	15%	102	85%

Travel time to a dental provider?

Less than 30 minutes		More than 30 minutes and less than 1 hour		More than 1 hour	
125	88%	10	7%	7	5%

Adequacy

According to the survey, participants showed high satisfaction related to communication with dental providers. For treatment options, decisions regarding patients care and patients’ empowerment are positively perceived. On the other hand, the patients’ feedback is rarely considered, while respondents are positively impressed by dental care safety, high quality, and good continuity of care.

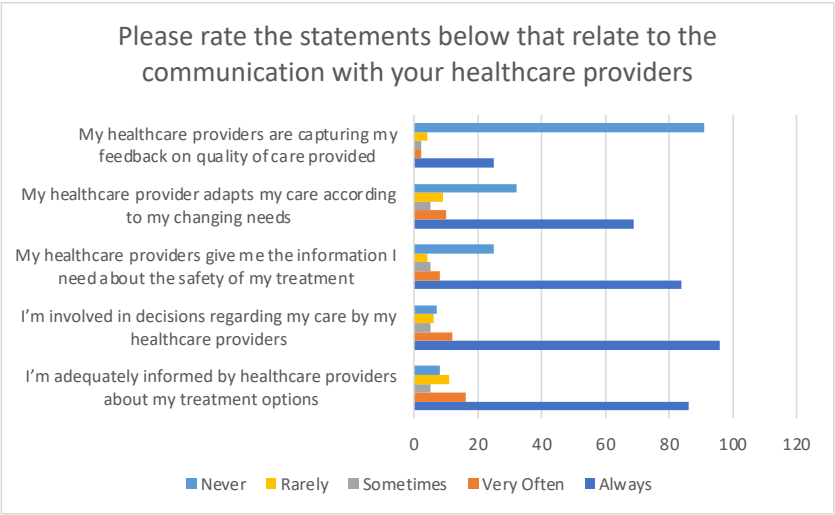


Table 23: Patients’ satisfaction

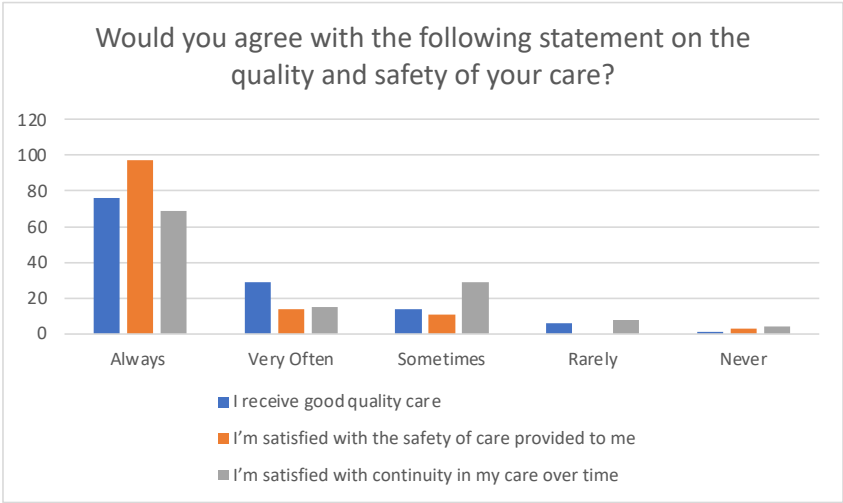


Table 24: Quality of care

Appropriateness

Only one single patient affirmed to feel stigmatized due to his ethnicity during the survey.

Have you ever felt stigmatised when seeking or receiving healthcare (treated differently or with unfairness)?

Yes		No	
127	99.2%	1	0.8%

Table 25: Stigma in dental care

Results from Supply Analysis in Port Sudan

Following the MoH facility lists, eight between dental clinics and hospitals were visited and evaluated. Port Sudan dental care offer includes three hospitals and five primary health centers.

Cover Page and Facility Identifiers

All the facilities are currently distributed in the city of Port Sudan. Management and ownership are under the MoH. Port Sudan Dental Hospital is the only specialized dental hospital in the region, while Tagadom Rural Hospital and Al Wihda Hospital are general hospital that also provide dental care. Also, five primary health centers offer dental services.



Figure 4: Port Sudan Dental Hospital



Figure 5: Tagadom Rural Hospital

Radiographic and Treatment Procedures

X-rays and radiographic instruments of any kind, including orthopantomography and computed tomography (CT) scans, are not provided in hospitals nor in primary health centers. Only Port Sudan Dental Hospital has x-ray machinery, but it is out of service. Moreover, facilities do not conduct any diagnostic testing of specimens using either laboratory equipment or diagnostic tests related to oral disease. Only Port Sudan Dental Hospital is able to send specimens (mainly oral mucosa biopsies) outside for testing and receive the results back. The

referral hospital for anatomy pathology is in Khartoum, about 670 km away. All the other facilities in Port Sudan refer patients at risk for oral cancer with high-risk lesions of the oral mucosa to the Port Sudan Dental Hospital.

Facility Staff Numbers and Occupation

Facility staff is composed of dentists and dental assistants. Port Sudan Dental Hospital hosts the largest number of dentists, seven, whereas primary health centers on average between one and two. Total number of dentists working in MoH facilities reported was seventeen.

Dental assistants can be found in both hospitals and primary health centers. The total number of dental assistants currently working was thirteen, of whom four were contracted by the Port Sudan Dental Hospital. Nurses in primary health centers provided the sterilization and disinfection of the dental cabinet, however, they are not dedicated only to the dental department. Only Port Sudan Dental Hospital has dedicated nursing staff, two.

Dental facilities do not benefit from internal dental laboratories. Moreover, personnel are not assisted by a routine system for continuous medical education (CME)/professional development. Therefore, no in-service education is carried out at a set time interval. Moreover, only the Port Sudan Dental Hospital functions as a training site for dental students.

Infrastructure

Dental facilities do not have any communication means, such as normal telephones. Personnel use their own mobile phones for external communication. Functioning computers are available in some facilities, specifically at the Port Sudan Dental Hospital, Al Thawra East, and Al Wihda Hospital. However, computers are only used to transmit OOP patients service provision through an intranet system connecting hospitals and the State MoH network.

Utilities are provided by local administration. All the facilities are connected to the city electricity grid. Generators are also present in all facilities. However, four primary health centers suffer from deficient secondary or backup source of electricity. During the 7 days before the survey, all the facilities suffered from lack of electricity for more than two hours. Water availability is mostly present in all dental clinics, but two facilities, Dar Es Salaam and Al Wihda Hospital, experienced water shortage for more than two hours during the 7 days before the survey. Particularly, Dar Es Salaam lacked water supply due to the city's distribution system shortage. In fact,

water supply is guaranteed by the Health Center directorate, which is the office in charge of purchasing and organizing the distribution of water resources. Obstacles during the chain of distribution due to poor management or infrastructural difficulties can hinder the distribution process, such as what happened in this case.



Figure 6: External electric source. Al Wihda Hospital

Health care Waste Management and Sterilization

Medical waste is managed similarly in all dental clinics. Sharps are placed in special containers, and placed inside each dental cabinet, identified by appropriate signage, and sealed for disposal. Together with all the hospitals/primary health medical waste they are stored off the facility, within the perimeter, and usually kept unprotected.



Figure 7: Medical waste storage. Al Wihda Hospital



Figure 8: Medical waste storage. Ahmed Gasim Health Center

Guidelines on health care waste management are not available for the staff nor is formal training in health care waste management practices, which has not been implemented in the two years before the survey.

Electric dry heat sterilizers are commonly used in all the facilities. However, hospitals/primary healths do not provide physical barriers to separate the decontamination area from the other sections to contain contamination on used items. Usually, autoclaves are placed near the dental chair. Also, the sterility of surgical instruments is not guaranteed by the utilization of rigid containers, peel-open pouches (e.g., self-sealed or heat-sealed plastic and paper pouches) or roll stock or reels (i.e., paper-plastic combinations of tubing designed to allow the user to cut and seal the ends to form a pouch, that are not provided).



Figure 9: Autoclave. Ahmed Gasim Health Center

Health financing and accounting

Guidelines for storage and procurement criteria are generally absent from dental facilities.

Regarding medical fees they are applied to dental care. The list of services covered, services exempted, and price are equal to those reported in section 1 paragraph “Health Benefit Package”.

About %95 of total beneficiaries in Port Sudan MoH facilities are insured with the NHIF, more than the %82 national average.

The only source of financing is the MoH, without any addition to the officially allocated budget from NGOs, other ministries, private insurances, and community programs. Only Abu Bakr As Sideeq Health Center received one dental chair from the local Academy of Health Science. It is important to report that communities

of neighboring health centers/hospitals are reported to make small donations to cover utility costs or can offer their skills and time for free for minor works within the facility.

Expenditure

General information about total facility expenditure is not internally collected regarding salaries, routine maintenance, electricity, water, telephone or other communication means, medical equipment, software or information system, management, and ICD coding and financial systems.

Individual patient records/chart and identifiers

Patient ID numbers for outpatients are not applied in primary health centers and hospitals, nor are individual patient charts or records, nor are standardized sets of electronic data entry screens to comprise a complete medical chart, nor ICD coding system.

Reports about outpatient dental activities are collected manually and submitted to local MoH and NHIF. Patient past medical histories (chronic disease) are scarce and final diagnosis might include very general information that reduce reporting accuracy (fever, oral pain, etc...).

[illegible]

Figure 10: Patients' register MoH facility Port Sudan

إجمالي التكلفة بالجنينة	تكلفة الدواء 75% بالجنينة	التشخيص النهائي	الأمراض المزمنة	الخدمات التشخيصية		العمليات	الاختصاصي	ملاحظات
				معملية	أخرى			
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Figure 11: Patients' register MoH facility Port Sudan

Service and infrastructures

On average primary health centers and hospital dental clinics are open 8-5 hours, 5 days per week. Shifts are usually divided between dentists in the morning and dental assistants, after breakfast (midday).

Each primary health center visited during the survey had at least one dental chair. Total dental chairs number was eighteen. Ten in Port Sudan Dental Hospital. However, only four of them were fully functioning (e.g. handpieces used for restorative treatment), three were functioning at Port Sudan Dental Hospital, and one at Ahmed Gasim Health Center. Functioning dental chairs in other hospitals and primary health centers were limited to dental chair three-way movements and aspiration.

Facility	Total number	Functioning
Port Sudan Dental Hospital	10	3
Tagadoum Rural Hospital	1	0
Ahmed Gasim HC	1	1
Al Thawra East HC	1	1
Abu Bakr As Sideeq HC	2	2
Omar Ibn Al Khattab HC	1	0
Dar Es Salaam	1	1
Al Wihda Hospital	1	1
Total	18	9

Table 26: Dental chairs number. Port Sudan

Infection control resources/supplies used are mostly equally available in the general outpatient dental area across different providers. Only Dar Es Salaam experiences a temporary lack of water supply. However, Covid19- infection control measures fostered the use and presence of soap for hand hygiene and alcohol-based handrub, that can be found in all the clinics. Posters reminding staff about hand hygiene or showing good hand hygiene techniques are also very common. Non-sterile gloves are provided in all the facilities, while sterile gloves are only at hospital level. Also, sharps containers are commonly used and placed beside dental chairs.

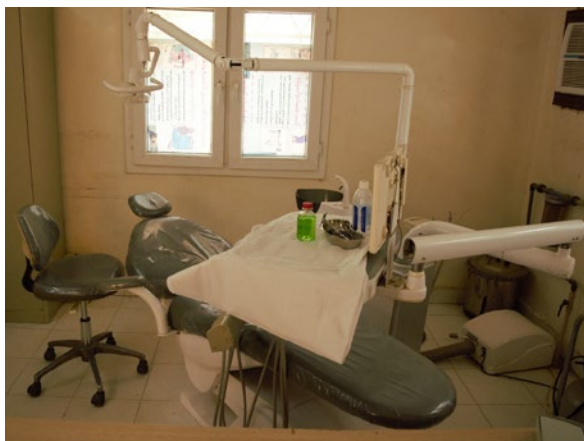


Figure 12: Dental chair.
Ahmed Gasim Health Center



Figure13: Sharp container.
Ahmed Gasim Health Center



Figure 14: Dental equipment.
Ahmed Gasim Health Center

Guidelines for infection control are provided by local MoH and inspections are reported monthly.

	Port Sudan Dental Hospital	Tagadoum Rural Hospital	Ahmed Gasim HC	Al Thawra East HC	Abu Bakr As Sideeq HC	Omar Ibn Al Khattab HC	Dar Es Salaam	Al Wihda Hospital
Clean running water (piped, bucket with tap or pour pitcher)	✓	✓	✓	✓	✓	✓	✗	✓
Soap (bar or liquid) for hand hygiene	✓	✓	✓	✓	✓	✓	✓	✓
Alcohol-based handrub	✓	✓	✓	✓	✓	✓	✓	✓
Poster reminding staff about hand hygiene or showing good hand hygiene techniques	✓	✓	✓	✓	✓	✓	✓	✓

	Port Sudan Dental Hospital	Tagadoum Rural Hospital	Ahmed Gasim HC	Al Thawra East HC	Abu Bakr As Sideeq HC	Omar Ibn Al Khattab HC	Dar Es Salaam	Al Wihda Hospital
Disposable paper towels for drying hands	X	X	X	X	X	X	X	X
Disposable latex gloves (non-sterile)	✓	✓	✓	✓	✓	✓	✓	✓
Disposable latex gloves (sterile)	✓	✓	X	X	X	X	X	✓
Waste receptacle bin with lid and plastic bin liner clearly marked, for example, by label or color, for infectious non-sharp waste	X	X	X	X	X	X	X	X
Does the waste receptacle for infectious non- sharp waste have a functional foot pedal to open it?	X	X	X	X	X	X	X	X
Sharps container ("safety box")	✓	✓	✓	✓	✓	✓	✓	✓
Environmental disinfectant (e.g. chlorine, alcohol)	✓	✓	✓	✓	✓	✓	✓	✓
Disposable syringes with disposable needles	X	X	X	X	X	X	X	X
N95 face masks	X	X	X	X	X	X	X	X
Eye protection (goggles, face shields)	X	X	X	X	X	X	X	X
Hair cover	X	X	X	X	X	X	X	X

Table 27: Infection control resources/supplies

Outpatient dental services

Among the eight facilities, only Port Sudan Dental Hospital and Ahmed Gasim Health Center were able to provide all the services covered by NHIF (examination, extraction, restorative treatment, scaling and root planning). Moreover, Omar Ibn Al Khattab Health Center, Dar es Salaam Health Center, and Al Whida hospital limit their provision of service to examination and extraction. Complex cases are often referred to Port Sudan Dental Hospital. Barriers for service provision are mainly related to dental equipment scarcity (e.g. ultrasonic cleaner for scaling and root planning, basic dental instruments, and consumables). Lack of handpieces or inefficient dental chairs hinder massively the provision of restorative treatments covered by the NHIF, so limiting the packet of services to examinations and extractions.

Prosthodontics is not covered by NHIF and only Port Sudan Dental Hospital and Ahmed Gasim Health Center provide the service, outsourcing the manufacturing of dentures and fixed prosthetics to local dental laboratories. Average costs are: \$45 dental crown and \$70 dentures. Costs and quality vary according to the supplier.

Orthodontic treatments and implantology (\$800 implant fixture) are limited to private dental providers.



Figure 15: Dentures/partial denture bite rims. Port Sudan Dental Hospital

	Port Sudan Dental Hospital	Tagadoun Rural Hospital	Ahmed Gasim HC	Al Thawra East HC	Abu Bakr As Sideeq HC	Omar Ibn Al Khattab HC	Dar Es Salaam	Al Wihda Hospital
Examination	✓	✓	✓	✓	✗	✓	✓	✓
Extractions	✓	✓	✓	✓	✗	✓	✓	✓
Scaling and root planning	✓	✓	✓	✗	✗	✗	✗	✗
Root canal treatment	✓	✗	✓	✗	✗	✗	✗	✗
Fixed prosthetic	✓	✗	✓	✗	✗	✗	✗	✗
Dentures	✓	✗	✓	✓	✗	✗	✗	✗
Restorative treatments	✓	✗	✓	✗	✗	✗	✗	✗
Orthodontic treatment	✗	✗	✗	✗	✗	✗	✗	✗
Implantology	✗	✗	✗	✗	✗	✗	✗	✗

Table 28: Dental services in Port Sudan MoH providers

Dental material in hospitals/primary health centers is limited to the type of services provided. Hence, amalgam, adhesive composite resins, glass ionomer cements, gutta percha, manual endodontic files, Ni-Ti files, Zinc Oxide Eugenol cements, and ultrasonic cleaner were available only at Port Sudan Dental Hospital and Ahmed Gasim Health Center, whereas periodontal curette also in Tagadoun Rural Hospital.

Data about hospitals/primary health centers performance were not available at facility level.



Figure 16: dental treatment. Port Sudan Dental Hospital



Figure 17: Dental treatment. Port Sudan Dental Hospital

Conclusions

The assessment of The Republic of Sudan's oral health care system, paired with the in-depth analysis of public health supply and oral health demand in the city of Port Sudan, showed endemic barriers within the national HCS contingent on each of the WHO building blocks.

As reported in the analysis, National policy directions are presented by the Sudan National Health Sector Policy Plan and the Oral Health Policy Plan. Overall, it can be seen that main long-term goals are directed toward the inclusion of oral health within primary care and UHC, the extension of the monitoring and evaluation system, and the improvement of the dental Health Information System. However, National policies implementation strategies remain broad and vague, while also lacking operationalized indicators for the monitoring process. Moreover, despite being included in HCS long-term strategy plan, primary prevention and oral health promotion are still underfunded since only few school-based programs are implemented in Khartoum State.

Dental service delivery in the Republic of Sudan is provided by the MoH jointly with NHIF with a comprehensive health benefit package. Dental services under the health benefit have zero cost-sharing requirements. However, services out of the health benefit package are entirely covered OOP. As deduced from the survey, more than %95 of the patients of MoH dental facilities benefit from NHIF coverage. Also, percentage of HCE related to dental care is very low (under %1 of total HCE). Paired with the low share of out-of-pocket payments, it appears that the levels of catastrophic health expenditure among the population due to dental care are lower than western countries.

Population health outcomes related to dental care are not collected nor reported, therefore it is not possible to compare them with health system improvements. Moreover, capacity and capabilities data cannot support the hypothesis that Sudanese public dental system is able to treat diseases in a timely and appropriate manner or to avoid the onset of diseases altogether.

Transparency in the health system is weakened somewhat by the co-existence of NHIF and substitutive public health insurances under specific ministries (Ministry of Interior and Armed Forces), especially in terms of entitlements to benefits and regulations and in terms of the complex criteria determining multiple eligibilities. A scarce network of health care providers cannot ensure high availability of services across the country. Additionally, accessibility in rural and decentralized areas seems to be even lower. Several of the eighteen Sudanese States appear to be unprepared in relation to MoH dental services. Only Khartoum State concentrates enough providers to meet oral health demand. Despite the results of the survey showing that reported unmet needs for medical care were very low, a high percentage of patients in MoH dental care facilities are covered by the NHIF and have a high education rate (secondary school and above). Considering the extremely low public dental care expenditure rate, patients' socio-economic characteristics from the survey, and the high poverty rate, it seems that lower population's quintiles do not access to public dental care, thus preferring to postpone or forgo dental care.

Health service-related data are collected at various points in Sudan HCS and mirror the fragmentation between NHIF, MoH, and other social insurance schemes and sectors of care. Data are comprehensive (providers are required to collect data in order to request payment at the point of usage), but generally of low quality. There is an array of databases at the Federal and State level with limited linkages between them. However, the fragmentation of databases complicates comprehensive health system performance assessment. The multitude of data collection and transmission systems enables systematic evaluations and the definition of providers performance monitoring strategies.

Epidemiological data about oral health is scarce and hard to estimate. Nevertheless, as reported in the assessment from Port Sudan, oral hygiene habits include toothbrush and miswak, and dietary risk factors seem to be limited to sugary coffee and tea in patients attending MoH facilities. Also, smoking (also counting Toombak) and alcohol usage seems to be rare. Also, according to the survey, access to dental care is usually due to contingent oral health discomfort or pain.

The quality of dental clinics care in Sudan is not measured by a set of defined indicators. However, as shown by the survey, patients perceive a high-quality service, good communication with dental providers, safety, and continuity of care. Treatment options, decisions regarding patient care and patient empowerment are positively perceived by patients. On the other hand, patients' feedback is rarely considered. In addition, it appears from the survey that patients are not stigmatized due to their social/ethnic identity in MoH facilities. MoH dental clinics in both hospitals and health centers are generally very fragile. Lack of electricity and water supply can hinder day to day activities when poorly managed, particularly in remote areas. Dental equipment scarcity limits services offered, even for dental treatments covered by the NHIF.

Overall, MoH dental personnel is scarce, poorly distributed, and suffers from a high attrition rate. Dentists' low salaries are marginally compensated by monthly bonus allocated according to performance rate by the NHIF. Dentists' education is mainly centred in the capital Khartoum, discouraging post-graduation redistribution to other States. Allied health professionals partially cover the gap in dental services, but often it's out of their scope of work, without a proper preparation.

Final Recommendations

Although in the Republic of Sudan the overall disease burden compared to HICs is still low, oral diseases are increasing in prevalence. Investments in oral health are very restricted due to the competing demands on scarce resources, thus making dentistry unavailable and unaffordable, often reserved for the wealthy. The need for system change is particularly relevant in LICs where the so-called westernised model of dentistry is unaffordable, unsustainable, and inappropriate. As so, most diseases remain untreated in most of the population, particularly in the poorest quintiles, and in those who have very restricted access to dental care. To effectively tackle the global burden of oral diseases, the HCS requires a fundamentally different approach. In the Republic of Sudan, due to the relevance of the private sector, the dental profession and the practice of dentistry are still very much dominated by a treatment-focused and interventionist approach. Moreover, the fundamental principles of dental training have remained broadly unchanged for decades. Although teaching on certain techniques and approaches has evolved, the dental surgeon paradigm persists, with dentists largely trained to intervene reactively (e.g., once the disease or problem has started to manifest itself) and surgically (using a drill, scalpel, or other instruments) rather than proactively and preventively. As such, the training of dentists prepares them to be disease-centred rather than patient-centred or health-centred (87).

In fact, many dental academies still continue to train dentists to work alone, instead of expanding the training broader range of dental professionals who are able to address the oral care needs of their patients and local populations (88).

To improve oral health outcomes, while being cost-effective and providing more accessible way of care, the Republic of Sudan might consider embracing a new paradigm and including oral health under UHC. Continuing to exclude oral health from UHC may jeopardizes long-term population health outcomes, also far from the mouth. Furthermore, this neglect sustains the assumption that oral health is conceptually distinct from systemic health.

As introduced by Fisher et al (7), efforts to integrate oral health into UHC focus on three areas. First, integrated essential oral health services and the basic package of oral care. Second, an oral health workforce geared towards population health needs and the social determinants of health. Third, financial protection and inclusion of dental care coverage in health insurance packages, as well as expanding fiscal space for oral health care. If coordinated, these interventions will address oral health policy and planning far from traditional model of restorative dentistry towards a preventive model of dental care able to promote oral health and integrating it across health systems at all levels.

National and State Level Policy

In line with the 74th WHO WHA resolution on oral health, it is recommended to frame oral health policies, plans and projects for the management of oral health care according to the vision and political agendas in health projected for 2030, in which oral health is considered as an integral part of general health, responding to the needs and demands of the public.

Overall, the definition of a strategic vision and central targets with clear responsibilities among various stakeholders could support the prioritization of health reform activities, and in doing so, introduce greater accountability into the health system. Therefore, Sudanese oral health Federal and State level policies can benefit from this new recommendation, and planning and developing State level policies, starting by endorsing the Oral Health Federal policy document drafted in 2017.

Despite national population median age is 18.3 years, as showed in Port Sudan, less than %10 of the attendants in public dental services were under 18 years. In Sudan %42.01 of the total population is between 14-0 years. Hence, dental care demand is expected to converge progressively toward young and young adult population in the near future. As reported in the literature, caries is predominant especially shortly after tooth eruption and in younger ages (90).

Multi-component school-based caries prevention program are associated with a decreased risk of untreated decay in primary and permanent dentition (91). Children can receive oral examinations, prophylaxis, glass ionomer cement sealants placed on all teeth, interim therapeutic restorations placed on all teeth with carious lesions, fluoride varnish, toothbrush, toothpaste, and health education. Also, children can be referred to local dentists for immediate follow-up care if needed. School-based programs can include both formal and informal education. This approach is well embraced by Khartoum State and its long-base program for schools, started in 2006, utilizing dental mobile units to improve access to care and foster oral health promotion.

Data collection and monitoring for epidemiology and surveillance

Monitoring the status of oral disease in a population is essential for setting achievable health policy goals, as well as for planning, implementing, and evaluating public health programs, and for defining oral health disease burden.

Taking as an example the US CDC model, States surveillance activities might include:

- ☞ Surveillance of oral diseases so that key oral health indicators are collected using standard approaches with attention to comparability across States. Also, collection and reporting of Basic Screening Survey (BSS) and Water Fluoridation Reporting System (WFRS);
- ☞ Identify available data on oral health conditions, access to care, intervention strategies, and workforce infrastructure. Key indicators for the National Oral Health Surveillance System (NOHSS) should be included in the surveillance plan (92).

Personnel

Dental staff, like other medical figures, although the high Federal training system production, suffer from numerous obstacles which prevent them from being able to serve properly the Sudanese population's oral health care demand.

As showed by the survey, the first hurdle for dental professionals is related to the delay in obtaining permanent registration (two to three thousand applications currently pending) as mainly due to MoH university hospital facilities to house and train new graduates. The MoH struggles to provide infrastructure to complete the internships program and suffers from the lack of academic staff.

To cope with this, other providers under other ministries, such as dental hospitals dedicated to the Armed Forces or Ministry of Interior, can supply and cover the gap, reducing career shifting and improving inter-ministerial communication.

The second macro-problem related to staff shortage complies with the high attrition rate among dental professionals. The tendency is to emigrate for better remuneration. Supplementary funds or incentives can be directed towards this, especially for dentists or allied health professionals in rural or decentralised areas that are currently understaffed. As of now, incentives in the form of bonuses are provided by the NHIF in proportion to the services rate provision. In this vein, in view of a steady increase in the number of insured Sudanese, higher than the services consumed and results in a net positive for the NHIF's funds. It may be coherent in the long run to target a reformulation of the incentive system that benefits the operators even more thus supplementing the meagre public salary.

Task-shifting: from dentist to allied dental professionals

Allied dental professionals can be a great value in the context of scarce resources focused on PHCs.

Their role is endorsed both by WHO, especially for LICs, and by international experiences (49). For example, dental therapist programs have been studied extensively in several countries and the quality of care has been consistently documented to equal care provided by dentists (93). The American Dental Association and its component state associations have opposed the adoption of dental therapist training and practice in the United States, mainly by asserting that it represents a second-tier or inferior level of care (94). This claim has been refuted by numerous studies (95). The dental therapist's scope of practice is restricted to basic care, including cavity filling, preformed stainless steel crown fitting, primary tooth pulp therapy, and simple extractions. In school-based programs, significant time is devoted to preventive treatment, such as individual and classroom dental health education and sealant and topical fluoride application. Dental therapists are endorsed by the American Public Health Association, the American Association of Public Health Dentistry, and the American Dental Hygienists' Association as a successful model for increasing access to care for underserved populations (96).

Sudan promotes the production of dental assistants and dental hygienists. Their impact can be massive in terms of primary prevention, especially for paediatric population, but they cannot moderate the absence and low retention of dentists. In fact, secondary prevention treatments, such as teeth reconstruction and root canal treatments, can legally be performed only by dentists.

Thus, the extension of some of those competencies to dental hygienists might result positively and fill the gap left by the lack of dentists, while also reducing referrals and indirectly benefiting overcrowded secondary level facilities.

The number of dentists-scientists worldwide is decreasing as the new generation of dental students favour clinical paths. As for many other LICs, Sudan's MoE needs to motivate young students to either remain in academics or to dedicate to research. This needs to be supported by an infrastructure and environment that enables short, medium, and long-term lines of research. Factors like the length of DDS-PhD training, high debt burden, economic disincentives as well as income differences between private and academic sectors are some of the major reasons for dental students to decline research paths. Because scientific and clinical training largely remain compartmentalized in dental school settings and poorly integrated within the institution at large, it is critical to invest in research education and in creating research infrastructure that generates

robust research capacity for the next generation of oral health research professionals. The impact of investing in global health not only improves the quality of life of the community but has the direct potential of improving the economy at country level. However, creating an oral health research site requires significant financial support that often is lacking in developing countries.

Health Information System (HIS)

Overall, from the assessment it emerges that MoH HIS is poorly organized and prone to endemic inefficiency.

Paper based data collection and transmission, jointly with a two-level hospitals/ health center dental services and patients' registration systems (for NHIF patients and internal auditing) increase exponentially facilities' data management complexity. Hence, it results in an impaired performance reporting that once received centrally by MoH and NHIF, can compromise the reimbursements accuracy. Coding uniformity and better data collection and transmission instruments can facilitate this process.

Medical coding is the process of converting healthcare procedures, diagnosis, services, etc., into universally accepted industry standard codes, which are then referred to for medical billing and insurance purposes. Medical coding is an important process in the entire medical billing cycle and plays a vital role in the reimbursement cycle, which ensures that health care providers are paid for the services they provide. Medically coded charts help the government to maintain a database of health records and statistics that can be used to guide policy makers to draft healthcare policies.

Globally two common medical coding classification systems are used namely, the International Classification of Diseases (ICD) and the Current Procedural Terminology (CPT). The International Classification of Diseases is a widely recognized international system for recording diagnoses, and also applied in Sudan. It is the standard diagnostic tool for epidemiology, health management, and clinical purposes defined by the World Health Organization (WHO). This includes the analysis of the general health situation of population groups. It is used to monitor the incidence and prevalence of diseases and other health problems, providing a picture of the general health situation of countries and populations. However, there are a few oral health ICD codes in Sudan are not very comprehensive, nor uniformed with NHIF or MoH registration system at hospitals/primary health centers level, but are instead deducted afterwards.

Therefore, more uniformity in dental service coding and data collection might be necessary to stimulate hospitals/ health center efficiency processes. Support from digitization can be an asset.

Care delivery and access to care

The allocation of dental resources, both personnel and infrastructure must be monitored and controlled at the State and Federal level. Data appear fragmented across levels. It seems evident that accurate information about services is not shared.

In addition, facilities maintenance and their activity are not monitored. Therefore, a better control and evaluation can be crucial, linked to a proper constant census and service monitoring. This must also include an analysis of the performance and efficiency status of the service.

Dental care services are limited to MoH facilities that are accredited with NHIF. Therefore, the population cannot benefit from other providers, even those publicly founded, such as Armed Forces and Ministry of Interior hospitals. Hence, provider fragmentation hinders the access to care and scatters the overall system of service provision. The extension of the accreditation beyond MoH's facilities can massively amplify the number of beneficiaries.

As emerged from the assessment in Port Sudan, dental facilities struggle to provide water and electricity, thus limiting the service provision. External secure sources of electric power and better management of water supply can overcome such hurdles.

Hospitals/primary health centers management systems are not generally supported by internal guidelines. This leads to risky and unmethodical management of important facilities' components. As reported by the survey, medical waste is exposed in unprotected areas and prone to clinical risk, staffing is not supervised by effective management criteria, doctors and allied health professionals are not supported by a professional development system, and there is no real supervision of consumables and medical instruments.

Healthcare waste contains potentially harmful microorganisms that can infect hospital patients, health workers, and the general public. Therefore, medical waste management, considering the facility as a whole and not only medical waste from the dental clinics, can benefit from better controls and enclosed areas, maintaining the same disposal cadence, but limiting space contamination and biological risk.

The definition and implementation of guidelines for the management of staff can have a positive impact on the provision of dental services, as can the proper monitoring of consumables and instruments. Current stock-out systems limit service provision. Therefore, stock control, otherwise known as inventory control, can

be used to show how much stock facilities have at any time, and to keep track of it. Efficient stock control allows facilities to have the right amount of stock in the right place at the right time. It ensures that capital is not tied up unnecessarily, and protects production if problems arise with the supply chain. Overall, scarce local resources can hinder hospitals/primary health centers purchasing power. However, the optimization of resources management might improve the utilization of existing equipment. Basic tools can be ensured with minimum stock level methods, by identifying a minimum stock level and re-ordering when stock reaches a certain level (also known as the Re-order Level), plus with regular reviews of stock. At every review, orders can be placed to return stocks to a predetermined level.

Continuous Medical Education is more complex to manage as it is a responsibility of the MoH and the Medical Counsellor. Currently there is the requirement but no a model for obtaining credits and no system for monitoring their provision. It may be useful to facilitate the delivery of courses and workshops with the help of State level directorates supported by local health facilities, thus reducing indirect costs related to travel time and opportunity costs.

Dental chairs and basic dental equipment appear to be a major problem in dental care provision. Without proper maintenance, dental chairs can be used only for examinations and extractions, thus limiting dental services, and crowding the few dental clinics that have functioning dental equipment. Extraordinary and routine maintenance is very tricky with an under-resourced health system. For this reason, simplifying dental equipment and optimizing basic instruments provision might result in a more cost-effective approach and sustainable system of dental care, particularly in more remote areas or decentralized centers. In addition, the utilization of diagnostic tools such as radiographic systems for dental use seems to be underestimated, as showed by the lack of x-ray or more advanced systems from Port Sudan's survey. If the dental HCS aims to become more efficient, the use of diagnostic tools is strongly recommended.

Mobile dental unit

According to the survey, challenges to be faced appear to be a few regarding dental clinics' setting, equipment, and infrastructure. Crucial points derive from endemic barriers related to basic dental chair functioning, water and electricity supply, and equipment maintenance. Consumables are frequently rationed and basic dental instruments not always available. Dental chairs, as pointed out, suffer from lack of care. Hence, restorative and rehabilitation dental treatments are not provided, essentially due to equipment failure.

Given these premises, more sustainable approaches can be defined as cost-effective with a better manageability in the long run. In fact, the current model based on fixed dental workstations represent a limit without any routine deep maintenance work.

The mobile dental unit can substitute fixed dental workstation making dental treatment possible in a variety of places. It benefits from a lower level of complexity and can be easily repaired in case of need.

Other than an electrical power source, the cost-efficient device can be operated self-sufficiently.

Usually, an integrated oil-free compressor provides the compressed air for operating the dental instruments. Bottles for fresh and wastewater are incorporated. An aspirator can be included. Most of all, in case of repair, even from remote areas and decentralized primary health centers, mobile dental units can be easily carried to the nearest center and restored after being renewed, without depending on local workforce for extraordinary maintenance work.

However, besides mobile dental units, essential equipment is to be provided in every dental clinic to deliver a basic dental service package (extraction, periodontology, conservative, and endodontic treatments), including basic dental instruments, such as dental handpieces, burs, excavators, burnishers, pluggers, curettes, forceps, elevators, and endodontic and restorative treatments.

Essential list of equipment for dental mobile unit:

Core dental unit

- o Three-way syringe (air/water/spray)
- o Electric micromotor with or without LED light (40,000-0)
- o Handpiece pressure: 3.5-2.5 bar
- o Electric scaler
- o Instrument hoses detachable
- o Spray water tank: 1.5 – 0.75 litres
- o High-performance suction hose (i.e., 220 l/min).
- o Suction fluid container: 1 litre (automatic overflow protection)
- o Compressor: Integrated oil-free compressor with an air tank for the supply of compressed air
- o Curing light: LED polymerization lamp for light curing dental composites

- o Foot control: One foot control pad for controlling the high- and low-speed instruments and one foot control pad for the scaler and the saliva ejector



Dental chair

- o Height of seat surface above ground 640 – 240 mm
- o Range of back rest angle °175 - °100
- o Loading capacity compliant with ISO 2011-6875 standard for dental patient (135kg)
- o Illumination can be included (i.e., chargeable light illumination)



External lighting

- o Light intensity: Max. 70,000 lux at a distance of 70cm
- o Different dimming levels operated via sensor
- o Colour temperature: 4500K (daylight quality)
- o Service life (LEDs): 70,000 hours



Portable x-ray

- o Handheld or used with a tripod
- o Battery-powered or electric-powered device
- o kV values in the 70 – 60 kV range

Access to care

Eventually, according to demand analysis, access to care indicators support the hypothesis that beneficiaries are mainly from districts nearby the hospitals/primary health centers of attendance (travel time less than 30 minutes). It seems that the absence of means to reach and use services, such as transportation to services that may be located at a distance, and the ability to take paid time off of work to use such services must also be considered as hindering factors. Hence, for geographical reasons dwellers living outside the facility's

catchment area seems to be excluded from access to care. Furthermore, in the case of Port Sudan, to the extent that a hospitals/primary health centers is not able to provide certain dental care due to its own constraints, it is unlikely that patients will move to other facilities or refer to providers that offer a more extensive package of care than those from which they come.

Additionally, the MoH dental facilities attendance and beneficiaries might experience possible selection bias. As shown, despite the fact that %36 of the population is currently under the poverty line and that patients spend on average roughly 4500 SDG or less on dental care annually, only %10 of study participants affirmed to forgo dental care due to economic reason. Hence, it might imply that low/very low-income households tend to skip dental care as a whole. In addition, it emerges that, despite the fact that %89 of the respondents stated “difficulties” to make ends meet, dental care still represents an essential good. However, it does not seem that patients attending MoH dental facilities risk financial hardship due to dental care.

On the other hand, MoH dental services quality seems adequate. In fact, it appears that MoH dental facilities patients show high satisfaction related to communication with dental providers. Treatment options, decisions regarding patients care and patients’ empowerment are positively perceived by patients. However, patients’ feedback is rarely considered, while respondents are positively impressed by dental care safety and good continuity of care. In addition, it is highly encouraging that although the presence of more than 500 ethnic groups in the country, episodes of stigma do not appear to be very frequent.

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