AMERICAN UNIVERSITY OF BEIRUT

CHALLENGES OF NON-COMMUNICABLE DISEASES RESEARCH IN SUDAN

CASE STUDY: HYPERTENSION AND SOCIO-ECONOMIC DISPARITIES AMONG WOMEN

By

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AN ABSTRACT OF THE THESIS OF

Shahd A Osman for Master of Science

Major: Epidemiology

Title: Challenges of Non-Communicable Diseases research in Sudan. Case study: Hypertension and socioeconomic Disparities among women.

Aim: To examine the non-communicable diseases (NCD) research agenda in Sudan and explore barriers and opportunities for NCD research. The prevalence of hypertension and its association with social and economic disparities are examined as a case study for knowledge generation.

Methods: For the first objective, qualitative interviews were conducted with seven key informants, including stakeholders from the Federal Ministry of Health, research institutes, WHO and researchers in private and public universities. Thematic analysis was performed and recurrent themes identified. For the second objective, secondary analysis of the Sudan Household and Health Survey (SHHS) 2010 data was conducted, focusing on adult females aged 25 years and above (n=16430). Descriptive statistics and logistic regressions were performed.

Results: Findings of the qualitative interviews identified four main barriers: 1) lack of funding; 2) inadequate research skills; 3) lack of political commitment; and 4) competing burden of communicable diseases. In parallel, seven opportunities for improvement were noted: 1) advocacy; 2) more funding opportunities; 3) recognition of NCD by policy makers; 4) capacity building; 5) strengthening of health information system; 6) building international partnerships; and 7) integrating NCD at primary health care. Analysis of the SHHS data revealed a low prevalence of hypertension among women (4.6%). Hypertension was significantly associated in a dose-response manner with increasing wealth index. Geographical discrepancies were also noted between states with hypertension being less prevalent in Eastern states (OR: 0.6, 95% CI: 0.4-0.8), Central States (OR: 0.75, 95%CI: 0.6-0.97) and Darfur region (OR: 0.3, 95% CI: 0.2-0.5) compared to Khartoum, the capital city.

Conclusion: Sudan is in its early stage of epidemiological transition; its economy and political instability make it vulnerable for undesirable consequences of globalization. While findings need to be interpreted with caution, currently, affluent segments of the population seem to be more affected by the transition. In spite of the barriers that face NCD research in Sudan, it is important to capitalize on the identified opportunities for knowledge generation and evidence-based policies and action.

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ABBREVIATIONS

NCD	Non-communicable diseases
LMIC	Low and Middle Income countries
WHO	World Health Organization
FMoH	Federal Ministry of Health
IDRC	International Development Research Centre
AUB	American University of Beirut
EMR	Eastern Mediterranean Region
SES	Socio-economic Status
SSA	Sub-Saharan Africa
HIC	High Income Country
DHS	Demographic Health Survey
GDP	Growth Domestic Product
SMoH	State Ministry of Health
SHHS	Sudan Household and Health Survey
MICS	Multiple Indicator Cluster Survey
UNICEF	United Nations Children Fund
CSPro	Census and Survey Processing System
SPSS	Statistical Package for social sciences
PHC	Primary Health Care

To my parents; a loving Father, and the soul of a wonderful Mother

CHAPTER I

INTRODUCTION

A. Background

Non-communicable diseases (NCD) have become the dominant causes of morbidity and mortality worldwide. Globally, around 63% of deaths are attributed to NCD with 80% in low and middle income countries (LMIC), imposing large economic and social burdens on systems already faced with limited resources [1]. In the Eastern Mediterranean Region, around half of deaths are linked to NCD [2]. Yet in some countries, notably those in Africa, the double burden of communicable and non-communicable diseases still prevails. Projections made for the year 2030 indicate that the burden of NCD in these countries will increase and exceed that of communicable diseases [1].

In LMIC, national economies and structural challenges influence government expenditure and resources for health on one hand, and have bearings on household incomes and health related individual behavior, on the other. Globalization heightens those effects with negative consequences by marketing harmful products such as tobacco, alcohol and unhealthy diets [1]. Furthermore, behaviors and contextual factors that are specific to LMIC countries may account for some heterogeneities and socio-cultural influences that shape NCD burden in these countries [3].

One such example is the Republic of Sudan, Sudan is the third largest country in Africa and has long been affected by conflict and civil war resulting in

January 2011 to the secession of the South .The governmental expenditure of Sudan (previously North Sudan) is mainly focused on security and defense, resulting in little resources and investments available for the health sector, education and basic infrastructure [4]. Although the country is rich in resources, their availability is greatly skewed and mostly untapped to the extent that almost half of the Sudanese are classified as poor [4]. Additionally, the existence of distinctive risk factors such as smokeless tobacco (*Toombak*) which is highly prevalent among men contributes to an epidemic of NCD, notably oral cancers. *Toombak* is locally produced and is very cheap, making it easier for the poor to consume [5]. The socioeconomic disparities, cultural and structural specificities in Sudan provide a unique opportunity to study NCD in a low-income country.

Research on NCD in Sudan is scarce [6]. The persistence of communicable diseases alongside the poor resources perhaps over shadows the potential rise of an NCD epidemic. The World Health Organization (WHO) emphasizes the importance of NCD surveillance at the country level, to be able to monitor risks, outcomes and evaluate the response of the health system [1]. Yet, surveillance, evaluation and reporting are totally lacking in the NCD Department of the Federal Ministry of Health (FMoH). A recent scoping review of academic publications on NCD in Sudan present in the Pubmed database, done as part of the International development Research Centre (IDRC)[*] project at the Faculty of Health Sciences, American University of

[*] Responding to NCDs and Strengthening NCD Research: From Cell to Society- Part of overarching Grant proposal to the Faculty of Health Sciences entitled 'Shaping Research for Health in the Arab World'

Beirut (AUB), showed that, in the past 22 years (1990-2012) less than 140 journal articles were published on NCD, the majority were clinical in nature and only 30% of these included a public health perspective [unpublished data].

In conclusion, NCD research is still in its infancy; as globalization, structural conditions and socioeconomic diversities provide an impetus for an increasing NCD burden in the coming future of Sudan while research and governmental data on NCD are very limited. Having said this, the study seeks to examine the NCD research agenda in Sudan and explore barriers and opportunities for knowledge generation on NCD in the country. It further draws on national data collected by the FMoH and the Centre of Statistical Bureau to demonstrate the burden and correlates of NCD in the country, focusing on hypertension as a case study.

B. **Objective of thesis:**

The overall aim of this study is to appraise the importance given to NCD research in Sudan, focusing on hypertension as a case study for the burden of NCD, and assessing its association with social and economic disparities.

Specific objectives:

1) To explore barriers and opportunities affecting the conduct of NCD research and the generation of data in Sudan.
2) To assess the burden of hypertension among adults in Sudan as a case study for the burden of NCD in the country.

3) To examine disparities by wealth indices and geographical locations associated with hypertension for the population under study.

C. Significance

Following the recent referendum and division of Sudan in 2011, the country is facing serious economic challenges that may add to the vicious circle of NCD and poverty transitions. This study is the first to focus on NCD using national data; it provides a baseline for comparison with future studies. In addition research in sub-Saharan Africa speculate an emerging epidemic of NCD due to rapid transitions, upgrading hypertension to a major risk factor even with the un-negotiable risks of diseases such as Human Immunodeficiency Virus and Malaria [7]. Furthermore, identifying barriers contributing to a deficient research pool of this growing epidemic will also help guide and motivate policy makers towards establishing efficient action plans for the future of health.

CHAPTER II

LITERATURE REVIEW

A. Non communicable diseases and socio-economic disparities

A rise of non-communicable diseases (NCD) is occurring in low and middle income countries (LMIC). The WHO global status report 2010 states that 80% of deaths due to NCD's occur in LMIC. It is believed that inequalities lead to this eminence, and most of these deaths may be avoided with adequate health interventions [1].

The situation is quite similar in the Eastern Mediterranean Region (EMR). The stepwise surveys done by the WHO in a number of countries in the region have shown an alarming prevalence of NCD risk factors. Almost 25% of the region's population has hypertension, six countries in the region are among the 10 with the highest prevalence of diabetes globally, and there is also a high prevalence of hyperlipidemia [2]

It is important to realize that although there is a general new concept supported by the WHO, and research that NCD are becoming more prevalent among LMIC and particularly among lower socio-economic levels, this notion needs to be confirmed at national and sub-national levels. An increased risk to NCD among different socio economic levels depend on the degree of epidemiological transition a country is facing [8].

NCD are largely attributable to behavioral risk factors; these risk factors seem to be inter-related with socio-economic status (SES) [8]. Marked trends of

urbanization occurring in LMICs have negative health influences on disadvantaged groups exposing them to NCD risk factors, in turn the consequential NCD add to their economic burden creating a viscous circle of poverty and disease [1].

The SES is a multifaceted concept; however it reflects an individual's access to resources in the form of materials, assets or social resources. Studies that link NCD to the SES focus on variables such as education, occupation, urban dwelling communities, and income or wealth [9].

Studies describing associations of socio-economic factors with NCD have given diverse results. In high income countries (HIC), higher education and income were associated with a better health status [10] In contrast; a study from India showed an association between higher socio-economic status and hypertension as well as a doubling in the risk of cardiovascular diseases among the more educated older participants [11]. Similar results were obtained from Costa Rica where such conditions as hypertension, obesity and mortality were more common in higher educated and affluent individuals [12].

Comparable differentials are obtained in studies examining the relationship between overweight and obesity, macro and micro social status. A cross country comparison involving 35 countries in North America and Europe revealed that while adolescents from wealthier families showed a higher prevalence of being overweight in Macedonia, conversely the less affluent adolescences in Ireland were more likely to be overweight. In general Mediterranean countries had higher prevalence's of overweight compared to

central Europe countries, yet when macroeconomics of countries was were examined, high income countries showed negative association with overweight, while in middle income countries, some presented a negative association while others a positive association [8].

Moreover, the World Health Survey study involving data from 41 LMIC, examined the relationship between socioeconomic inequality and NCD. Socioeconomic inequalities were more evident in low income countries; the study found that education and wealth exhibit a negative association with NCD such as, angina, asthma, and arthritis while there is a positive association between wealth and diabetes [13]

Other examples with similar conclusions are given in a review of cardiovascular risk factors from a socio-cultural perspective in Sub-Saharan Africa (SSA). The review examined studies from different countries in the region, and concluded that the region is undergoing an epidemiological transition affecting the epidemiology of disease. It further stated that factors of globalization such as urbanization, the huge gap between social levels, low physical activity and the loss of geographical boundaries are playing a negative role on the health status in the region by increasing the prevalence of conditions such as hypertension, diabetes and dyslipidemia [7].

B. Non-Communicable Diseases Research in Low and Middle Income Countries

The availability of research on NCD is mainly from HIC, and it has provided the world with fundamental information about major risk factors of NCD [14, 15]. Nevertheless, a review done by Miranda and colleagues highlighted how contextual issues in LMIC justify why extrapolation from high income countries research may not be practical [14].

Nowadays when we compare mortality from communicable diseases to non communicable diseases in LMIC, we find it to be 36.4% and 58.2% respectively. The epidemiological transition is occurring at a faster pace than developed countries, leaving many developing countries facing a double burden of disease. Effects of globalization and urbanization due to a variety of causes along with a mixture of complex political, economical issues and internal conflicts also serve as valid grounds for why there is a need for contextual research [14].

A compelling example is the possibility of the existence of both problems of under nutrition and over nutrition in the same household, which demonstrates the complexity of the societal impact. Furthermore we must not forget that these countries may also have different environmental, genetic and cultural profiles that affect risk and the representation of disease [3].

Compiling research from both LMIC and HIC will benefit both parties; this may occur through replication and additional exploration of areas such as infection and NCD, possible breakthroughs of new risk factors and evaluation of interventions that may or may not work in different settings [15].

C. Barriers to NCD research:

Even though there is a remarkable rise of NCD in SSA, research is very limited. Research programs on national scales are important to identify risk factors specific to the region that contribute to this fast growing epidemic [16]. Surveillance is pivotal for priority setting and allocation of resources to combat this epidemic through prevention and control methods. The WHO also stressed on the importance of strengthening surveillance, and collecting data on NCD and their risk factors incorporated into national health information systems. Unfortunately if present most countries have weak surveillance [1].

A policy forum report by Dalal and colleagues listed possible causes contributing to this knowledge gap. The barriers suggested, were lack of funding and shortage of capacities; the review also emphasized on the fact that the current available estimates of morbidity and mortality from countries in the region are invaluable for setting health priorities or describing disease trends; as low resources and limited accessibility to health care services in many parts of the region render those estimates inaccurate. However national cross-sectional surveys such as the Demographic Health Survey (DHS) that included information on NCD, done in some African countries have helped shed light on the burden of NCD and disease trends [16].

Research conducted in the region appears to mainly be of a cross-sectional nature and though these studies are important, Holmes and colleagues described why it is also important to conduct cohort studies in Africa. They summarized their reasons by identifying specific burdens, different genetic profiles and variety of social and cultural behaviors that are considered as

distinctive factors with a potential to motivate political commitment. The policy forum also explained that currently, research is impeded due to a shortage of scientists, lack of international funds and the inadequate financial capacity of these countries [3].

D. Sudan Overview

1. Geography and demography

Sudan is the third largest country in Africa and the sixteenth in the World; it is located in North Eastern Africa and is surrounded by seven countries; Libya, Egypt, Eretria, Ethiopia, South Sudan, Central African Republic and Chad. Its' distinctive location sets it in the middle between the Arab world and Africa; with the Red sea on its eastern coast connecting it to the Middle East. The Northern part lies within the Saharan belt, while the central part is considered Sub-Saharan [17]. This also makes it the main crossroad between the North and South of Africa. The Sudan is characterized largely by a flat terrain. The River Nile crosses the county form the south to the north, however Sudan is considered as a semi-arid as it is challenged by climate changes leading to soil erosion, desertification and drought [18].

Its population is around 34 million, with more than 40% below the age of 15 years old and only 3.3% over the age of 65. Males and females are of equal ratios and the median age is 19 years old. Sudanese people originate from both Arab and African tribes; Sudanese Arabs, Beja, Nuba, Fallata and Fur.

However, Arab culture prevails and most of the country speaks Arabic language [19].

2. History and Conflict

After its independence from Anglo-Egyptian rule in 1956, Sudan began to suffer from continuous conflict, famine and long periods of draught. The long period of civil war between the North and the South resolved in 1972 in Addis Abba peace agreement only to be reignited in 1983 till 2005. In 2005, the Government of Sudan lead by the National Congress Party signed a peace agreement with the Sudan's People Liberation Movement, chosen front of the South [17].

The peace agreement ended the war, but it also called for referendum that took place in 2011 and resulted in the secession of South Sudan. In January 2011, South Sudan was inaugurated as the newest country globally.

The turbulence continued between the new neighbored countries, with rising conflicts on border areas, mainly around the Blue Nile and South Kordofan region. In addition to others conflicts, mainly in the western region of Darfur which has been ongoing since 2003, has resulted in thousands of deaths and the displacement of more than two million people [20].

3. Economy

Sudan is a country rich in natural resources, however political wavering manifested in its deteriorating economy. In spite of the sanctions, Sudan was the 17th fastest growing economy in the world in 2010 with the rapid growth being attributed mainly due to the oil boom that began 1999. However, after the secession of South Sudan in 2011, more than 80% of the oil revenue was lost, and there is a rapid decline in economy [17]. Historically, the country has been known to depend on agriculture; more than 80 % of Sudanese survive from agriculture today. Nevertheless, more than 45% of Sudanese live below the poverty line. Only 20% of the arable land in Sudan is actually used [21]. Neglect of agriculture and industry, during the period where Sudan has enjoyed oil revenues, contributed to the failure of these sectors to flourish the economy of the country, the rate of inflation have been rising continuously after the secession reaching today more than 40% [21]. With the ongoing conflicts, loss of oil, weak infrastructure and a huge external debt that consumes more than 60% of Sudan's GDP, it is likely that the country will continue to suffer from recession for a long period of time [4].

Disparities in development in rural and urban and the continuing conflicts are driving the country towards further urbanization. Nowadays, the capital Khartoum has a population of five million people, and two million of them are believed to be internally displaced, with a rate of annual urbanization of 3.7%; this rate will deepen poverty in both the rural and urban settings and further affect the agriculture sector [22].

4. Health care system

The health care system of the public sector is made up of three levels that are implemented as a mean of decentralization of health care. The hierarchy starts with the FMoH, its main responsibility lies in setting national health policies, strategic plans, legislation of health along with evaluation and monitoring of the entire health system. Another important role of the FMoH is the development of human resources which involves training, planning and distribution of health professionals around the states. The next level is the State Ministry of Health (SMoH) (currently the Republic of Sudan has 17 states) which functions include; implementing policies, programming and developing projects with detailed plans. SMoH's works in liaise with localities and support them. The third level is, the local health authority, this is based on the district health system to deliver primary care to the community [22].

The structure of the healthcare system requires significant health care resources which are actually not available, the distribution of resources between the levels lacks balance and the localities have insufficient material and human resources [23]. The majority of the health care professionals in Sudan work in the public sector. A major contributor to the problem of the health care system is that the health sector is under financed, the expenditure on health is only 6.3% from country's GDP this figure, though represents an increase from previous years is still far below a minimum of 15% set by the Abuja declaration[†] that Sudan has agreed on [23].

[†] African Union countries meeting in Abuja, Nigeria(2001) pledged to increase government funding for

The health care system focus on curative care, with the majority of the population seeking care in hospitals with less reliance on the primary health care system. Reasons include; nonfunctional health centers, less than optimal standards and shortages in the health care staff. Figures from the FMoH show, that only 33% of the health professionals work at a primary care level [6, 22].

Generally, 70% of health professionals' work in urban areas, catering to the needs of only 30% of the society therefore creating a shortage in rural areas. Note 38% of the health care cadres are concentrated in Khartoum [24]. Moreover, Sudan suffers from a serious problem of emigration of health professionals. A study done by Badr 2005 showed that, 60% of the physicians registered at the Sudan medical council are working outside the country [24].

The FMoH recognizes the importance of the primary health care and human resources and has set strategic plans to deal with these issues and strengthen the health care system. However, progress of these strategies is yet to be shown.

E. Case study: Hypertension

Hypertension is believed to be the cause of 12.8% of deaths worldwide and 3.7% of disability adjusted lives. Hypertension is a leading risk factor of many serious conditions including stroke and ischemic heart diseases. In 2008 the prevalence of hypertension worldwide was 40% with the highest prevalence of 46% of adults present in Africa [25]; in second place was the EMR with a prevalence of 41% in adults. Hypertension akin to other NCD is rising in

health to at least 15% of the GDP

LMIC due to the epidemiological transition [26]. A study done in both urban and rural areas across four countries in SSA showed that hypertension is the most prevalent risk factor of cardiovascular disease, and that Sub-Saharan Africans are at increased risk to develop complications at earlier ages, such as end organ damage when compared to Caucasians [27].

In Sudan, hypertension is the most common among all other NCD, representing almost 25% of the burden of NCD it is also the most frequent treated condition in outpatient clinics [28]. A stepwise survey conducted by the WHO in Khartoum in 2005-2006 has reported that the prevalence of hypertension among adults aged 25 years and above, was 23.6% however, only 11.3% were aware that they were hypertensive [29].

A number of studies highlighted the burden of hypertension in Sudan either directly or indirectly. A study generated amongst school children aged 6-12 years in Khartoum showed that 4.9% of the children were pre hypertensive and 4.9% were suffering from hypertension. The study also mentioned that hypertension in those kids was strongly associated with an increased Body Mass Index. The study also suggests that childhood obesity is an effect of urbanization, and the increasing prevalence of hypertension among this age group is an indicator of the epidemiological transition the country is undergoing [30]. Another study targeting the police force in Sudan has showed that the prevalence of hypertension among that group to be around 27% with approximately 30% hypertensive individuals aware of their condition. Furthermore the prevalence of hypertension was found to be associated with increased age, overweight and higher levels of education [31].

Different studies directed towards heart disease, renal disease and stroke in Sudan have all shown that hypertension is among the most common risk factors for the development of those conditions and emphasized on the role of controlling and preventing hypertension to limit these complications [32, 33, 34].

CHAPTER III

METHODOLOGY

The objectives of the study are addressed using two distinct methods. The first objective is fulfilled through qualitative interviews with key informants on NCD research in Sudan. The second and third objectives are achieved through quantitative analysis of secondary data. The data used is that of the Sudan Household and Health Survey (SHHS) conducted in the year 2010.

A. Qualitative interviews

In order to acquire an insight of the NCD research status in Sudan, semi-structured interviews were conducted with key stakeholders involved with NCD research. The interview guide prepared was reviewed by a faculty member in the AUB for wording and comprehensiveness and was piloted prior to data collection; subsequently wording amendments were introduced based on feedback. Key informants were identified through relevant institutions such as Federal Ministry of Health, World Health Organization, Research Centers and Universities. For feasibility and time limitation, one to two informants from each relevant agency were interviewed, consequently a total of seven participants were interviewed as similar themes started to reoccur from interviews.

An informed consent was obtained prior to the interview, purpose of the research was explained and participants were told that participation is voluntary and they can stop the process of the interview whenever they wish.

Interviews were conducted using Arabic or English Language according to the participant's preference; however all interviewees opted using English, yet some used Arabic expressions during their interviews, which were later translated by the interviewer to English. All the interviews were conducted by the researcher; each session lasted between 20-30 minutes. The issues elaborated on were the opinions of the participants about the current and past situation of NCD research, driving forces and barriers of NCD research in general, funding for NCD research, availability of qualified researchers and suggested recommendations. A copy of the questions and items discussed is available in the appendix 1and 2 (English and Arabic versions). The main aim of the interviews was to inquire about, whether NCDs are a research priority and the current obstacles holding back research. The interview responses were written by the interviewer; the transcripts were coded and then plotted in a matrix for analysis, where themes and sub-themes that emerged were then identified.

B. Secondary Data Analysis

1. Study design and sample Coverage

The data for the secondary analysis were drawn from the nationally representative SHHS 2010 data. The SHHS was carried by the FMoH and the Central Bureau of Statistics, in collaboration with several ministries and institutions of the government as well as regional and international organizations. The primary objectives of the survey were to provide up-to-date

information for assessing the situation of children and women in Sudan; and to monitor progress toward goals established in the Millennium Declaration and other internationally agreed upon goals, as a basis for future action to inform policies and interventions. The methodology was based on the models and standards developed by the global Multiple Indicator Cluster Survey (MICS) project, an international household survey programme developed and supported by the United Nations Children's Fund (UNICEF). The survey tools consisted of five sets of questionnaires: (i) a *Household Questionnaire* which was used to collect information on all *de jure* household members and the household; (ii) a *Women's Questionnaire* administered to all women aged 15-49 years in each household; and (iii) a children's *questionnaire* administered to mothers or caretakers of all children under five years of age living in the household; (iv) Men's questionnaire administered to men living in the household; and (v) *Food Security Questionnaire*. The data used for the purpose of this study was that based on the data obtained using the *Household Questionnaire* as it is contains the module on chronic diseases and injuries.The questionnaires were pre-tested during the last quarter of 2009 and the first quarter of 2010 and modifications were made to the wording and translation of the questionnaires based on the results of the pre-test.

Training programs for the fieldwork were conducted for all the states involved in the second SHHS during the month of February and March 2010, the duration of training varying between 7-10 days. The training was conducted at three levels -- national, sub-national and state levels. To ensure consistency, the sub-national training sessions for all trainees in all states were conducted by the

same trainers. The training included lectures and discussions relating to interviewing techniques and the contents of the questionnaires, supervision and monitoring of quality of data. Towards the end of the training period, trainees spent some days in the field to practice interviewing in selected states.

The SHHS sample included 15,000 households, but 14,921 were found to be occupied. Of the aforementioned sample, a total of 14,778 households were interviewed successfully with a household response rate of (99.0 %) [35]. More details on sample coverage can be found in the 'Sudan Household Health Survey second round Final Report' (2012). Briefly, the response rate for households was marginally higher in rural areas (99.2 %) compared to urban areas (98.6 %). The women's overall response rate was also higher in rural areas (93.1 %) than that in urban areas (90.6 %).

For men the overall response rate was of 33.6 % calculated from the men's interviews. One of the reasons for the low response rate for men was that at the time of visit to the households by the interviewer, men in a large proportion of the households were working.

For the purpose of this study, we limited the sample to women who are 25 years and above, who responded to the household survey, yielding a total sample of 16340 participants. The restricting of this study to women was made for two reasons: 1) The poor response of males to the SHHS, thus threatening the external validity of results; and more importantly, 2) The SHHS lacked information regarding smoking status; thus limiting the possibility of including smoking as a potential confounder in our analysis. Smoking prevalence among

women is estimated, from other resources, to be as low as 2 % [36].This lack of variability in the smoking behavior among women would preclude the consideration of smoking as potential confounder. The age of inclusion (25 years) was chosen to make results comparable to the literature.

2. Variables and Measurements

Hypertension constituted the main dependent variable, and the wealth index the main independent variable. Other covariates assessed were: age, marital status, literacy, level of education, employment, geographical location (states) and area (urban vs. rural).

Hypertension was assessed based on self report of the respondent to a single question in the household survey asking, if they were ever diagnosed as hypertensive before from a health care professional, and responses were coded as present (1) and absent (0).

Wealth index was constructed based on information on the ownership of consumer goods, household conditions, water and sanitation, and other characteristics that are related to the household's wealth, with weights (factor scores) being assigned to each asset. Each household was then assigned a wealth score based on these weights and the assets owned by that household. The exact weight given to each asset and the exact items included in the final score was not available to the Principal Investigator of this study. The final score of the wealth index ranged from (-1.3 to 3.7), with those in the minus

category representing those below the poverty line in Sudan. The index was then divided into five quintiles from lowest (poorest) to the highest (richest). The wealth index is assumed to capture the underlying long-term wealth through information on the household assets, and is intended to produce a ranking of households by wealth, from poorest to richest. It is treated in the study as the main independent variable and the focus of the analysis.

3. Plan of Analysis

In the SHHS, the data were entered into microcomputers using the Census and Survey Processing System (CSPro) software. In order to ensure quality control, all questionnaires were double entered and internal consistency checks were performed. Procedures and standard programs developed under the global MICS4 project and adapted to the SHHS questionnaires were used throughout. Data were entered into SPSS and data processing was concluded in 2011.

For the analysis done in this study, Statistical Package for Social Sciences (SPSS) version 19 was used for all analysis. Descriptive analysis of the data was conducted to describe the variables of interest with graphical and numerical output, in an attempt to detect any outliers, or mistakes that may have occurred during data entry. Prevalence of hypertension was measured for the population under study. Univariate analysis conducted for all variables followed by bivariate analysis, cross tabulating each independent variable against hypertension and were then regressed adjusting for age. Variables for which the cross tabulations yielded a p-value more than 0.2 were further

included in the Multiple Logistic Regression. Crude and adjusted odds ratio, and 95% confidence intervals are reported. Co-variates include in the logistic regression were:

1. Age: categorized into five groups '25-34', '35-44', '45-54', '55-64', and ≥65, coded as 1, 2, 3, 4, and 5 respectively.

2. Marital status: categorized into four groups 'Never married', 'Married', 'Widowed', and 'Divorced/Separated', coded as 1, 2, 3, and 4 respectively.

3. Literacy: defined as the ability of the person to read and write coded 0 for 'No' and 1 for 'Yes'

4. Level of education: grouped into three categories 'No school', 'primary/khalwa[‡]/adult learning[§]', and 'secondary and above' and coded 1, 2, and 3 respectively. Primary education, khalwa, and adult learning were grouped together as they all represent a similar basic level of education. Secondary and higher education were grouped together to account for the small sample size in these categories.

5. Employment: 'Not employed' and 'Employed' coded as 0 and 1 respectively.

6. Area: 'Rural' and 'Urban', coded 0 for rural and 1 for urban.

7. States: The 15 states of Sudan were grouped into six main regions 1)'Khartoum', 2)'Northern states' which comprised Northern state and River

[‡] Khalwa is Quaranic pre-elementary school
[§] Adult learning is a literacy programme offered to illiterate adults

Nile state, 3)‘Central states’ which are Gezira state, Blue Nile state, White Nile state and Sinnar state, 4)‘Eastern States’ with Red Sea state, Kasala state, and Al Qadarif State 5)‘Darfur region’ comprising North Darfur, West Darfur and South Darfur, and 6) ‘Kordofan Region’ with North Kordofan and South Kordofan.

C. Ethical consideration

The AUB institutional review board ranked the study as low risk and qualified it for an exempt. Data by the SHHS were obtained directly from the Centre Bureau of Statistics, without any personal identifiers. Informed consent before the interview was solicited from the key informants; their personal information however, remained confidential in the final write up of the thesis.

CHAPTER IV

RESULTS

A. Qualitative Findings

1. General Perception of the situation of NCD research in Sudan

Most of the respondents described the situation of NCD research in Sudan as, poor or weak. Though when compared to the past, respondents believed that it has improved. In their opinion, research on NCD previously was non-existent. Respondents voiced certain concerns regarding the limited sources, mainly routine sources, the quantity and the quality of available data. Respondents felt that available data are limited, coming from scattered studies and relying mainly on hospital records. Studies conducted were judged to be of questionable quality and often with misinterpreted results. In summary, whilst there is a growing interest in the field of NCD research, data generated remains scarce and does not commensurate with international prospects of quantity and quality.

"*I consider it in its budding stages*". (Researcher, Academic Public Institute)

"*National studies are very few, I don't say they are non-existing but they are very few."* (Clinical Researcher)

Most of the respondents also reflected on the lack of interest of funding agencies towards NCD research, noting that funds are directed towards such concerns as communicable diseases, maternal and child health, and with the

main mandate of national surveys focusing on these issues. One of the respondents expressed that by saying:

"NCD couldn't compete with the burden of the communicable diseases, and the communicable diseases are internationally funded, the situation is not within our control and beyond our ambitious wishes" (Researcher, Academic Public Institute)

2. Driving Forces for NCD research

a. Increased burden and associated cost

When asked about the driving forces behind NCD research, respondents described several factors that contribute to the movement towards NCD research; most of the respondents mentioned the fact that there is an increasing burden of NCD and this is becoming apparent.

"Everybody is seeing it; everybody is seeing how common cardiovascular diseases are becoming. Similarly, cancer, renal disease, road traffic injuries have been on the rise and everybody is seeing it! This has slightly drawn the attention, but not enough to the extent to be a priority in research agenda and funding." (Researcher. Private Academic Institute)

They also mentioned that this increase in burden of disease creates an economic burden on the health system that in turn may act as a driving force.

b. Global interest

Another major driving force described was the global interest, and the global move towards controlling NCD. Respondents felt that, currently, it is expected

from Sudan to report on the situation of NCD. A respondent went on to describe this 'push factor' as 'pressure', saying,

"There is an international and global interest in combating NCD. Together the global and individual interest create more pressure on the academic institutes to conduct NCD research" (Researcher, Academic Private Institute)

c. Personal initiatives/interests

Furthermore, respondents thought that personal initiatives are also considered driving forces that motivate students, a researcher or their supervisor to conduct research on NCD.

3. Barrier to Research

a. Lack of funding

According to the respondents, lack of funding, associated with current economic crisis, was noted as the most significant barrier against NCD research. The government does not allocate any fund for research on NCD nor do academic institutes. Funding merely depends on donor support, however, as mentioned before, international funding agencies are concerned with other mandates and don't perceive NCD as a priority. The only UN funding agency currently known to the respondents as a supporter of NCD research is the WHO, yet funds allocated are still meager. One respondent noted NCD are not a priority for international agencies in Sudan, as they fear from communicable diseases that may cross borders, causing pandemics in the region. Recently,

there was a yellow fever outbreak in the conflict-stricken region of Darfur. When respondents were asked to rate on a scale from one-to-ten the adequacy of funding vis-à-vis the burden of NCD in the country, responses ranged from one-to-four. One of the respondents (who rated this item as two) noted:

"Of course this is about priorities, first there is a very low budget, the national budget of health is very low, and then it goes according to priorities. Research comes last in the health system, first come the supplies and human resources; research is a luxury, you cannot have dessert if you are starving!" (Clinical Researcher) another respondent had a similar perception and went on saying: *"Don't you have a zero in your scale? (grin), ok but I will not give more than one, unfortunately. The NCD program in the Ministry of Health is the most deficient program, as I told you; it is not seen as a priority".* (Researcher, FMoH)

b. Inadequate research skills

Researchers' capacity was a prominent obstacle mentioned by most respondents, lack of knowledge and expertise were described as a problem among students, health practitioners and the supervisors themselves. Fields that need to be strengthened according to the respondents were research methodology, epidemiology and statistics. One of the respondents, a researcher and a public health actor, mentioned that it is important to also conduct 'cohort studies' to research NCD but there is a shortage of expertise that can undertake such study designs. A respondent summarized the reason behind the lack of expertise by saying, *"The reason is that there is absence of training and lack of*

confidence to undertake research in the field of NCD" (Researcher, Academic Private Institute). Other respondents believe that the limited capacity in NCD research is further complicated by the quick turn over of staff, lack of incentives and emigration of skillful cadre. One of the respondents phrased that by saying,

"The problem of the brain drain and turnover of the skillful cadre make things difficult. At my Institute, I think the situation is unfavorable; although there is interest and we have put a plan to build the capacity of the available cadre, human resources capable of undertaking NCD research are scarce." (Researcher, FMoH)

When respondents were asked to rate the available capacities to undertake researches on NCD on a scale from one-to-ten, varying responses were provided (range two-nine). Some felt it was low and gave ratings of two and three, while others felt they were competent in cross sectional studies yet poor in cohort. The high rating (nine) was given by a respondent affiliated with a research institute and was specific to cross-sectional studies.

c. <u>Lack of political commitment</u>

Another commonly mentioned barrier among the respondents was perceived to be attributed to a lack of political commitment. Respondents noted that research, as a whole, is not being seen as a priority issue let alone research on NCD. When asked about the barriers of research, one of the respondents explained this point by saying,

"Policy makers want money to be put in actions and interventions that will clearly show an immediate impact; they don't see the relevance of data and evidence to any output" (Researcher, Academic Private Institute)

When one of the respondents was asked to rate the interest of policy makers in NCD research, he noted, "*While some policy makers have recently started to appreciate the importance of tackling NCD as a priority area, but between me and you I will still give this item a rating of two (grin) this is off record (another grin)"* (Researcher, FMoH).Of note is that most of the respondents gave ratings that were below five, even those who believe that policy makers interest is improving there is still no practical steps to enhance research.

d. Competing burden of communicable diseases

Respondents also described the double burden of communicable and non communicable diseases as being a barrier halting research on NCD; they believe that the health system and academic institutes still prioritize communicable diseases which seem to overshadow all other areas of need. Even those interested in NCD do not find support. One of the respondents explained by saying,

"The track of Community Medicine hardly considers specialties other than communicable diseases, even when researchers submit proposals of different topics- for example health economics- their proposals are shut down-rejected." (Researcher, Academic Private Institute)

4. *Opportunities for Improvement*

a. Advocacy

In providing ideas to improve the situation of NCD research most of the respondents agree that we should start by advocacy. Advocacy is needed to improve awareness about this rising epidemic, both in the community and among policy makers. Respondents believed that this is the first step towards change.

b. More funding opportunities

With funding cited as a major barrier, allocation of funds for NCD research was consistently suggested by the respondents. The respondents believed that it is crucial to provide funds for research on NCD both nationally and internationally, with one of them giving a pro-active suggestion to mainstream NCDs within the 'Poverty Alleviation Strategy' that allegedly is the most funded area "*we ought to include an NCD strategy within the national strategic health plans for poverty alleviation, because you know the burden of NCD will lead to the vicious circle, that will lead to more economic burden, more health related disabilities, and will make the economic situation get worse, and this strategy (the Poverty Alleviation Strategy) is the only strategy that has lots of funds".* (Researcher, FMoH)

c. Recognition of NCD by policy makers

Many respondents believed that the lack of research, in addition to the lack of funding, for NCD research is due to the insufficient recognition of NCD as a

serious public health issue by policy makers. In order to improve this situation, NCD need to be put in the priority working area at a policy making level. One of the respondents noted *"Policy makers need to realize NCD as a priority in their agenda, it is a fact that diseases that kill now are really non communicable diseases more than anything else, and the policy makers do not realize this."* (Researcher, Academic Private Institute)

d. Capacity building

Respondents thought there should be capacity building at all professional levels, academic institutes should focus on teaching skills required for researchers to feel comfortable to conduct research on NCD, and respondents also suggested that institutes should play a role in directing researchers and students to undertake research in this field.

e. Strengthening of the health Information System

Data on NCD are hard to find, most of the respondents felt that the disintegrated health information systems do not provide solid and routine data that may be also used for research, one of the respondents elaborated on this issue by saying:

"The information on NCD is very meager; there is lack of information, as usually 60% of chronic diseases patients go to private clinics so information is lacking. When the information system is proper our area of needs will appear."(Researcher, Academic Public Institute)

f. Building national and international partnerships

Some of the respondents believed there is a very important factor neglected when tackling NCD, which is the fact that it is a multi-sectoral problem. *"One of the main missing areas which need to be highlighted is the multi-sectorality of NCD, and so the Ministry Of Health should not be the only driving force but rather a consortium of authorities that are all concerned"*(Researcher, Academic Private Institute). Respondents noted that sectors such as media, ministry of education, jurisdiction, commerce, drug companies, agriculture etc., are all stakeholders and need to be involved in combating NCDs. Participants also believed that establishing international links are necessary to improve the situation.

g. Integrating NCD at the primary health care (PHC) level

Improving research on NCD is not an issue that stands in isolation, respondents believed it is part of dealing with the emerging epidemic, thus it evolves with strengthening of the health system. Respondents thought the health system has a curative bias and a clinical approach, an approach that doesn't really cater for NCD which should be addressed from a primary health level and through preventive rather than curative measures.

B. Secondary Analysis of SHHS 2010

1. Sample description and Bivariate Analysis

The total sample of this study was 16340 females aged 25 years and above, the crude prevalence of hypertension was found to be 756(4.6%). The prevalence of hypertension was measured in subtype groups of; age, marital status, literacy, education, occupation, state and wealth index~~,~~ these are all listed in Table One.

Age has been divided into five categories, the prevalence of hypertension increased significantly moving from one category to the other, starting with a prevalence of 0.6% in age group '25-34'years until it reached a prevalence of 14% in the last category ' ≥65' years of females. Marital status was grouped into four groups; the majority of women were married (73%). Prevalence of hypertension among singles was 1%, among married was 4.1%, widowed 10% and among the divorced/separated group was 5.1%. 'Married' (OR: 2, 95%CI: 1.2-3.5), 'widowed' (OR: 1.86, 95%CI: 1.06-3.27), and 'divorced/separated' (OR: 2.2, 95%CI: 1.2-4.1) were twice as likely to develop hypertension compared to 'never married' after adjustment to age (Table Two).

Prevalence of hypertension among 'literate' and 'illiterate' was very close, 4.5% and 4.7% consecutively; however after adjustment to age, literate women (OR: 2.7, 95%CI: 2.3-3.3) were found to be almost three times more likely to be hypertensive compared to illiterate women. Similarly, more educated women seem to have an increased likelihood of hypertension, 'primary/khalwa/adult learning' (OR: 2.4, 95%CI: 2-2.8), 'secondary and

above' (OR: 3.1, 95%CI: 2.4-4.1) compared to 'No school'. The majority of the women were not employed (81%). Nevertheless employed and not employed had a comparable prevalence of hypertension, 4.4% and 4.7% respectively. Women living in urban areas (OR: 2.1, 95%CI: 1.8-2.4) were found to be twice as likely to develop hypertension compared to women living in rural areas after adjusting to age.

The states of Sudan were grouped into six main regions and the capital state Khartoum was set as the reference category; all regions (Northern, Central, Eastern, Kordofan, and Darfur) seemed to be protective against hypertension when compared to Khartoum. This was most evident in the Darfur region.

The wealth index was divided into five quintiles from the lowest to the highest, hypertension was found to be significantly associated with wealth; the odds ratio of each level showed a steady increase when compared to the first level even after adjustment to age; odds ratio and 95% confidence intervals were as follow; the second level OR: 2, 95%CI: 1.3-3.5, the third level OR: 4.5, 95% CI: 2.9-7, the fourth OR: 8.6, 95% CI: 5.5-13 and for the fifth and last level OR: 12, 95% CI: 7.8-18.5.

2. Possible confounders

As the wealth index is our main independent variable, we analyzed its association of hypertension adjusting for each one of the remaining variables along with age, to see if any of the variables confound its association with

hypertension. However none of the variables had considerably altered the association between the wealth index and hypertension, results are listed in Table Three.

3. Multivariate analysis

The multivariate analysis included all variables with a p value ≤0.2 in the bivariate analysis. The results of the multivariate analysis are summarized in Table Four. The factors that remained associated with hypertension were age, wealth index and marital status through all category levels. For geographical regions, the Central states (OR: 0.75, 95%CI: 0.6-0.97), Eastern states (OR: 0.6, 95% CI: 0.4-0.8) and Darfur (OR: 0.3, 95% CI: 0.2-0.5) remained significant, contrary to Kordofan and Northern states that became insignificant. Association of education remained significant only for the primary/*khalwa*/adult learning compared to no schooling, and was lost when comparing to secondary level and above. Finally, the association of the area (whether urban or rural) with hypertension became insignificant when entered into the multivariate analysis.

CHAPTER V

DISCUSSION

Findings of this study point to a low prevalence rate of hypertension among adult Sudanese women. Only one in ten women reported health professional-diagnosed hypertension. Associations of the wealth index with prevalence rate of hypertension were significant, net of the effect of potential confounders. A dose response relationship was established with increasing likelihood of hypertension with increasing wealth. Sudan is in its early phases of epidemiological transition, and these findings corroborate with results from the West early in their phase of development. Furthermore, the in-depth interviews revealed a number of barriers and opportunities for promoting NCD research. These are discussed in detail below.

A. Discussion of Qualitative findings

The requirements of research systems have been earlier described in the literature. These include the presence of a national policy for research, funding opportunities, research capacity (human resources and equipped institutes), leadership, methods of priority setting, regulation, supervision of ethical issues and an efficient information system [37]. The FMoH has noted in its '25 year Strategic Plan for the Health Sector' that data on NCD is deficient [6]; this is in line with a preliminary scoping review done by a research team from the AUB on NCD research published within the period (1990-2012) by Sudan, which uncovered a low number of NCD research (less than 140 journal articles);

notably studies which comprised public health themes presented less than 30% of the total publications (unpublished data).

This has driven the current study to inquire about areas that may be deficient, and hence impeding NCD research. The study was an attempt at providing a collective view of what key informants in the field of NCD regard as barriers and opportunities for research in Sudan. Through in-depth interviews, key informants identified four main barriers against NCD research and seven opportunities for improvement.

In summary, the four main reasons that were cited by the key informants as barriers were:1) lack of funding; 2) lack of expertise; 3) lack of political commitment; and, 4) the competing burden of communicable diseases. These barriers are similar to those identified from other LMIC. In parallel, seven opportunities have emerged and these were 1) advocacy, 2) allocation of funds, and 3) recognition of NCD by policy makers, 4) capacity building, 5) strengthening of the health information system, 6) building international links/partnerships and 7) integrating NCD at the primary health care level. Barriers and opportunities are grouped below into four broad themes of areas to act upon.

1. Advocacy and Leadership

To begin with, it is clear from the findings that there is a need to create a system; but the importance of advocating for NCD is the first and foremost intervention for paving the way forward. Advocates, as described by Chapman, do not only present their worries to stakeholders and wait for their decisions,

but they argue for their cause and provide ultimate support that counteracts against resistance to change that may arise from their opponents [38]. Thus the role of advocacy requires leadership. The International Union for Health Promotion has also emphasized on the importance of providing leadership by National Governments to address NCD [39].

2. Capacity building, Partnership and sustainability

The WHO NCD research agenda identified key elements for strengthening research in LMIC; these elements are very similar to those stated by our key informants [40]. Yet, besides the needs for training, funding, priority setting etc., the WHO notes that the underlying causes lie in the brain drain of skilled health professionals. This is of particular importance in Sudan, since it suffers from emigration and fast turnover of health professionals [24], which has also been cited by our key informants as a barrier in the face of NCD research. Therefore, effective training of scientists to enable them to compete for research grants can help discourage this phenomenon.

Likewise international links and partnerships can benefit both LMIC and HIC, while partnership with LMIC provide distinctive opportunities for research, partnerships with HIC allow pooling of resources, expertise and a good chance for the development and training of young researchers in LMIC and sustainability.

3. Funding and Political Commitment

Funding for NCD research in Sudan currently relies on donor support; however it is also very limited and is mainly through the WHO. Investment in NCD research is necessary to provide evidence on what is needed and applicable in our contextual settings. Funding agencies need to realize that investing in NCD research will essentially help save from the tremendous cost on health systems caused by the burden of NCD. Furthermore it is crucial for funders and international partners to realize that funds for research should also be directed on faculty development; that is to say, it should not just be offered for conducting particular studies but rather create collaborations with institutes that will help build national research capacities.

On another scale to encourage the policy makers and the government to support and fund research on NCD, and also for them to perceive the importance of research, it is vital to involve them in priority setting. It has been mentioned by our key informants that on one hand, policy makers do not see NCD as a priority, and on the other, they would prefer to invest in interventions that give immediate outcomes; which research does not provide. However, Ebrahim and colleagues' (2013) note, that research and action should go simultaneously hand in hand; yet their concern was on how this can be implemented on the ground. It has been recognized in literature that priority setting is actually a matter of debate; engaging stake holders and policy makers in the process of priority setting will allow them to appreciate and utilize

research [15]. One avenue to increase local funds for research is the increased taxation on tobacco industries and tobacco products, which according to the WHO can be very efficient and workable in LMIC [41].

4. Information system and PHC

Strengthening of the health information system is a key element that will direct policy makers towards priorities while also serve as a database for monitoring and surveillance creating a backbone for NCD research.

Key informants in our study have emphasized the importance of a well-integrated health information system, which currently is lacking in Sudan. For research to be utilized, it needs to be based on high quality data. Also, an established information system will allow continuous surveillance and monitoring of NCD and their risk factors.

Finally, key informants underscored the need to integrate NCD within the PHC level. PHC units are the first point of patient care; and to undertake research on NCD, morbidity registries from PHC could be very informative. They also provide an ongoing source suitable for surveillance and detection of unique risk factors.

In summary, NCD research in Sudan is still in its infancy and the process of improving research on NCD is an intertwined issue. This creates a challenge of building up a health research system efficient enough to produce and maintain

quality research relevant to the country's context and addressing its changing needs.

B. Discussion of quantitative findings:

The prevalence of hypertension among women in Sudan did not exceed 5%; however Sudan does lacks studies to compare as a bench mark. In comparison, this percentage appears to be lower than those listed in a review study done for SSA; which reported a range of 6%-48% in the region. The low prevalence can be attributed to two main factors. First, the population in Sudan is a young population and the country is still at an early stage of demographic transition, with 35.2% between the age of 25 and 64 and only 3.3% in the older age groups of 65 years and over. In the sample, the majority of women were young, aged '25-34' 35.6% and aged '35-44' 25.4%, which means more than 60% of the sample, are below 45 years of age. Second, hypertension is a silent disease and many people are unaware they are hypertensive; therefore diagnosis relies on self report. In an earlier study, in the United States, the proportion of undiagnosed hypertension was found to be 16.1 % nationwide, another study, also in the United States, showed that up to 74% of hypertensive African Americans are undiagnosed [42] In SSA ~~a~~ review, by Addo and colleagues, revealed that less than 40% of individuals that meet the criteria of hypertension were known to be hypertensive in most studies from the region [43] Similarly, in Sudan, the stepwise survey done in Khartoum, the capital, revealed a hypertension prevalence of (23.6%) while only (11.3%) were aware, likewise a study done on a community of police officers households has also shown that only (30%) of hypertensive's were aware of their condition. [29,31]

The socioeconomic factors examined in our study were; wealth, education, urbanity and occupation respectively. In our study, wealth showed a strong positive association with hypertension; with higher levels of wealth index revealing increased rates of hypertension. Similarly, higher levels of education also seemed to show a positive association at a bivariate level, findings which lost significance in the multivariate analysis when comparing 'no school' with 'secondary level or above' and was maintained for the 'no school' compared to 'primary/khalwa/adult learning'. Furthermore, a significant positive association between living in urban dwellings and hypertension at a bivariate level was also lost in the multivariate level; which is probably justified when we consider urbanity as a marker of wealth. Lastly, employment showed no association with hypertension in our study; however the majority of women in our sample were not employed (81%) which may have obscured a possible association.

The above findings are in contrast to a review done by Grotto and colleagues, which claims that low socio economic status is associated with increased blood pressure. In addition, the review specifically cited education, occupation, income and wealth, to be inversely associated with hypertension. Lastly, the review also mentioned that urban dwellings and weak national economies further shape that risk [44].

Nevertheless, our findings corroborate results from studies conducted in LMIC such as India and Costa Rica, suggest that an expected healthier lifestyle in more educated and wealthier individuals is masked in these communities; due to the effect of globalization that exposes them to unhealthy diets and bad habits they tend to adopt [11,12]. A systematic review done by Addo and

colleagues stated that, hypertension in Sub-Saharan Africa is in the rise, especially in urban communities [43].

On examining the relationship between hypertension and the different geographical areas of Sudan; Khartoum showed the highest prevalence of hypertension compared to all other regions at a bivaraite level. Khartoum as the capital state of Sudan, it is more affected by globalization and urbanization, therefore it is plausible that residents of Khartoum are more likely to encounter behavioral risk factors of smoking, unhealthy eating habits, and a sedentary lifestyle contrary to other parts of the country. A study done by Salman and colleagues (2010) in Khartoum has shown that obesity and hypertension are on the rise among adolescents which portends an epidemiological transition [30]. Furthermore, the stepwise survey by the WHO in Khartoum in (2006) has shown that 62.5% of women in Khartoum are overweight or obese and prevalence of hypertension among women is around 22%. Nonetheless, it is generally difficult to explain geographical discrepancies [29].

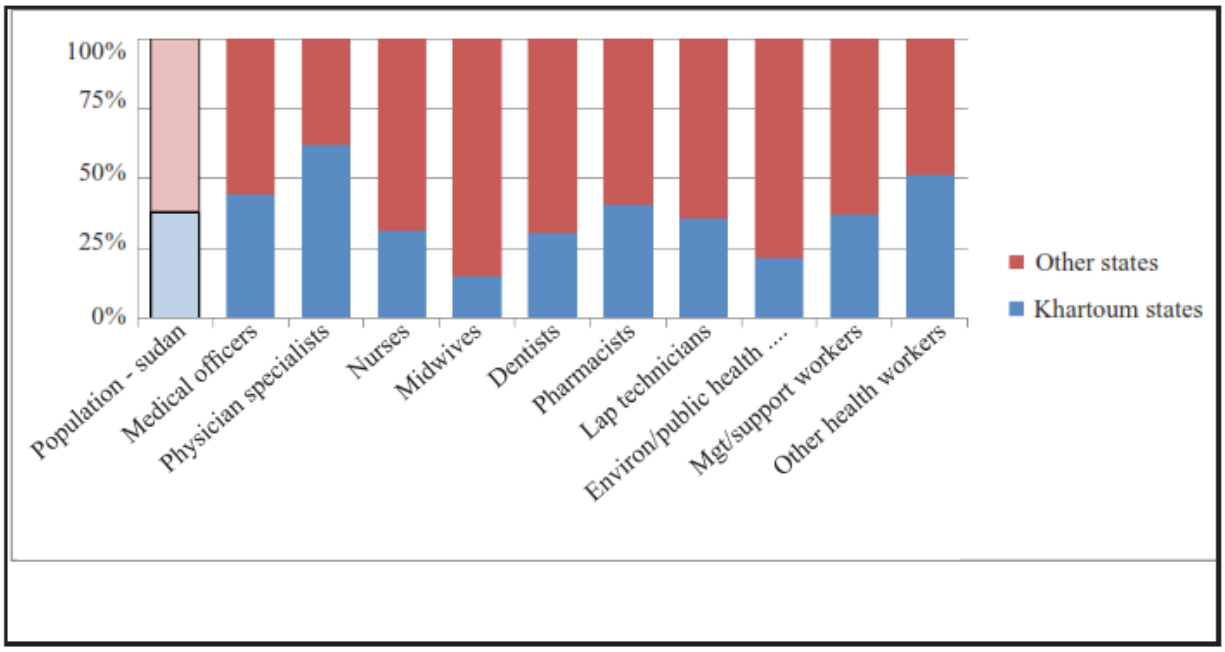
In a study done in rural and urban Nigeria, the authors believed that environmental discrepancies related to distribution of hypertension cannot be well understood, even though they may be related to prenatal theories and psychosocial factors [45].In the multivariate analysis, the protective factor of the Northern region, and the Kordofan region become insignificant when compared to Khartoum, while it remained significant in other regions. Nevertheless, further studies are needed to explore the reasons behind the differences, so as to be able to determine if genetical and environmental factors are employed. However, these variations may have another rationale, we

found the most pronounced disparity compared to Khartoum, was that of Darfur (OR: 0.11, 95%CI: 0.07-0.5).

Darfur is a conflict area and health care facilities are scarce and unavailable in comparison to Khartoum, therefore they are less likely of being diagnosed. A shortage of health facilities and health professionals is present in all regions of the Sudan when compared to Khartoum, although it may be more evident in Darfur [24]; Figure One illustrates the distribution of health professionals in Khartoum, compared to all other states. Furthermore conflict regions, such as Darfur, are still overwhelmed by communicable diseases and prone to outbreaks, therefore lagging behind in the process of the epidemiological transition.

The association between hypertension and marital status among women in Sudan needs some attention. In our study, it was found that marriage and marital transitions were associated with a high likelihood of hypertension compared to 'Never married' women, this result contradicts studies that suggest 'Married women' are at a lower risk of hypertension compared to 'Never married' [46].We are not certain why this is the situation in Sudan, but perhaps since hypertension was self reported, married women may have encountered more chances of visiting health facilities (pregnancy/child birth), that enabled a diagnoses of their condition.

Figure One: Distribution of health professionals in all states compared to Khartoum



Source: National Human Resources for Health observatory-Sudan.

C. Limitations and strengths

This study has a number of limitations. Analysis of the quantitative data was based on secondary analysis of the SHHS; the burden of hypertension relied on self reports which may provide an underestimate for the true prevalence rates in the country. Studies conducted elsewhere reveal a high percentage of undiagnosed hypertension (range 16%-74%) [42,43]. Also, the likelihood of selection bias leading to inflation in the associations between wealth and hypertension cannot be ignored. Higher wealth and accessibility to more assets

may mean higher accessibility to health facilities and more opportunities for diagnosis. Nevertheless, the items used to construct the wealth index in this study comprised of household goods and may not necessarily reflect the individual's income.

Furthermore, information on behavioral risk factors related to hypertension, such as tobacco use, alcohol consumption, physical inactivity and dietary intake were lacking, thus were not evaluated in this study and their relation to hypertension and socio economic status could not be determined. In turn, this contributed to the restriction of the sample to women only, to avoid the possible confounding effect of smoking, and limited the generalizability of study findings to men. Further, the study is a cross sectional survey thus we cannot establish a temporal relationship between socioeconomic status and hypertension.

As for the key informant interviews, there is limited information in the literature on how to explore barriers to conducting research in certain fields. Studies usually focus on issues of research from a priority settings angle, as in to explore areas that need research. Subsequently we created our own interview schedule that we thought may serve our objectives. Key informants were selected through a purposive method; they may have not reflected the opinions of all stakeholders.

In spite of the above, the study used the data from the SHHS; the survey is national study covering all states of Sudan; therefore, the sample frame and the sample size is representative of Sudanese women. Also, the study included a

qualitative approach that helped shed light on the reasons behind the limitations of national surveys in collecting data regarding NCDs. The key informants selected were experts in the field of NCD research and interviews allowed us to explore the situation of NCD research in Sudan. Their input can be used as a guide for policy makers to tackle this problem. This study is timely, as Sudan is in its early phase of an epidemiological transition and is experiencing a lot of changes that subjects it to the negative health effects associated with globalization.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

This is the first study to identify barriers and opportunities of NCD research in Sudan, thus serving as a platform that may guide stakeholders to strengthen the health research system for NCD. National evidence is essential for the development of public health action plans and making evidence-based decisions that will help combat this problem. Hypertension as a case study revealed some of the pitfalls in national surveys when collecting data regarding NCD. However, the study findings highlighted disparities that are associated with wealth and geographical locations. The recommendations based on this study, which will mitigate barriers to NCD research and diminish the knowledge gap in Sudan to cope with this fast growing epidemic, are:

- Advocacy, to prioritize NCD research among policy makers and stakeholders.
- Mobilization and allocation of funds, at national and international levels, to undertake NCD research
- Capacity building by supporting undergraduate and postgraduate training in research methods.
- Introducing surveillance, monitoring and evaluation programs to the NCD department in the Federal Ministry of Health; along with the other WHO recommended units.
- Strengthening the Health Information System to serve as a reliable and efficient database on NCD.

- Integrating NCD in the primary health care level to monitor a larger number of the population, on risk factors and burden of disease.
- Establishment of international partners to support research and exchange expertise.

Sudan is undergoing a critical phase with economic recession, political instability and considerable inequities, rendering the country vulnerable to the adverse effects of globalization in addition to the toll present from the current situation. This study is meant to provide a baseline for further studies in the area.

TABLES

Table One: Distribution of baseline characteristics among Sudanese women in the total population and hypertensive sub sample, 2010.

Variables	**Baseline population**		**Prevalence of Hypertension**	
	N	**%**	**n**	**%**
Total sample	16340		756	4.6
Age				
25-34	5818	35.6	33	0.6
35-44	4144	25.4	99	2.4
45-54	3340	20.4	237	7.1
55-64	1622	9.9	193	11.9
≥65	1388	8.5	194	14.0
Marital status				
Never married	1450	8.9	14	1.0
Married	11917	73	486	4.1
Widowed	2123	13	212	10
Divorced/separated	836	5.1	43	5.1
Literacy				
Illiterate	9942	60.8	465	4.7
Literate	6394	39.1	290	4.5
Level of education				
No school	9156	56.0	445	4.9
Primary/adult learning/ khalwa	4636	28.4	222	4.8
Secondary +	2545	15.6	89	3.5
Employment				
Employed	3026	18.5	133	4.4
Not employed	13242	81.0	617	4.7
Area				
Rural	10805	66.1	380	3.5
Urban	5535	33.9	376	6.8
States				
Khartoum	1229	7.5	119	9.7

Table One cont'd

Northern States	2668	16.3	209	7.8
Central States	4452	27.2	218	4.9
Eastern States	3065	18.8	102	3.3
Kordofan region	2037	12.5	72	3.5
Darfur region	2889	17.7	36	1.2
Wealth index quintiles				
First	2694	16.5	23	0.9
Second	3522	21.6	66	1.9
Third	3498	21.4	132	3.8
Fourth	3319	20.3	228	6.9
Fifth	3307	20.2	307	9.3

Table Two: Crude and adjusted for age odds ratio, 95% Confidence intervals and P-value of different covariates related to hypertension, 2010.

Variables	**Association with hypertension**					
	Unadjusted OR	**95 % CI**	**Crude P-value**	**Adjusted OR for Age**	**95% CI**	**Adjusted P-value**
Total sample						
Age						
25-34	1	-	0.000	-	-	-
35-44	4.3	2.9-6.4	0.000	-	-	-
45-54	13.9	9.3-19.3	0.000	-	-	-
55-64	23.7	16.3-34.4	0.000	-	-	-
≥65	28.5	19.6-41.4	0.000	-	-	-
Marital status						
Never married	1	-	0.000	1	-	0.048
Married	4.4	2.56-7.4	0.000	2	1.2-3.5	0.009
Widowed	11.4	6.6-19.6	0.000	1.86	1.06-3.27	0.031
Divorced/ separated	5.6	3-10.2	0.000	2.2	1.2-4.1	0.014
Literacy						
Illiterate	1	-	-	1		-
Literate	.968	0.83-1.1	0.674	2.7	2.3-3.3	0.000
Level of education						
No school	1	-	0.013	1	-	0.000
Primary/adult learning/*khalwa*	0.99	0.84-1.2	0.853	2.4	2-2.8	0.000
≥Secondary	0.71	0.56-0.9	0.004	3.1	2.4-4.1	0.000
Employment						
Not Employed	1	-		1	-	
Employed	0.94	0.78-1.14	0.314	0.9	0.74-1.1	0.314
Area						
Rural	1	-	-	1	-	-
Urban	2	1.7-2.3	0.000	2.1	1.8-2.4	0.000
States						
Khartoum	1	-	0.000	1	-	0.000
Northern States	0.8	0.63-1	0.054	0.6	0.5-0.8	0.000

Table Two cont'd

Central States	0.5	0.38-0.6	0.000	0.4	0.3-.54	0.000
Eastern States	0.3	0.24-0.4	0.000	0.3	0.2-0.4	0.000
Kordofan region	0.34	0.25-0.5	0.000	0.3	0.2-0.4	0.000
Darfur region	0.12	0.1-0.17	0.000	0.11	0.07-0.15	0.000
Wealth index quintiles						
First	1	-	0.000	1	-	0.000
Second	2.2	1.4-3.6	0.001	2	1.3-3.5	0.002
Third	4.6	2.9-7.1	0.000	4.5	2.9-7	0.000
Fourth	8.6	5.6-13.2	0.000	8.6	5.5-13	0.000
Fifth	11.9	7.8-18.2	0.000	12	7.8-18.5	0.000

Table Three: Wealth index quintiles Odds Ratio, adjusted for different factors related to hypertension, 2010.

Variable (ref. category)	Wealth index quintile (first quintile)							
Adjusted for:	Second quintile		Third quintile		Fourth quintile		Fifth quintile	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Marital status/age	2.1	1.3-3.5	4.6	2.9-7.2	8.8	5.7-13.6	12.5	8.1-19.2
Literacy/age	2.1	1.3-3.4	4.4	2.8-6.8	7.8	5-12	10.3	6.6-15.9
Education level/age	2.1	1.3-3.4	4.3	2.8-6.8	7.9	5.1-12.3	10.6	6.8-16.8
Employment/age	2.3	1.4-3.7	4.7	2.98-7.5	9.0	5.8-14.2	12.6	8.1-19.6
Area/age	2.1	1.3-3.4	4.3	2.7-6.8	8.1	5.2-12.7	11.1	7.2-17.4
State/age	1.85	1.14-3.0	3.6	2.3-7.5	6.45	4.1-10.2	8.6	5.5-13.6

Table Four: Results of Multivariate Logistic Regression, 2010.

Variable (ref.)	Adjusted OR	95% CI	P-value
Age (25-34)			
35-44	3.7	2.5-5.5	0.000
45-54	12.2	8.4-17.9	0.000
55-64	23.3	15.6-34.8	0.000
≥65	28.7	19.0-43.3	0.000
Marital status (never married)			
Married	2.9	1.7-5.0	0.000
Widowed	2.9	1.6-5.1	0.000
Divorced/separated	3.6	1.9-6.9	0.000
Level of education			
Primary/adult	1.3	1.1-1.6	0.007
≥ Secondary	1.3	0.9-1.7	0.117
Area(Rural)			
Urban	1.2	0.98-1.4	0.081
States(Khartoum)			
Northern States	0.8	0.6-1.0	0.105
Central States	0.75	0.6-0.97	0.031
Eastern States	0.6	0.4-0.8	0.000
Kordofan region	0.84	0.6-1.2	0.312
Darfur region	0.3	0.2-0.5	0.000
Wealth index			
Second	1.8	1.1-2.9	0.018
Third	3.2	2.0-5.2	0.000
Fourth	5.5	3.4-8.8	0.000
Fifth	6.96	4.3-11.3	0.000

APPENDIX I

Interview Guide (English)

- What is your opinion about the current situation of Non-communicable Diseases research in Sudan?
- What is your opinion about the past situation of Non-communicable Diseases research in Sudan?
- What have been the main driving forces for the promotion of research on NCD till now?
- What do you believe are the main barriers obstructing further research on NCD in Sudan?
- In a scale of one to ten, how will you rate the interest of health policy makers and strategic planners in research concerned with non communicable diseases? Where one represents least interest and ten maximum interest?
- In a scale of one to ten, how will you rate the capacity level of human resources that currently exist to undertake research on NCD? Where one represents lowest level and ten highest level?
- In a scale of one to ten, how will you rate the capacity level of human resources that currently exist to undertake research on NCD? Where one represents lowest level and ten highest level?
- In your opinion, how can the situation of Research on NCD be improved in Sudan?
- Any additional issue you would like to raise, discuss in this area?

APPENDIX II

دليل المقابلة (العربي)

- ما هو رايك عن وضع البحوث والدراسات في مجال الامراض المزمنة الحالي في السودان ؟
- ما هو رايك عن وضع البحوث والدراسات في مجال الامراض المزمنة فيما مضى في السودان ؟
- ما هي في اعتقادك القوى الدافعة الرئيسية التي تقوم بتعزيز اجراء البحوث في مجال الامراض المزمنة الى الان؟
- ما هي في اعتقادك العوائق الرئيسة التي تعرقل اجراء المزيد من البحوث في هذا المجال في السودان؟
- في مقياس من واحد للعشرة كيف تصنف مدى اهتمام القائمين على وضع الاستراتيجيات والسياسات للصحة بالبحوث والدراسات المعنية بالامراض المزمنة ؟ حيث واحد تمثل اقل درجة من الاهتمام و عشرة اقصى درجة اهتمام
- في مقياس من واحد للعشرة كيف تصنف مستوى القدرات المتوفرة في الموارد البشرية لاجراء البحوث حاليا في هذا المجال؟ حيث واحد تمثل اقل مستوى من القدرات و عشرة اعلى مستوى.
- في مقياس من واحد للعشرة الى اي مدى تعتقد ان التمويل المتاح حاليا لاجراء البحوث و دراسات في الامراض المزمنة يمثل العبء الناتج من هذه الامراض؟ حيث واحد اقل تمثيل و عشرة اعلى تمثيل.
- برايك، كيف يمكن ان نحسن وضع البحوث و الدراسات في مجال الامراض المزمنة في السودان؟
- هل لديك مسالة اخرى تريد طرحها او مناقشتها في هذا المجال؟

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