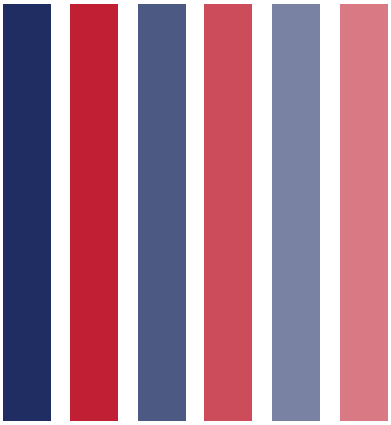
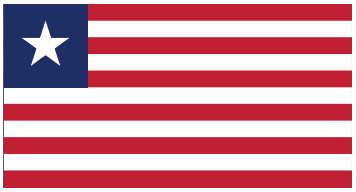


The Liberia Noncommunicable Diseases & Injuries (NCDI) Poverty Commission Report

November 2018

LIBERIA NCDI POVERTY Commission

Reframing Noncommunicable Diseases and Injuries for the Poorest Billion



FOREWORD

As Liberia's population of 4.2 million recovers from the consequences of a series of civil wars (1989-2003) and the devastating Ebola viral disease outbreak (2014-2015) that took away several thousand lives (including healthcare workers), we are now presented with new challenges in responding to the threat of Liberia's increasing noncommunicable disease and injury (NCDI) burden. In spite of gains made in addressing maternal health and communicable diseases, the rapid rise in NCDIs in Liberia is imposing great strain on our health system. As a result of past disruptions, our systems and processes supporting the various sectors of our society were severely weakened. Yet in the health sector, we are strengthening our systems, with indicators pointing to humble but progressive improvement of health care services.

Despite World Health Organization (WHO) reports that NCDs account for 71% of deaths worldwide, NCDs and injuries were entirely left out of the Millennium Development Goals. The 2015 Summit on Sustainable Development Goals (SDGs) held promise though, finally recognizing the NCDI burden as a major challenge for sustainable development in the 21st century and adopting NCDs as one of the key SDG targets to address in the ensuing fifteen years (2015-2030). To achieve these targets, concerted efforts are needed, with contribution of all disciplines and sectors nationally and support from civil society and global partners.

With much work still ahead, the Liberian Ministry of Health (MOH) is taking significant steps to meet global NCDI goals. Under a newly established NCD Division, strategic instruments to guide and regulate Liberia's national response to the disease burden are being developed. The National NCD Policy and Strategic Plan (2016-2021) was launched and additional guiding policies, such as a National Cancer Policy and Radiation Guidelines, are nearing completion. Clinical protocols are also being drafted, promising to offer needed guidance in provider's clinical training and enhance the quality of care delivery in NCDI management.

As severe, chronic conditions, NCDIs require significant investment by the patient, family, and society. Yet with 50.9% of Liberia's population living in absolute poverty, as the 2016 Household Income and Expenditure Survey (HIES) demonstrates, interventions are often financially out of reach for our people. The MOH is proud to have constituted a group in partnership with the global *Lancet* Commission on Reframing NCDs and Injuries for the Poorest Billion to highlight Liberia's experience in responding to the rising global scourge of NCDIs. Under the leadership of Dr. Fred Amegashie (MoH) and Dr. Jason Beste (PIH), the Liberia Noncommunicable Disease and Injury (NCDI) Poverty Commission has worked throughout 2017 to gather information to show the country's NCD burden and intervention profile.

This Liberia NCDI Poverty Commission report doubles as a critical baseline assessment and advocacy tool for the type of services requiring investment. I implore all local and international partners to thoroughly peruse the document with the purpose of contributing to the alleviation of the NCDI burden on our population. In 2016, NCDIs constituted an estimated 37.9% of Liberia's total disease burden and 43.4% of all deaths. From our Commission's findings, we see that a modest increase in the percentage of our national health expenditure allocated to NCDs could reduce yearly premature deaths by 1,300 by the year 2030. As the Ministry of Health, we recognize the opportunity for action described in this report and are committed to do our part.

With profound gratitude, we acknowledge those who came together from diverse sectors, including MOH and other government agencies, academia, and civil society, to constitute the Liberia NCDI Poverty Commission. We heartily acknowledge the immense effort by all Commission members and colleagues, which culminated to produce this great work. In addition, we appreciate the invaluable support and resources from Partners In Health NCD Synergies, Harvard Medical School, and WHO's local office here in Liberia.

Hon. Wilhelminah S. Jallah, MD, MPH
MINISTER OF HEALTH
Republic of Liberia

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Appendices for this report are published separately and can be accessed and downloaded at www.ncdipoverty.org/Liberia-report.

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Acronyms & Abbreviations

ACEI	Angiotensin Converting Enzyme Inhibitors
ADHD	Attention Deficit Hyperactivity Disorder
ANC	Antenatal Clinic
BMI	Body Mass Index
BPHS	Basic Package of Health Services
CFR	Case Fatality Ratio
CHA	Community Health Assistant
CHF	Congestive Heart Failure
CKD	Chronic Kidney Disease
COPD	Chronic Obstructive Pulmonary Disorder
CVD	Cardiovascular Disease
DALY	Disability Adjusted Life Years
DDR	Demobilization and Reintegration
DHS	Demographic Health Survey
DNA	Deoxyribonucleic Acid
EBV	Epstein Barr Virus
ECG	Echocardiogram
EPA	Environmental Protection Agency
EPHS	Essential Package of Health Services
EVD	Ebola Virus Disease
FDA	Forestry Development Authority
FY	Fiscal Year
GBD	Global Burden of Disease
GOL	Government of Liberia
HEIS	Household Income Expenditure Survey
HFU	Health Financing Unit
HIV	Human Immunodeficiency Virus
HPV	Human Papilloma Virus
HMER	Health Management Information Systems, Monitoring and Evaluation, and Research Unit, MOH, Liberia
IHD	Ischemic Heart Disease
IHME	Institute of Health Metrics & Evaluation
IHP+	International Health Partnership
IPV	Intimate Partner Violence
JFK	John F. Kennedy
JPCU	Joint Project Coordinating Unit
LDHS	Liberia Demographic Health Survey
LEC	Liberia Electricity Corporation
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LMHRA	Liberia Medicines & Health Products Regulatory Authority
LMIC	Low & Middle-Income Countries
LPRC	Liberia Petroleum Refinery Corporation
LRA	Liberia Revenue Authority
MDD	Major Depressive Disorder
MFDP	Ministry of Finance and Development Planning
MICAT	Ministry of Information, Culture & Tourism
MNS	Mental, Neurological & Substance Use
MOF	Ministry of Finance
MOH	Ministry of Health
MOHSW	Ministry of Health and Social Welfare
MRI	Magnetic Resonance Imaging
NCD	Non-Communicable Disease
NCDI	Non-Communicable Diseases & Injuries
NGO	Non-Governmental Organization
NHA	National Health Account
NHIP	National Health Investment Plan
NHP	National Health Plan
OPD	Out-Patient Department
PIH	Partners In Health
PTSD	Post-Traumatic Stress Disorder
RHD	Rheumatic Heart Disease
RTA	Road Traffic Accident
SARA	Service Availability & Readiness Survey
SCD	Sickle Cell Disease
SCT	Sickle Cell Trait
SDACH	S.D.A Cooper Hospital
SES	Socio-Economic Status
TBI	Traumatic Brain Injury
THE	Total Health Expenditure
UHC	Universal Health Coverage
UN	United Nations
UNFPA	United Nations Fund for Population Activities
UNHCR	United Nations High Commission on Refugees
UNMIL	United Nations Missions in Liberia
VIA	Visual Inspection with Acetic Acid
WHO	World Health Organization
YLL	Years of Life Lost

ACKNOWLEDGMENTS

Many individuals and organizations from across Liberia and outside the country have generously contributed to the development of this report, for which the Ministry of Health (MoH), on behalf of the Government of Liberia, extends profound gratitude. We acknowledge the immense efforts and support from our partners who selflessly provided technical support during this process: the Secretariat of *The Lancet* Commission on Reframing NCDs and Injuries for the Poorest Billion, the Program in Global Noncommunicable Disease and Social Change in the Department of Global Health and Social Medicine at Harvard Medical School, and Partners In Health (PIH).

We acknowledge the support of the then Honorable Minister of Health of Liberia, Dr. Bernice Dahn, for her leadership and provision of an enabling environment that supported and sustained the Commission's work. We are also grateful to members of the current upper administrative echelon of the MoH (led by the Honorable Minister, Dr. Wilhelmina S. Jallah) for their support, which was exemplified through supervision, mentoring and technical backstopping. Special gratitude is also extended to the Chief Medical Officer/Deputy Minister for Health Services, Dr. Francis N. Kateh; the Assistant Ministers for Preventive Services, Dr. Samson K. Arzoaquoi (former) and Madam Joyce Sherman, whose bureau provides direct oversight to the NCDs program; and the Assistant Minister for Curative Services, Dr. Catherine T. Cooper, who chaired most Commission meetings.

We express our gratitude to a number of Programs/Departments from the MOH, Line Ministries, Medical and Training Institutions, NGOs, and CSOs, who lent their time and expertise to the design of this document: the MoH NCD Division, Health Management Information Systems, Monitoring and Evaluation, and Research (HMER) Unit, National Health Promotion Division, and Health Financing Unit; National Commission on Disabilities; World Health Organization (WHO); Diabetes Management Association of Liberia; Liberia Cancer Registry; Liberia Cancer Society; A.M Dogliotti College of Medicine; Liberia Medical and Dental Association; John F. Kennedy Medical Center; Ministry of Justice; Ministry of Gender Children and Social Protection; Liberia Institute of Statistics and Geo-information (LISGIS); SightSavers; Global Health Innovation and Action (GHIA) Foundation; Redemption Hospital; Ganta United Methodist Hospital; and JJ Dossen Hospital.

EXECUTIVE SUMMARY

Non-communicable diseases and injuries (NCDIs) comprised a large share of Liberia's burden of disease in 2016, accounting for an estimated 37.9% of the national burden from all causes and 43.4% of all deaths. Although it is often believed that NCDIs only affect older populations, over half (51.5%) of the NCD disease burden and almost more than two-thirds (69.8%) of the injury burden occur in Liberia before the age of 40. Global frameworks for NCDIs typically focus on four major disease areas (cardiovascular disease, chronic respiratory disease, diabetes, and cancer) linked to four main behavioral and metabolic risk factors (tobacco use, harmful use of alcohol, unhealthy diet, and physical inactivity). However, in Liberia's socioeconomic and environmental context, these conditions comprise less than a third (only 30.6%) of the estimated NCDI disease burden. Beyond traditional risk factors due to behavior, risk factors related to poverty, the environment, and chronic infections play a significant role for many of the chronic, severe NCDs.

Although NCDIs are one of the focus areas of Liberia's Essential Package for Health Services, basic services are limited, especially in rural and public-sector facilities. This results in limited basic service availability to the most-in-need and most-at-risk populations. Additionally, capacity and readiness for advanced NCDI care is extremely limited and concentrated only in urban referral centers. Management of NCDIs is often costly to the economy and imposes a heavy burden to already struggling economies, especially in low- and middle-income countries. To date, resources for NCDIs remain constrained, with only 18% of total health resources going towards NCDIs. Of this spending, 75% is provided by households through out-of-pocket expenses, which is substantially higher than other conditions. This undoubtedly contributes to catastrophic expenditures and further impoverishment.

In 2017, the Government of Liberia through the Ministry of Health established the Liberia NCDI Poverty Commission in collaboration with the *Lancet* Commission on Reframing Non-Communicable Diseases and Injuries for the Poorest Billion. The objectives of the Liberia NCDI Poverty Commission were to explore and quantify the burden of NCDIs (particularly in relation to poverty) and current service availability and to propose an expanded list of priority NCDIs and interventions that could have a favorable impact on the health and economy of Liberia.

After reviewing data on the overall burden of disease, equity profiles of disease conditions, severity and disability of illnesses, and age profiles of those effected, the Commission selected 19 NCDI disease conditions to be included in an expanded agenda on NCDIs. Building on existing Liberian plans and policies; these conditions include asthma, chronic obstructive pulmonary disease, cardio-

vascular disease, rheumatic heart disease, diabetes (type 1 and 2), cervical cancer, non-Hodgkin lymphoma, breast cancer, major depressive disorder, schizophrenia, substance abuse disorders, anxiety disorders, epilepsy, sickle cell disease, vision loss, refraction and accommodation disorders, cirrhosis, chronic kidney disease, and motor vehicle road injuries. From an evidence-based package of interventions recommended for Universal Health Coverage, the Commission selected 33 potential interventions to be introduced or intensified within the health sector to target these priority NCDI conditions. The interventions were selected based on the following criteria: potential health impact, cost-effectiveness, financial risk protection, and priority to those "worst-off" or most vulnerable to terms both of poverty and of lifetime health, including those impacted by severe conditions at younger ages and those that could avert more severe or premature complications.

The Commission estimated that implementing these prioritized interventions – including outpatient, inpatient, surgical, mental health, rehabilitation, palliative care, and laboratory services, along with facility- and central-level indirect costs – is forecasted to cost 13.8% of total health expenditure in Liberia, or 2.1% of the gross domestic product, roughly USD $ 9.21 per capita. These interventions are estimated to potentially avert over 1,300 premature deaths annually by the year 2030. The cost of these NCDI interventions could be funded through cross-sector interventions, including: taxation on tobacco, alcohol, and sugar; improving health sector efficiency; and re-aligning donor funding for NCDIs. This Commission also emphasizes the need for improved data on NCDIs through registration, tracking and analysis of NCDI conditions and an integrated and multi-sectorial approach to the mitigation of NCDIs to allow for a better organized, systematic and cost-effective response to NCDIs.

Owing to the burden NCDIs inflict on populations across all age groups, especially in rural communities, and the cost to the economy particularly in struggling economies in low-income countries, an integrated multi-sectorial prioritization of NCDI prevention, screening and diagnostics, treatment, and management in Liberia is needed. Such prioritization would help avert death, disability and impoverishment for patients and their families and may benefit the economy through reduced expenses to the healthcare system and improved productivity of the population. Mitigating the barriers to access to NCDI care and investing in NCDI health literacy will go a long way in supporting Liberia to achieve global targets for NCDIs, improve health outcomes, and ultimately enhance Universal Health Coverage.

1. Background, History and Policy Context

1.1 LIBERIA DEMOGRAPHICS AND HEALTH SYSTEM

The population of Liberia is estimated to be just over 4.7 million people (990,966 households, with a mean of 4.3 people per household).[1,2] Liberia's population is very young, with 44.5% of the population under the age of 15 years and a high national age dependency ratio of 89.9%; in rural areas, this ratio is over 100%.[2] Nationally, 50.9% of the population lives in absolute poverty, and 16.5% live in extreme poverty, which is higher in rural areas (71.6% and 26.5%, respectively) than urban areas (31.5% and 7.2%, respectively).[2] In 2005, the Government of Liberia (GOL) through the Ministry of Health (MOH) published a Basic Package of Health and Social Welfare Services for Liberia.[3] This policy document developed and mandated a package of health interventions to be delivered to the population in a decentralized fashion through strategy set forth by the National Health Policy, 2007, and National Health Plan, 2007-2011.[4,5] Following this, the Essential Package of Health Services (EPHS) was published in a policy document, and also in the National Health and Social Welfare Policy, 2011, and its accompanying ten-year National Health and Social Welfare Plan, 2011-2021.[6,7]

These documents outlined the new Essential Package, offering more diversified services and improved access to care in an effort to produce a healthy population while fostering social protection for all. New services added to the EPHS included: Environmental and Occupational Health, Neglected Tropical Diseases (NTDs), Non-communicable diseases (NCDs), Social Welfare, and the School Health Services. NCDs were included because of the growing population of elderly Liberians in addition to the realization that the prevalence of NCDs was increasing among younger citizens as well as within people in the lower socio-economic stratum of society.

From 2014-2015, the Ebola Virus Disease (EVD) epidemic brought about a severe disruption of health services. The National Health Investment Plan for Building a Resilient Health System in Liberia, 2015-2021 (NHIP) was developed and implemented in response, seeking to build a resilient health system that could ensure universal access to safe and quality health care services.[8]

The plan details nine strategic investment areas, three of which were developed in the period immediately following the EVD epidemic: (1) creating a fit-for-purpose, productive, and motivated health workforce; (2) building re-engineered health infrastructures; and (3) strengthening epidemic preparedness and response (including surveillance and Early Warning Systems). The MOH believed that NCD services delivery would be improved with the development of all nine investment areas. In addition, to ensure that the population has access to basic health services, the GOL created a new cadre of health care workers called Community Health Assistants (CHA); to date, an estimated 2,800 CHAs

have been recruited and trained. This community-based structure is crucial for early referrals to clinics and for follow up care for chronic conditions, such as NCDIs.

1.2 ORGANIZATION AND GOVERNANCE OF NCDIS IN LIBERIA

The NCD Division of the Ministry of Health is guided by the following mandates: to develop effective policies to govern NCDI interventions in Liberia, advocate for the mobilization of resources including the development of appropriate capacity for NCDI service provision, coordinate stakeholders involved in work in the country to ensure efficient utilization of resources for NCD (including eye health), and provide quality assurance of service provision through regular monitoring and evaluation. The Division works with units of the MOH (i.e. National Health Promotion Unit) to disseminate health promotion messages in both English and local languages. The NCD Division also engages the Community Health Services Department (CHSD) on awareness development and other interventions in the community, such as media talk shows and school health presentations. The NCD Division works closely with programs within CHSD to ensure that NCD preventive and curative services are integrated into the overall health care delivery in collaboration with other line Ministries (i.e. Education; Youth and Sports; Gender, Children and Social Protection; Transportation; Information, Culture and Tourism (MICAT); and Justice) and other health sector partners.

1.3 INTRODUCTION AND AIMS OF THE LIBERIA NCDI POVERTY COMMISSION

In January 2017, the Liberia Non-communicable Disease and Injury (NCDI) Poverty Commission was established by the Liberia Ministry of Health in collaboration with *The Lancet* Commission on Reframing Non-Communicable Diseases and Injuries (NCDIs) for the Poorest Billion.[9] Appreciating the burden of NCDI conditions affecting the Liberian population, including NCDIs driven by risk factors associated with poverty, this Commission used existing data sources to summarize the impact of the NCDIs on the health of Liberians and to establish the relationship of poverty with NCDIs in Liberia. With this information, the Liberia NCDI Poverty Commission then developed a proposed package of health sector interventions to raise the visibility and understanding of severe, chronic NCDIs for policy makers and civil society in Liberia, with the hope of informing future service planning and effective resource allocation.

Specifically, the stated aims of the Commission are as follows:

- To establish the burden of disease of NCDs and injuries in Liberia, particularly in relation to socioeconomic risk factors;
- To understand and document the current availability and coverage of health

sector services for NCDIs in Liberia;

- To prioritize NCDI conditions that require intervention in Liberia, emphasizing those conditions causing the largest burden of morbidity and mortality for the Liberian population, with a particular focus on those that affect the worst off or cause severe disability and those that are inequitably addressed for those living in poverty;
- To propose a package of cost-effective interventions to address priority NCDIs in Liberia;
- To estimate the cost and potential impact of these interventions and forecast the potential fiscal space in Liberia for financing these interventions;
- To highlight the voices of those impacted by NCDIs particularly affecting populations living in poverty.

In order to achieve these aims, the Ministry of Health nominated a group of experts within Liberia in the field of NCDIs to participate in this Commission. These experts included leaders from the Ministry of Health (i.e. the Divisions of Curative Services, Health Financing, and School Health), Government Institutions (Ministry of Justice, Ministry of Gender, Children and Social Protection, LISGIS, National Commission on Disabilities, National Public Health Institute of Liberia, Ministry of Education) medical schools (i.e. AM Dogliotti College of Medicine), referral hospitals (i.e. JFK Memorial Hospital, J.J. Dossen Hospital, Redemption Hospital), World Health Organization, World Bank, civil society (i.e. Diabetes Management Association, , Liberian Cancer Society) and non-governmental partner organizations (i.e. Partners In Health, Sightsavers). Commissioners participated in four subcommittee working groups, which included: 1) Burden of Disease, 2) Health Sector Interventions, 3) Health Financing, and 4) History, Governance, and Patient Advocacy. The Commission convened a series of four consultative meetings over a one-year period, with financial and technical support from Partners In Health, Harvard Medical School Department of Global Health and Social Medicine, and *The Lancet* Commission on Reframing NCDs & Injuries for the Poorest Billion.

1.4 METHODOLOGY

Further information on The *Lancet* Commission on Reframing Non-Communicable Diseases and Injuries (NCDIs) for the Poorest Billion and the Liberia NCDI Poverty Commission can be found online at: http://www.ncdipoverty.org/. The detailed methodology and analytic framework used by the Commission is described in detail in the Appendix and elsewhere.[10]

In brief, the Commission first established and accessed available data sources related to the specific aims of the Commission. First, a thorough literature review was conducted, consisting of all studies published before January 31st of

2017. The search terms corresponded to Level 2 NCDI categories from the Global Burden of Disease (GBD) Study 2016 combined with the word "Liberia."[11,12]

Studies were included if they met any of the following criteria: (1) contained data on prevalence, risk or mortality from NCDIs preferably stratified by socio-economic strata or by geographic location; (2) reported distributions of types of NCDI cases among admissions and deaths at health facilities; (3) reported on interventions or service delivery models for NCDIs. Estimates of prevalence, disability-adjusted life years (DALYs), and percent of total deaths from the GBD Study 2016 were used for specific NCDs, injuries, and risk factors. The proportion of NCD burden attributable to behavioral and metabolic risk factors was examined by calculating the joint attribution in GBD to the set of risks with indicators in the WHO Global Monitoring Framework; further detail is described in the Appendix. The Liberia STEPS Survey, 2011, which focuses on obtaining data on behavioral and metabolic risk factors for NCDs, was reviewed.[13]

The 2013 Liberia Demographic and Health Survey was also utilized for data on NCDI risk factors, such as tobacco use, alcohol use and adult nutritional status among men and women aged 15-49 years disaggregated by wealth quintile.[14]

Baseline availability of services was estimated using the Liberia Service Availability and Readiness Assessment (SARA), 2016.[15] Service availability was then analyzed by disease condition, level of the health system, urbanicity, and county, and both reported availability of services and readiness, determined by the observed availability of designated tracer items, were analyzed. These data were reviewed and validated by Commissioners to establish baseline availability of services. In addition, information on the availability of referral-level services was provided by expert reports from Commission members.

After this data collection, Commissions undertook a process to prioritize certain diseases among NCDIs conditions based on principles of priority setting recently recommended by global bodies.[16] The Commission chose to analyze and rank NCDI conditions based on the estimated burden of disease of each condition in Liberia (as measured by DALYs).[12]

The severity of each condition was measured using the average years of life lost (YLL) per death, and the disability of each condition was measured using the years of life with disability (YLDs) per incident case. Finally, the impact in Liberia compared to high-income countries was estimated for each condition by comparing the rate of DALYs per 100,000 population. One hundred and ninety (190) NCDI conditions from the GBD Study 2016 database were analyzed along these metrics, and a summary score was provided to each condition according to the average of the ranking quartiles on each metric. The 50 conditions with the highest summary score were then reviewed by a sub-committee of Commissioners. Commissioners then chose conditions that were believed to contribute sig-

nificantly to adverse health and economic consequences in Liberia, could be feasibly and effectively controlled in Liberia, and were complementary to ongoing strategy and efforts by the government of Liberia.

Information regarding evidence-based and cost-effective health sector interventions for NCDIs was obtained from the 3rd Edition of the *Disease Control Priorities (DCP3)*, a publication by the Disease Control Priorities Network (DCPN) that compiles collected data on the most cost-effective interventions to achieve Universal Health Coverage (UHC) in low- and low-middle income countries.[16–19] Further details of DCP3 can be found online at www.dcp-3.org/

The unit cost for each intervention was provided on average across low-income countries and then adjusted for the cost of health sector expenditure in Liberia for tradeable costs. Indirect costs to the health system were applied through standard adjustments (described below). These interventions and associated costs were reviewed by the Commission for 1) alignment with stated NCDI priority conditions and 2) feasibility and desirability in the Liberian context. Each intervention was assigned a baseline coverage in Liberia, estimated from existing data sources where available, including SARA, STEPS, and DHS surveys, as well as expert reports from the Commissioners. The Commission then assigned target coverage rates for each intervention by the year 2030. The total cost of implementing the selected interventions at target coverage levels was then calculated.

Finally, information on fiscal space for NCDIs and potential financing, including both domestic and external sources, were collected from national health and program budgets. Facility-based information from major hospitals in Liberia, including Redemption Hospital, John F. Kennedy Medical Hospital, ELWA Hospital, and Jackson F. Doe Memorial Hospital, were collected using primary data on the types and cost of NCDs services offered at these facilities. The Health Financing Unit's resource mapping, which provides forward-looking information on both government and donor sources was reviewed for information on NCDs. Expenditure information on spending on NCDs over the past five years was retrieved from the National Health Accounts database and reviewed.

2. Burden of NCDI disease in Liberia

2.1 OVERVIEW OF BURDEN OF NCDI DISEASE

NCDIs claim an increasingly large share in the total burden of disease in Liberia. GBD 2016 estimates showed that 37.9% of all DALYs and 43.4% of all deaths of all causes were accounted for by NCDIs.[12] Due in part to an increased prevention and control of communicable, maternal, neonatal, and malnutrition diseases, the relative proportion of all causes of disease burden due to NCDs has more than doubled in the last two decades (Figures 1).

An increasing proportion of total DALYs is attributed to NCDIs

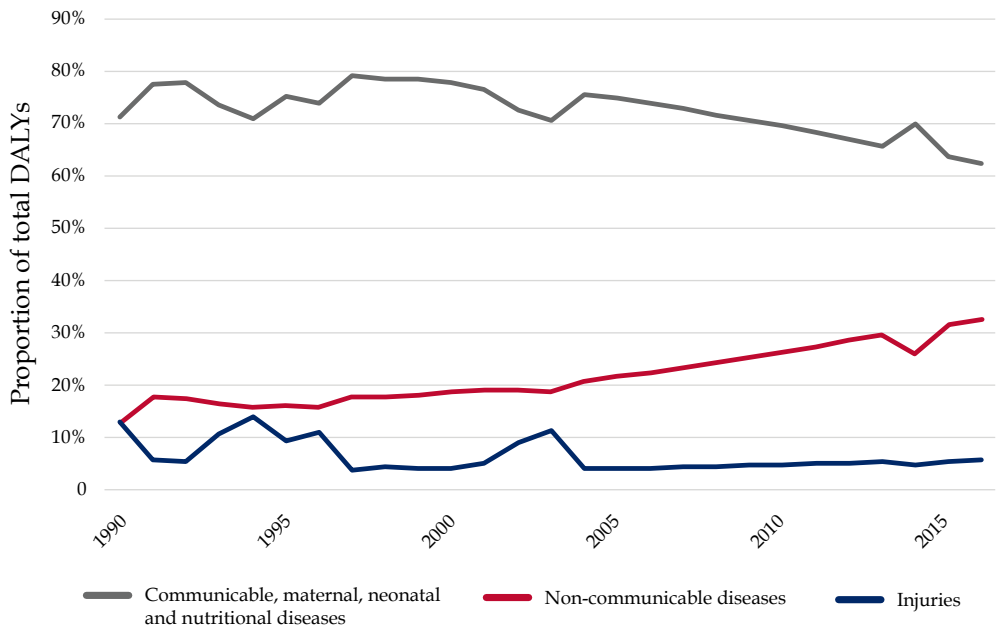


Figure 1. Proportion of total DALYs in Liberia between 1990-2016 estimated to be due to Communicable, maternal neonatal, and nutrition diseases; Non-communicable diseases; and Injuries (Source: GBD, 2016)

Although commonly thought to occur only at older ages, 51.5% of NCD DALYs and 69.8% of injury DALYs in Liberia in 2016 occurred before age 40 (Figure 2).

51% of NCD DALYs and 70% of injury DALYs occur before age 40

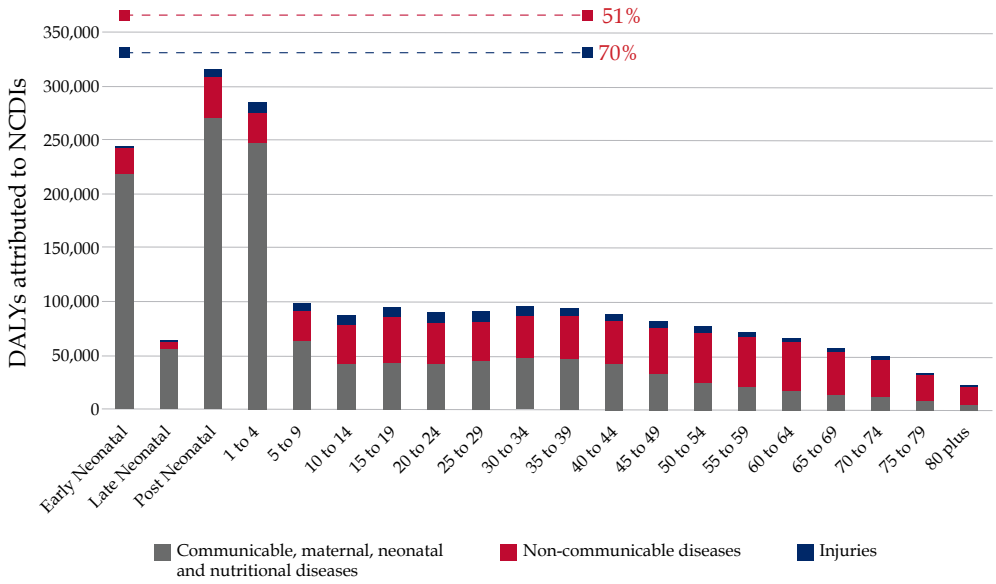


Figure 2. Estimated share of DALYs attributed to NCDIs in Liberia in 2016 by age group (Source: GBD, 2016)

Of all DALYs due to NCDs in Liberia in 2016, less than one-third (30.5%) are due to the "4x4" conditions (cardiovascular diseases (CVDs), cancers, type II diabetes, and chronic respiratory diseases) targeted by the WHO Global Action Plan for the Prevention and Control of Noncommunicable Disease (2013-2020) (Figure 3).[12,20] Additionally, the 30.5% of DALYs attributed to these 4x4 NCD conditions is far lower than that of high-income countries, where approximately 46.4% of all NCDI DALYs are attributed to these conditions.[12]

Nearly 70% of NCDI DALYs are due to conditions other than those included in the traditional 4x4 model

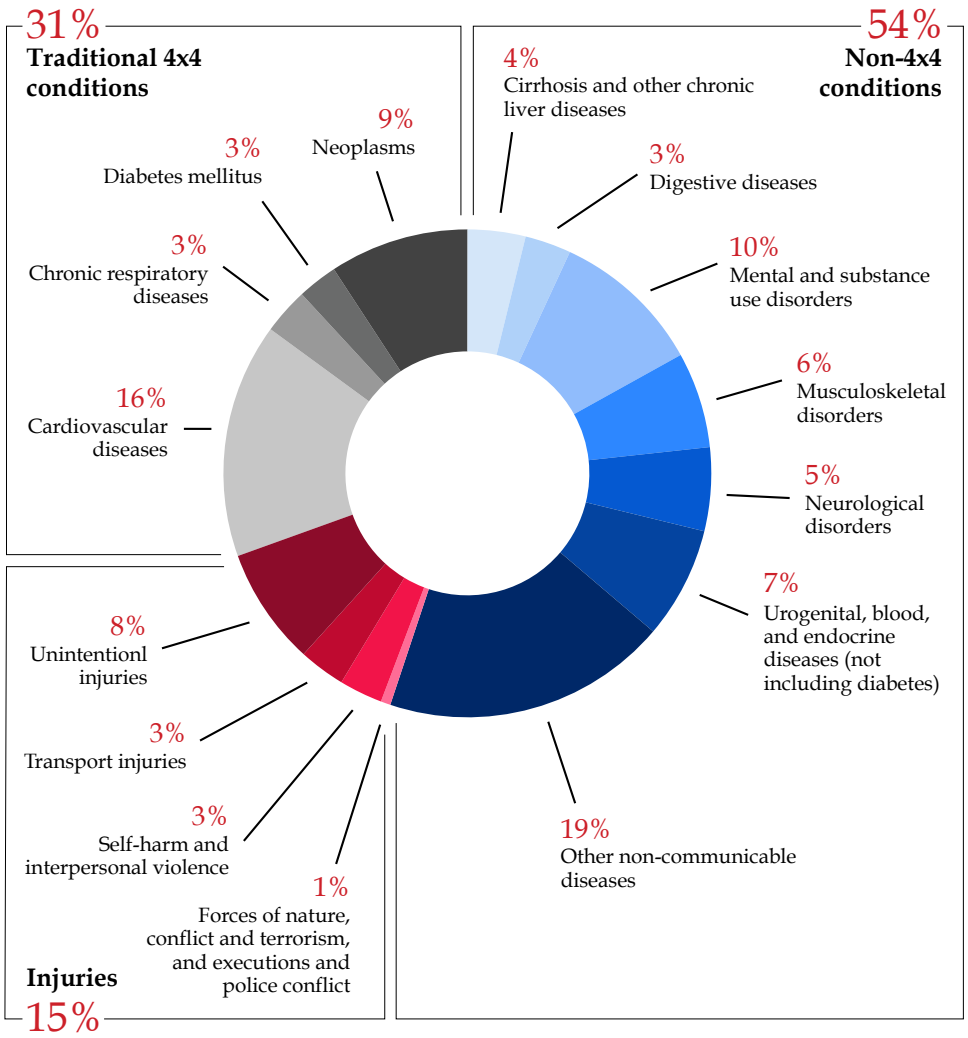


Figure 3. Estimated proportion of DALYs attributed to NCDIs in Liberia in 2016, by traditional "4x4" conditions, non-"4x4" conditions, and injuries (Source: GBD, 2016)

2.2 RESULTS OF LITERATURE REVIEW

A detailed literature review was conducted for all NCDI-related studies published from January 31, 2006 to July 31st, 2016.[10] The results of this search are summarized in Table 1. Out of 542 search results, 51 (9.4%) studies met the inclusion criteria and only 14 (2.6%) articles contained data on socioeconomic status of participants. Most studies were either population-based (N=26) or health facility-based (N=17). Overall, there was a dearth of literature on NCDIs in Liberia and we found no published studies on several high burden diseases including diabetes, chronic respiratory disorders and liver cirrhosis. The following subsections describe findings from the literature search in the context of the data

available from GBD 2016, with an emphasis on determining differences in the risk factors, incidence, prevalence, or treatment of each disease condition based on socioeconomic status. The results of the full literature review are detailed in the Appendix.

NCDI Category	Total number of PubMed search results (#)	Articles that met the inclusion criteria (#)	Articles with any data on socioeconomic status (#)
Cardiovascular diseases	9 (1.7%)	2	1
Chronic respiratory diseases	2 (0.4%)	1	0
Cirrhosis and other chronic liver diseases	1 (0.2%)	0	0
Diabetes, urogenital, blood and endocrine disorders	74 (13.7%)	9	0
Digestive diseases	36 (6.6%)	2	0
Injuries	62 (11.4%)	17	7
Mental and substance use disorders	31 (5.7%)	8	5
Musculoskeletal disorders	14 (2.6%)	0	0
Neoplasms	14 (2.6%)	3	0
Neurological disorders	68 (12.5%)	7	1
Other Chronic diseases	6 (1.1%)	1	0
Other NCDs	215 (39.7%)	2	0
Risk factors	10 (1.8%)	0	0
TOTAL	**542**	**51 (9.4%)**	**14 (2.6%)**

Table 1. Summary of PubMed search results for NCDIs in Liberia (January 31st 2006-2017)

2.3 OVERALL RISK FACTORS FOR NCDIS

The GBD Study 2016 examines the following risk factors:

- Metabolic risk factors are high fasting plasma glucose, high total cholesterol, high systolic blood pressure, high body mass index, low bone mineral density, and decreased glomerular filtration rate.
- Behavioral risks including child and maternal malnutrition, tobacco, alcohol and drug use, dietary risks, sexual abuse and violence, unsafe sex, and low

physical activity

- Environmental risk factors of unsafe water, sanitation and handwashing, air pollution, occupational risks and other environmental factors.

Overall, the GBD estimates that only 29.3% of NCD DALYs were attributed to metabolic and behavioral GBD risk factors in 2016.[12] The majority (70.7%) of the NCD DALYs were, instead, attributed to GBD environmental risk factors or not attributed to GBD risk factors (Figure 4).

Two-thirds of NCD DALYs are not attributed to behavioral and metabolic risk factors

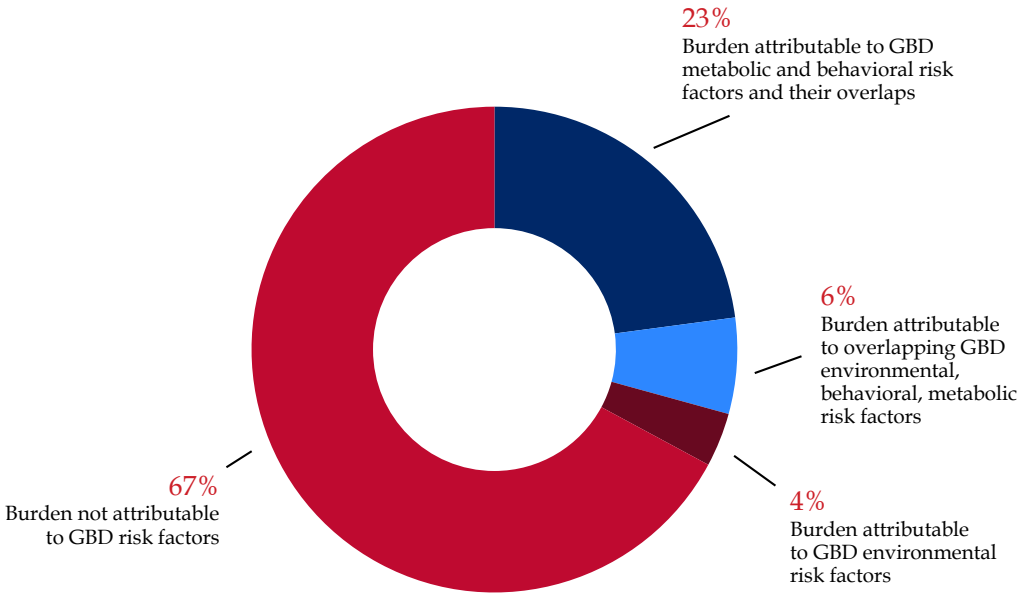


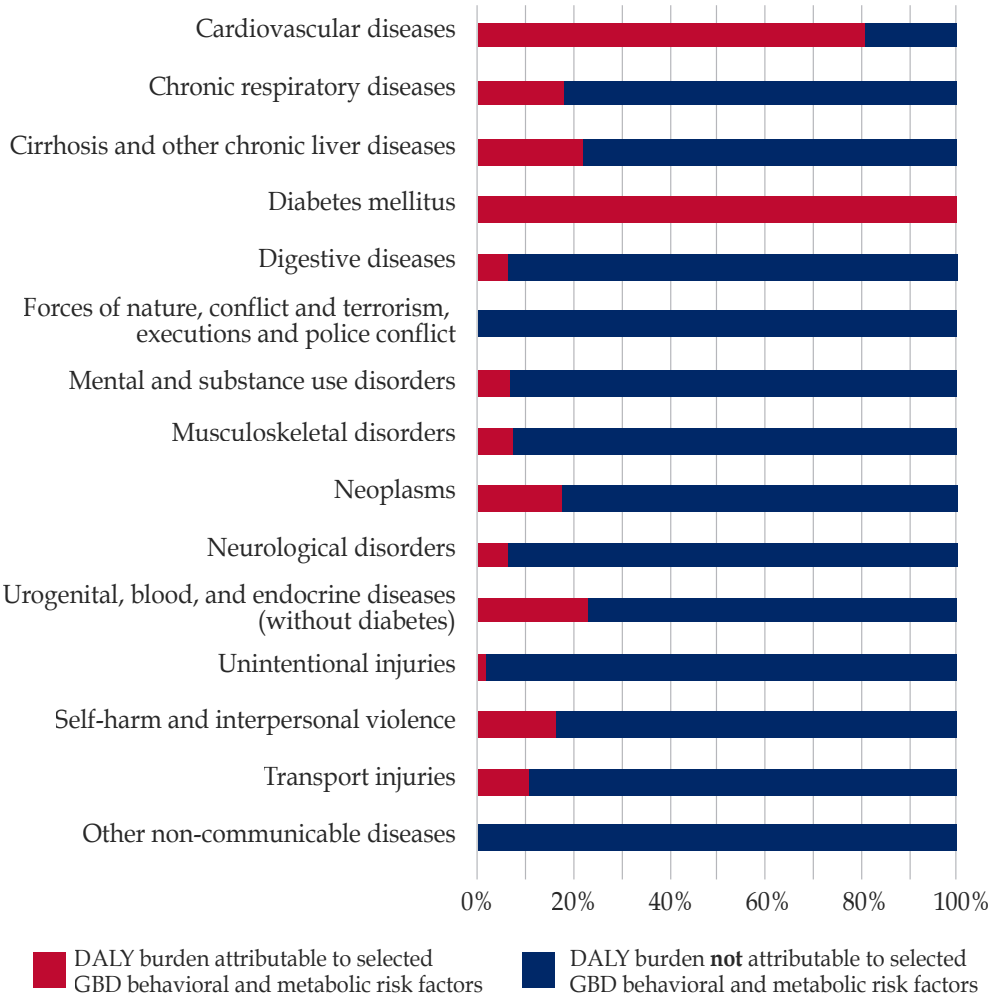
Figure 4. Percentage of NCD DALYs not attributable to GBD metabolic, behavioral and environmental risk factors (Source: GBD, 2016)

Selected behavioral and metabolic risk factors – including alcohol use, smoking, obesity, and hypertension – have traditionally been named as high contributors to NCDI conditions. As Figure 5 represents, the proportion of burden attributable to this selected set of behavioral and metabolic risk factors is high for some NCDI conditions, particularly cardiovascular disease, chronic respiratory disease, cirrhosis, and diabetes (Figure 5).

However, as Figure 5 displays, the proportion of burden attributable to these behavioral and metabolic risk factors for a number of these conditions, such as CVD, is not entirely due to this selected set of factors. A substantial part of CVD's

burden, for example, is not attributable to these selected behavioral and metabolic risk factors.

DALY burden attributable to selected behavioral and metabolic risk factors



**Selected GBD behavioral and metabolic risk factors included: "Alcohol use","Low physical activity","Diet high in sodium", "Smoking","Smokeless tobacco","Secondhand smoke","High systolic blood pressure", "High fasting plasma glucose","High body-mass index", "Diet high in trans fatty acids","High total cholesterol","Diet low in fruits","Diet low in vegetables"*

Figure 5: Percentage of NCDI DALYs not attributable to selected GBD behavioral and metabolic risk factors (Source: GBD, 2016)

Across the NCDI conditions analyzed, the majority have very large proportions of their burden that are not attributed to this selected set of behavioral and metabolic risks. Overall, almost all of the NCDI disease categories display minimal proportion (<50%) of burden attributable to selected behavioral and metabolic risk factors.

Possible risk factors comprising this large proportion of risk not attributable to these selected behavioral and metabolic GBD risk factors are listed in Table 2 below.[21] These risk factors are largely comprised of factors related to poverty, environment, and chronic infections.

NCD Disease Categories	Condition	Risk Factors related to poverty
Cardiovascular	Hypertension	Treatment gap, idiopathic
	Pericardial disease	Tuberculosis
	Rheumatic valvular (heart) disease	Streptococcal diseases, treatment gap
	Cardiomyopathies	HIV, Tuberculosis, other viruses, parasitic infections, pregnancy
	Congenital heart disease	Maternal rubella, micronutrient deficiency, treatment gap, idiopathic
Dental	Caries	Hygiene, treatment gap
Endocrine	Diabetes	Undernutrition, treatment gap
	Hyperthyroidism and hypothyroidism	Iron deficiency
Hematology and oncology	Cervical cancer, gastric cancer, Lymphomas, Kaposi Sarcoma, Hepatocellular Carcinoma	Infectious diseases, HPV, H. Pylori, HIV, Hepatitis B, Malaria, hygiene, treatment gap
	Breast cancer, CML	Treatment gap, idiopathic
	Hyperreactive malarial splenomegaly, Hemoglobinopathies	Malaria, hygiene
Musculo-skeletal	Chronic osteomyelitis	Bacterial infection (commonly Staphylococcus aureus), tuberculosis
	Musculoskeletal injury	Trauma, infection
Neurological	Epilepsy	Meningitis, malaria, cysticercosis (tapeworm), malnutrition, treatment gap
	Stroke	Rheumatic mitral stenosis, endocarditis, malaria, HIV
Psychiatric	Depression, Psychosis, Somatoform Disorders	War, untreated chronic diseases, undernutrition, treatment gap
	Schizophrenia, bipolar disorder	Treatment gap, idiopathic
Respiratory	Chronic obstructive pulmonary disease	Indoor air pollution, tuberculosis, schistosomiasis, treatment gap
Renal	Chronic kidney disease	Streptococcal disease, schistosomiasis, HIV, Tuberculosis, Hepatitis B & C, sickle cell anemia

Table 2. NCDI conditions and possible risk factors related to poverty (Source: PIH Guide to Non-Communicable Diseases, 2012)

2.4. BEHAVIORAL RISK FACTORS BY SOCIOECONOMIC QUINTILE

Wealth Quintile	Uses Cigarettes (%)		Uses any tobacco product (%)		Uses Alcohol (%)		Underweight (%)		Overweight (%)		Obese (%)	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Lowest	16.6	0.7	17.0	1.9	55.1	26.3	10.1	3.8	3.8	14.6	3.8	3.4
Second	14.2	0.2	14.6	0.9	58.2	23.3	9.7	5.2	5.2	15.0	5.2	5.7
Middle	13.0	0.2	13.3	0.6	51.0	23.9	10.8	7.7	7.7	16.6	7.7	6.8
Fourth	3.7	0.7	5.1	0.8	44.0	26.2	12.4	11.3	11.3	20.5	11.3	10.0
Highest	3.6	0.0	4.0	0.1	46.0	32.7	9.8	11.5	11.5	20.8	11.5	14.6

Table 3. Tobacco use, alcohol consumption in the past month, and BMI range in men and women aged 15-49 years by wealth quintile (Source: LDHS, 2013)

Tobacco, direct and indirect, is associated with multiple health conditions including cancer, heart diseases, stroke, diabetes and respiratory diseases. In Liberia in 2016, tobacco was responsible for 2.3% of total DALYs in men and 0.8% in women.[12] In previous survey data, the STEPS, 2011, recorded high prevalence of tobacco use at 17.2% among men and 2.8% among women aged 25-64 years.[13] Of those who smoked, 13.9% of men and 1.3% of women reported daily use. Average initiation age among those who smoked daily was 21.3 years. Second-hand smoke also significantly affects children and infants. In terms of second-hand smoke, 37.5% and 43.1% of the sampled population reported exposure at home and at work, respectively, on one or more occasions over the past week.[13] The 2013 LDHS reported lower prevalence rates than the 2011 STEPS survey, with 10.2% of men age 15-49 using tobacco and only 0.8% of women this age using tobacco (Table 3).[13,14] Across both sexes, cigarettes are the most used tobacco product. Tobacco use increases with increasing age, lower education level, and decreasing wealth. Disaggregating by wealth quintile, the highest tobacco use rates in both men and women were among the lowest income level, with 16.6% of men in the lowest quintile using cigarettes compared to 3.6% in the highest quintile.[14] Use is higher in rural areas (15.2%) compared to urban areas (6.7%).

For Liberia, the 2016 GBD Study attributed alcohol as the cause to an estimated 3.2% of total DALYs across all causes and 5.1.% of total deaths in men.[12] In women, it caused 2.2% of total DALYs and 4.2% of total deaths. In addition to direct impact, alcohol use is also a causal factor in more than 200 disease and injury conditions, including mental and behavioral disorders, liver cirrhosis, cancers, cardiovascular diseases, violence and road traffic accidents.[11] Liberia's STEPS survey 2011 recorded current alcohol consumption levels at 34.3% among men and 14% among women.[13] Two years later, the LDHS 2013 found higher rates, with an overall 50.4% of men and 26.8% women reporting alcohol use in

the preceding one month.[14] Of particular concern was the DHS 2013 finding that 21.5% of pregnant women and 22.6% of breastfeeding women reported alcohol use in the month preceding the survey, out of which 13.5% and 7.5% respectively drank almost every day. Across age, education, and wealth quintile, variation of alcohol use was reported, with highest alcohol use among the 45-49 age group, among those with no education (10% women and 19% men), and among those in the lowest wealth quintile (10% women and 17% men). Table 3 details the DHS 2013 findings of alcohol use by wealth quintile.

The Liberia STEPS survey 2011 reported that 4% of men and 4.2% of women were underweight; 43% of men and 57% of women had high BMI; 27.6% of men and 28.3% of women were overweight; and 15.4% of men and 28.7% of women were obese.[13] The LDHS 2013 found slightly higher rates, with 10.6% of men age 15-49 years and 7% of women the same age reportedly underweight, 8.2% of men and 17.9% of women were overweight, and 1.2% of men and 8.6% of women obese.[14] The highest proportion (15%) of underweight women was found among the 15-19 age group, while women of childbearing age were more likely to be overweight. Obesity and overweight prevalence increase with age and wealth quintile. Higher overweight and obesity prevalence were seen in urban settings (12.1% and 10.6%, respectively) compared to rural areas (5.6% and 5.4%). Increased wealth was also correlated with higher overweight and obesity prevalence, as shown in Table 3.

Low fruit and vegetable intake can be a risk factor for cancer, obesity and cardiovascular disease among others.[11] The 2011 STEPs survey found 96.1% of the population eating less than 5 servings of fruit and/or vegetables, with an average of only 0.7 servings of fruit and 1 serving of vegetables consumed per day.[13]

Of STEPs survey 2011 participants, 47.3% had high levels of activity while 33.2% had low levels of physical activity. Of the low level, women had 36.6% compared to men (29.8%).[13] Most physical activity was work related. Findings in the survey were not disaggregated by household wealth or location.

2.5 KEY FINDINGS OF THE NCDI BURDEN OF DISEASE IN LIBERIA

- 37.9% of all DALYs and 43.4% of all deaths in Liberia were accounted for by NCDIs in 2016. Although commonly thought to occur only at older ages, 51.5% of NCD DALYs and 69.8% of Injury DALYs in Liberia in 2016 occurred before age 40.
- Only 30.5% of DALYs due to NCDIs are attributable to the four diseases traditionally included in global NCD monitoring frameworks: cardiovascular diseases, neoplasms, diabetes, & chronic respiratory diseases.
- 70.7% of NCD DALYs could not be attributed to traditional behavioral or metabolic NCD risk factors, such as tobacco, alcohol, and obesity.

- Tobacco is used by 0.8-2.8% of adult women and 10.2-17.2% of men and is more prevalent in the lowest wealth quintile. Alcohol consumption varied from 14.0-26.8% in women and from 34.3-50.4.0% in men. For men, alcohol consumption was highest in the lowest wealth quintile, though this relationship was opposite for females. 57.0% of women and 43.0% of men had high BMI, which was associated with increasing wealth quintile.
- According to the STEPs 2011 survey, 30.7% of adult respondents had hypertension and the vast majority (88.2%) were not on anti-hypertensive treatment. Of total survey respondents, 29.9% had never had previous blood pressure measurement. 19.2% of the total sample had raised fasting blood glucose and were on medication for diabetes.
- Neoplasms are responsible for 7.6% of total deaths from all causes and 3.5% of total DALYs in Liberia. Neoplasms are more prevalent among women (0.12%) versus men (0.05%). This is explained by the high prevalence rate in females of breast cancer (0.04%) and of cervical cancer (0.06%). The majority of cancer deaths are attributed to liver cancer and stomach cancer. Among the 5-14 age group though, leukemia and lymphoma make up a substantial portion of childhood NCD deaths, responsible for approximately 11.1%.
- CVD is responsible for an estimated 14.7% of total deaths and 5.9% of DALYs due to total causes. Overall prevalence of CVD is 4.6% and IHD is 1.1%. Peripheral artery disease prevalence is 0.7%. CVD are a major mortality cause in those over 50, most of the deaths accounted for by IHD and stroke.
- Asthma has a 4.5% prevalence and causes significant morbidity in children, while COPD (0.8% prevalence) is more seen in older age groups.
- Diabetes has a 2.1% prevalence. High comorbidity of chronic kidney disease suggests poorly controlled diabetes. Less than half (45.7%) of DALYs due to diabetes, blood, urogenital and endocrine disorders are attributed to GBD risk factors, which include high BMI, high fasting blood glucose and hypertension.
- Sickle cell disease has a 0.1% prevalence and the trait is present in 12.3% of the population. This high rate is likely explained by the malaria endemicity. 33.2% of Liberian women are carriers for the G6PD deficiency gene and 13.1% of males are affected.
- Liver cirrhosis has a low prevalence but high case fatality ratio, causing 2.7% of total deaths. Less than half (22.5%) of this burden is attributed to risk factors of alcohol and drug use, while 77.5% of the DALYs are attributed to poverty and infectious related factors, such as hepatitis and other infectious factors.
- Tension-type headaches and migraines are widely prevalent, at 24.9% and

11.4% respectively. Epilepsy prevalence has been estimated at 0.5% by GBD, while historical estimates claimed rates as high as 4.9% in endemic regions. Most of the risk for neurological disorders are unattributed to GBD risk factors (selected environmental/occupations, behavioral, metabolic factors).

- Considering nearly one-third of the Liberian population fought in the civil wars, mental health accounts for a considerable burden. Estimates for prevalence of depression varied widely from 7.1% nationwide to as high as 52.4% among former combatants. PTSD also had high rates varying from 12.6% nationwide to 56.9% among former combatants. Substance abuse varied from 1.4% to 7%, with rates higher (14%) in former combatants and substance use, in general and within this population subset, being seen more among men. Studies have also highlighted the inadequate availability of mental health services.

- Musculoskeletal disorders (mainly low back and neck pain) have a 10.0% population prevalence, mostly among those of working age.

- Congenital disorders have a 1.1% prevalence and contribute significantly to DALYs among children. Skin and subcutaneous diseases are present in 33.5%, sense organ diseases in 18.2% and oral disorders in half (49.7%) the population, but these conditions have a low contribution to total DALYs.

- Injuries contribute to 5.5% of total DALYs, with 1.2% due to transport injuries and 3.0% due to unintentional injuries. Several studies have published on intimate partner violence estimating rates as high as 55.7%. For transport injuries, 72.1% of DALYs are not attributable to GBD risk factors. GBD risks of occupational factors, alcohol and drug use, sexual abuse and violence explain only 27.9% of the injury DALYs.

[For further information on methods and sources for these findings, including full results of the literature review with citations, please refer to the appendix.]

3. Current availability of NCDI services

3.1 LIBERIA ESSENTIAL PACKAGE OF HEALTH SERVICES

During Liberia's 14 years of civil war, 242 of the country's 293 public health facilities operating before the war were destroyed.[22] Most health workers also fled the country. Under the Liberia Essential Package of Health Services (EPHS), standards for health facilities were established in terms of services offered, equipment and medication available, staffing pattern, training, and guidelines.[7] In the area of NCDIs, the EPHS specifies that hospitals (second-level and referral facilities) should maintain capacity to manage and treat the following NCDIs and related conditions: diabetes mellitus (including diabetic ketoacidosis and hypoglycemia), hypertension, congestive heart failure, asthma, COPD, and screening for cervical cancer.

In regard to mental health conditions, EPHS mandated that hospitals screen for and treat epilepsy, anxiety, depression, substance abuse, schizophrenia, and self-harm/suicide.[7] Trauma and surgical services required at the hospital level include wound debridement, acute burn management, suturing, closed repair of fractures, chest tube insertion, closed repair of dislocated joints, removal of foreign bodies, club foot repair, congenital hernia repair, open reduction and fixation for fractures, amputation, laparotomy, and urethral stricture dilation, and blood transfusions. Palliative care standards include analgesic (oral or injectable morphine), anti-emetics and anti-inflammatory medications. Also included in the Essential Package for hospitals are diagnostics, such as serum electrolytes, full blood count, blood typing, renal function tests, liver function tests, electrocardiogram, x-ray, ultrasound, and computed tomography (CT) scan.

Per the EPHS, NCDI services specified for health center level are more limited and restricted primarily to management of simple hypertension and acute treatment of hypoglycemia; however, the full package of mental health management is included. Health centers are also required to provide some basic surgical services, such as wound debridement, acute burn management, suturing and chest tube insertion. Advanced diagnostics are not included in the Essential Package for health centers, and the required formulary of medications for NCDIs is more limited.

3.2 OVERALL AVAILABILITY AND DISTRIBUTION OF NCDI SERVICES

According to the Liberia SARA 2016 survey, the overall availability of NCDI services is low.[15] Only 43% of all health facilities surveyed reported the ability to provide diagnosis and management of select cardiovascular diseases, 22% for diabetes, and 32% for chronic respiratory diseases. Objective readiness for each

of these services, based on availability of essential items and commodities as defined by the SARA survey, was similarly low. On average, facilities had 43% readiness for cardiovascular services, 49% readiness for diabetes care, and 37% readiness for chronic respiratory disease care.

The SARA 2016 shows a low overall coverage of NCDI services and even these results are likely overestimated, given periods of equipment stock-outs, personnel shortages, training deficiencies, and general barriers to access to care for patients.[15] The reported availability of services is higher in urban than in rural areas. Figures 6 and 7 show this geographic discrepancy, with lower availability of reported services for each NCDI condition as well as essential components for each service in rural compared to urban areas. Counties with the highest reported availability for NCDI services included Margibi, River Gee, Montserrado, and Grand Gedeh. Conversely, counties with the lowest reported availability included Bong, Grand Cape Mount, Lofa and Maryland.

Lower reported availability of NCDI services in rural facilities

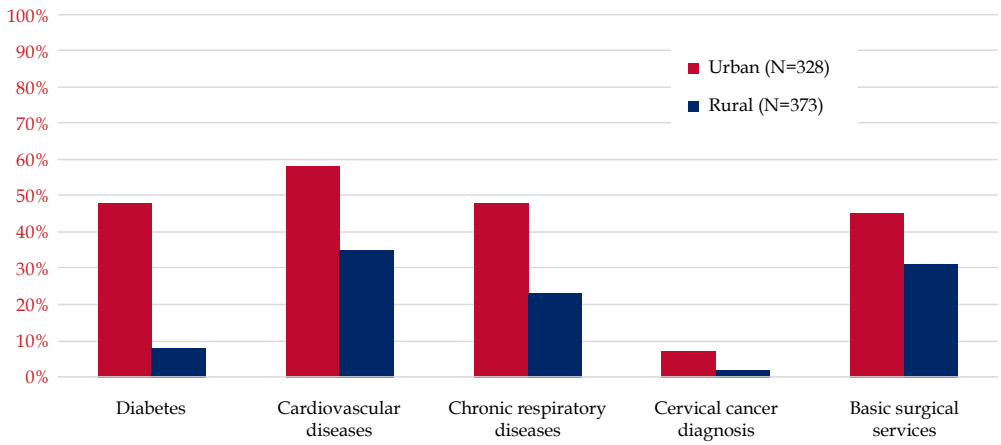


Figure 6. Availability of NCDI services in urban vs. rural facilities in Liberia in 2016 (Source: Liberia SARA, 2016)

Low measured readiness to provide NCDI services in health facilities

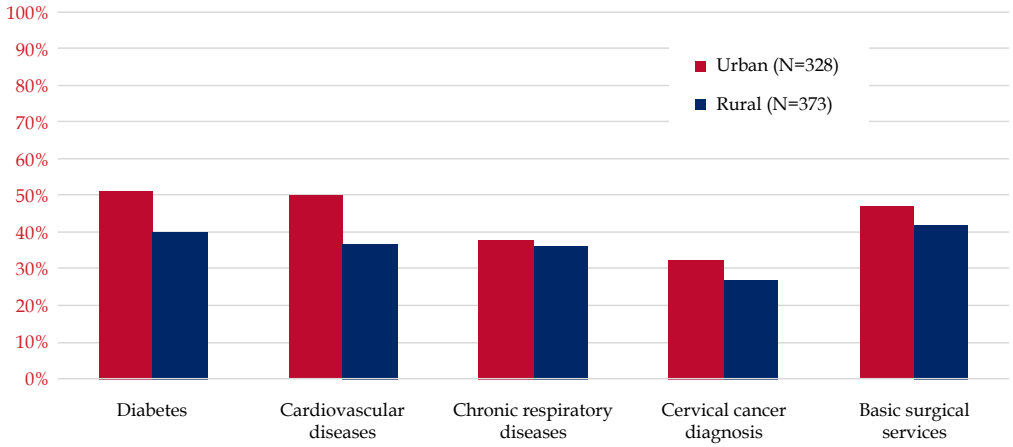


Figure 7. Readiness to provide NCDI services in urban vs rural facilities in Liberia in 2016 (Source: Liberia SARA, 2016)

Using the multidimensional poverty index to assess poverty on a range of health, education, and household asset indicators, a poverty threshold was established to represent the poorest billion individuals globally, or those deprived of at least 5 of 8 indicators as reported by household surveys.[23] Using this index, 48.8% of Liberians would be considered as living in the poorest billion people globally.[23]

Examining service availability for a specific NCDI condition, Figure 8 demonstrates how service availability for diabetes diagnostic and management services, shown by the blue dots, is more concentrated in the capital city of Monrovia. The red dots showing the limited availability of these services in rural settings outside of the urban capital.

Availability of diabetes services is concentrated in urban centers

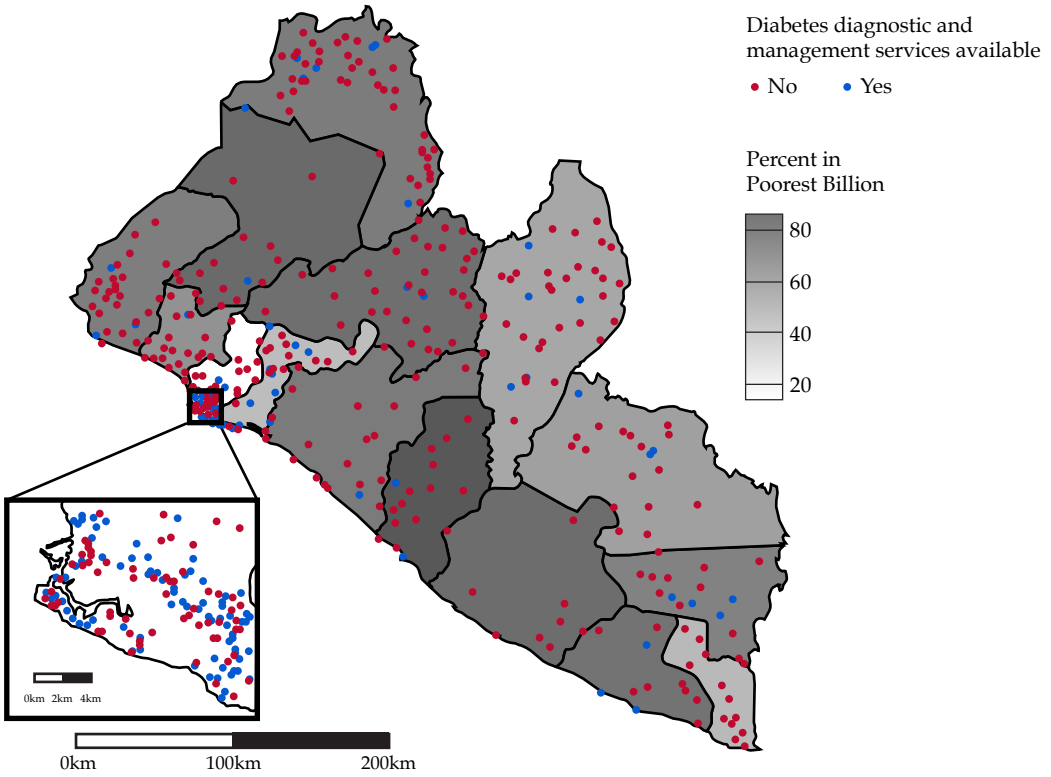


Figure 8. Availability of diabetes diagnostic and management services by county (*Source: Liberia SARA, 2016)*

The SARA 2016 also shows a lower reported availability of services in government/public facilities, across three disease areas (diabetes, cardiovascular, and chronic respiratory disease); this facility variance is displayed in Figure 9.[15] Specific tracer items are described in each disease area in the following sections and Appendix.

Availability of key NCDI services is lower in public facilities

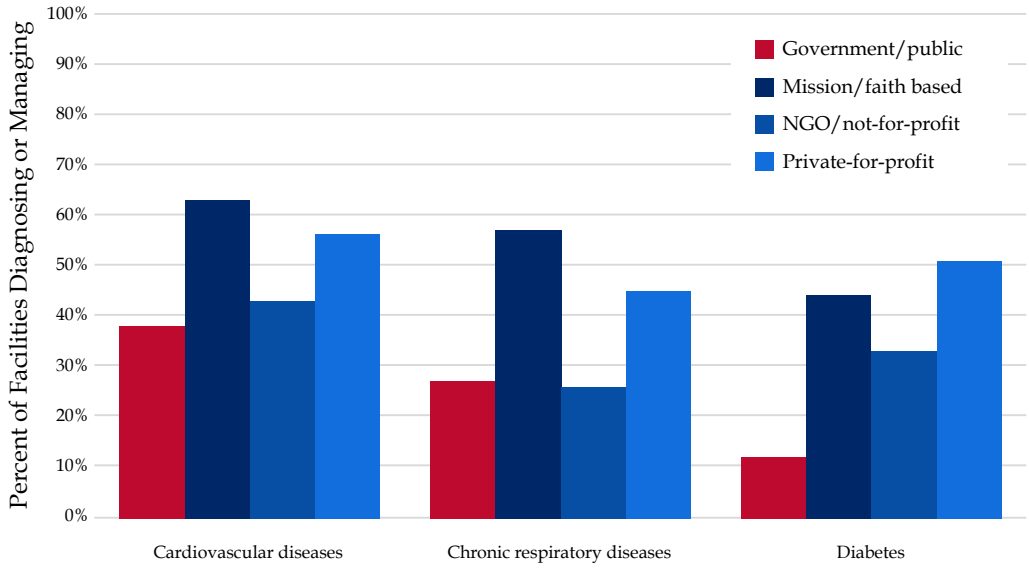


Figure 9. Reported availability of diabetes, cardiovascular, and chronic respiratory disease services in government facilities compared to private facilities (Source: Liberia SARA, 2016)

3.3 AVAILABILITY AND READINESS OF BASIC NCDI SERVICES COMPARED TO EPHS STANDARDS

3.3.1 Diabetes readiness

For diabetes, EPHS guidelines at hospital level include the ability to manage and treat diabetes mellitus, as well as diabetic ketoacidosis.[7] As of the SARA 2016, the mean availability of tracer items for diabetes at the hospital levels was 63%.[15] Of the standard components included in EPHS at the hospital level, there was high availability of blood pressure apparatus (100%), adult weighing scales (93%), and glucose 50% injectables (93%). However, much lower availability of diabetes-specific diagnostics and medications, including blood glucose testing (71%), insulin (60%), metformin (60%), and glibenclamide (62%), was found. In regard to the inpatient management of acute diabetic ketoacidosis, hospitals were lacking in essential tools for high-quality management, including normal saline injection and serum electrolytes (18%). Training of health workers was low, with

only 3% of hospitals demonstrated trained staff and only 22% of hospitals with guidelines available. Overall, hospitals in Liberia had an average of 63% of all tracer items for diabetes, though no hospital had all tracer items required. Mean readiness was higher in urban facilities (51%) compared to rural facilities (40%). At the health center level, at which the diagnosis and management of hypoglycemia is only suggested by EPHS , 64% of health centers had blood glucose testing had injectable glucose available.[7]

3.3.2 Cardiovascular diseases readiness

By EPHS standards, hospitals in Liberia are required to diagnose and treat hypertension and congestive heart failure.[7] In the 2016 SARA, hospitals had a high availability of general equipment (stethoscope, blood pressure apparatus, and adult scale).[15] Of the first-line anti-hypertensive medications, availability ranged widely, including hydrochlorothiazide (83%), beta blockers (60%), ACE inhibitors (40%), and calcium-channel blockers (29%). Aspirin was available in 66% of hospitals. There was low availability of trained staff (6%) and guidelines (6%). On average, 61% of hospitals had the required tracer items available. Mean readiness was higher in urban facilities (50%) than in rural facilities (37%). For the management of congestive heart failure, 77% of hospitals had furosemide tablets and 80% had oxygen. 59% of the hospitals had ultrasound capacity, though it is not clear if this was available and ready for cardiac echocardiography, and only 25% of hospitals had electrocardiogram available. Availability differed greatly between urban and rural facilities for both ultrasound (85% vs. 54%) and ECG (62% vs. 18%). At the health center level, which EPHS requires to manage hypertension, anti-hypertensives were available at the following: hydrochlorothiazide (71%), beta blocker (36%), ACE inhibitors (24%), and calcium channel blockers (16%).

3.3.3 Chronic respiratory diseases readiness

EPHS recommends the ability to manage and treat asthma and COPD at the hospital level.[7] Of the hospitals surveyed in the 2016 SARA, 77% had oxygen available, 35% had peak flow meters, and 46% had spacers for the administration of inhaled medications.[15] Although there was a high availability of inhaled salbutamol (90%), there was limited availability of the inhaled corticosteroid beclomethasone (18%). For the management of acute respiratory exacerbations, there was a relatively high availability of injectable epinephrine (96%), though slightly lower for other commodities, including injectable hydrocortisone (72%), oral prednisolone (80%) and oxygen (77%). Forty-seven percent (47%) of hospitals had functional X-ray diagnostic capacity. Hospitals demonstrated limitations in trained staff (7%) and guideline availability (17%). On average, hospitals had availability of 58% of all tracer items, and no hospital met all requirements. Readiness did not differ significantly between urban (38%) and rural (36%) facilities.

3.3.4 Cervical cancer screening readiness

According to EPHS standards, hospitals and health centers are required to have the ability to screen for cervical cancer and refer cases when necessary.[7]At the hospital level, 90% of hospitals surveyed in the 2016 SARA had a speculum available, though only 21% had acetic acid required for cervical cancer screening (6% of health centers).[15] Both trained staff (19%) and guidelines (6%) were also lacking. Overall, hospitals had availability of 34% of all tracer items, which was higher in urban areas (32%) than rural areas (27%).

3.3.5 Mental health and epilepsy readiness

For both hospital and health center levels, the EPHS recommends facilities be able to manage and treat epilepsy, anxiety, depression, substance abuse, schizophrenia and self-harm or suicide according to EPHS standards.[7] At the primary care level, these conditions must be identified and referred to higher-levels of care for further care per appropriate referral pathways. For the management of acute and chronic epilepsy detailed in the EPHS, the 2016 SARA found low and highly-variable availability of medicines at the hospital level, including: carbamazepine (38%), lorazepam injection (0%), phenobarbital (65%), phenytoin (28%), and valproate sodium (4%).[15] For other mental health conditions, such as depression and psychosis, low medication availability was found as well, including amitriptyline (56%), chlorpromazine injection (58%), fluoxetine (13%), haloperidol tablet (54%), and lithium (5%).[15] The first-line medication for acute epileptic convulsions, diazepam by injection or rectal administration, was overall found to be available in only 5% of facilities overall, with higher availability in urban (10%) compared to rural (2%) facilities.

3.3.6 Trauma and injury-related surgical services readiness

The management of injuries requires the provision of a package of basic surgical services at the hospital level as per EPHS guidelines.[7] However, surgical capacity has historically been limited due to shortages in health provider, evidenced both by a 2011 survey of 12 Liberian public hospitals that found only 2 meeting basic surgical standards and by a 2011-2012 study of 11 government district hospitals that found coverage of an average of 0.2 surgeons per hospital (less than 0.1 per 10,000 population) and 0 anesthesiologists.[24,25] Per the SARA 2016, the availability of the EPHS package of basic surgical services has also been variable at the hospital level, including low availability of wound debridement (75%), acute burn management (75%), suturing (75%), closed repair of fracture or dislocated joints (51%), removal of foreign body (71%), and chest tube insertion services (55%).[15] Despite EPHS's mandate for service provision, complex or comprehensive surgical services recommended for injuries per EPHS were available at only select hospitals, including availability of open reduction and fixation for fractures (27%), laparotomy (69%), and amputation (46%) services.[7,15] On the

average, hospitals displayed an average readiness of 48% for blood transfusion. The EPHS also mandates the provision of some of these basic surgical services at the health center level. The 2016 SARA found moderate availability of these services, including availability of wound debridement (48%), acute burn management (49%), and suturing (55%).[15] In general, availability of basic surgical services was consistently more available at facilities in the urban areas in Government/public and privates facilities compared to private and government/private facilities in the rural areas.

3.3.7 Palliative care readiness

Although a palliative care package is not defined in the EPHS, there are a number of palliative medications listed in the EPHS mandated at hospital and health center levels.[7] Of those medications, hospitals surveyed in the SARA 2016 were found to have variable availability of analgesics, including paracetamol (91%), ibuprofen (71%) and morphine injectable or tabs (52%).[15] It is noted that 87% of hospitals did have available dexamethasone injection, and 76% of hospitals have metoclopramide injection for intractable nausea and vomiting. Morphine was four times more available in urban (4%) compared to rural (1%) facilities.

3.4 AVAILABILITY AND CAPACITY FOR SPECIALTY NCDI SERVICES

Historically and up to date, medical specialists and specialty services have been scarce in Liberia.[22] The EPHS, which lays out a 10-year strategic scale-up of health services, lists specialists and specialty services at the county and regional hospital levels.[7] In Liberia, there are 15 county hospitals, with one per county. In some counties, there are smaller district hospitals, where more limited services are available. Additionally, located in some of these counties are faith-based hospitals. Regional hospitals are located at Phebe in Bong County and another at Tappita, in Nimba County (Jackson F Doe Hospital). JFK Medical Center is the only tertiary hospital in the country. In Years 4 to 10 of the EPHS' strategic plan, the government set targets for staffing each of its hospitals with specialists including one to three General Surgeons, Obstetricians, Orthopedic Surgeons, Anesthetists, ENTs, Ophthalmologists, Radiologists, Dentists, Pediatricians, Internists, Nutritionists, and Psychologists.

In 2003, following 14-years of protracted civil war, there were only 30 physicians in the country and most of the population had little or no access to healthcare.[22]

The Ebola Virus outbreak of 2014-2015 was another substantial shock to the health system, overwhelming basic health care functioning and claiming the lives of more than 200 health care workers, including 4 medical doctors.[26] According to the Liberian Medical and Dental Association, Liberia currently has 347 licensed medical doctors to serve a population of 4.6 million people; of these physicians, most (249 or 71.2%) are general practitioners. Liberia has one medical school and, in September 2013, it matriculated the first class of doctors

into a newly established residency training program. The program, which trains internists, obstetricians/gynecologists, pediatricians, and surgeons, graduated its first class in September 2017. However, as Table 4 shows, there are currently very few specialized physicians to support referral level NCDI services. This includes specialists such as nephrologists, hematologists/oncologists, pathologists, gastroenterologists, pulmonologists, neurosurgeons and plastic surgeons. Of the specialists currently practicing in Liberia, most are concentrated in the capital city of Monrovia. Many of these specialists are also expatriates and are affiliated with non-governmental organizations, which may limit sustainability.

Medical Specialty	Number of Doctors in Liberia	% By Medical Specialty	Number of Liberian Doctors	% of Doctors in Liberia who are Liberian Doctors	Number of Foreign Doctors	% of Doctors in Liberia who are Foreign Doctors
General Practice	250	69.8%	196	78.4%	54	21.6%
Dentistry	6	1.7%	2	33.3%	4	66.7%
Dermatology	1	0.3%	1	100.0%	0	0.0%
Ear, Nose & Throat	1	0.3%	1	100.0%	0	0.0%
Emergency Medicine	2	0.6%	0	0.0%	2	100.0%
Family Medicine	6	1.7%	1	16.7%	5	83.3%
Infectious Diseases	1	0.3%	0	0.0%	1	100.0%
Internal Medicine	9	2.5%	1	11.1%	8	88.9%
Neurosurgery	1	0.3%	1	100.0%	0	0.0%
OB-GYN	12	3.4%	6	50.0%	6	50.0%
Occupational Health	1	0.3%	0	0.0%	1	100.0%
Ophthalmology	6	1.7%	6	100.0%	0	0.0%
Orthopedics	2	0.6%	2	100.0%	0	0.0%
Pathology	1	0.3%	0	0.0%	1	100.0%
Pediatrics	16	4.5%	4	25.0%	12	75.0%
Psychiatry	4	1.1%	1	25.0%	3	75.0%
Public Health	21	5.9%	20	95.2%	1	4.8%
Radiology	3	0.8%	2	66.7%	1	33.3%
General Surgery	12	3.4%	5	41.7%	7	58.3%
Trauma	1	0.3%	1	100.0%	0	0.0%
Anesthesiology	1	0.3%	0	0.0%	1	100.0%
Veterinary Medicine	1	0.3%	1	100.0%	0	0.0%
Total	**358**		**251**	**70.1%**	**107**	**29.9%**

Table 4. NCDI specialist availability in Liberia, as of October 2017 (Source: Liberia NCDI Poverty Commission)

The 2011 EPHS also set targets for advanced services to be provided at regional hospitals, including CT scan, echocardiogram and peritoneal dialysis.[7] Further, the EPHS also sets targets for regional hospitals to manage lung, breast and cervical cancers, though the Package did not specify as to whether the management is recommended to be medical (chemotherapy) or surgical. The EPHS does not provide a plan for the expansion of services to include organ transplantation or newborn screening test for congenital or genetic disease, such as sickle cell anemia or congenital hypothyroidism. Table 5 describes the current availability

of selected key referral services for NCDIs in Liberia, highlighting the distribution between public and private facilities. Through expert report, the Liberia NCDI Poverty Commission identified 7 centers currently offering type 1 diabetes care, 4 offering chemotherapy services, and 2 with capacity for cardiac echocardiography. However, these services were primarily offered by partner and private institutions, which have both limited scope of services and frequent stock-outs or service disruptions. In Liberia, there are currently no available services for radiotherapy, cardiac surgery, dialysis, kidney transplant, or newborn screening. In terms of advanced diagnostic imaging, there is one functioning CT scanner, with an additional three CT scanners and two MRI machines under development.

Specialized NCDI Service	Total Number of Centers in- Country	Number Public Institutions Offering Services	Number of Private Institutions or NGOs Offering Services
Follow-up Type-1 diabetes	7	3 (JFK, Phebe, Redemption Hospitals)	4 (Ganta/Life for a Child, JJ Dossen Hospital/PIH, Pleebo Health Center/PIH, Catholic Hospital)
Cardiac Echocardiography	3	1 (Redemption Hospital)	2 (Tappita, JJ Dossen/PIH)
Cardiac Surgery	0	0	0
Chemotherapy Services	4	2 (Redemption Hospital , Tappita [Burkitt's only])	2 (Mt Sinai Hospital/Hope for Women, Catholic Hospital)
Radiotherapy Services	0	0	0
Dialysis	0	0	0
Kidney Transplant	0	0	0
CT Scan Capacity	1 (+3 pending)	1 (Tappita, JFK pending)	0 (ELWA Hospital, Social Security both Pending)
MRI Scan Capacity	0 (+3 pending)	0 (JFK, Tappita both, pending)	0 (Social Security pending)
Newborn screening for congenital/ genetic disorders	0	0	0

Table 5. Availability of specialized NCDI services in Liberia, as of October 2017 (Source: Liberia NCDI Poverty Commission)

At the national referral hospital, JFK Memorial Hospital, patients with NCDs are seen at designated pediatric and adult NCD clinics. The clinics are staffed with 2 or 3 medical doctors, a physician assistant, and nurses or nurse aids. The pediatric clinic treats congenital and rheumatic heart failure, sickle cell disease, epilepsy, asthma, cerebral palsy, and Trisomy 21. Previously, there was a pediatric cardiologist providing echocardiograms, but this position was vacated in August 2017. Periodic international campaigns provide surgery for selected heart disease.

Outside of the dense urban capital, one Liberian county has been providing diagnosis and management for type 1 diabetes. Supported by Life for a Child (International Diabetes Federation), Ganta Hospital has a program that allows patients under the age of 26 years to receive insulin and diabetes supplies (glucometers, test strips, lancets, syringes) free of charge.[27] Life for a Child supplies insulin, that is shipped from the US and Canada, and provides training and support to the medical staff coordinating the program. In 2017, Partners In Health began supporting a pilot in Maryland County of a decentralized NCD clinic, which is able to treat comprehensive type 1 and type 2 diabetes, congestive heart failure, hypertension, liver disease, chronic kidney disease, asthmas/COPD, sickle cell disease and epilepsy.[28]

4. Current spending on NCDI services

4.1 GOVERNMENT EXPENDITURES ON NCDIS

As per the most recent published National Health Account of FY 2013/2014, total health expenditure in Liberia was US $301 million, representing a per capita expenditure of US $72.[29]

Of this, the GOL and donor contributions comprised 16% and 39%, respectively. Out-of-pocket spending by households represented 43% of the total health expenditures, or USD $30 per household per year. Overall, USD $53 million was spent on NCDIs, which constituted 17.6%% of the total health expenditures.

Aiming to achieve the Abuja Declaration's call for countries to allocate 15% of national budgets to health, the GOL has consistently increased its contribution towards the Health Sector budget from approximately 7% in FY 2005/06 to 14.6% in FY 2017/18.[30–32]

Yet despite the tremendous increase in GOL allocation towards health, mainstreaming NCDs into the National Budget has been a challenge. Donor partners, such as WHO, have made commitments to fund select non-communicable diseases areas. However, of the total anticipated resource envelope for health in FY 2017/18 (USD$ 150M), only USD $369,000.00 is earmarked for NCDs.[32]

4.2 OUT-OF-POCKET SPENDING ON NCDIS

The National Health Account FY13/14 showed that out-of-pocket spending for NCDIs was substantially higher than for other conditions.[29] For NCDIs, 74.7% of all expenditures were out-of-pocket from households. This was greater than out-of-pocket spending for malaria (60%), HIV/AIDS (30%), TB (48%), and reproductive, maternal, neonatal, child, and adolescent health (19%).

The DHS 2013 showed that average annual household health expenditure was ~USD $111, and that expenditures were slightly higher in urban households (~USD $116) and in the two highest income quintiles (~USD $120 in the fourth and ~USD $151 in the fifth).[14] Per capita annual health expenditure was higher for females (~USD $19) than males (~USD $16). Amongst females, the highest per capita health expenditure was for women from the highest wealth quintile (~USD $28) but was second-highest among women in the lowest wealth quintile (~USD $21). At the time of the DHS 2013, 95.7% of women and 92.7% of men reported no health insurance coverage.

According to more recent household survey data through the 2016 HIES, Liberians spent 1.9% of non-food consumption on regular preventive and outpatient health services, though this did not include hospitalizations or other extraordinary health expenses.[2] Consumption of these outpatient health services was

higher in rural areas (2.4%) as compared to urban areas(1.5%) , and was more than twice as high in the poorest quintile (2.7%) as compared to the wealthiest quintile (1.2%).[2] Percent expenditure on health was highest in the North Western (2.5%), North Central (2.3%), and South Central (2.2%) regions. In terms of hospitalizations, 3.4% of the population had been hospitalized in the previous 12 months, and 72.7% of expenditures for overnight hospitalizations were over LD $1,000. Those in the poorest quintile were far more likely to travel more than 60 minutes to reach primary health care than the wealthiest quintile (28.9% vs. 9.6%), to obtain services in government facilities (82.9% vs. 35.4%), and travel by foot to the health care provider (72.5% vs. 42.7%). Expenditure on NCDIs versus other conditions was not specified in the HIES.

5. Priority setting for NCDIs in Liberia

5.1 EXPANSION OF NCDI PRIORITY CONDITIONS

The objective of the Liberia NCDI Poverty Commission was to recommend a package of cost-effective health sector interventions that could be implemented in Liberia to address NCDIs with an emphasis on conditions affecting the poor. In the analysis of the Commission, as described in the methodology section, a group of 20 priority conditions were selected based on the overall health impact of each condition ("burden of disease"), the severity of the condition in terms of premature mortality ("severity"), the extent of disability caused by the condition on each individual affected ("disability"), and the inequity of health outcomes from the condition as compared to other regions of the world ("equity"). Data for each condition were provided by the review of literature, available disease burden estimates through GBD 2016, and national surveys. The selected conditions are listed in Table 6.

Disease category	Prioritized disease/condition
Respiratory	Asthma
	Chronic obstructive pulmonary disease
Cardiovascular – behavioral & metabolic etiologies	Hypertension, Hypertensive heart disease, Ischemic heart disease, hemorrhagic stroke, ischemic stroke, CHF/cardiomyopathy
Cardiovascular - other etiologies	Rheumatic heart disease
Endocrine	Diabetes mellitus (Type 1 and 2)
Cancers	Cervical cancer
	Burkitt's lymphoma (Non-Hodgkin lymphoma)
	Breast cancer
Mental Health	Major depressive disorder
	Schizophrenia / Psychotic disorders
	Substance abuse disorders
	Anxiety disorders
Neurologic	Epilepsy
Congenital	Sickle cell disorders
Primary eye care / Other	Vision loss including childhood blindness
	Refractive errors including accommodation disorders
Liver	"Cirrhosis" - etiologies include hepatitis B, hepatitis C, alcohol, other causes
Renal	Chronic kidney disease
Surgical & Injuries	Motor vehicle road injuries

Table 6. NCDI conditions selected for prioritization (Source: Liberia NCDI Poverty Commission)

These conditions represent a diverse set of non-communicable diseases that currently have an enormous impact on the health of Liberians, and in many cases affecting those living in rural or impoverished regions (as described in "Burden of NCDI Disease in Liberia"), with limited diagnostic and management services available in Liberia (as described in "Current availability of NCDI services").

5.2 SELECTED INTERVENTIONS FOR EXPANDED NCDI HEALTH SECTOR CAPACITY

Addressing the prioritized NCDI conditions in Liberia proposed by the Liberia NCDI Poverty Commission will involve the design, implementation, integration, and scale of a complex set of health sector interventions, some of which already exist within the health care system, and others that have yet to be introduced. A package of cost-effective interventions to achieve universal health care, including NCDs and injuries, in low-income countries has recently been recommended by the Disease Control and Priorities (DCP) group in its 3rd edition (DCP3).[16–18] This guidance is based on the best evidence available globally, which is interpreted by DCP health economists and public health experts with the goal of defining a package of interventions to achieve UHC.[18,19] The interventions recommended by DCP3 for UHC contain 68 interventions targeting NCD and injury conditions. These interventions were costed for low-income countries using the best evidence available and adjustment for the price of health care personnel on a country level. Each intervention was additionally assigned an ordinal ranking for its properties of cost-effectiveness, financial risk protection, and equity based on the literature and expert opinion by the DCP3 group. The rankings are from 0-4 (0-6 for financial risk protection), with 0 representing the minimal value in each metric. The interventions were also assigned a target level of the health system: population, community, health center, first-level hospital, and referral/specialty hospital.

These interventions were evaluated and judged by the Commission based on the following criteria: alignment with the prioritized disease conditions, feasibility in the Liberian context, cost-effectiveness, provision of financial risk protection (or protection against catastrophic expenditures), and provision of some priority to the "worst-off" (i.e., children, individuals suffering from severe disease, those living in poverty, etc.). After evaluation according to these above criteria, 33 interventions were selected for further evaluation. Table 7 lists these 33 interventions, organized by NCDI condition. The baseline coverage for each intervention, estimated by the Commissioners using available data sources and expert opinion, are listed for each condition; the desired target coverage by the year 2030 is listed as well. The total cost of each intervention was determined by multiplying the direct unit cost of each intervention adjusted for Liberia by the estimated population in need of each intervention in Liberia. Direct costs included personnel, equipment, testing services, diagnostics, drugs and other

consumables. A 50% indirect cost was added to the total direct cost to account for indirect costs at the facility level, including items such as laboratory, buildings, rent, maintenance, and utilities. An additional 17% indirect cost was added for non-facility-based costs, such as financing, supply chain, and health information systems. The incremental cost for each intervention was then determined by multiplying the total cost by the coverage increment.

The total annual cost for the incremental increase in coverage represented by the NCD interventions proposed in this package is estimated at USD $29.5 million. Using the most recent published National Health Account 2013/2014 figures for total health expenditure of USD $301 million in FY13/14 (USD $72 per capita) and nominal gross domestic product of USD $1978 million, the NCD interventions represents 1.5% of GDP.[1,29] This incremental annual investment would therefore represent 9.8% of current total health expenditure or approximately USD $6.54 per capita annually. Mental health interventions would represent 1.1% of THE or an additional USD $0.77 per capita annually and surgical interventions another 2.8% of THE or USD $1.90 per capita annually. Overall, combining the incremental cost of NCD, mental health, and surgical interventions would represent 13.8% of THE and 2.1% of GDP, or approximately $9.21 per capita annually.

A high priority set of interventions from the DCP3 set of interventions would be projected to avert approximately 1,324 deaths (ages 5-69) per year by 2030. This estimate is based on current NCDI mortality rates estimated through the GBD Study 2016 adjusted for the estimated population in 2030 with the estimated effect size for a similar package of interventions proposed by the DCP3 group.[12,16,18] According to 2015 mortality rates, this figure would represent an approximate 10% reduction in expected premature deaths in the year 2030. Although this figure provides a reasonable estimate of averted deaths, given the number of additional interventions selected by the Liberia NCDI Poverty Commission compared to the Essential UHC package defined by the DCP3 group, the number of deaths averted is likely underestimated. Furthermore, this analysis does not include averted morbidity, which would be considerably greater than averted mortality and provide substantial benefit to many more individuals, particularly given the emphasis on interventions for severe conditions affecting those at younger ages.

Cost effectiveness, financial risk protection, and equity scores for selected health sector interventions for expanded NCDI services in Liberia

Condition	Intervention	Cost Effectiveness Rating	Financial risk protection rating	Equity rating	Baseline coverage 2018	Target coverage 2030	Incremental cost (USD $)	Health system level
Respiratory	Low-dose inhaled corticosteroids and bronchodilators for asthma and for selected patients with COPD	1	3	1	0.01	0.36	$5,836,727	Health Center
	Management of acute exacerbations of asthma and COPD using systemic steroids, inhaled beta-agonists, and, if indicated, oral antibiotics and oxygen therapy	1	4	1	0.15	0.5	$3,593,913	First-Level Hospital
	Management of acute ventilatory failure secondary to acute exacerbations of asthma and COPD; in COPD use of bilevel positive airway pressure preferred	0	1	1	0	0.05	$133,762	Referral Hospital
	Mass media messages concerning use of tobacco and alcohol	4	1	1	0.04	0.3	$31,499	Population
Breast cancer	Treat early stage breast cancer with appropriate multimodal approaches, including generic chemotherapy, with curative intent, for cases that are referred from health centers and first-level hospitals following detection using clinical examination	4	4	1	0.01	0.35	$47,998	Referral Hospital
Cervical Cancer	Opportunistic screening for cervical cancer using visual inspection or HPV DNA testing and treatment of precancerous lesions with cryotherapy	3	3	1	0.05	0.4	$195,434	Health Center
	Early detection and treatment of early-stage cervical cancer	0	4	1	0.01	0.35	$8,003	First-Level Hospital
Childhood Cancers	Treatment of early-stage childhood cancers (such as Burkitt and Hodgkin lymphoma, acute lymphoblastic leukemia, retinoblastoma, and Wilms tumor) with curative intent; treatment in pediatric cancer units or hospitals	2	5	2	0.01	0.3	$14,293	Referral Hospital
Cardiovascular	Long term management of ischemic heart disease, stroke, and peripheral vascular disease with aspirin, beta blockers, ACEi, and statins (as indicated) to reduce risk of further events	2	2	1	0.05	0.4	$3,105,062	Health Center
	Mass media messages concerning healthy eating or physical activity	4	1	1	0.01	0.35	$41,190	Population
	Opportunistic screening for hypertension for all adults and initiation of treatment among individuals with severe hypertension and/or multiple risk factors	1	1	1	0.05	0.4	$501,212	Health Center
	Screening and management of hypertensive disorders in pregnancy	1	3	3	0.1	0.45	$10,543	Health Center
	Provision of aspirin for all cases of suspected myocardial infarction	4	2	1	0.1	0.45	$115	Health Center
Cardiovascular & Rheumatic Heart Disease	Medical management of acute heart failure	4	5	3	0.1	0.45	$2,626,775	First-Level Hospital
	Medical management of heart failure with diuretics, beta-blockers, ACEi, and mineralocorticoid antagonists	4	4	3	0.05	0.4	$1,286,349	Health Center
Rheumatic Heart Disease	Treatment of acute pharyngitis in children to prevent rheumatic fever	4	2	1	0.05	0.4	$80,686	Health Center
	Secondary prophylaxis with penicillin for rheumatic fever or established rheumatic heart disease	0	1	1	0.02	0.35	$85,576	Health Center
Diabetes	Screening and management of diabetes among at-risk adults, including glycemic control, management of blood pressure and lipids, and consistent foot care	4	2	1	0.05	0.4	$4,725,492	Health Center
	Screening and management of diabetes in pregnancy (gestational diabetes or preexisting Type II diabetes)	1	3	3	0.05	0.4	$741,217	Health Center
	Retinopathy screening via telemedicine, followed by treatment using laser photocoagulation	3	2	1	0	0.1	$128,955	Referral Hospital

Condition	Intervention	Cost Effectiveness Rating	Financial risk protection rating	Equity rating	Baseline coverage 2018	Target coverage 2030	Incremental cost (USD $)	Health system level
Chronic kidney disease	Screening and management of albuminuric kidney disease with ACEi or ARBs, including targeted screening among people with diabetes	2	2	1	0.05	0.4	$670,349	Health Center
Sickle Cell	In settings where sickle cell disease is a public health concern, universal newborn screening followed by standard prophylaxis against bacterial infections and malaria*	4	2	3	0	0.36	$430,549	First-level Hospital
Vision	Vision prescreening by teachers; vision tests and provision of ready-made glasses on-site by eye specialists	2	2	1	0.01	0.35	$84,564	Community
Epilepsy	Management of epilepsy, including acute stabilization and long-term management with generic anti-epileptics	4	4	3	0.1	0.5	$165,410	Health Center
Injuries & Cross-cutting	Basic rehabilitation services*	N/A	N/A	N/A	0.05	0.25	$2,657,521	First-level Hospital
	Palliative care and pain control services*	N/A	N/A	N/A	0.05	0.3	$2,286,937	First-level hospital
NCD subtotal incremental cost							**$29,490,131**	
Depression; Anxiety	Management of depression and anxiety disorders with generic antidepressant therapy and psychosocial treatment	3	4	1	0.05	0.4	$1,604,441	Health Center
Bipolar Disorder	Management of bipolar disorder using generic mood-stabilizing medications and psychosocial treatment	2	4	2	0.01	0.3	$1,519,704	Health Center
Psychotic Disorders	Management of schizophrenia using generic anti-psychotic medications and psychosocial treatment	2	4	2	0.05	0.4	$328,751	Health Center
Mental Health subtotal incremental cost							**$3,452,896**	
Surgery	Basic outpatient surgical services*	N/A	N/A	N/A	0.15	0.5	$888,066	Health Center
	Basic first-level hospital surgical services*	N/A	N/A	N/A	0.15	0.45	$7,511,837	First-level Hospital
	Expanded first-level hospital surgical services*	N/A	N/A	N/A	0.1	0.3	$66,772	First-level Hospital
	Specialized surgical services*	N/A	N/A	N/A	0.01	0.2	$114,180	Referral Hospital
Surgical subtotal incremental cost							**$8,580,855**	
Grand incremental cost							**$41,523,882**	

Table 7. Cost effectiveness, financial risk protection, and equity scores for selected health sector interventions for expanded NCDI services in Liberia (Source: Liberia NCDI Poverty Commission)

5.3 INTEGRATION AND DELIVERY OF EXPANDED NCDI SERVICES

Each of the four health system levels in Liberia will address different NCD interventions that will be integrated into the delivery of services. At the community level, which is at the base of the pyramid of the health system (See Figure 10), there are currently very few specific NCD interventions being offered. We propose adding preventative mass media messaging concerning healthy eating and physical activity as well as the unhealthy use of tobacco and alcohol. In addition, we propose adding vision screening by teachers and provision of glasses at this level. These interventions were chosen to be employed at this level because of the existing infrastructure and human resource capacity. Since every county and district has numerous schools, implementing planned teacher-led vision screening programs led by the Ministry of Education will identify early vision problems through this screening modality. Identified children will then be referred to a higher health system level to undergo enhanced vision screening and access to glasses. These interventions should be carried out in a culturally appropriate manner using the local language, including sign language when needed, in order to ensure accessibility.

At the next service delivery level, which is the health center, there is limited capacity to screen and treat for NCDIs. Health centers are currently able to screen for hypertension in pregnant women and offer limited anti-hypertensive, epilepsy, diabetes, and mental health medications. We propose that the health center level should offer a more extensive list of NCDI interventions including: screening and management of hypertensive and diabetic disorders in pregnancy; screening for cervical cancer using VIA or HPV DNA testing and treatment of precancerous lesions with cryotherapy; screening for breast cancer via routine breast exams; screening for liver cancer via clinical exams; screening for hypertension for all adults and outpatient management of hypertension; primary and secondary prevention of rheumatic heart disease; management of heart failure, diabetes, chronic kidney disease, asthma, epilepsy, depression/anxiety, bipolar disorder, and schizophrenia; diabetes self-management and education; and use of aspirin in case of suspected myocardial infarction. These proposed interventions will be integrated using existing clinical staff after receiving didactic and in-service training on detection, diagnosis, and management of NCDIs. Psychological disorders can be managed by nurses who have received mhGAP training, which has been conducted in every county in collaboration with the Carter Center.[33] Essential NCDI equipment and pharmaceuticals will be procured by government and donors and delivered through the existing public supply chain system. OPD and ANC existing infrastructure will be used to deliver these proposed services; any renovations needed may be funded through the MoH, donors, and NGOs.

At the next health system level, the county hospital, Liberia presently faces challenges when providing NCDI care.[15] According to the 2016 SARA, medication

availability remains limited, with the following coverage across all county hospitals: glibenclamide (62%), metformin and regular insulin (60%), atenolol (60%), ACE inhibitors (40%), and calcium channel blockers (29%).[15]

From a human resource perspective, less than 7% of county hospitals had staff trained to manage cardiovascular, metabolic (diabetes), and chronic respiratory disease. Availability of mental health medications and cervical cancer diagnosis was also low. In order to provide higher acuity NCD services, county hospitals should provide the following interventions: medical management of acute asthma/COPD exacerbations, sickle cell screening and management, medical management of acute heart failure, treatment of early-stage cervical cancer, basic rehabilitation services, palliative care and pain control services. Once again, existing staff and infrastructure can be used to deliver these services. Nurses and physician assistants can be trained to deliver these interventions, while physicians can provide oversight and ongoing mentorship. Procurement of the necessary pharmaceutical and equipment supply chains will use the existing public procurement system. Partners and donors will be identified to support various county hospitals with trainings and procurement of necessary supplies. NCD trainings will be led and directed by the MoH's NCDs Division and funded through partners, donors and the MoH.

The final and top level of the health system, the referral hospital, is reserved for patients with the highest illness severity and thus, in the case of NCDs, patients with severe NCDs and particular cancers. JFK and Jackson Doe Hospitals offer limited chemotherapy for Burkitt's Lymphoma and a couple of general surgeons perform mastectomies for breast cancers. The MoH is partnering with Mt. Sinai Hospital in the US and the Clinton Health Access Initiative to ensure sustainable availability of pathology services and chemotherapy, respectively. In addition to services for childhood cancers and breast cancer, referral hospital should also prioritize services for specialized surgical services, acute respiratory failure, and complications from diabetes, such as screening and treatment for retinopathy.

Proposed health system integration of selected NCDI interventions

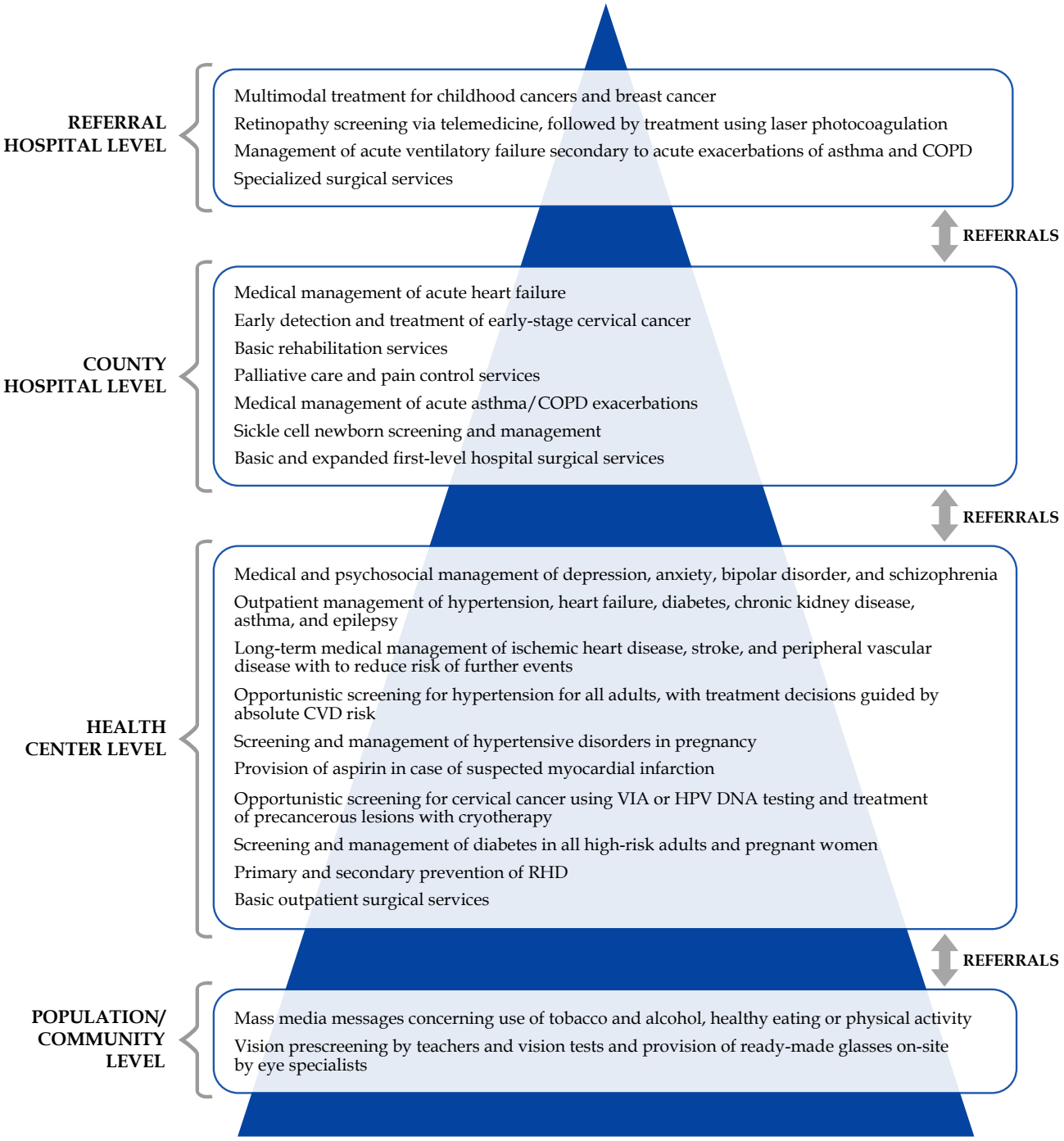


Figure 10. Proposed integration of selected interventions into Liberia health system levels (Source: Liberia NCDI Poverty Commission)

5.4 AFFORDABILITY AND FISCAL SPACE FOR PROPOSED INTERVENTIONS

Highlighting the burden of disease of NCDIs in Liberia, a country with a primarily rural population and a high overall level of poverty, this report proposes a set of interventions to introduce or intensify in the health system. Though the overall cost of these interventions appears high in relation to current health expenditure, it may be appropriate for the burden of disease and alleviate further impoverishment of the population. In order to generate and mobilize adequate resources to finance such interventions, this Commission supports the GOL's current proposed efforts and strategies, including steps towards Universal Health Coverage via the Liberia Health Equity Fund.[34] Proposals for sources to support increased fiscal space include increasing health-sector specific resources through earmarked taxation, such as "sin" taxes on tobacco and alcohol, surcharges on automobile registrations or insurance, levies on airline tickets or international departures, or a proportion of value-added taxes. Increasing government budget for health to achieve Abuja Declaration goals of 15% government expenditure on health would also contribute to increased fiscal space. Revenue could also be generated through improving efficiencies in the health sector. Examples may include the development of a joint project coordination unit (JPCU), rather than separate project coordination units for each partner, and the establishment of the International Health Partnership (IHP+). Finally, in order to optimize cross-sector efforts and funding, additional efforts can be made to maintain and align donor funding towards national strategic priorities such as NCDIs.

5.5 ROLE OF INTERSECTORAL INTERVENTIONS FOR NCDIS IN LIBERIA

Health system interventions alone are not sufficient to prevent the risk and impact of NCDIs on the Liberian community. Although not specifically addressed in the analysis of this report, it is important to acknowledge and emphasize the importance of multisectoral interventions on NCDIs. Appendix Table 1 shows potential policy instruments that could mitigate various risk factors for health conditions leading to NCDIs, thus potentially preventing the onset and progression of NCDIs. The table also suggests key governmental sectors that would be vital for the leadership, management and governance of such NCDI interventions. Liberia has made progress in achieving a number of these key multisectoral policies. For instance, increased taxation on alcohol and tobacco products and an excise tax on imported products are under consideration through the Ministry of Finance/LRA.[35]

6. Patient narratives: "The Voices of NCDI Poverty"

Diabetes – A 28-Year-Old Woman from Maryland County

Diabetes is a common NCDI in Liberia affecting both young and old. In Maryland County, far from the capital city, the ability to diagnose and properly manage diabetes is limited. Few health centers and hospitals can test blood glucose levels. The national drug supply includes metformin and sulfonylureas as treatment, but insulin is rarely available. A 28-year-old woman living in Maryland County described her experience.

"I didn't know anyone with diabetes, but I was just drinking and drinking water and so I knew that was not a normal thing, so I came to the hospital." At JJ Dossen Hospital, now supported by the NGO, Partners In Health, she had her blood sugar tested and it read over 600 mg/dl. She was admitted to the hospital and started on insulin therapy but now is managing her diabetes using oral tablets and diet management alone. "It can be difficult when you are told you cannot eat rice, it can be hard to buy some of the food." Now, several months after starting treatment she states "I am taking my treatment on time. The tablets are easy because the injection used to hurt but the tablet is easy." Reflecting on her experience she states "When I first got diabetes, every day I used to cry, but when you see someone who can talk to you and tell you it will be ok, then you feel better, otherwise you want to do harm to yourself. More places in Liberia need people who can talk to people to prevent themselves from diabetes, giving them the treatment and care."

Asthma – A 29-Year-Old Man from Brewerville

Asthma is an NCDI that affects both young and older population. A 29-year-old male from Brewerville who has been afflicted with asthma says he was diagnosed at a UN clinic in Mamba point in the year 2000. At that time, he could not breath well, especially when he would exercise. He said,

"Asthma has affected my life in a way that I'm unable to do extreme exercise…I manage my condition by following all the preventative measures to avoid crisis…[however], when it first started I used to come to hospital frequently because I had crisis most often because I was a kid and could not easily follow the rules but later when I grew up and understand my condition. I follow all the prevention and usually travel with my Salbutamol spray." He now is able to live a normal life after he learned about asthma and was provided with medication. When asthma is treated correctly, people can live a healthy lifestyle. Our 29-year-old patient recently stated, "There is no major challenge I'm faced with right now

because I'm aware of my condition and what to do to avoid it." According to this patient, "more places in Liberia need [treatment sites] to prevent [patients] from going into crisis, giving them the right treatment and care."

Breast Cancer – A 52-Year-Old Woman Living in Monrovia and a 28-Year-Old Woman from West Point

Cancer is another common NCDI and for many women in Liberia. However, there is little access to basic screening or care for breast and cervical cancer. One 52-year-old woman living in Monrovia shared her experience with breast cancer.

"It started with hot skin and cold, from there my breast started hurting me and it had a knot in it. After one week my tay-tay (breast) started getting big and everyone was afraid so my family decided to take me to a native doctor because they felt it was witch activities. After a while it was still the same and started to get worse with pain. I spent two months looking for help but it was not possible until I got seriously ill and was taken to Tappita (large referral hospital). It was there I was told by the doctor that I had cancer of the breast and I needed to get surgery. It has been hard for me, living with one breast is not easy but I have managed to take my treatment on time and accept the condition. My community has come to know that it was not witchcraft and they started supporting me."

Another woman, a 28-year-old from West Point, the largest slum in Monrovia, was able to receive chemotherapy for her cervical cancer; however, she states that "the treatment is really a problem, it is very expensive and I have a lot of side effects, I spend $25 USD for every chemotherapy treatment I do." In her community, most families live on less than $100 USD per month. She summed up the issue in Liberia saying, "This sickness is really affecting our women and young girls. The treatment is so expensive that people can't afford to pay for it and they end up dying. There is no message given to people about this condition, so when you have it people consider you like an outcast and that neglect can kill you. I'm asking people to come and help our women and girls."

Hypertension and Diabetes – A 47-Year-Old Woman from Jacob Town

Many patients suffer from more than one NCDI. Such is the case with a 47-year-old woman from Jacob Town, Montserrado County, who has both hypertension and diabetes. She was diagnosed with both of these NCDIs during an admission for hyperosmolar hyperglycemic state. Having multiple NCDIs really can create many challenges and obstacles in one's life. This patient stated:

"Diabetes and hypertension has changed my life in many ways. I'm not able to move about like a normal person because of this sickness. I can't do my market

again. I can't do my garden and I can't walk long distances. All my activities are depending on people to help me. People have to give me money before I eat, go to hospital, pay my rent, and so on. I don't have anyone to take care of my children. My life has taken another way and I expect to go to my early grave." These diseases also can put a financial burden on patients. This patient stated, "I used to come [to the clinic] every week, but later monthly, and that is what I'm doing now. It takes 50 minutes by car to go to the clinic and costs money to go to every clinic appointment…I have to ask people for help before I am able to get my medicine and food, I spend $10 USD to get the medications." But with treatment, financial, and psychosocial support, patients can live a long and prosperous life.

KEY FINDINGS AND RECOMMENDATIONS

KEY FINDINGS

- **NCDIs comprised a large share of the burden of disease in Liberia, and it is increasing.** In 2016, 37.9% of all DALYs and 43.4% of all deaths were accounted for by NCDIs, and the relative burden of NCDs has doubled in the past two decades.
- **NCDIs occur at young ages.** 51.5% of NCD DALYs and 69.8% of Injury DALYs in Liberia occur before age 40.
- **The burden of NCDs is very diverse.** Only 30.5% of NCD DALYs are due to the four conditions included in global NCD monitoring frameworks (cardiovascular disease, chronic respiratory disease, diabetes, and cancer), significantly lower than in high-income countries, where approximately 46.4% of all NCD DALYs are due to these conditions.
- **Most of the NCD burden cannot be attributed to individual lifestyle choices and risk factors may differ between socioeconomic groups.** 70.7% of NCD DALYs could not be attributed to measured behavioral or metabolic risk factors, such as alcohol, smoking, obesity, and hypertension. Other risk factors may include those related to poverty, the environment, and chronic infections.
- **Services for basic NCDIs are lacking.** Availability of specific medications, equipment, staffing, and guidelines required for NCDI delivery and specified by the Liberia Essential Package of Health Services is limited. Service availability is lower in rural, as compared to urban, facilities and lower in public, as compared to private, facilities. Capacity and availability of specialized services and personnel for NCDIs is extremely constrained. According to the STEPs survey, the vast majority of those affected by hypertension and diabetes were not accessing treatment due to lack of awareness.
- **NCDIs are underfunded and lead to impoverishment.** To date, resources for NCDIs remain constrained, with only 18% of total health resources going towards NCDIs. Of this spending, 75% is provided by households through out-of-pocket expenses, which is substantially higher than other conditions. This undoubtedly contributes to catastrophic health expenditures and impoverishment.

RECOMMENDATIONS

- **We must expand our NCDI focus.** After review of data of the overall burden of disease, equity profile of disease conditions, severity and disability of illness, and age profile of those effected, this Commission selected 19 NCDI disease conditions for which health sector interventions should be introduced or intensified. These conditions build on the existing Liberia strategic planning, and include asthma, chronic obstructive pulmonary disease, hypertensive heart disease and stroke, rheumatic heart disease, diabetes (type 1 and 2), cervical cancer, non-Hodgkin lymphoma, breast cancer, major depressive disorder, schizophrenia, substance abuse disorders, anxiety disorders, epilepsy, sickle cell disease, vision loss, refraction and accommodations disorders, cirrhosis, chronic kidney disease, and motor vehicle road injuries.

- **There are proven health interventions that can address these NCDIs.** Of an evidence-based package of interventions recommended for Universal Health Care, this Commission selected 33 potential interventions to be introduced or intensified within the health sector to target these priority NCDI conditions. These interventions were selected on the criteria of potential health impact, cost-effectiveness, financial risk protection, and priority to the "worst-off", including those that could avert more severe or premature complications.

- **We can prevent early deaths from NCDIs.** With implementation of these proposed interventions at a realistic level of coverage, we expect that over 1,300 premature deaths can be averted annually by the year 2030.

- **More investment in NCDIs in needed.** The proposed interventions would cost approximately USD $9.21 per capita, or 13.8% of the current total health expenditure. Introducing taxes on NCDI risk factor substances such as tobacco and alcohol, improving health sector efficiency, and aligning donor funding for NCDIs could support fiscal space for such interventions.

- **More data on NCDIs is needed.** There was a paucity of published literature on NCDIs in Liberia, with only 51 published studies over the past 10 years. Data on incidence, prevalence, morbidity, and mortality due to NCDIs has not been well established at the household and population level, and expenditures on health care for NCDIs has not been well disaggregated.

- **Multisectoral action is required.** Multisectoral action for the prevention and mitigation of NCDIs has not yet been sufficiently established in Liberia. For an organized and systematic response, high-level commitment from key stakeholders in all sectors is required.

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