

Surgical Volume in Sierra Leone



A nationwide population-based perspective

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SURGICAL VOLUME IN SIERRA LEONE; A NATIONWIDE POPULATION-BASED PERSPECTIVE

(Cover picture by Jonathan Vas Nunes. Oral consent was given by study participants.)

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by

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Picture by Daniel van Leerdam. Oral consent was provided for taking this photo.

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Abbreviations

AIGT	Arts Internationale Gezondheidszorg en Tropengeneeskunde (Medical Doctor specialized in Global Health and Tropical Medicine)
CS	Caesarean Section
DCP3	Disease Control Priorities, 3 rd edition
DHS	Demographic Health Survey
EA(s)	Enumerator Area(s)
GDP	Gross domestic product
HH(s)	Household(s)
HHM(s)	Household member(s)
HHrep	Household representative
HIC	High-income country
LCoGS	Lancet Commission on Global Surgery
LIC	Low-income country
LMICs	Low- and middle income countries
MDC	Sierra Leone Medical Dental Council
MiSP(s)	Minor Surgical Procedure(s)
MASP(s)	Major Surgical Procedure(s)
MoHS	Ministry of Health and Sanitation (of Sierra Leone)
MO(s)	Medical Officer(s)
NA(s)	Nurse Anaesthetist(s)
NSOAP	National Surgical, Obstetric and Anaesthesia Plan
OOP	Out-of-pocket
POMR	Perioperative Mortality Rate
PRESSCO	Prevalence Study on Surgical Conditions
REDCap	Research Electronic Data Capture
SCHO(s)	Surgical Community Health Officer(s)
SDG(s)	Sustainable Development Goal(s)
SLIHS	Sierra Leone Integrated Household Survey
SOA	Surgeons, Anaesthetists and Obstetricians
SOSAS	Surgeons Overseas Surgical Assessment of Surgical Need
STP	Surgical Training Program in Sierra Leone (organized by CapaCare, a Norwegian Non-Governmental Organization, and the MoHS)
SV	Surgical Volume
UNFPA	United Nations Population Fund
UHC	Universal Health Coverage
WHO	World health organization

Glossary

Catastrophic health expenditure	An expenditure of more than 40% of non-food household expenditure (1) or 10% of overall household expenditure. (2)
Enumerator area / Cluster	The geographic area where the households are located that are assigned to be interviewed.
Essential surgical disorder	Conditions that can be successfully treated by a surgical procedure (and other surgical care) that is cost-effective and feasible to promote globally. (3)
Essential surgical procedures	Cost-effective surgical procedures that would lead to significant improvements in health if they were universally delivered. (3)
Essential surgical package	Package of 44 essential surgical procedures, presented by DCP3 (Appendix 1). (3)
First-level hospital	Those that have about 50-200 beds, serve roughly 50000-200000 people, and have fairly well-developed surgical capabilities with doctors with surgical expertise. (3)
Free Health Care Initiative	Programme, introduced in 2010 in Sierra Leone to provide free health care for pregnant and lactating women and children under 5 years. (4)
Household	Every person who eats from the same pot as the head of household and slept in the household the night before the visit of the enumerator.
Household representative	A male or female member of a household recognized as such by the other household members. The household representative is generally the person who has the economic and social responsibility for the household.
Informal healthcare providers	Healthcare delivery by non-credentialed facilities, operating independent of professional bodies
Minor surgical procedure	Those surgical conditions that are feasible to treat in community facilities & primary health centres (outside the operation theatre) according to the DCP3 essential surgery package. (3) OR/AND The suturing, incision, excision, or manipulation of tissue; or other invasive procedure that NOT requires anaesthesia. (5,6)
Major surgical procedure	The suturing, incision, excision, or manipulation of tissue; or other invasive procedure that DOES require local, regional or general anaesthesia. (5,6)
Out-of-pocket payments	Out-of-pocket payments (OOPs) are defined as direct payments made by individuals to health care providers at the time of service use. (7)
Perioperative care	The provision of operative, perioperative and non-operative management for all surgical conditions. Perioperative care also includes preoperative assessment (including the decision of whether to

	operate or not), provision of safe anaesthesia, and postoperative care. (3)
Perioperative mortality rate	Percentage of deaths occurring after any surgical procedure. (8)
Primary health centre	Implies a facility with overnight beds and 24-hour staff (as would be needed for procedures such as normal delivery). Also known as community facility. (3)
Private health facility	Collection of heterogeneous facilities; independent hospital or clinic, informal facility or formal for profit entity, that may include (un)licensed providers, and non-profit, faith-based and non-governmental organizations. (9)
Public health facility	Facilities where public health care is usually provided by the government through the national health care system. (9)
Referral & specialized hospital	A facility that has advanced or subspecialized expertise for treatment of one or more surgical conditions, not usually found at lower-level facilities. (3)
Surgical care	Term used in this thesis for Surgical, Anaesthesia and Obstetric perioperative care
Surgical procedure	The suturing, incision, excision, or manipulation of tissue; or other invasive procedure that usually, but not always, requires requires local, regional, or general anaesthesia. (5)
Surgical volume	Total number of surgical procedures done in an operating room per 100.000 population. (8)

Abstract

Introduction Globally, five billion people do not have access to safe, affordable and timely surgical care, disproportionately affecting LMICs. REF In order to monitor and evaluate national surgical care systems, six surgical indicators have been proposed in 2015 by the Lancet Commission on Global Surgery (LCoGS). Surgical Volume (SV - number of major operations per 100.000 people) and Perioperative Mortality Ratio (POMR - number of people dying during and after surgery divided by the SV) are two of these indicators. In Sierra Leone, data has been collected for SV and POMR through the LCoGS recommended facility-based approach. This methodology has its limitations, especially in LMICs. In this study data on SV and POMR is collected through a population-based methodology. The results serve as a triangulation of the existing data.

Methodology For this PRESSCO (PREvalence Study on Surgical CONditions) study a nationwide cross-sectional, descriptive study was conducted between September 2019 and March 2020. Using the sampling frame of Statistics Sierra Leone, 75 clusters were randomly selected. In each cluster, 25 households were randomly selected to take part in the survey. Quantitative data was collected through a tool based on the SOSAS methodology, on tablets used by trained local enumerators with a medical background. A household representative was selected as a proxy for its household members for relaying information on surgical procedures performed within the previous year.

Results Of the 1875 targeted households, data were analysed for 1854 (98,8%). 10.001 household members were included. 1221 minor surgical procedure were reported (incidence of 12,2%). 152 major surgical procedures were identified, providing a nationwide SV of 1520 per 100.000 population (LCoGS indicator 3). Female household members and children underwent significantly less major surgical procedures compared to their adult male counterparts. The most common procedures were hernia repairs (30,9%), caesarean sections (23,7%) and appendectomy's (13,8%). Of the minor procedures, 81,3% were labelled as essential. For the major procedures 87,5% was essential. No significant differences were seen in the incidence of major procedures for participants living in different districts. However, only 61,2% of major operations were performed in the district of residence. It was reported that 78,9% of the major surgeries were performed in the public sector. An estimated 5,9 - 10,5% of the surgeries were done at unregulated facilities, corresponding to at least 6757 major procedures annually in Sierra Leone. The all-cause in-hospital POMR was 2,1% (LCoGS indicator 4).

Discussion Although the SV of 1520/100.000 is well-below the 5000/100.000 LCoGS benchmark, it is 3-4 times higher compared to the previous facility-study. Underreporting within the public surgical facilities could partially explain the difference. The high percentage of essential surgeries suggest an undeveloped surgical system with limited focus on specialized surgical care. Furthermore, our results show an important inequality in access to surgical care. More (inter)national research is needed to further identify this issue regarding decreased access for woman and children. Unregulated surgery poses a potential problem for quality of surgical care. Additional qualitative research and investing in regulatory processes could be a way forward to improve enhance quality management in the surgical field in Sierra Leone.

Key words: global surgery, essential surgery, surgical volume, perioperative mortality rate, Sierra Leone.

Preface

My name is Daniel van Leerdam, I am a doctor from the Netherlands with a specialization in Global Health and Tropical Medicine (AIGT). From 2016 until 2018 I have worked in Sierra Leone, as program coordinator of the CapaCare Surgical Training Program (STP) and clinician in a rural hospital.

During my clinical work, which was primarily dedicated to surgical and obstetrical mentoring of the students of the STP, I closely saw part of the huge burden of surgical conditions in Sierra Leone. The surgical team performed procedures on a daily basis with satisfactory results most of the times. Although the costs related to surgical procedures were low in comparison to other hospitals, many patients had difficulties to afford emergency and elective surgical care. Short-term external initiatives, offering free surgery to alleviate surgical burden for specific conditions (e.g. inguinal hernias), could count on long lines of patients who wanted to be included.

Also, care in the hospital for surgical conditions was frequently considered by patients as a last resort. Usually patients were initially treated in a traditional setting and came to the hospital in a very late stage of the disease.

In my role as program coordinator of the STP I had the privilege to visit partner hospitals all over the country where students were posted. Over the years, access to surgical care had improved through the 'free health care initiative'. This initiative only included obstetric cases and children under the age of 5. As a result, the STP students were mostly involved in emergency obstetrics in the governmental partner hospitals. In general, low volumes of elective and emergency general surgical cases were performed. Through discussions with the STP students, I came to understand that various health workers (not only medical doctors), owned their private clinics where surgery was performed regularly. Government health workers are paid very little, and surgery is an income-generating activity. Desperate people take desperate measures to feed their families.

Of course, it is not right to assume that unregulated surgery happens on a large scale in Sierra Leone based on stories. Also, it would be false to blindly accept that the quality of care of these activities is substandard compared to the governmental and regulated private sectors. However, D. Watters and colleagues have said it well in a recent paper. "What is not measured has the risk of being perceived not to exist." (10)

The idea got stuck in my head, so I was very happy to hear that there was a plan to conduct a household survey in Sierra Leone. My former employer, Dr. Håkon Bolkan, the chairman of CapaCare, encouraged me to partake in this study. It would provide an interesting opportunity to observe the surgical activity from a novel perspective. A population based approach that had the possibility to include all surgical procedures, regardless of the location where they were performed. It proved to be an excellent topic for the thesis of my master of international public health.

Introduction

Surgical Care Globally

The right to health and well-being for every individual is acknowledged in article 25 of the United Nations' Declaration of Human Rights. (11) However, as of 2017, half of people on this planet cannot obtain access to high-quality healthcare. (12)

This has become very apparent with regard to surgical, anaesthesia and obstetric care (hereafter referred to as 'surgical care'). Globally, five billion people do not have access to safe, affordable and timely surgical care. Low- and lower-middle-income countries (LMICs) are disproportionately affected; here nine out of ten people cannot access the most basic surgical services. (13) Of the 313 million surgical procedures that are performed each year throughout the world, only 6% are conducted in the poorest countries where one-third of the population lives. (14)

Added to this, it is estimated that 30% of the worldwide burden of disease requires some sort of surgical care. (8) Surgical conditions such as traumatic injuries, complications of childbirth, abdominal emergencies, congenital anomalies and cancers may lead to death or severe mortality without safe and timely surgical care. (3,8,15) Establishing equitable access to quality surgery and anaesthesia may prevent up to 16.9 million deaths annually. (16) To avert disability and to save lives, an estimated additional 143 million operations are needed in LMICs. (14)

Low operative volumes are associated with high case-fatality rates from common, treatable surgical conditions. A rate of 5.000 surgical procedures per 100.000 population per year has been associated with desirable health outcomes (life expectancy of 75 years and maternal mortality ratio (MMR) of \leq 100 women per 100.000 live births). (17) Focusing on delivering essential surgical care - procedures for surgical conditions with the highest health burden - would lead to substantial improvements in health. (3) The Lancet Commission on Global Surgery (LCoGS) has recommended a rate for all surgical procedures combined of 5.000/100.000 population per year as a target for LMICs to achieve. (8) The suggested target should not be seen as an endpoint but as minimal level for the delivery of emergency and essential surgical care. (8) Naturally, the optimal volume of surgical procedures differ from one area to the next based on patient needs and access to surgical healthcare services.

Essential Surgery

In a surgery-dedicated volume of Disease Control Priorities - 3rd edition (DCP3), a package of 44 essential surgical procedures were suggested. Safe anaesthesia and perioperative care are necessary components of all of these. The procedures rank among the most cost-effective health interventions and are feasible to promote and organize globally. (3) It is proposed by the authors of the DCP3, volume Essential Surgery that the first level hospitals (district hospitals) should be the key facilities for delivery of essential surgical care. The first level hospitals should be able to provide 80-90% of essential surgical services. (3,8) Because surgical care goes beyond the operation theatre, procedures may include non-surgical techniques such as assisted vaginal delivery as an alternative to caesarean section (CS). (3) In appendix 1, a full overview of the essential surgical package is included.

Surgery & Economics

Apart from the contribution and restoration of individual physical well-being, surgical care has secondary economic implications. Globally, a quarter of all patients who undergo surgery, experience catastrophic health expenditure. (18) On macroeconomic level there is evidence that improved population health contributes to economic growth. Following the current tendency in surgical burden of disease, LMICs are estimated to lose up to 2% of gross domestic product (GDP) - \$12.3 trillion - by 2030 through diminished population health due to untreated surgical conditions. (19) Scaling up surgical care in LMIC towards the minimal required level as suggested by the LCoGS is estimated at \$250 billion, a relatively small investment compared to the estimated loss of maintaining the status quo. (20)

Advocacy

For decades, international efforts to enhance surgical care in LMICs has been realized mainly through relatively short-term missions by (specialist) volunteers. (21,22) In recent years however, efforts of the World Health Organization (WHO), the Disease Control Priority (DCP) Network and LCoGS have resulted in a new approach focussing on health system strengthening, moving away from disease specific programmes. The new field of Global Surgery emphasizes on a participatory, evidence-based, health equity methodology to surgical care in low-resource settings. (21,23) This initiative harmonizes well with the proposal of Universal Health Coverage (UHC), outlined in the Sustainable Development Goals (SDGs), to refocus primary on health system development. (24)

In 2015, political acceptance and recognition of surgical care as a core component of health systems was stated by the United Nations member states through the World Health Assembly (WHA). The resolution WHA68.15 passed unanimously, declaring that UHC will be impossible to achieve without ensuring that safe, timely, and affordable surgical, obstetric, and anaesthesia care is available and accessible. (8,25) With this recognition, it is expected that progress will be made in the years to come to adopt surgical services as a vital part of any national health system.

Surgical System Indicators

Health information management is needed for monitoring and evaluation of the performance of the health system, (26) and carefully selected indicators (and its related targets) can be regarded as the backbone of health information systems. (27) Core indicators should be valid (it needs to measure what it intends to measure), relevant (useful for decision-making) and feasible (and affordable) to execute. (10,27) Well-defined indicators should promote uniform data collection from relevant data sources for standardized and (internationally) comparable information. (27,28)

Textbox 1:

During the MDG era it was observed that a compact set of indicators (e.g. for maternal health) could focus attention and collect wide support for a specific topic. An indicator such as maternal mortality ratio has become widely accepted to characterize a nations health status and has directed a wide range of interventions toward maternal care.

Source: Adapted from Watters et al. 2018.

Adhering to the standards described above, the LCoGS recently proposed six surgical indicators (and suggested the sources for data collection) to monitor the status of each country's surgical care system (see table 1). (8,10) Since there is a considerable knowledge-gap with regard to the status of surgical care globally, (8,29,30) the first step is for countries to collect baseline data using the proposed indicators. This can be translated into information for a needs-assessment, and provide input for planning of surgical care delivery through national surgical, obstetric and anaesthesia plans (NSOAP).

Further dissemination of the surgical information, through reporting of findings, can enhance the value by making it accessible to (inter)national decision-makers. As a result, policymakers can better understand the demands and advocate for those in need. (27)

The same indicators should be used to monitor the acquired progress towards UHC in 2030.

Table 1. Global surgical indicators as suggested by the LCoGS

Indicator	Definition	Data Source	Target
<i>Group 1: Preparedness for surgical and anaesthesia care</i>			
1. Access to timely essential surgery	Percentage of population that can access within 2 h a facility capable of performing the 3 Bellwether procedures (caesarean delivery, laparotomy, treatment open fracture)	Facility records and population demographics	80% of population by 2030
2. Specialist surgical workforce density	Number of specialist surgical, anaesthetic, and obstetric (SAO) physicians per 100.000 population	Facility records, data from training and licensing bodies	100% countries with 20 SAO/100.000 by 2030
<i>Group 2: Delivery of surgical and anaesthesia care</i>			
3. Surgical volume	Total number of surgical procedures done in an operating room per 100.000 population	Facility records	5000/100.000 population 100% countries by 2030
4. Perioperative mortality	Percentage of deaths occurring after any surgical procedure before discharge from the hospital	Facility records and death registries	100% by 2030 tracking POMR
<i>Group 3: Effect of surgical and anaesthesia care</i>			
5. Protection against impoverishing expenditure	Direct out-of-pocket (OOP) costs from surgical care >10% of annual income	Household surveys, facility records	100% protection by 2030
6. Protection against catastrophic expenditure	Direct OOP costs driving family/household income below poverty line	Household surveys, facility records	100% protection by 2030

Adapted from: LCoGS, Global Surgery 2030 (2015): evidence and solutions for achieving health, welfare, and economic development. (8)

Indicators 3 and 4, Surgical Volume (SV) and Perioperative Mortality Rate (POMR), focus on measuring delivery and quality of surgical care, respectively. These indicators have recently been adopted in both the WHO 100 health indicators and the World Bank's World Development Indicators, signifying the acceptance of the surgical system indicators. (31,32)

LCoGS Indicator # 3: Surgical Volume (SV)

SV measures surgical activity per year in each country, defined as the number of major surgical procedures (MASP) per 100.000 population. All procedures - defined as incision, excision or manipulation of tissue that needs local, regional or general anaesthesia - conducted in an operating room are included. SV and can be translated into the 'met need' of the population's surgical burden.

Currently, national data on SV is scarce, more so in LMICs. Recently, it was found that 72 countries (information about 39% of the global population) have reported SV. Of those that reported, median SV per 100.000 people was 3.375 for upper middle income, 2.445 for lower-middle income and 328 for low income countries. (30)

There are challenges that are faced with the collection of national SV. Most LMICs do not have a reporting system in place (10), leading to the labour-intensive process of manual collection of data from the theatre logbooks in each operating facility. In addition, data from procedures performed in outpatient setting or the emergency room are not routinely included, leading to an underestimation of SV. (33,34) Underreporting of procedures in the logbooks could also occur on facility level. It might simply be forgotten, or alternatively, there may be reasons for systematically not recording operations (e.g. illegitimate practices or illegitimate payment habits). Furthermore, information from the private sector is more difficult to obtain.

Surgery and the Private Sector

The private sector, acting outside the scope of the government, has a large role in LMICs. (35) The main categories are private non-for-profit, for-profit and informal providers. The last group, encompasses care-delivery by non-credentialed workers or facilities operating independent of professional bodies, has been highlighted as an underappreciated global barrier to the quality of care. (36)

In LMICs, a large private sector is associated with low quality services, poor effectiveness of the public system, lack of regulatory infrastructure, and high out-of-pocket payment. In addition, there is a lack of published data available from this sector to evaluate their performance. (9,37)

Despite the knowledge that in most countries the surgical care delivery exists of a mixture between public and private facilities, (38,39) little is known about the contribution of the private sector to the SV as data collection of surgical procedures in the private sector remains challenging. (14,30,40)

Minor Surgical Procedures (MiSP)

Minor procedures are those surgical procedures that generally not require anaesthesia (e.g. wound dressing and -needle- punctures). For this thesis, the definition of minor procedures has been broadened. Included are those procedures that according to the DCP3 are feasible to perform in community facilities and primary health centers. (3) Some of these are more patient-friendly when performed with local anaesthesia (e.g. suturing, tooth extractions).

MiSPs are usually not part of the SV, because they are not routinely performed in an operating theater, but several have been labeled as essential

by the DCP3 and have been suggested to be part of the essential package (Appendix 1).

If these procedures are performed in primary health facilities they are very cost-effective. Further, the preventive value of individual minor procedures, such as tooth extractions (41) and normal deliveries (42) has been widely recognized. Currently, many of these minor procedures are performed at first level hospitals. Promoting the delivery of MiSPs at primary level may free up surgical capacity within the secondary surgical system, thus helping to reduce surgical burden simultaneously. (3,43)

LCoGS Indicator # 4: Peri-operative mortality rate (POMR)

In high-income countries, a considerable decrease in POMR as a response to health care improvements was observed over the last decades. (44,45) Unfortunately, the same progress in anaesthesia and surgical practises and improvement in post-operative monitoring has not yet occurred in LMICs, resulting in a stagnation of the POMR. (46-48) Despite patients being younger, having less co-morbidities and undergoing less complex surgery in a recent African Surgical Outcomes study, the patients were twice as likely to die compared with higher-developed settings. (47) This suggest that apart from increasing surgical access in LMICs, there should be a synchronized focus on quality of surgical care. POMR is used for a crude, population-based evaluation for safety; (8,49) one out of six dimensions of healthcare quality. (36)

The LCoGS defines the in-hospital POMR as the number of (all-cause) deaths following a surgical procedure that occur before discharge, with the SV as the denominator (indicator 4, see table 1). Currently, much of the information on POMR are estimates based upon modelling studies of facility data. Only 28 countries worldwide have nationally representative data available for this indicator. (30) Comparability of these data is limited due to lack of uniform reporting. (50) Especially the timeframe during which mortality occurs is inconsistent and much discussed in the literature. (30,51)

POMR collection upon discharge, as suggested by the LCoGS, may introduce an inconsistency as timing of discharge varies among facilities. Furthermore, it leaves a gap in the evaluation of post-operative management, causing an underestimation of POMR. Several studies suggest that in-hospital mortality underestimates all-cause 30-day mortality from 30 up to 70%. (40,46) While, a 30-day mortality is proposed as a more robust indicator, the collection would require a post-discharge follow-up which may not always be feasible in many LMICs. With this in mind, LCoGS argues that at present it is more important to have one single, unadjusted statistic, on a national level to monitor and compare POMR.

Data sources and collection approaches

Data for surgical indicators can be collected through facility-based and population-based approaches. An example of a population-based approach are household surveys (e.g. Demographic Health Survey, DHS). These surveys have become an important source of information in LMICs and are considered to provide the most reliable data to measure certain health indicators. (27) An important disadvantage is that the household survey is more time-consuming and expensive compared to a facility-based survey. However, it has been recommended recently that 'it is absolutely feasible and desirable to integrate specifically designed question modules that represent anaesthesia-surgical indicator categories'. (29)

For sustainability purposes it would be necessary for the surgical data collection methods to be driven at the local level on the longer term. (8,30) However, the creation of partnerships with (inter)national and academic organizations to support the process initially has been championed in the literature. (21,29)

Surgical Care in Sierra Leone

Sierra Leone is a low-income country (LIC) in West-Africa with a population of 7.6 million inhabitants. (52) The country is divided in 5 provinces, 16 districts, 190 chiefdoms and 12.856 sections or Enumeration Area's (EAs). (53,54) In the previous decades Sierra Leone has faced a 10-year civil war (which ended in 2002) and a devastating Ebola epidemic (2014-2016) in which nearly 7% of all healthcare workers died. (55)

On the Human Development Index, Sierra Leone ranks as number 181 out of 189 countries. (56) Life expectancy at birth is 54, maternal mortality ratio is 1120 per 100.000 live births and 1 in 10 children die before the age of 5. (52) The burden of surgical conditions is significant, with 25% of the population estimated to be in need of surgical care. Moreover, it is proposed that 25% of the deaths could be averted with access to surgical care. (57)

The public healthcare system is made up of peripheral health units (n=1160), first level (or district) hospitals (n=17), regional hospitals (n=4), and tertiary hospitals (n=2). (58) The surgical staff of district hospitals usually consists of Medical Officers (with 2 years of general training after medical school), surgical clinical health officers (SCHOs) and nurse-anaesthetists (NAs). Both SCHOs and NAs are an associate clinician, task-sharing cadre that go through a government-owned, United Nations Population Fund (UNFPA) sponsored, training program of 3 and 1 years respectively. (59,60) District hospitals provide several essential surgical services. A nationwide facility survey in 2012 showed that approximately two-third of the SV in the public sector was performed in district hospitals. (61) The tertiary hospitals, and most regional hospitals, are staffed with specialist surgical providers and provide a broader range of surgical care. In 2012, there were ten specialist surgeons in public hospitals; 21 full-time surgical positions including anaesthetists and obstetricians. (61,62)

Table 2. Number of surgical procedures performed in 2012 in Sierra Leone

Surgical providers →	<i>Specialists</i>	<i>Physicians/ Medical officers</i>	<i>Associate Clinicians</i>	Total number (%)
↓ Sector				
<i>Government</i>	3.091	5.700	211	9.026 (40,8%)
<i>Private non-profit</i>	6.999	3.481	1.121	11.601 (52,4%)
<i>Private for profit</i>	1.082	147	287	1.516 (6,8%)
Total	11.172	9.328	1.619	22.143 (100%)

Adapted from: Bolkan et al, The Surgical Workforce and Surgical Provider Productivity in Sierra Leone: A Countrywide Inventory (2016). (61)

The private sector in Sierra Leone consists mainly of private non-profit and private for-profit providers. They range from first level hospital sized

facilities to small surgical clinics. Approximately half of the surgical workforce is employed in the private sector in Sierra Leone, performing about 60% of the national SV in 2012. Little is known with regard to the size and the activities of the informal sector.

The surgical workforce in Sierra Leone, all sectors combined, encompasses less than 5% of the LCoGS-target (indicator 2 in table 1) of 20 surgical health workers per 100.000 population. (61) It should be noted that NAs were excluded in these figures. In rural areas, the densities of specialists and physicians were 26.8 and 6.3 times lower, respectively, compared with urban areas. (61)

According to a nation-wide facility survey conducted by Bolkan et al, the public and private combined, found an annual rate of 400 surgeries per 100.000 inhabitants (LCoGS-indicator 3 in table 1). There is a 30-fold difference between the district with the highest and the district with the lowest incidence rate. Based on this SV, 92% of the estimated surgical burden in Sierra Leone was unmet in 2012. (63)

A multicounty study from 2016 about barriers to access surgical services showed that the low surgical workforce is one of the factors that contribute to poor access to surgical services in Sierra Leone. Other reported barriers for persons who died of a surgical condition were lack of money (55%), delay in decision-making to reach out for healthcare (32%) and unavailability of healthcare facility (13%).(64)

Cause-specific postoperative mortality rates in Sierra Leone have been reported in several publications. Recently, the nationwide POMR for caesarean sections were determined on 1.5%. (65) This is 30 times higher compared to the Netherlands. (66) Quality of surgical care is not the only aspect explaining this difference in POMR; other factors such as antenatal care will play a role too.

To the best of our knowledge, nationwide all-cause POMR for all surgical procedures (indicator as suggested by the LCoGS) has not been reported for Sierra Leone.

Study aim & Justification

The aim of this study is to acquire national data on two of the surgical indicators as proposed by the LCoGS in Sierra Leone. National data on Surgical Volume and Peri-Operative Mortality Rate will be collected using a household survey. To the best of our knowledge, there are no population-based studies with regard to SV or POMR in Sierra Leone (see literature search strategy in appendix 2).

The results of this study will help to triangulate the data already available for SV in Sierra Leone. Furthermore, measuring surgical volume by a household survey might also provide additional insight into surgical procedures performed by informal providers or facilities.

In conclusion, with this study we will analyse the data on the two surgical indicators for Sierra Leone; monitoring SV and providing baseline information on POMR. We will process this information into public knowledge through publication of the evidence, and trust to make a valid contribution to the field of global surgery. The Sierra Leonean health authorities and/or the national surgical committee may need the results of this study to inform their decisions.

Study questions

- I. What is the national annual incidence rate of surgical procedures (SV) in Sierra Leone?
 - o How many, and what type of minor procedures were performed?
 - o How many, and what type of major procedures were performed?
 - o What proportion of procedures can be classified as essential surgical procedures?
 - o Where did the participants reside who underwent a major surgical procedure?
 - Urban/Rural
 - District
 - o What is the population rate of major surgical procedures performed per district?
 - o What is the proportion of procedures that were performed outside the district of residence?
 - o What was the contribution to the surgical volume of each sector?
 - Public
 - Private regulated
 - Private unregulated
- II. How does the data collected through this household survey (population-based approach) compare to the standard facility-based approach for determining the national annual surgical volume?
- III. What is the all-cause peri-operative mortality rate in Sierra Leone?
 - o What are the characteristics of the participants who passed-away during or after a surgical procedure?
 - o What was the in-hospital POMR? And the 30-day POMR?

Study Objectives

- Objective 1: To describe and compare the main study characteristics
 - o Sub-Objective 1.1: Household characteristics
 - Number of households
 - Size of households
 - Location of households
 - o Sub-Objective 1.2: Individual characteristics participants
 - Gender
 - Age
 - o Sub-Objective 1.3: Characteristics of HHMs who underwent a surgical procedure
 - Gender
 - Age
 - Residence
 - Urban/Rural
 - District

- Objective 2: To determine National Annual Surgical Volume in Sierra Leone
 - o Sub-Objective 2.1: Classification of surgical procedures
 - Minor
 - Major
 - o Sub-Objective 2.2: Classification of surgical procedures in essential surgical categories
 - o Sub-Objective 2.3: Characteristics of procedure location
 - District of procedure
 - Type of facility
 - Government
 - Private
 - o Private regulated/Non-regulated

- Objective 3: To compare data on Surgical Volume from this household survey (2019) with the standard facility-based approach (2017)
 - o Sub-Objective 3.1: Surgical Volume
 - o Sub-Objective 3.2: District of procedures performed
 - o Sub-Objective 3.3: Type of facility of procedures performed
 - government/private sector
 - o Sub-Objective 3.4: Incidence of key procedures

- Objective 4: To assess all-cause peri-operative mortality rate in Sierra Leone
 - o Sub-Objective 4.1: Characteristics of HHMs who passed away after a major surgical procedure
 - Sex, Age, Residence
 - Timing of POM (7d, 30d)
 - Type of surgical procedure
 - Procedure location
 - o Sub-Objective 4.2:
 - Determine the all-cause peri-operative mortality rate
 - in-hospital POMR vs 30-day

Methods

Literature study

A literature review was conducted to provide relevant background information. The search strategy is described in appendix 2.

Study type

For this thesis a nationwide cross-sectional, descriptive study was conducted. Data collection on surgical indicators (SV & POMR) was population-based, through a quantitative household survey (HHS).

Data collection for this thesis was part of a larger initiative, the 'PREvalence Study on Surgical COnditions' (PRESSCO) and was based on the methodology of the 'Surgeons Overseas Surgical Assessment of Surgical Need 2012' (SOSAS 2012). In collaboration with Surgeons Overseas and multiple academic institutions and organizations (Appendix 3), the SOSAS 2012 was repeated together with five additional supplementary modules on prevalence and incidence of specific surgical conditions.

Development of the survey tool

The questionnaire of the SOSAS 2012 was used as an example for the development of the SV module. Several rounds of consulting with supervisors and experts on questionnaire development were conducted.

For the collection on SV, a distinction was made between minor and major surgical procedures. Minor procedures were identified as those that were feasible to perform in community facilities or primary health centres (based on the DCP3 essential surgical package) (3) or other procedures with manipulation of tissue without the use of anaesthesia. A short list of these procedures (including 'other') were to be presented to the respondent for improved categorization (Appendix 4). No further information was asked with regard to the minor procedures. Major procedures were defined as the suturing, incision, excision or manipulation of tissue or other invasive procedure that requires local, regional or general anaesthesia. In order for the major procedures to be recognized by the respondent, the most common procedures (based on the DCP3 essential package) were translated in Crio (Appendix 4). If the procedure could not be recognized, the 'other or unknown' response would lead the questionnaire to a list with surgical problems and locations in the body. It was estimated that this information would be sufficient for classifying in the broader categories of the essential surgical package. For each major procedure, subsequent questions followed on were the procedure was performed. A list with all registered private hospitals was obtained from the Sierra Leonean Medical and Dental Council (MDC) (Appendix 5). These were presented to the participant based on the district where the procedure was done. If other or unknown was answered as a response, there would be no further questions to identify this facility. In order to get a full picture of the SV (full numerator and denominator) these same questions would be asked for household members (HHM) who passed away in the last 12 months. In addition, questions were added to determine the timing of passing after the (last) major surgical procedure to establish the POMR of major surgical procedures. Within the questionnaire 3 minor and 3 major procedures could be included for each household member.

The questionnaire was incorporated in a secure web application for building and managing online surveys and databases called Research Electronic Data Capture (REDCap - <https://www.project-redcap.org/>) and uploaded on password secured Samsung tablets (Galaxy Tab A6, 2016) with mobile Internet access.

Sample size

Sample size was calculated using the formula for a single proportion with specified precision:

$$n = \frac{Z^2 P(1 - P)}{E^2}$$

In above equation, n is the sample size and Z is the statistic corresponding to the desired confidence level set at 95%, given as 1,96. P is the expected population proportion of the outcome, and E is the standard error, estimating precision. Based on the data reported by Bolkan et al. (63) the incidence rate of major surgical procedures was expected to be 0,4%. In addition to the major procedures, we estimate that at least twice as many minor procedures are performed. This results in an estimated period prevalence (P) of (major and minor) surgical procedures combined of ± 1% per year (P=0,01). Precision was set up at 0,2% (corresponding to 20% of the estimated prevalence). The design effect was set rather high at 6. This correction was applied as a response to relevant biases (described below) and possible clustering of the outcome in both EAs and randomized households, as undergoing a surgical procedure might be linked to the socioeconomic status. The sample size was therefore calculated in the following way:

$$n = \frac{1,96^2 \times 0,01(1 - 0,01)}{0,002^2} = 9.702$$

Under the assumption that some household representatives (HHrep) will not consent to partake in the survey to disclose the surgical conditions of the household members (HHMs), we have chosen to add a margin of 5% to the sample size. Thus, a sample size of 10.187 participants was calculated to estimate national surgical volume. Taking into consideration an estimated 5,6 HHMs per HH in Sierra Leone, (67) a minimum total of 1.819 HHs is needed to achieve this sample size.

Because of the collaborative nature of this research initiative, where the repeat of the SOSAS study from 2012 is the foundation, a similar methodology was maintained. In line with the SOSAS, 1875 HHs were selected.

Sampling methodology

Sampling was done in two stages. First, for the PRESSCO study, 75 clusters or enumeration areas (EA) were randomly selected by Statistics Sierra Leone with a probability proportional to population size and explicit stratification for district and urban/rural setting (see figure 1 for the location of the clusters). This general simplified method has been described previously and was used by SLL for the DHS in Sierra Leone (68,69).

The second sampling stage took place within the assigned EA, where a list of all HHs was composed. A HH is defined as: "all people eating from the same pot and having slept in the household structure the night before arrival of the team in the EA". (69) With the HH list in hand the first HH was randomly selected using a random calculator. Subsequently, the 25 HHs were identified with an interval (calculated as total number of HHs in the EA divided by 25) from the first HH. Replacement of the pre-selected HH was only allowed if the randomly chosen HH appeared to be empty, on three separate visits.

Inclusion of participants

Within each of the 1875 selected HHs, the HHrep was identified. In case of absence of the HHrep, an alternative adult household member (HHM) could step in. The HHrep was provided with information about the study and was responsible for the informed consent for the HH. Hereafter, a list of all HHM was constructed in order of age. For each of the HHM, questions were asked regarding minor and major surgical procedures that took place within the past 12 months. In addition, information about HHMs who passed away in the last year was provided during this interview.

Training of data collectors

Before the start of the data collection a 5-day training was organized for the team involved with data collection. Fifteen State Enrolled Community Health Nurses were selected after a thorough selection and evaluation procedure as enumerators. Five surgically trained community health officers (SCHOs) were added to the group with a double role as enumerators and data-checkers. Three field-supervisors from Statistics Sierra Leone with extensive DHS-experience, completed the data collection team. The activities in the training were focused on familiarizing the enumerators and supervisors with the questionnaire (and the incorporated surgical terminology), the use of the tablets and clarification of the roles within the teams during the data collection. The main objective was to enhance the quality of the data.

Data collection

Three teams of enumerators, each headed by a field-supervisor and accompanied by a data-checker, collected data from October until the November 2019 and again from the February 2020 until March 2020 via face-to-face interviews in the respondent's homes. The supervisors were responsible for sensitization of the EA, the randomization of the households and the overall management of the executive process of data collection. Onsite checks were conducted daily by the data-checkers. On all the tablets of the enumerators, the obtained questionnaires were examined for integrity before leaving the EA. No consistency or logical checks were included in the survey. As soon as an internet connection was available, the data were uploaded to a cloud-based server and external data checks were performed. For this purpose, the data was transferred into a preformatted Excel spreadsheet (Microsoft® Office 365, Redmond, WA, USA), wherein incongruences in the data could be identified efficiently. Feedback to the team in the field was given as soon as convenient in case the enumerator had to return to the household for clarifications. Necessary adaptations were made by updating the dataset through the REDCap software on the tablet.

Data was collected on a total number of 78 clusters. As explained earlier, the initial plan was to include 75 clusters, however during the data-checks concerns were raised with regard to the early data collection in the Freetown clusters. It was concluded to incorporate another 3 Western-Area Urban (WAU) clusters at the end of the data collection in order to replace the 3 clusters with reduced data quality.

Statistical analysis

The final (crude) dataset was downloaded from the REDCap database and imported in Excel. Instead of the expected 1950 records (every HH is one single entry), more than 2000 were identified. Several empty entries and duplicates were observed (e.g. originating from resuming paused interviews in new REDCap records), and removed. Data (with regard to district of residence, localities, cluster number, etc) was revised and adapted where possible. The exact steps for the data cleaning process are described (Appendix 6).

Subsequently, the full cleaned dataset was divided into several smaller databases which contained the data linked to the different objectives of this study. These databases were analysed using the statistical software program Stata 16 (Stata Corporation, College Station, TX, USA) (Appendix 8).

Weight adjustments have not been applied for this thesis. Although, stratified for locality and districts, differences were still observed with regard to the national proportions (also see table 4). The process of weight adjustments proved to be beyond the scope of this thesis. Therefore, care must be taken when interpreting the results at the national level, as proportions could be inadequate.

Limitations and biases

Since the data collection is based on self-reporting, several potential biases might affect the reliability of data obtained. First, recall bias, might result in participants erroneously responding to questions based on the inability to remember the event accurately. It is found to be related to the length of the recall period and the characteristics of the investigated event. (70) Recall errors could have been less frequent with submitting the questionnaire directly to the HHM who underwent the procedure. (71) However, from previous HHS we learnt that male HHM were less frequently present during the interviews. (57) Also, since surgery in Sierra Leone is connected to significant HH expenses, (52) it is reasonable to assume that the HHrep is closely involved in the decision-making process to send a HHM for surgery. Surgery can be considered as a major life event, and a recall period of a year is more adequate compared to lesser events (e.g. number of colds per year). (71) Although recall bias is difficult to overcome, the severity and sporadic element of the event combined with the recall period of one year is believed to minimize errors. (29,70)

Second, as the questionnaire might contain sensitive questions (e.g. disclosure of informal procedure location) social desirability bias could occur. Response data can be affected by external approval, for example from the enumerator. (70) To address this, local interviewers were specifically trained to be sensitive and to avoid prejudging openly.

Observer bias, introduced by the interviewer was mitigated by thorough selection and training of the enumerators. In addition, internal and external data checks were introduced to monitor the completeness and quality of the data.

Finally, we recognize the limitation of the use of the English language for the questionnaire. However, we adhered to the experiences of Statistics Sierra Leone and the DHS-protocol for Sierra Leone for it is not feasible to have the questionnaire translated in all major tribal languages.

The biases described above have been taken into account during the design phase and were incorporated in the design factor.

Ethical considerations

Ethical approval for the PRESSCO was obtained from both the Sierra Leone Ethics and Scientific Review Committee and the International Review Board of Norway.

During the data collection each team was provided with an information letter from the MoHS and a copy of the ethical approval. These documents, together with general verbal information about the study were presented by the field-

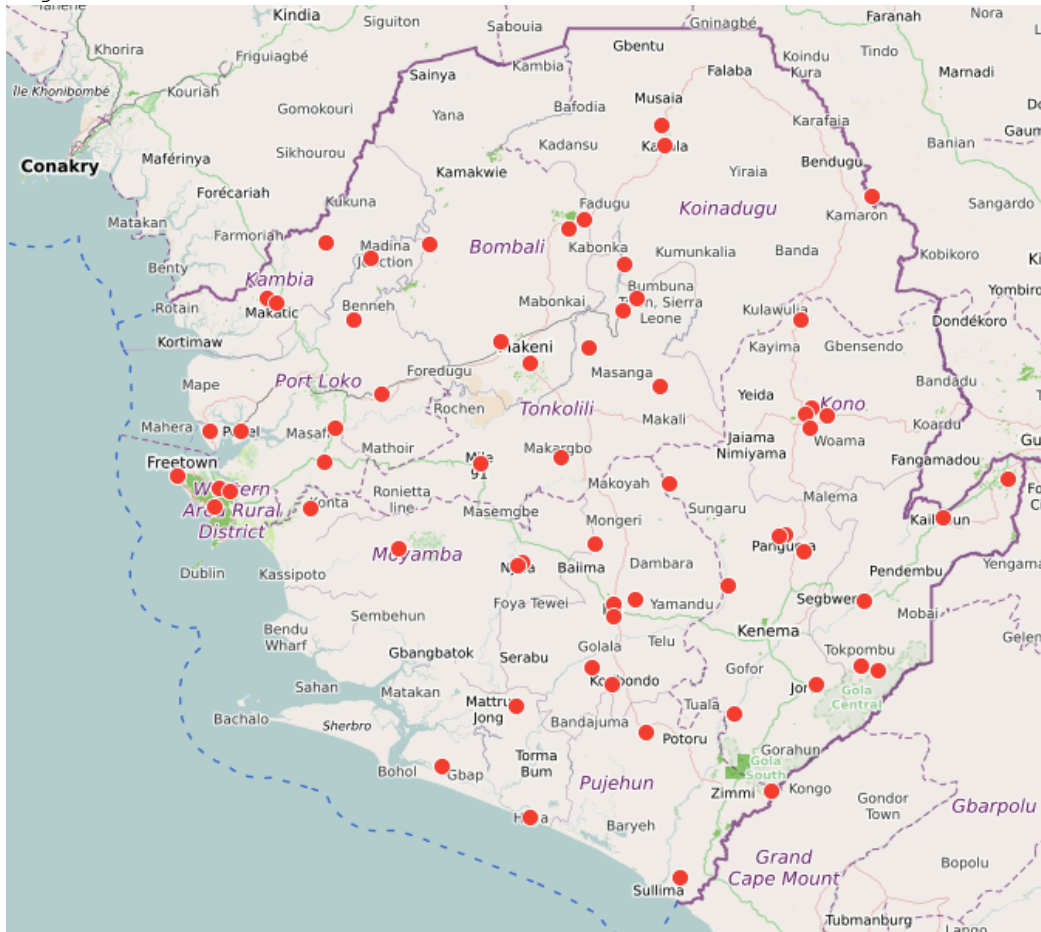
supervisor to the chiefs of the EA upon arrival. There were no refusals on cluster level to participate. Within the HHs, informed consent was taken from the HHrep through a consent form (Appendix 7) that was translated by the enumerators in the local language and verbally presented. After the interview, each participant received an information card with study contact details, for questions or withdrawal of consent.

It was communicated that no medical care would be provided by the data collection team. However, in case of medical emergencies, the team would respond to the best of their abilities to stabilize the patient and arrange transportation to the nearest relevant health facility. A referral letter was offered to patients with medical or surgical conditions that required non-urgent care.

Privacy and confidentiality were guaranteed to all participants by avoiding sharing any personal information outside the research group. Collected information was saved anonymously and stored in password-protected databases.

The study was conducted as a collaborative effort, with national (Statistics Sierra Leone, MoHS, Masanga Medical Research Unit, CapaCare SL) and international institutions and organizations providing efforts and resources. Development of research capacity through international cooperation is considered one of the foremost goals of this academic enterprise.

Figure 1: Location of the selected clusters within the PRESSCO study.



Study findings

Chapter one; Study Characteristics

A total number of 75 clusters were included, corresponding to 1875 households. Nineteen households did not provide consent and for two households data was unaccounted for. This leads to a total of 1854 households that were included, a response rate of 98,8% (table 3).

Of these, 1241 (66,9%) were located in a rural and 613 (33,1%) in an urban setting. The majority of households (63,6%) had a medium size of 3-6 members, both in rural and urban localities, and the mean household size was 5,2 household members (table 3). This is close to the 5,6 HHMs used in the sample size calculation exercise.

A total number of 10.001 household members (will be referred to as participants from now on) were included within this study. Of these, 9.647 (96,5%) were living participants and 354 (3,5%) passed away within the previous year. This provides us with a crude death rate of 35.4 people per 1000 population.

Within the study group a majority of the participants 6782 (67,8%) resided in a rural setting (table 3). Although a proportional allocation was pursued during the sampling, table 4 shows that this study sample has a significant overrepresentation of the rural areas compared to the population data separately provide by the Sierra Leone Integrated Household Survey (SLIHS).

Textbox 2: SLIHS

"In 2018, a similar household survey was conducted by Statistics Sierra Leone. The Integrated Household Survey (SLIHS 2018), while larger in included households, was generally comparable to the PRESSCO study; it was composed from the same sampling frame and stratification was done for district and localities. Probability proportional to size was applied for the districts, but the urban/rural distribution was allocated disproportionately to 'represent the wide variety in living conditions in the urban areas'."

A significant majority within the study group was female (52,2%). Table 4 shows that this is an adequate representation from the population. The mean age of the participants was 23,9 years, with nearly one third (31.9%) of the participants being younger than 10 years (table 3).

In table 3 the basic study characteristics of the PRESSCO are compared with the SLIHS. For mean household (HH) size, significant differences were observed. The rural household had on average 1 household member less (5.2 vs 6.2). Also, the size of the households was distributed differently between the studies; in the PRESSCO a majority of the households (63,6%) was of medium size (3 to 6 HH members), while the prevalent group (44.4%) in the SLIHS was households of large size (7 to 10 HH members). The mean age for PRESSCO was 7 months and 6 days more compared to the SLIHS and the gender distribution was comparable between the studies.

Table 3: Basic PRESSCO data compared with SLIHS 2018

	PRESSCO 2019			Sierra Leone Integrated Household Survey (SLIHS) 2018			Significance **
	Rural (%)	Urban (%)	Total (%)	Rural (%)	Urban (%)	Total (%)	
Household data							
No of HHs included	1252 (66,8%)	623 (33,2%)	1875 (100%)	3440 (50,3%)	3400 (49,7%)	6840 (100%)	
No of HHs interviewed	1241	615	1856	3440	3400	6840	
No of HHs with available data	1241	613	1854	3440	3400	6840	
Response rate	99,12%	98,39%	98,89%	100%	100%	100%	
Mean HH size	5.2	5.1	5.2	6.2	5.8	6.0	P<0.0001
Small HH (1-2 HHMs)	10,2%	13,5%	11,3%			2,2%	P<0.0001
Medium HH (3-6 HHMs)	64,5%	61,8%	63,6%			41,9%	P<0.0001
Large HH (7-10 HHMs)	21,7%	19,9%	21,1%			44,4%	P<0.0001
Very large HH (>=11 HHMs)	3,6%	4,7%	4,0%			11,6%	P<0.0001
Individual data							
Participants	6782 (67,8%)	3219 (32,2%)	10001 (100%)				
Alive	6507	3140	9647 (96,5%)				
Deceased	275	79	354 (3,5%)				
Death rate, crude	40,5/1000 population	24,5/1000 population	35,4/1000 population	16,0/1000 population *	12,8/1000 population *	14,7/1000 population *	
Gender							
Female	3489 (51,5%)	1727 (53,7%)	5216 (52,2%)	52,1%	52,1%	52,1%	P=0.88
Male	3289 (48,5%)	1490 (46,3%)	4779 (47,8%)	47,8%	47,9%	47,9%	P=0.88
Mean age	24,2	23,4	23,9			23,3	P=0.005
Age groups							
0-9 years	2319 (34,2%)	868 (27,0%)	3187 (31,9%)			30,1%	P=0.003
10-19 years	1306 (19,3%)	820 (25,5%)	2126 (21,3%)			22,9%	P=0.003
20-29 years	1043 (15,4%)	625 (19,4%)	1668 (16,7%)			15,3%	P=0.004
30-39 years	775 (11,4%)	382 (11,9%)	1157 (11,6%)			11,8%	P=0.636
40-49 years	512 (7,5%)	208 (5,5%)	720 (7,2%)			7,9%	P=0.045
50-59 years	352 (5,2%)	145 (4,5%)	497 (5,0%)			6,0%	P=0.001
>60 years	429 (6,3%)	132 (4,1%)	561 (5,6%)			6,1%	P=0.107
Unknown/Missing			85 (0,9%)				

* Data from Sierra Leone 2015 Population and Housing census. (72)

** Significance of the difference between totals.

Table 4. Sample PRESSCO and population Sierra Leone

	Sample PRESSCO (% of total)	Population SLIHS 18 (% of total) *	Variance
Gender			
Female	5216 (52,2%)	3.928.798 (52,1%)	P = 0.8424
Male	4779 (47,8%)	3.606.085 (47,9%)	P = 0.8424
Locality			
Rural	6782 (67,8%)	4.754.139 (63,1%)	P < 0.0001
Urban	3219 (32,2%)	2.780.842 (36,9%)	P < 0.0001
District			
Bo	773 (7,7%)	617.618 (8,2%)	P = 0.0701
Bombali	639 (6,4%)	399.656 (5,3%)	P < 0.0001
Bonthe	333 (3,3%)	229.355 (3,04%)	P = 0.1327
Falaba	334 (3,3%)	248.096 (3,29%)	P = 0.9556
Kailahun	587 (5,9%)	546.308 (7,25%)	P < 0.0001
Kambia	441 (4,4%)	386.718 (5,13%)	P = 0.0010
Karene	391 (3,9%)	279.711 (3,71%)	P = 0.3181
Kenema	860 (8,6%)	668.009 (8,87%)	P = 0.3454
Koinadugu	278 (2,8%)	258.575 (3,43%)	P = 0.0006
Kono	624 (6,2%)	384.743 (5,11%)	P < 0.0001
Moyamba	569 (5,7%)	359.520 (4,77%)	P < 0.0001
Port Loko	853 (8,6%)	646.715 (8,58%)	P = 0.9434
Pujehun	367 (3,7%)	342.726 (4,55%)	P < 0.0001
Tonkolili	936 (9,4%)	756.425 (10,04%)	P = 0.0343
Western Area Rural	384 (3,8%)	406.306 (5,39%)	P < 0.0001
Western Area Urban	1632 (16,3%)	1.004.500 (13,33%)	P < 0.0001
Total	10.001 (100%)	7.534.981 (100%)	

* Data from the Sierra Leone Integrated Household Survey Report (2019). (54)

Chapter two; Surgical Volume (SV)

Of all the participants, 1.095 (incidence of 10.9%) reported having had at least one minor surgical procedure (MiSP) in the previous year (table 5). Male participants had more MiSPs, but this is no significant difference. When observed in the different age groups, minor procedures were more common in between the ages of 21 and 50 years (49,9% of MiSPs were performed). In table 5, the age group 51-60 is used as a baseline for comparison, this group had an incidence closest to the mean. In the youngest age group (0-10y) significantly fewer MiSP were performed. In the groups 21-30y, 31-40y, 41-50y the odds of having received a MiSP were significantly higher (1,94, 1,70 and 1,70 respectively).

The odds undergoing a MiSP were similar for both for participants from urban and rural localities of. In addition, the district of residence did not increase the odds of receiving a MiSP. Only the participants who lived in Kailahun, underwent significant more minor procedures.

A total of 140 participants (incidence of 1,4%) had at least one major surgical procedure (MASP) in the previous year (table 6). Female participants underwent significantly less surgical procedures compared to male participants. The odds for females for receiving a MASP were 0.66 time lower compared their male counterparts.

Table 5: Participants with minor surgical procedures (MiSPs)

	All included participants	Participants with (1 or more) <u>MiSP</u>	95% CI	Odds ratio	P-value (95% CI)
	Number (%)	Number (incidence)			
Gender					
Female	5216 (52,2%)	542 (10,4%)	0,096 - 0,113	1,13	P=0,059 (0,99 - 1,27)
Male	4779 (47,8%)	553 (11,6%)	0,107 - 0,125		
Unknown	6 (0,1%)				
Age Group					
0-10 years	3187 (31,9%)	205 (6,4%)	0,056 - 0,073	0,61	P=0,003 (0,44 - 0,85)
11-20 years	2126 (21,3%)	191 (9,0%)	0,078 - 0,103	0,88	P=0,455 (0,64 - 1,22)
21-30 years	1668 (16,7%)	298 (17,9%)	0,161 - 0,198	1,94	P<0,001 (1,41 - 2,67)
31-40 years	1157 (11,6%)	185 (16,0%)	0,139 - 0,182	1,70	P=0,002 (1,22 - 2,37)
41-50 years	720 (7,2%)	115 (16,0%)	0,134 - 0,189	1,70	P=0,003 (1,19 - 2,42)
51-60 years	497 (5,0%)	50 (10,1%)	0,076 - 0,130		Base outcome
>60	561 (5,6%)	47 (8,4%)	0,062 - 0,110	0,82	P<0,345 (0,54 - 1,24)
Unknown/Missing	85 (0,8%)	4			
Locality					
Rural	6782 (67,8%)	752 (11,1%)	0,104 -0,119	0,96	P=0,51 (0,83 - 1,09)
Urban	3219 (32,2%)	343 (10,7%)	0,096 -0,118		
District of Residence					
Bo	773 (7,7%)	73 (9,4%)	0,075 -0,117	0,86	P=0,29
Bombali	639 (6,4%)	62 (9,7%)	0,075 -0,123	0,88	P=0,44
Bonthe	333 (3,3%)	33 (9,9%)	0,069 -0,136	0,91	P=0,62
Falaba	334 (3,3%)	42 (12,6%)	0,092 -0,166	1,18	P=0,36
Kailahun	587 (5,9%)	83 (14,1%)	0,114 -0,172	1,35	P=0,03
Kambia	441 (4,4%)	41 (9,3%)	0,068 -0,124	0,84	P=0,35
Karene	391 (3,9%)	37 (9,5%)	0,066 -0,128	0,86	P=0,43
Kenema	860 (8,6%)	90 (10,5%)	0,085 -0,127	0,96	P=0,77
Koinadugu	278 (2,8%)	40 (14,4%)	0,105 -0,191	1,38	P=0,09
Kono	624 (6,2%)	51 (8,2%)	0,061 -0,106	0,73	P=0,06
Moyamba	569 (5,7%)	69 (12,1%)	0,096 -0,151	1,13	P=0,40
Port Loko	853 (8,6%)	89 (10,4%)	0,085 -0,127	0,96	P=0,76
Pujehun	367 (3,7%)	43 (11,7%)	0,086 -0,155	1,09	P=0,63
Tonkolili	936 (9,4%)	124 (12,3%)	0,111 -0,156	1,26	P=0,07
WAR	384 (3,8%)	41 (10,7%)	0,078 -0,142	0,98	P=0,92
WAU	1632 (16,3%)	177 (10,8%)	0,094 -0,125		Base outcome
Total	10.001	1095 (10,9%)	0,103 -0,116		

Table 6: Participants with major surgical procedures (MASPs)

	All included participants Number (%)	Participants with (1 or more) Major Surgical procedure Number (incidence)	95% CI	Odds ratio	P-value (95% CI)
Gender					
Female	5.216 (52,2%)	59 (1,13%)	0,009 - 0,015	0,66	P=0,017 (0,47 - 0,93)
Male	4.779 (47,8%)	81 (1,69%)	0,013 - 0,021		
Unknown	6 (0,1%)				
Age Group					
0-10 years	3.187 (31,9%)	5 (0,2%)	0,001 - 0,004	0,08	P<0,001 (0,03 - 0,21)
11-20 years	2.126 (21,3%)	22 (1,0%)	0,006 - 0,016	0,53	P<0,001 (0,31 - 0,92)
21-30 years	1.668 (16,7%)	32 (1,9%)	0,013 - 0,027	Base outcome	
31-40 years	1.157 (11,6%)	24 (2,1%)	0,013 - 0,031	1,08	P=0,770 (0,63 - 1,85)
41-50 years	720 (7,2%)	20 (2,8%)	0,017 - 0,043	1,46	P=0,19 (0,83 - 2,57)
51-60 years	497 (5,0%)	19 (3,8%)	0,023 - 0,059	2,03	P=0,016 (0,14 - 3,62)
>60	561 (5,6%)	16 (2,9%)	0,016 - 0,046	1,50	P=0,19 (0,81 - 2,76)
Unknown/Missing	85 (0,8%)	2			
Locality					
Rural	6782 (67,8%)	91 (1,3%)	0,011 - 0,016	1,14	P=0,47 (0,80 - 1,61)
Urban	3219 (32,2%)	49 (1,5%)	0,011 - 0,020		
District of Residence					
Bo	773 (7,7%)	8 (1,0%)	0,004 - 0,020	0,73	P=0,45
Bombali	639 (6,4%)	12 (1,9%)	0,010 - 0,033	1,34	P=0,41
Bonthe	333 (3,3%)	2 (0,6%)	0,001 - 0,220	0,42	P=0,25
Falaba	334 (3,3%)	6 (1,8%)	0,007 - 0,039	1,28	P=0,60
Kailahun	587 (5,9%)	13 (2,2%)	0,012 - 0,038	1,58	P=0,19
Kambia	441 (4,4%)	7 (1,6%)	0,006 - 0,032	1,13	P=0,77
Karene	391 (3,9%)	0			
Kenema	860 (8,6%)	15 (1,7%)	0,010 - 0,029	1,24	P=0,52
Koinadugu	278 (2,8%)	3 (1,1%)	0,002 - 0,031	0,76	P=0,65
Kono	624 (6,2%)	8 (1,3%)	0,006 - 0,025	0,91	P=0,83
Moyamba	569 (5,7%)	7 (1,2%)	0,005 - 0,025	0,87	P=0,75
Port Loko	853 (8,6%)	10 (1,2%)	0,006 - 0,021	0,83	P=0,63
Pujehun	367 (3,7%)	6 (1,6%)	0,006 - 0,035	1,16	P=0,75
Tonkolili	936 (9,4%)	14 (1,5%)	0,008 - 0,025	1,06	P=0,87
WAR	384 (3,8%)	5 (1,3%)	0,004 - 0,030	1,11	P=0,82
WAU	1632 (16,3%)	23 (1,4%)	0,009 - 0,021	Base outcome	
Total	10.001	140 (1,4%)	0,012 - 0,016		

The age group with the highest incidence of MASPs was 51-60y (table 6). Compared to the base outcome, significantly more MASPs were performed in this group (OR 2,03). Significantly fewer major procedures were observed in the two youngest age groups 0-10y and 11-20y. The odds of undergoing a MASP were 0,08 and 0,53 respectively, compared to the baseline. While the group of

children under 10 year represented 31,9% of the participants, they had only 3,6% of the major procedures. No significant differences were seen in terms of incidences of MASPs and the locality of residence. This is similar for district of residents if the base outcome is set on the district with closest to the mean incidence (WAU). Additionally, if the district of residence with the lowest incidence for MASP (Bonthe 0,6%) is compared to the district with the highest incidence (Kailahun 2,2%) no statistically significant difference is observed in this study (p=0.08, CI 0.84 - 16.7). However, no MASPs were observed for participants living in Karene district.

In table 7, all the MiSPs that have been performed in the previous year within the study group have been summarized. A total of 1221 minor surgical procedures we performed, corresponding to an incidence of 12.2%. This is slightly different compared to the incidence of participants with MiSPs, findings from table 5, and can be explained because 126 (10,3%) of the MiSPs were done as a second or third procedure.

If extrapolated to the general population, we estimate an incidence rate of 12.210 minor procedures per 100.000 population. The most common minor procedures were normal deliveries (20.0%), tooth extractions (19,7%) and incision & drainage (17.4%). Other and unknown minor procedures consisted of 4.5% and 0.1% respectively.

Table 7: Overview Minor Surgical Procedures

	Number (% of all minor procedures)	per 100.000 population (incidence %)	95% CI
Minor Surgical Procedures			
<i>General Surgery</i>			
Incision & Drainage of abscess	212 (17,4%)	2120 (2,1%)	0,018 - 0,024
Male Circumcision	104 (8,5%)	1040 (1,0%)	0,009 - 0,013
Urinary Catherization	11 (0,9%)	110 (0,1%)	0,0005 - 0,002
Dressing of Wounds	135 (11,1%)	1350 (1,4%)	0,011 - 0,016
Punctures	28 (2,3%)	280 (0,3%)	0,002 - 0,004
<i>Obs&Gyn</i>			
Normal Delivery	244 (20,0%)	2440 (2,4%)	0,021 - 0,028
<i>Trauma/Injury</i>			
Suturing of Laceration	124 (10,2%)	1240 (1,2%)	0,010 - 0,015
Conservative management of fractures	58 (4,8%)	580 (0,6%)	0,004 - 0,007
<i>Dental</i>			
Tooth extraction	240 (19,7%)	2400 (2,4%)	0,021 - 0,027
<i>Other</i>			
Unspecified	56 (4,5%)	560 (0,6%)	0,004 - 0,007
Unknown/Missing	9 (0,7%)	90 (0,1%)	0,001 - 0,002
Total	1221 (100%)	12.210 (12,2%)	

A summary of the MASPs has been provided in table 8. A total of 152 major procedures were observed within the last year in the study group, corresponding to an incidence of 1,52%. The annual national surgical volume (SV) is estimated on 1520 procedures per 100.000 population.

Twelve major operations (7,9%) were done as a second procedure for a participant in the same year, this explains the difference in incidence for MASP compared to table 6.

The MASPs listed in table 8 are those proposed in the questionnaire (appendix 4). The most common procedures were hernia repairs (30,9% of all procedures), CS (23,7%) and appendectomy's (13,8%). These three procedures make up for more than two-thirds of all MASPs in the study group. 14 procedures (9,2%) could not be identified directly by the HH representatives

and were marked as 'other'. With the additional information provided they were classified into the surgical categories.

Table 8: Overview Major Surgical Procedures

	Number of major procedures (%)	Per 100.000 population (incidence %)	95% CI
Major Surgical Procedures			
<i>General surgery</i>	82 (53,9%)	820 (0,82%)	0,0065 - 0,010
Repair of abdominal perforations	2 (1,3%)	20 (0,02%)	0,0000 - 0,0007
Abdominal operation, unspecified	1 (0,7%)	10 (0,01%)	0,0000 - 0,0005
Appendectomy	21 (13,8%)	210 (0,21%)	0,0013 - 0,0032
Cholecystectomy	0		
Colo/Ileostomy	0		
Groin hernia repair	47 (30,9%)	470 (0,47%)	0,0035 - 0,0062
Hydrocelectomy	0		
Orchidectomy	0		
Cystostomy catheter	0		
Cardiac operation	0		
Mastectomy or lumpectomy breast	1 (0,7%)	10 (0,01%)	0,0000 - 0,0005
Other, general surgery	10 (6,6%)	100 (0,1%)	0,0005 - 0,0018
<i>Obs&Gyn</i>	45 (29,6%)	450 (0,45%)	0,0033 - 0,0060
Caesarean Section	36 (23,7%)	360 (0,36%)	0,0025 - 0,0050
Ectopic pregnancy	1 (0,7%)	10 (0,01%)	0,0000 - 0,0005
Manual vacuum aspiration and dilation and curettage	*	*	*
Tubal Ligation	1 (0,7%)	10 (0,01%)	0,0000 - 0,0005
Hysterectomy (pregnancy related)	0		
Hysterectomy (non-pregnancy related)	0		
Myomectomy	3 (2,0%)	30 (0,03%)	0,0001 - 0,0009
Uterus prolapse operation	0		
Obstetric fistula repair	0		
Other, Obs&Gyn	4 (2,6%)	40 (0,04%)	0,0001 - 0,0010
<i>Trauma/Injury</i>	11 (7,2%)	110 (0,11%)	0,0005 - 0,0020
Chest drain	0		
Fracture reduction (conservative)	2 (1,3%)	20 (0,02%)	0,0000 - 0,0007
Fracture reduction (surgical)	4 (2,6%)	40 (0,04%)	0,0001 - 0,0010
External fixator	0		
Amputations	2 (1,3%)	20 (0,02%)	0,0000 - 0,0007
Skin grafting	1 (0,7%)	10 (0,01%)	0,0000 - 0,0005
Surgical wound debridement	2 (1,3%)	20 (0,02%)	0,0000 - 0,0007
Other, trauma/injury	0		
<i>Non-trauma orthopedic</i>	0 (0%)	-	
Sequestrectomy	0		
Other, non-trauma orthopedic	0		
<i>Dental operations</i>	2 (1,3%)	20 (0,02%)	0,0000 - 0,0007
<i>Eye operations</i>	9 (5,9%)	90 (0,09%)	0,0004 - 0,0017
<i>Congenital operations</i>	0 (0%)	-	
Cleft lip repair	0		
Club foot repair	0		
Hydrocephalus shunt	0		
Anorectal malformation repair	0		
Other, congenital	0		
Unknown	3 (2,0%)	30 (0,03%)	0,0001 - 0,0009
Total	152 (100%)	1520 (1,52%)	

* Manual vacuum aspiration and dilation and curettage was not mentioned as part of the questionnaire in the list of proposed procedures recognizable by the HHrep.

Three procedures (2%) lacked additional information and could not be classified and were subsequently marked as 'unknown'. No 'non-trauma orthopedic' and 'congenital' operations were captured within the study group. In addition, 'manual vacuum aspirations and dilatation and curettage' was not observed. This procedure happened to be absent from the questionnaire, and could be represented in 'Other, Obs&Gyn'.

For table 9, the layout and idea of DCP3 essential surgical package is used (appendix 1). In this overview (vertically) the MiSPs and MASPs have been grouped in the broader surgical categories proposed by the DCP3. Also, the procedures observed in the study sample were labelled as 'essential' and 'non-essential'. Horizontally, the category health facility best suited to perform the surgical procedure was outlined.

Within the study group, 81,3% of the observed minor procedures were essential. For the major procedures (2nd and 3rd hospital category combined), a total of 87,5% were essential procedures.

Out of all the MASPs, only nine (5,9%) were categorized as more complex essential procedures that should ideally be done at a more specialized health care facility. Other examples of essential procedures from this category are 'obstetric fistula repairs' and 'congenital operations' (Appendix 1), but again, these were not observed in the sample.

Table 9: Classification of procedures in PRESSCO sample according to the essential surgical package

	1 st category community/primary health facility <i>minor procedures</i>	2 nd category first level hospital <i>major procedures</i>	3 rd category second and third level hospital <i>major procedures</i>
	Number of procedures	Number of procedures	Number of procedures
General Surgery	490	82	
Essential	327	75	
Non-essential	163	7	
Obs/Gyn	244	45	0
Essential	244	40	
Non-Essential	0	5	
Trauma/Injury	182	11	
Essential	182	9	
Non-Essential	0	2	
Non-trauma Orthopedic		0	
Essential		0	
Non-Essential		0	
Dental	240	2	
Essential	240	0	
Non-Essential	0	2	
Congenital			0
Essential			0
Non-Essential			0
Visual			9
Essential			9
Non-Essential			0
Other	56	-	0
Essential procedures	993 (81,3%)	124 (86,7%)	9 (100%)
Non-essential procedures	219 (17,9%)	16 (11,2%)	0 (0%)
Unknown	9 (0,7%)	3 (2,1%)	
Total procedures	1221 (100%)	143 (100%)	9 (100%)

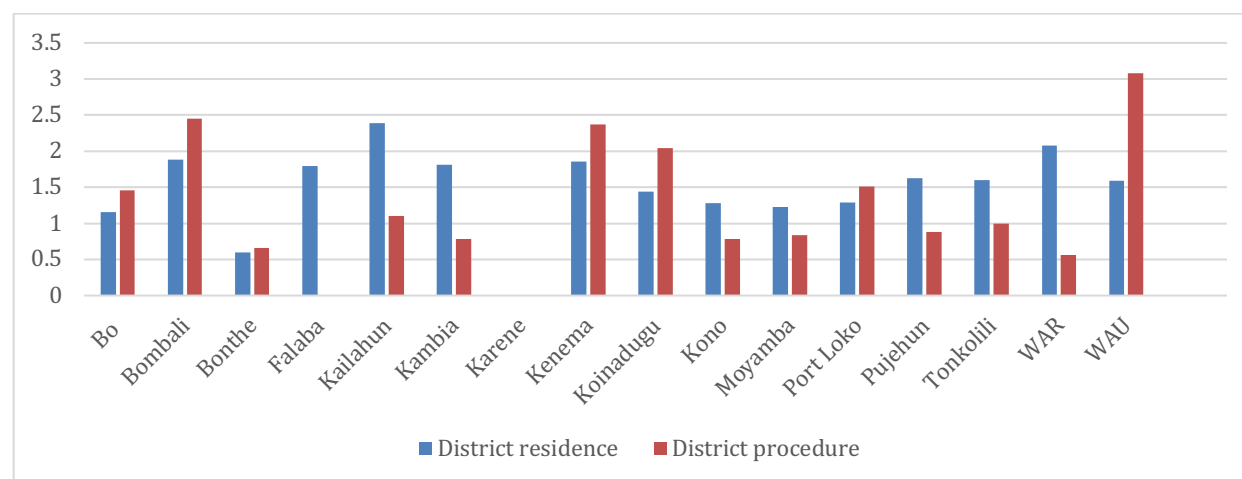
Layout from this table is adapted from the DCP3 essential surgical package (Appendix 1). (3)

With regard to the distribution of MASPs per district, we need to clarify the difference between 'district of residence' and 'district of procedure'. District of residence refers to the district where the participant's (that underwent a MASP) household is located. The district of procedure means the district where the surgical facility is located that has performed the MASP. In table 10 (and figure 2) the MASPs are sorted by district. The three districts where most MASPs were performed were WAU, Bombali and Kenema (incidences of 3,08%, 2,45% and 2,37% respectively). However, the top three districts where most population has undergone a MASP were Kailahun, WAR and Bombali (incidence of 2,39%, 2,08% and 1,88% respectively).

Table 10: Major Surgical Procedures per district

	Number of procedures performed in sample (% of total)	Per 100.000 population (incidence %)	Number of procedures performed in sample (% of total)	Per 100.000 population (incidence %)
	District of residence		District of procedure	
Bo	9 (5,92%)	1164 (1,16%)	12 (7,89%)	1463 (1,46%)
Bombali	12 (7,89%)	1877 (1,88%)	13 (8,55%)	2450 (2,45%)
Bonthe	2 (1,32%)	601 (0,60%)	2 (1,32%)	659 (0,66%)
Falaba	6 (3,95%)	1796 (1,79%)	0	
Kailahun	14 (9,21%)	2385 (2,39%)	8 (5,26%)	1103 (1,10%)
Kambia	8 (5,26%)	1814 (1,81%)	4 (2,63%)	779 (0,78%)
Karene	0		0	
Kenema	16 (10,53%)	1860 (1,86%)	21 (13,82%)	2374 (2,37%)
Koinadugu	4 (2,63%)	1439 (1,44%)	7 (4,61%)	2040 (2,04%)
Kono	8 (5,26%)	1282 (1,28%)	4 (2,63%)	783 (0,78%)
Moyamba	7 (4,61%)	1230 (1,23%)	4 (2,63%)	838 (0,84%)
Port Loko	11 (7,24%)	1290 (1,29%)	13 (8,55%)	1514 (1,51%)
Pujehun	6 (3,95%)	1635 (1,63%)	4 (2,63%)	879 (0,88%)
Tonkolili	15 (9,87%)	1603 (1,60%)	10 (6,58%)	996 (1,00%)
WAR	8 (5,26%)	2083 (2,08%)	3 (1,97%)	555 (0,56%)
WAU	26 (17,11%)	1593 (1,59%)	41 (26,97%)	3075 (3,08%)
Unknown	0		6 (3,95%)	
Total	152 (100%)	1520 (1,52%)	152 (100%)	1520 (1,52%)

Figure 2: Major Surgical Procedures per district (incidence %)



The fact that participants were not operated in their own district for these MASPs implies that people travel for their surgical procedures. In table 11, an overview is provided for which MASPs the participants find operative care in their own district and for which they travel to other districts. Overall, about one-third (34,9%) of the participants have travelled to other districts for their MASPs in the previous year. Procedures for trauma/injuries and eye operations were mostly performed in non-resident districts (72,7 and 66,7% respectively). CS were mostly performed in the districts of residents (80%).

Table 11: Major Surgical Procedures performed in district of residence

	Procedure done in district of residence	Procedure not done in district of residence	Unknown	Total number of MASPs
Major Surgical Procedures				
<i>General surgery</i>	52 (63,4%)	27 (32,9%)	3 (3,7%)	82 (100%)
Repair of abdominal perforations	1	1		2
Abdominal operation, unspecified	1			1
Appendectomy	13 (61,9%)	7 (33,3%)	1 (4,8%)	21
Groin hernia repair	31 (66,0%)	15 (31,9%)	1 (2,1%)	47
Mastectomy or lumpectomy breast		1		1
Other, general surgery	6	3	1	10
<i>Obs&Gyn</i>	34 (75,6%)	11 (24,4%)		45 (100%)
Caesarean Section	30 (80%)	6 (20%)		36
Ectopic pregnancy		1		1
Myomectomy	2	1		3
Tubal ligation	1			1
Other, Obs&Gyn	1	3		4
<i>Trauma/Injury</i>	3 (27,3%)	8 (72,7%)		11 (100%)
Fracture reduction (conservative)	1	1		2
Fracture reduction (surgical)		4		4
Amputations		2		2
Skin grafting	1			1
Surgical wound debridement	1	1		2
<i>Dental operation</i>	1 (50%)	1 (50%)		2 (100%)
<i>Eye operation</i>	3 (33,3%)	6 (66,7%)		9 (100%)
<i>Unknown</i>			3	3
Total	93 (61,2%)	53 (34,9%)	6 (3,9%)	152 (100%)

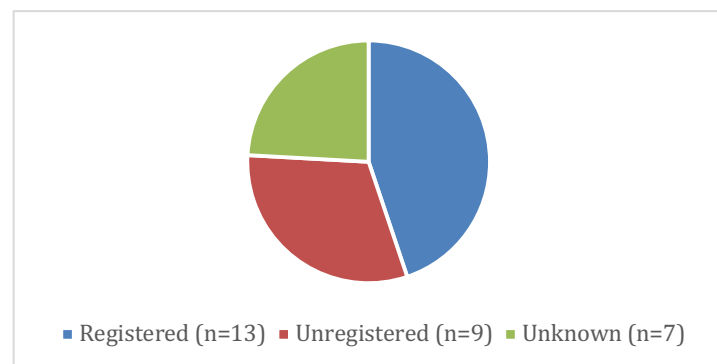
In table 12 the results with regard to the procedure locations have been pictured. Nearly four-fifth (78,9%) of the MASPs have been performed in the public sector against nearly one-fifth (19,1%) in the private sector. CS, appendectomies and hernia repairs were predominantly done in the governmental hospitals (91,7%, 90,5% and 70,2% respectively).

Table 12: Facility type of Major Surgical Procedures

	Governmental facility	Private facility, registered	Private facility, unregistered	Private facility, unknown	Unknown facility	Total
Major Surgical Procedures						
<i>General surgery</i>	64 (78%)	5 (6,1%)	6 (7,3%)	6 (7,3%)	1 (1,2%)	82
Repair of abdominal perforations	2					2
Abdominal operation, unspecified	1					1
Appendectomy	19 (90,5%)	1 (4,8%)		1 (4,8%)		21
Groin hernia repair	33 (70,2%)	4 (8,5%)	6 (12,8%)	3 (6,4%)	1 (2,1%)	47
Mastectomy or lumpectomy breast	1					1
Other, general surgery	8			2		10
<i>Obs&Gyn</i>	40 (88,9%)	5 (11,1%)				45
Caesarean Section	33 (91,7%)	3 (8,3%)				36
Ectopic pregnancy	1					1
Tubal ligation	1					1
Myomectomy	2	1				3
Other, Obs&Gyn	3	1				4
<i>Trauma/Injury</i>	9 (81,8%)	1 (9,1%)	1 (9,1%)			11
Fracture reduction (conservative)	1		1			2
Fracture reduction (surgical)	4					4
Amputations	2					2
Skin grafting	1					1
Surgical wound debridement	1	1				2
<i>Dental operation</i>	1	1				2
<i>Eye operation</i>	6 (66,7%)	1 (11,1%)	2 (22,2%)			9
<i>Unknown</i>				1	2	3
Total	120 (78,9%)	13 (8,6%)	9 (5,9%)	7 (4,6%)	3 (2,0%)	152

Of the 29 procedures that were performed in the private facilities, almost half (44,8%) were done in facilities that were registered with the MDC (figure 3). For about a quarter (24,1%) of the cases it was unknown in what type of private facility the HH member had their procedure. Almost one-third (31%) underwent their procedure in an unregistered private facility.

Figure 3: Major Surgical Procedure in Private Facilities



The most common private MASP was the hernia repair (44,8%). Of these 13 procedures, 6 (46,2%) were done at unregistered facilities, equalling 60 per 100.000 population which represent more than 4000 hernia repairs per year in Sierra Leone. Additionally, 22,2% of the eye operations were done in the private unregistered sector (table 12).

Chapter three; population-based SV compared to facility-based SV

In table 13, the main (and most relevant for comparison) results have been outline against the data from a surgical mapping conducted in 50 hospitals in Sierra Leone in 2017. (73) It must be noted that as a consequence of the study design, the number of MASPs observed in the PRESSCO (population-based study) is much smaller compared to the facility-based study. This makes it more complex to compare. Confidence intervals for the incidence rates have not been calculated (because it concerns a extrapolation at population level), but these would certainly be wide due to the low numbers. Overall, the SV is almost 4 times higher in this study compared to the facility survey (1520/100.000 population vs 406/100 population). This also reflects in the incidences for MASPs in the different districts.

Table 13: Surgical Volume compared; PRESSCO 2019 vs Surgical Mapping 2017

	PRESSCO 2019 (population-based study)		Surgical Mapping 2017 (73) (facility-based study)	
	Procedures performed in study sample (% of total)	Procedures per 100.000 population (incidence %)	Procedures performed in study sample (% of total)	Procedures per 100.000 population (incidence %)
District of procedure				
Bo	12 (7,9%)	1463 (1,46%)	5044 (16,6%)	827 (0,83%)
Bombali	13 (8,6%)	2450 (2,45%)	2735 (9,0%)	426 (0,43%)
Bonthe	2 (1,32%)	659 (0,66%)	258 (0,85%)	123 (0,12%)
Falaba	0		*	*
Kailahun	8 (5,26%)	1103 (1,10%)	357 (1,2%)	64 (0,06%)
Kambia	4 (2,63%)	779 (0,78%)	509 (1,7%)	139 (0,14%)
Karene	0		*	*
Kenema	21 (13,82%)	2374 (2,37%)	1046 (3,4%)	162 (0,16%)
Koinadugu	7 (4,61%)	2040 (2,04%)	906 (2,9%)	209 (0,21%)
Kono	4 (2,63%)	783 (0,78%)	1206 (4,0%)	225 (0,23%)
Moyamba	4 (2,63%)	838 (0,84%)	119 (0,39%)	35 (0,04%)
Port Loko	13 (8,55%)	1514 (1,51%)	2548 (8,4%)	392 (0,39%)
Pujehun	4 (2,63%)	879 (0,88%)	668 (2,2%)	182 (0,18%)
Tonkolili	10 (6,58%)	996 (1,00%)	2206 (7,3%)	393 (0,39%)
WAR	3 (1,97%)	555 (0,56%)	369 (1,2%)	80 (0,08%)
WAU	41 (26,97%)	3075 (3,08%)	12.451 (40,9%)	1112 (1,11%)
Unknown	6 (3,95%)			
Total	152 (100%)	1520 (1,52%)	30.423 (100%)	406 (0,41%)
Facility type				
Government	78,9%	1199 (1,12%)	48,6%	197 (0,20%)
Private	19,1%	290 (0,29%)	51,4%	209 (0,21%)
Unknown	2,0%			
Key major surgical procedures				
Caesarean section	36 (23,7%)	360 (0,36%)	8434 (27,7%)	119 (0,12%)
Groin hernia	47 (30,9%)	470 (0,47%)	4884 (16,1%)	69 (0,07%)
Appendectomy	21 (13,8%)	210 (0,2%)	1144 (3,8%)	16 (0,02%)
Eye surgery	9 (5,9%)	90 (0,09%)	4108 (13,5%)	58 (0,06%)

* The district Falaba and Karene were not yet formed at the time of data collection

In addition, a noteworthy variance is seen with regard to the facility type where procedures were performed. In the PRESSCO more than three-fourth of (78,9%) were done in the public sector, whereas this was about half the procedures (48,6%) in the facility mapping. This variance is mostly due to the difference in surgical activity in the public sector (1199 vs 197 procedures per 100.000 population in the PRESSCO and facility survey respectively, a six-fold difference).

As for the key MASPs, in both studies CS and hernias were the most common surgical procedures performed. The proportion of CS out of all operations was relatively similar for the household survey and the facility study (23,7% and 27,7% respectively), but the incidence was 3 times higher for the PRESSCO study compared with the facility based study. For groin hernias the proportion of total procedures was almost two times higher in the PRESSCO (30,9% vs 16,1%) and the incidence rate 7 times higher.

Chapter four; Peri-operative Mortality Rate (POMR)

The characteristics of the deceased participants who have also undergone a MASP in the previous year have been summarised in table 14. These participants are 11 in number, of the in total 140 participants with a MASP (also see table 6). Five of the identified deceased passed away within 30 days after the procedure. This provides us with an unadjusted, all-cause, 30-day POMR of 3,6%. All five participants were female and had a mean age of 38,6 years. Three died within a month after a CS, which gives a perioperative mortality of 8,3%. The unadjusted, all-cause 7-day POMR is 2,9%. The unadjusted, all-cause in-hospital POMR (indicator as proposed by the LCoGS) was 2,1%. Sufficient information for two deceased participants was not available to be able to categorize them into the POMR group.

Table 14: Deceased participants who underwent a major surgical procedure

Case nr.	Gender	Age	District of residence	Urban / Rural	Problem before surgery	Type of MASP before death	Time between MASP and death	Location of passing away	Facility type	District of procedure
1	Male	65	Western Area Urban	Urban	Abdominal distention or pain	Groin hernia	> 30 days	Home	Private	Western Area Urban
2	Female	50	Western Area Urban	Urban	Mass (growth or swelling)	Other, general surgery	≤ 7 days	Hospital	Government	Port Loko
3	Female	35	Port Loko	Rural	Sickle cell disease	Caesarean Section	≤ 7 days	Hospital	Government	Kenema
4	Female	64	Kenema	Urban	Abdominal distention or pain	Abdominal operation, unspecified *	≤ 7 days	Home	Government	Western Area Urban
5	Female	22	Western Area Urban	Rural	Prolonged/obstructed labour	Caesarean Section	≤ 30 days	Home	Government	Western Area Urban
6	Female	48	Kono	Rural	Mass (growth or swelling)	Mastectomy/lumpectomy	> 30 days	Home	Government	Western Area Urban
7	Male	23	Kenema	Rural	Abdominal distention or pain	Groin hernia	> 30 days	Community Health Clinic	Private	Western Area Rural
8	Female	22	Bombali	Rural	Hypertension	Caesarean Section	≤ 7 days	Hospital	Government	Port Loko
9	Male	60	Port Loko	Rural	Groin hernia	Groin hernia	> 30 days	Hospital	Government	Western Area Urban
10	Male	?	Kambia	Rural	Abdominal distention or pain	Groin Hernia	Unknown	Home	Government	Kambia
11	Male	30	Kono	Rural	None	Groin Hernia	Unknown	Home	Government	Kono

Participants marked grey passed away within 30-days of operation. Dark grey died at home and are not included in the LCoGS POMR.

* Household member was operated twice (2x abdominal operation, unspecified)

Discussion

Surgical Volume

To our knowledge, the methodology of a household survey to gather data for the LCoGS indicator 'surgical volume - SV' is novel.

The national annual surgical volume (incidence rate of MASPs) of 1520 procedures per 100.000 population is almost four times the volume observed in previous facility-based studies in Sierra Leone. (63,73) While facility-based studies are the selected method for the LCoGS to generate data on the SV indicator for sake of feasibility (8), in low-resource settings various challenges can be identified that can lead to underrepresentation of the SV. First, the data we have collected strongly suggests the presence of surgically active facilities that have not been registered with the MDC. This hinders the identification of these facilities, which is necessary before data collection in facility based studies can be conducted. Secondly, not all identified facilities provide the consent for surgical logbook data to be collected. Finally, the theatre logbooks might be incomplete. Registration could simply be forgotten, or avoided to allow for illegitimate payment practises. Indirect indications for this latter manifestation could be the high percentage of procedures performed in the governmental sector found in this study (78,9%; compared to 48,6% in the facility-based study). The discrepancy between what is reported by the HH representative and what is written in the surgical logbooks could, however, also be influenced by bias in this study. Some private non-profit hospitals are collaborating closely with the government and might be perceived as a governmental facilities by the people. Nevertheless, the remarkable difference between the population-based and the facility-based SV invites for subsequent investigations. Qualitative research with surgical health care professionals could provide a better insight, despite the possibly sensitive topic. Although, the SV is higher compared to the previous finding, it is still well below the proposed minimal benchmark of 5000 operations per 100.000 population as set by the LCoGS. When the LCoGS-target is taken as a denominator, approximately 70% of the surgical burden remains unmet in Sierra Leone.

Essential Major Surgical Procedures

Zooming in on the individual major procedures provides an impression of their share on the overall SV. The high percentage of the SV that can be categorised as essential procedures (87,5%) is another interesting finding. Ghana is situated in a similar setting in West-Africa, but categorized in an income level higher compared to Sierra Leone (lower-middle). A recent paper of a facility-based survey shares a nationwide essential surgical rate of 77% on a SV of 416/100.000 population. (74) In this study, the proportion of CS on the SV is 23,7%. This is a very similar percentage as suggested by Weiser et al. in 2016. "In low-resource settings CS accounted for 29,6% of all operations performed. In high-expenditure countries this was only 2,7%." (14) This data suggest that as the surgical capacity develops, and total health expenditure increases, the percentage of essential surgeries as part of the SV drops. In this study, the three most frequent procedures (hernia's, CS and appendectomy's) make up for two-thirds the SV. Of course, the focus is apprehensible as these three procedures deal with disorders with a high burden, (3,75) and can be classified as potentially lifesaving and cost-effective. On the downside, it signifies that there is less attention for other (essential) surgical disorders. Especially, more specialised surgical care (e.g. trauma, orthopaedics and congenital operations) were hardly observed. Only 5,9% of the SV was labelled as tertiary surgical care (following the DCP3 model in table 9). All of these procedures consisted of eye operations. It suggests that tertiary care, with just two tertiary

hospitals in Sierra Leone, is vastly underdeveloped and that people with more demanding conditions do not receive the required surgical care.

Caesarean section (CS) rate

The percentage of CS as part of the SV is both in line with earlier publications and a previous facility-based study in Sierra Leone (table 13). In line with the higher SV in this study, the incidence of CS is larger compared to the facility based study (360 vs 119 per 100.000 population respectively). This had consequences for the CS rate. If we use the crude birth rate (33,4/1000 population) as a denominator we see a CS rate of 10,8%. This is much higher than earlier published results by Bolkan et al. and Holmer et al. (2,1% and 2,9% respectively). (65,76) Of course, we need to be careful with sub-analysis for specific procedures as the numbers are quite low and the PRESSCO was not powered for this. Nevertheless, if a proportion of CS between 20-30% of the SV is credible for Sierra Leone, and we rely on the total SV of this study, the CS rate might in reality be higher than was thought based upon the facility studies. Further research is needed to be able to explain this difference.

Inequities in surgical care

Another highly relevant finding of this study is that significant less major surgical procedures (MASPs) were conducted among female participants. The difference was also observed for minor surgical procedures (MiSPs), but just fell short in reaching statistical significance ($P=0,059$, CI 0,99 - 1,27). Questions with regard to gender equity and access to surgery must be raised looking at this result. Very little of the literature in the global surgical field mentions gender inequities, but a very recent publication describes a disparity between females and males in the global burden of surgical disease. The estimated overall prevalence of surgical disease among women compared to men is approximately 3:1. (77) In Sweden, a high-income country where the surgical burden is believed to be met with an annual SV of 17.480/100.000 population, 10% more surgeries were performed for woman. (33) Contrarily, in the SOSAS study in Sierra Leone this was not reflected. Males were more likely to report a present need for surgical care than were females. (57) The author explains that the study design, underrepresenting healthy males, might contribute to the difference. Nevertheless, based on the global estimates we would have expected a higher frequency of surgical procedures among females, not significantly fewer as observed here. This implies that access to surgical care is considerably poorer for females in Sierra Leone, even despite the 'free health care initiative' (see textbox 3). A contributing reason for this would be the less empowered position of females in Sierra Leone. Due to high out-of-pocket costs for surgery in Sierra Leone, household heads (traditionally males) are responsible to grant permission for a surgical procedure. (78) It is suggested that the collection of funds is more difficult to obtain for females in need of surgery compared to males. Other barriers for receiving surgical procedures for vulnerable populations (e.g. -perceived-quality of care and distance from health facilities) are thought to play a smaller role, (64) but should still be examined in more detail.

Textbox 3: Free Health Care Initiative

The Free Health Care Initiative was implemented in 2010 in Sierra Leone. Through this program free preventive and curative healthcare services for pregnant woman, lactating mothers and children under 5 years is offered in all governmental hospitals. Indirect costs, related to transport to the facility, feeding in case of admission, lack of income by the hospitalized patient and sometimes medicines and materials that are not available in the facilities, are to be covered by the patient.

Additionally, significant fewer surgical procedures were seen in the youngest age group (both MiSPs and MASPs). In the literature, very little is known with respect to the burden of pediatric surgical conditions. (79) It is estimated that 1,9% of the total global burden of disease is due to congenital anomalies. (80) Hence, this group of conditions alone would be responsible for approximately 15% of the surgical burden. A report from 2013, based on the SOSAS study, found that 15,6% of the children under 10 year had at least one surgical condition in Sierra Leone. (81) The low incidence of MASPs for this group (0,2% - equals 200 procedures per 100.000 children under 10 years) would mean that an alarming 99% (0,2 of 15,6%) of the pediatric surgical burden is unmet. If the conditions observed by Groen et al would include minor and major surgical conditions, and we would combine the incidence of MiSPs and MASPs found in this study (6,6%), still 57,7% of these conditions would be left untreated. The absence of congenital procedures in this study underlines the unequal access to surgical care for children. Of course, congenital procedures are performed to some degree in Sierra Leone, but unfortunately so infrequent that not witnessed in the study sample. The plausible reasons for this inequity would be similar as described above for the female population.

Access to Surgical Care

We were surprised to see that people living in rural localities had a similar incidence of undergoing both minor and major surgical procedures compared to people living in urban areas. It has been demonstrated that physical distance of a health facility is one of the key factors of access to care. (82,83) Also it has been shown that more surgical procedures were performed in urban districts compared to rural districts. (63) As most surgical facilities are located in urban settings we expected that rural populations had less surgeries performed compared to urban population. For all procedures identified we recorded both the district of residence and the district where the procedure was performed. Concentrating on the 'district of procedure' presents a larger inter-district difference in incidence compared to using 'district of residence' as a variable. In other words, the people in Sierra Leone are travelling for undergoing major surgical procedures. One-third of the MASPs were performed outside the district of residence. Only 13% of Sierra Leoneans give 'the unavailability of health care' as a reason for not seeking care, (64) while geospatial mapping shows that approximately 30% of the population live outside a surgical access zone. (84) Access to surgical care would probably benefit if hospitals with adequate staff and infrastructure were available in the district of residence. Also, it would likely decrease the amount of financial resources spent on transport and other indirect costs.

Although the difference for surgical activity between districts was not as large as expected, we need to be aware and mention that no major procedures were observed in the district of Karene. This means that the incidence of MASPs is very low for its 300.000 inhabitants. Unfortunately this is not surprising as Karene is very remote with bad infrastructure and does not have an operational government first level hospital currently.

Unregulated surgery

Almost six percent of the SV was performed in private facilities not registered with the Sierra Leone Medical and Dental Council (MDC). A further five percent of the major procedures was done in a private hospital where the respondents could not tell if the facility was on the presented list with MDC registered facilities or not. This means that approximately 5,9% - 10,5% of the surgical volume in Sierra Leone (equals 6757 - 12.026 major surgical procedures) are performed in an unregulated facility annually. Additional research will be necessary to get a better insight of the full volume and the quality of care. This will be difficult due to the sensitivity of the topic.

Perioperative Mortality Rate (POMR)

The POMR in this study was 2,1% for all procedures combined, which is consistent with a POMR of 1,9% from a prospective study of nearly 25.000 procedures by trainees and graduates of a Surgical Training Program in Sierra Leone. (59) Furthermore, the POMR found in this study is in line with a cohort study in 25 African countries. In a cohort of 11.193 hospitalized patients who underwent a surgical procedure, 239 passed away; a POMR of 2,1%. (47)

For POMR after CS, more data from Sierra Leone is available; the reported in-hospital POMR lies between 0,7% and 1,9%. (59,65,85) In this study we see a POMR of 8,3% for CS specifically (3 out of 36). However, this percentage needs to be regarded with caution. This study was not designed for a sub-analysis for specific surgical procedures. The numbers observed are low, so the confidence interval will be rather broad.

As touched upon in the introduction, the definition with regard to the timeframe of measurement of the POMR is important. Our data suggests that in-hospital POMR underestimates the 30-day all-cause POMR by 41,7% (2,1 vs 3,6%). However, a feasible, uniform method of data-collection for POMR is paramount. If researchers keep on being mindful of the systematic underestimation of in-hospital POMR, it should be realistic to promote the LCoGS POMR metric globally.

Minor surgical procedures

Based on the available literature in global surgery, a distinction was made between minor and major surgical procedures. Minor procedures are generally performed without (general) anaesthesia and not routinely in an operation theatre. Because of the preventive nature of MiSPs and their feasibility to organize at primary level, promoting these can be considered as a relatively low-hanging fruit. Monitoring of the minor procedures is the first step and can provide useful information for surgical system planning.

The incidence of MiSPs in our study is 12,2%, eight times more frequent compared to MASPs. As far as we know, no benchmark has been set on the incidence rate of minor surgical procedures. Also, we believe no data on nationwide level for low-resource settings specifically on minor procedures has been published yet. This makes comparison impossible at this stage. To be able to value the data on MiSPs, the incidence of normal deliveries (24/1000 population) plus CS (3,6/1000 population) can be compared to the crude birth rate in Sierra Leone (33,4/1000 population). (52) There is a gap of 5,8 births per 1000 population not accounted for in the PRESSCO study. Instrumental and assisted vaginal deliveries have not been included, but these rates are thought to be low. (86)

The underrepresentation of the normal deliveries in this study could be explained by the perception of the event. It is a relatively new concept to think of normal deliveries as a minor surgical procedure. (3) The enumerators were trained to specifically ask for deliveries (and other minor procedures) and include these regardless of the location where they were performed. Despite this, around 40% of women in Sierra Leone still give birth at home, (87) and the HH representatives might not perceive this as a surgical procedure. Similarly, we have tried to capture male circumcision in our study. And although it is common practice in Sierra Leone for cultural reasons, we only found an incidence of 1%. Also here, the ritual might not be seen as a (minor) surgical procedure and is therefore not routinely reported. It would have been quite interesting to know where and under what conditions MiSPs were performed. The role of traditional medicine in the execution of minor surgical procedures is still to be examined, however this was beyond the scope of this study.

Reliability

This is the first time this specific survey has been carried out, so the test-retest consistency is still to be determined. As an approximation, the baseline characteristics of the PRESSCO study were compared with a similar, recently conducted instrument (SLIHS) in table 1.

The sample had a similar distribution for gender, but there were differences in the mean household size and age. Regarding age, this could be explained by the larger number of urban households that were included in the SLIHS (48,7%) compared to the PRESSCO (33,2%). The mean age is lower in the urban subgroups, so a larger proportion of urban households will lower the overall mean age. For household size, the difference could be explained through a slight alteration in the definition of household members (HHMs). In the SLIHS the definition was 'persons who live together and make common cooking arrangements'. In the PRESSCO another criterium was added; the household member also should have slept in the household the previous night. Through the stricter definition, potential HHMs that would have been included in the SLIHS, were excluded in the PRESSCO. Taking the above considerations in account, the baseline data of the PRESSCO provides sufficient assurance that the sample reflects the population of Sierra Leone correctly.

Textbox 4: Additional thoughts on internal consistency reliability

The internal consistency reliability was not applicable for the main outcomes because they were straight forward (e.g. surgery yes/no, mortality yes/no). However, it was proposed to add an item to the survey where surgical scars were observed, hereby measuring the same outcome in an alternative way. Unfortunately this was not realistic for the current survey, for it was decided to make the household representative proxy for the household members (see methods section).

Upon designing the questionnaire we were not sure if household representatives were able to recognize the surgical procedures. The procedure list was created mainly based on the essential surgical package (but not too extensive with 'only' 34 different procedures). In case the household representatives did not recognize the procedure other questions would gather information to make a classification. It turned out that 88,8% of the respondents knew what surgical procedure was performed. For internal consistency purpose, it would be preferable to combine the two methods of questioning in all cases to the same outcome in a parallel way. Still, there was a need to be very thoughtful of the added value of each item in order to avoid a too lengthy overall survey.

Strengths & Limitations

The main strengths of this household survey are that the sample is representable nationwide and that it provides an overview that can be triangulated with facility-based gathered data. With this parallel approach it is possible to get an insight of the surgical activity from facilities where data could not be gathered through the facility-based survey. Either because facilities were not identified, did not provide consent to share their theatre logbooks or had - for some reason - incomplete logbooks. Moreover, household surveys are a widely accepted tool for incidence and prevalence research. The methodology for the determination of SV (which is an incidence rate) conducted in this household survey might be stronger compared to a facility based approach.

The sample size calculation has been adapted to have a better insight of the aggregated incidence of both minor and major surgical procedures. The external validity for the major and minor surgical procedures will be credible.

Furthermore, the collaborative approach with a crucial role for Statistics Sierra Leone is another strength. This organization is also tasked with conducting the DHS in Sierra Leone and has therefore much experience with household surveys. Through their methods of sampling and their field supervision during the data-collection we believe the quality of this study was further enhanced.

This study has important limitations to take into account. First, like all household surveys, this study is subject to several biases as described in the methods section. These biases could be illustrated through an example. The following potential uncertainties can be raised regarding items in the questionnaire concerning surgery in private facilities. Does the HHrep really remember the name of the private facility that was visited (recall bias)? And is he or she able to point it out consistently in a list of facilities with guidance of the enumerator (potential interviewer bias)? Social-desirability bias might be present. Perhaps it is known that non-registered facilities are not legitimate and participants avoid to disclose this information (information bias)? In addition, surgical providers working in a governmental setting might invite patients to come for a particular surgical procedure to their private clinic. Will the participant realize that while they have presented themselves in a governmental hospital and they are operated upon by a governmental worker, they are in fact in a private setting?

These potential biases may affect the content validity of the study; is the questionnaire actually measuring what it is intending to measure?

Of course, the biases were taken into consideration upon planning the sample size. Still we have to remain mindful of the biases when interpreting the results.

Secondly, although the survey instrument was based on the validated SOSAS questionnaire, the instrument for this particular study was newly designed. Because it is the first time that it has been used, no established validity is known. It would have been preferable to validate the instrument prior to the start of the study through parallel pre-testing within a single household. Unfortunately, this was practically not possible due to limited time and resources.

Thirdly, sub-analyses were conducted regarding the different types of major surgical procedures and the location where they were performed. Because the identified number of major procedures are rather small (152 in number), it is difficult to portray an accurate picture for individual procedures for the whole country based on this sample. In other words, for these sub-analyses the external validity will be lower.

Finally, the weight adjustment was not done for this thesis, so extrapolation to a nationwide view will contain inaccuracies for localities and districts. Nevertheless, this study provides us with an indication of the most frequent procedures and the locations where they were performed.

Conclusions

This thesis describes a novel, population-based approach to obtain insight in the surgical volume of a low-income country. Triangulation of the widely accepted facility-based approach is important because it is not fully understood if the complete incidence of surgical procedures is provided through this methodology for low-resource settings.

We see an incidence rate of major surgical procedures of 1520 per 100.000 population; a figure 3,7 times higher compared to the earlier facility-based data. Still, the encountered SV remains well below the LCoGS benchmark of 5000 major surgical procedures per 100.000 population. The unmet surgical need is 70%.

Of the SV, 87,5% are categorized as essential surgical procedures based on the DCP3 classification. The three most common procedures combined (groin hernia repairs, CS and appendectomy's) make up two-third of the total SV. The high focus on these essential procedures is plausible, since the burden of these conditions is significant. However, at the same time it also implies a neglected group of slightly more advanced surgical conditions with a noteworthy burden of disease.

Furthermore, this study reveals an inequity in access to surgery. Women and children underwent significantly less major surgical procedures even though they are thought to have a larger surgical burden. Because the difference is seen despite the free health care initiative, that promotes cost-free (surgical) treatment for these groups, it is even more alarming.

In contradiction of previous evidence, rural and urban populations have similar access to surgical care. A contributing factor mitigating the physical access is the relatively high percentage of people who travel to another district for their surgical procedures (34,9%).

With regard to the facility of procedure, a high percentage (78,9%) of operations were performed in the public sector. Also, the data is suggestive for the occurrence of surgical activity in unregulated private facilities. The contribution of this sector was at least 5,9%, which represent approximately 6757 operations annually in Sierra Leone.

The all-cause, in-hospital POMR, the fourth surgical indicator as proposed by the LCoGS, is 2,1%. This adds to the little (nationwide) mortality data available for Sierra Leone and is line with the previously published regional, procedure related and facility specific results. Noteworthy is that this study further underlines the formerly reported underrepresentation of the in-hospital POMR. However, the value of adhering to a uniform method of presenting the data for this metric is transcending.

Finally, the incidence of minor surgical procedures is 12,2%. To our knowledge, this figure cannot yet be plotted against a benchmark or other data on minor surgeries. The potential value of further promoting this group essential procedures at primary-level is fundamental however, and we believe more research should be conducted with this focus.

Recommendations

The recommendations have been grouped in three categories. First, recommendations for follow-up studies. These are directed to the research community as a whole, but could also entail proposals for this particular study group simultaneously.

Secondly, based on this research some recommendations have been drafted for the policymakers in Sierra Leone. The findings and recommendations will be presented to them through the organisation of CapaCare.

Finally, recommendations will be provided for this study group in case a repeat of this study (in the future, or another setting) is aspired.

Research community

- As household surveys could play an important part in triangulating the facility data of the third and fourth LCoGS indicators, it would be interesting to repeat this (or a similar) study in other low- and middle income settings. The test-retest consistency of this instrument would be examined, providing valuable information on the data collected in this study retrospectively.
We are conscious of the logistic and economic disadvantages of a household survey as compared to facility-based surveys. That is why the research community should look into the feasibility of including items on the LCoGS surgical indicators in excising household surveys, for example the DHS.
- In addition, we recommend that further research should be conducted to explain the possible underreporting of the surgical volume in Sierra Leone and potentially in similar low resourced settings. Qualitative research could be organized with surgical health workers, but because of the sensitive topic, a population-based approach would be another option. Also, through this method user experiences for the surgical system could be obtained.
A mixed methodology should be applied, where first people in the communities with a recent surgical procedure are identified. Subsequently, qualitative methods can be used to learn more about the experiences from the perspective of patients concerning to surgery. The decision-making process to look for surgical care, which surgical facilities are chosen and what the perioperative experiences are.
- Furthermore, we want to stimulate reporting of potential inequities in surgical care. In many instances, when data is collected through facility-based studies, information is collected on age and gender. However, these are not always presented as results in scientific papers. If inequality in access to surgical care is also prevalent in other (similar) settings, more attention should be paid to this topic.
For Sierra Leone specifically, more research should be done to affirm these study result regarding inequality. At the same time, we should aim to understand why, despite the free health care initiative, woman and children are experiencing barriers to surgical care. Subsequent qualitative research would be the correct tool to apply to find answers.

Policymakers in Sierra Leone

- This data indicates that, in line with previous reports, there is much work to be done to promote and improve surgical and anaesthesia practises in Sierra Leone. Besides that access to proper healthcare (including surgical care) is a human right, investing in surgical

care at primary and first level is very cost-effective. First steps have been undertaken toward this goal and a NSOAP is under construction momentarily. However, broad governmental support is still to be assembled.

- The Sierra Leonean Medical and Dental Council is carrying out tremendous work. However, to be able to achieve their role as quality auditor of health facilities, their means and staff are insufficient. Strengthening this institution will allow them to perform spot checks at health facilities throughout the country. This might inhibit the practise of unregulated surgical care and enhance the quality of care.
- The final recommendation for the policymakers concerns the district of Karene. The data suggest a very inadequate access to surgical care for the people in this district, a troubling thought surely. Investing in a first level hospital with adequate logistics, staff and supplies is easier said than done. Nevertheless, for equality reasons, this should be a priority for the government of Sierra Leone.

This study group

- In case of a repeat we should learn from our limitations and improve. First, the questionnaire should be validated. As explained before, this was planned but because of constraints in time and resources not executed. We would be especially interested to observe if the household representative provides the same information as the patient who actually underwent the surgical procedure. During this (blinded) pre-test, we would also try to observe the scar of the household member who underwent a procedure (if applicable) to validate their responses with regard to the choice of procedures on the list.
- Additionally, we would try to include items in the instrument to check the internal reliability. For example, concerning surgical procedures, we will combine the procedure the household representative chooses from the presented list with additional questions regarding the surgical problem. This would make the instrument slightly larger, but hopefully even more reliable in the end.
- Finally, next time we would collect information on the procedure location of minor surgical procedures. It is valuable to know if these procedure were performed in the traditional, primary/community or first-level/district setting. We might have underestimated the significance of the information concerning these procedures for surgical system strengthening purposes.

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Appendices

Appendix 1 - Package of essential surgical procedures

Platform for delivery → Category Essential ↓ surgical procedures	1 st level <i>Community Facility & Primary Health Centers</i>	2 nd level <i>First-level (District) hospitals</i>	3 rd level <i>Referral and specialized hospitals</i>
General Surgical	1. Drainage of superficial abscess	1. Repair of gastrointestinal perforations	
	2. Male circumcision	2. Appendectomy	
		3. Bowel obstruction	
		4. Colostomy	
		5. Gallbladder disease	
		6. Hernia, including incarceration	
		7. Hydrocelectomy	
		8. Relief of urinary obstruction	
Obstetric, gynecologic, and family planning	3. Normal delivery	9. Cesarean birth	1. Repair obstetric fistula
		10. Vacuum extraction/ forceps delivery	
		11. Ectopic pregnancy	
		12. Manual vacuum aspiration and dilation and curettage	
		13. Tubal ligation	
		14. Vasectomy	
		15. Hysterectomy for uterine rupture or postpartum hemorrhage	
		16. Visual inspection and cryotherapy for cervical lesions	
Injury	4. Resuscitation with basic life support measures	17. Resuscitation with advanced life support measures	
	5. Suturing of laceration	18. Tube thoracostomy (chest drain)	
	6. Management of non-displaced fractures	19. Trauma laparotomy	
		20. Fracture reduction	
		21. Irrigation and debridement of open fractures	
		22. Placement of external fixator; use of traction	
		23. Escharotomy/ fasciotomy	
		24. Trauma-related amputations	
25. Skin grafting			
Non-trauma orthopedic		27. Drainage of septic arthritis	
		28. Debridement of osteomyelitis	
Dental procedures	7. Extraction		
	8. Drainage of dental abscess		
	9. Treatment for caries		
Congenital			2. Repair of cleft lip and palate
			3. Repair of club foot
			4. Shunt for hydrocephalus
			4. Repair of anorectal malformations
Visual impairment			6. Cataract surgery
			7. Eyelid surgery for trachoma

Adapted from Disease Control Priorities, 3rd edition (3)

Appendix 2 – Search Strategy March 2020

Search engines used: PubMed, Embase. Limitations: English language only.

Global & Essential Surgery

((global surgery) OR (global health))
AND ((surgical care) OR (essential surgical care) OR (essential surgery) OR
(operative care) OR (general surgery))
AND ((universal health care) OR (universal health coverage) OR (universal access))
189 hits → 6 (selected after reading abstracts)

Global surgery indicators

((global surgery) OR (global health))
AND (surgical care)
AND (surgical indicators)
351 hits

(surgical indicators) OR (surgery indicators))
AND (surgical volume)
AND (global surgery)
71 hits

10 (selected after reading abstracts)

Surgical Volume and Met - & Unmet need

((global surgery) OR (global health))
AND ((essential surgical care) OR (essential surgery))
AND ((surgical volume) OR (met need) OR (unmet need))
86 hits

(surgical care) OR (essential surgical care) OR (essential surgery) OR (operative
care) OR (general surgery))
AND ((surgical volume) OR (surgical capacity))
AND ((met need) OR (unmet need))
168 hits

5 (selected after reading abstracts)

Population-based / Community-based approaches for determining surgical volume:

((global surgery) OR (global health))
AND ((surgical care) OR (essential surgical care) OR (essential surgery) OR
(operative care) OR (general surgery)) AND ((met need) OR (unmet need) OR (surgical
volume) OR (surgical capacity))
AND (population based)
114 hits

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative
care) OR (general surgery))
AND ((met need) OR (unmet need)) AND ((surgical volume) OR (surgical capacity))
AND (population based)
19 hits

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative
care) OR (general surgery))
AND ((met need) OR (met needs) OR (surgical volume))
AND (household survey)
27 hits

((global health) OR (global surgery))
OR ((surgical care) OR (essential surgical care) OR (essential surgery) OR
(operative care) OR (general surgery))
AND ((met need) OR (met needs) OR (surgical volume))
AND ((population) OR (household))
AND ((low middle income country) OR (LMICs) OR (LMIC))
51 hits

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative care) OR (general surgery))
AND ((met need) OR (unmet need) OR (surgical volume))
AND (household survey)
46 hits

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative care) OR (general surgery))
AND ((met need) OR (unmet need) OR (surgical volume) OR (surgical capacity))
AND (population based)
AND (household survey)
24 hits

2 (selected after reading abstracts)

Peri-operative mortality rate

(global surgery indicators)
AND (perioperative mortality)
31 hits → 6 (selected after reading abstracts)

Surgery in private sector in LMICs

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative care) OR (general surgery))
AND ((private) OR (private sector))
AND ((low middle income) OR (LMIC) OR (LMICs))
127 hits

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative care) OR (general surgery)) AND ((private) OR (private sector))
AND ((regulated) OR (unregulated))
AND ((LMIC) OR (LMICs) OR (low middle income))
18 hits

4 (selected after reading abstracts)

Surgical Care in Sierra Leone

((surgical care) OR (essential surgical care) OR (essential surgery) OR (operative care) OR (general surgery)) AND (Sierra Leone)
140 hits → 16 (selected after reading abstracts)

- Total of 49 publications selected after reading abstracts
 - o Of these, 46 proved useful after reading of the document
- 32 additional documents/publications were identified through snowballing.

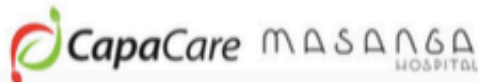
Total of 78 documents used for this thesis.

Prevalence Study on surgical conditions 2019

*SOSAS Repeat / Lower urinary tract symptoms / Groin hernia /
Chronic wounds / Surgical volume / Maternal and perinatal health*

Study protocol version 2.4 (final) | 18th September 2019

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Appendix 4 - Selection from PRESCCO questionnaire, section B.

"With the following questions we will like to know if the household member had a surgical procedure in the last 12 months. Surgical procedure is also known as an operation. "

[Surgical procedure: '... suturing, incision, excision, or manipulation of tissue; or other invasive procedure performed in an operating theater or procedure area regardless of anaesthesia type or surgical provider']

B3.1. Minor procedures:

Did the household member undergo any of the following (minor) procedures in the last 12 months?

Yes
 No

[Examples:

- incision and drainage of an abscess
- circumcision (if male)
- normal delivery (so no caesarean birth, vacuum extraction or forceps delivery) - suturing of wounds
- punctures
- conservative treatment of fractures (so no operation)
- tooth extractions
- urinary catheterisation
- surgical dressings]

B3.3.1 Minor procedures:

Which of the following minor procedures has taken place for the household member in the last 12 months?

- incision and drainage of an abscess
- **circumcision** (if male)
- **normal delivery** (so no caesarean birth, vacuum extraction or forceps delivery)
- suturing of wounds
- punctures
- conservative treatment of fractures (so no setting of bones or operation)
- tooth extractions
- urinary catheterization
- surgical dressing (without anaesthesia)
- other

[Other minor surgeries: any procedures with manipulation of tissue where no anaesthesia was used]

[Anaesthesia: putting to sleep of a patient during the operation, or numbing of body part, usually with an injection in the back or the specific body part]

B4.1. Major procedures:

Did any of the household members undergo a major procedure that required anaesthesia in the last 12 months?

Yes
 No

[Anaesthesia: putting to sleep of a patient during the operation, or numbing of body part, usually with an injection in the back or the specific body part]

B5.1. Type of major surgical procedure:

Would you be able to explain what kind of surgical procedure was done for the household member in the last 12 months?

Yes
 No

[if yes, proceed to B5.2] [if no, proceed to B6.1]

B5.2. Type of surgical procedure: [only if B5.1 is 'Yes']

What kind of surgical procedure was done for the household member in the last 12 months?

Dropdown list with recognizable surgical procedures:

- 1, Appendectomy (appendix was removed)
- 2, Gallbladder operation (bitter-bitter operation)
- 3, Colo/ileo stomy (bowel was led to the abdomen; kakabag)
- 4, Stomach/bowel perforation (hole in the stomach was repaired, gutbus)
- 5, Abdominal operation, other (abdomen was opened, not sure what was done, belleh operation)
- 6, Groin hernia (belleh bozien)
- 7, Hydrocele (bozien)
- 8, Orchidectomy (removal of 1 or 2 testicles, pull one balls)
- 9, Heart operation
- 10, Cystostomy catheter (rubber for piss na belleh)
- 11, Surgical wound debridement (cleaning the wound/penda with anaesthesia, na theata)
- 12, Mastectomy/lumpectomy (operation of the breast, cut the bobby)
- 13, Caesarean birth (operation for born)
- 14, Tubal ligation (turn the womb)
- 15, Hysterectomy, pregnancy related (pull the womb during belleh)

- 16, Hysterectomy, non-pregnancy related (pull the womb whe you no pa belleh)
- 17, Myomectomy (operation pa growth na womb)
- 18, Uterus prolapse operation (operation for womb/something hang pa woman side)
- 19, Obstetric fistula (operation piss/toilet leak)
- 21, Ectopic pregnancy (operation pa pekin no lay down na the womb)
- 22, Chest drain (Fix rubber na the chest)
- 23, Fracture reduction, conservative (draw the bone)
- 24, Fracture reduction, surgical (operation for bone broke)
- 25, External fixator (operation for broken bone, with 'iron')
- 26, Amputations (cut of finger/toe/arm/leg after accident)
- 27, Skin grafting (cut your body for patch the sore/penda)
- 29, Sequestrectomy (operation for rotten bone)
- 30, Dental operation (any operation to the mouth, operation pa teeth problem)
- 31, Eye operation (operation for eye)
- 32, Cleft lip (split lip)
- 33, Club foot (kobo foot)
- 34, Hydrocephalus (big head)
- 35, Anorectal malformations (kaka o lock)
- 36, OTHER [if OTHER, proceed to B6.1]

B6.1. Body part involved in surgical procedure:

In which part of the body was the surgical procedure done?

- Face, Head, Neck
- Chest, Breast, Back
- Abdomen
- Groin, Genitalia, Buttocks
- Extremities
- Not sure / unknown

B6.2. Type of surgical problem:

What problem did the household member have that needed a major surgical procedure?

[Fill in the type of problem that suits best with the undergone surgical procedure, more answers could be possible, e.g. 'Injury' and 'Wound' or 'Burn' and 'Deformity (acquired)']

- Injury
- Burn
- Wound
- Obstetric
- Gynecological; not pregnant
- Abdominal distention or pain
- Inability to urinate
- Mass or growth (soft)
- Mass or growth (solid)
- Deformity (congenital)
- Deformity (acquired)
- Dental
- Visual
- Unknown

Injury: The person obtained a problem after an accident (e.g. broken bone after fall, or wound after motorcycle crash). Type of injury

is not important here.

Burn: The person obtained a burn after exposure to fire or boiling water.

Wound: Open skin; sometimes leaking blood, pus or liquid.

Obstetric: Bleeding and/or disease around childbirth.

Gynaecological: Problem with the menstrual cycle, the womb or bleeding not related to childbirth.

Abdominal: The person had pain or distention in the belly, or problems with eating or passing stool.

Mass or growth (soft): Mass or growth which feels soft and can be manipulated (e.g. lipoma, hernia)

Mass or growth (solid): Mass or growth which feels firm and usually more difficult to manipulate (e.g. hydrocele, tumor)

Deformity (congenital): The person is born with the problem (e.g. club feet, cleft lip)

Deformity (acquired): The person had a (spontaneous - not after trauma) deformity of body or limbs later in life (e.g. chronic osteomyelitis)

Dental: The person had a problem with the teeth

Visual: The person had a problem with eyesight

Appendix 5 - Private health clinics registered with the Sierra Leone
Medical and Dental Council (MDC)

1 The Central Clinic (Dr. Arthur D.O Wright)
2 Diagnostic Clinic (Dr. Len Gordon-Harris)
3 Family Dental Clinic (Hon. Dr. Tawoeo Tara-Koroma)
4 Private Surgery (Dr. M.L.E. Asgill)
5 Arab Egyptian Medical and Development Agency
6 Arab Egyptian Medical and Development Agency
7 Traditional Chinese Medical Hospital
8 Health Redeemers Clinic (Dr. Modupeh M. Wilson)
9 Dr. Robbin-Coker's Clinic
10 Dr. Hassan Hariri Clinic Now (Howe Street Clinic) Dr. Arthur C. Williams, Dr. H. Hariri
11 Dr. Chouman's Clinic
12 L.M. Memorial Clinic (Dr. L. M'Baimba Baryoh)
13 Consonance Chinese Hospital
14 Davidson Nicol Medical Centre (Dr. Sylvester Nicol)
15 Choitram Memorial Hospital
16 Sierra Leone Bottling Co. Ltd
17 The Well Woman Clinic
18 New Medical Centre
19 The Aberdeen Emergency Clinic
20 Afro Arab Kinship Organization
21 W.H.R.O Clinic
22 Marie Stopes (Sierra Leone)
23 Medical Clinic
24 Afro Arab Kinship Clinic
25 Cupid Health Centre
26 Rapha Maternity Hospital
27 Blessed Mokaba Central Community Clinic
28 Bambara Town Clinic Bambara
29 Dr. Bundu-Kamara's Surgery
30 Nactib New Life Hospital (Dr. C.T.H Bell)
31 Pa Mackie Memorial Hospital
32 People's Laboratory
33 FamCare Medical Centre
34 Arab (S.H.A.D) Clinic
35 Thullah's Community Health Clinic
36 United Methodist Church Hospital
37 New Harvest Community Health Clinic
38 Ramsy Medical Laboratories
39 Junes Roness Clinic (Dr W.B.O Robert)
40 W.H.R.O Clinic
41 Afro Arab Kinship Association Clinic
42 Dr. Matilda B. King's Clinic
43 We Yone Clinic
44 Kamba Clinic
45 Waterloo Street Clinic (Dr. T.B. Kamara)
46 Marie Stopes Sierra Leone
47 World Islamic Call Society Clinic
48 Wellington Arab Clinic
49 Katelena Clinic
50 Gbaneh Health Centre
51 FAK's Medical
52 AML Camp Clinic
53 Afro Arab Kinship Association Clinic
54 International Humanitarian Relief
55 Heart and Hand Care Inc
56 Women's Health Care Centre (Dr. I. Peters, Dr. Akim Gibrill)
57 The Ear, Nose and Throat Clinic (Dr.J. A Songo-Williams)
58 Salam Orphanage (Africa Muslim Agency)
59 Marie Stopes Sierra Leone
60 Lowcost Arab Clinic
61 San Paolo Clinic
62 Yonibana Sai Hospital
63 Lion Heart Medical Centre
64 Bekon Community Health Centre
65 Al-Sheefa Arab Clinic
66 Children's Day Clinic (Dr. Lottie O. Whitfield)
67 Krim Clinic (Dr. Tom T. Rogers)
68 Hope Clinic
69 Good Shepherd Clinic
70 The Family Clinic
71 Rijanic Day Care & Surgical Unit (Dr. M.C.O Forde)
72 Tani Nicol Dialysis and Rehabilitation Centre
73 Satus Medical and Diagnostic Services
74 Abanita Hospital
75 Hope and New Life Clinic
76 Magbenteh Community Hospital
77 Holst Roness and Rekhav Private Dental Clinic

78 BRAC Diagnostic Laboratory
79 Africa Muslim Agency Clinic
80 Alisod Clinic
81 Loreto Health Services
82 Holy Spirit Catholic Hospital
83 Liverpool Street, Clinic
84 Lula Green Memorial Clinic
85 UMC Eye Clinic
86 Welbodi Clinic and Consultancy (SL) Ltd
87 Aberdeen Women's Clinic
88 West End Clinic, Dr. Olabisi Claudius-Cole
89 Mubarak Clinic
90 Gyne Helath Centre, Dr. Andre Bangura
91 West African Rescue Association Ltd
92 The Kindoya Hospital
93 The Sowa Clinic
94 Walk-in Medical Associates
95 Shuman Medical Clinic and Laboratory
96 Pa Brima Abu Memorail Clinic
97 Our Lady of Guadalupe Clinic
98 Vulnerable Empowerment and Advocacy Committee Clinic
99 Dama Surgery
100 Pepel (AML) Medical Centre
101 WBHO (AML) Clinic
102 Makeni (AML) Clinic
103 Amsale A. Ganda Clinic
104 Mercy Hospital (UMC)
105 Bucksal Clinic
106 Morning Star Helath Centre
107 Ahmadiyah Muslim Hospital
108 Suna's Anointed Nursing Home
109 Allopathic Health Centre, Dr. S.K. Kamara
110 ADDAX Bioenergi (SL)
111 Hamada Clinic
112 Mankapr Thula Community Clinic
113 Bai Bureh Memorial Community Hospital
114 Ihsan Community Clinic
115 Obstetrics and Gynaecology Clinic
116 Shand Clinic (WHRO), Ibrahim Hamid
117 Yangadi memorial Helath Clinic, Issa Kanu
118 Old Dominion in Salone Hospital (ODINSAL)
119 Cluny Jo Mandarina Memorail Rahbilitation Centre
120 Bo Children's Hospital, Dr. MAS Jalloh 076618033
121 Gila's Children and Community Hospital
122 Al Shaffa Arab Clinic, Abdul Latiff
123 Pyramids Croup Helath Centre, Prof. Saleh Abd-El Mageed
124 DYB Clinic and Maternity Centre, Doreen Yomie Beckley
125 Health and Wealth Diagnostic Clinic, Mr. Nwajei george
126 Al-Baraka Clinic
127 GCON Hope Centre Dental Clinic
128 Arab Egyptian Medical and Development Clinic, Ehab M. El-Naggar
129 Jencil Medical Clinic
130 Nicksan medical centre, Dr. Strasser-Nicol
131 Planned Parenthood Association of Sierra Leone
132 Dermatology Clinic
133 Lion Heart Medical Centre, Edward Turay
134 China Guang-ti Clinic, Dr. Zhao
135 Iran Poly Clinic
136 Funkia Clinic
137 Rokel Arab Clinic
138 All African Peoples Dev. And Empowerment Project (WIND)
139 UCI Community Medical clinic
140 Media Community Helath Centre
141 Physio-Fitness Centre, Mr. Brian Conton
142 Treasure Health Hospital, Dr. L. M'Baima Baryoh
143 Dr. Hames Russell's Clinic
144 Ahmadiyya Muslim Hospital
145 Global Helath Services Foundation
146 Khadijah's clinic
147 Makkah clinic
148 Pentagon Health Care Centre , Dr. Alex B.J. Kanu
149 Redeemer's Hospital and Nursing Home, Dr. Modupeh M. Wilson
150 Melvan Dental Clinic, Dr. Ivan Reffell-Wyse
151 Health Life Charitable Clinic
152 Planned Parenthood Association of Sierra Leone
153 Rahma Clinic
154 Shuman Medical Centre
155 Family Dental Care, Dr. Talal rahmeh
156 Hope and New life Health Care Centre
157 34 Military Hospital Laboratory (Dr. Foday Sahr)
158 Save the Children International Staff Clinic
159 De Nest Maternity Clinic (Dr. Samuel K. Sidique)

160 Medical Care Clinic (Dr. Kombrabai Kanu)
161 Mary Immaculate Maternity Clinic (Dr. James A. Samba)
162 Aspen Medical Clinic Sierra Leone (Dr. Nellie Bell)
163 Healthy Steps Paediatrics (Dr. Albertine Harvey)
164 AIDS Healthcare Foundation Wellness Clinic
165 Dave Kay Dental Clinic (Dr. David I. Kamara)
166 Medical Clinic (Dr. Donald Bash-Taqi, Dr. Kelvin A. Nicolls, Dr. Angela Edwin)
167 God's Grace Health Care Clinic
168 Alisod Islamic Clinic (Alhaju Amadu Wuriw Sall)
169 Bojojo Clinic (Dr. William B.O Roberts)
170 Josephine Memorial Hospital
171 Salone Diagnostic (Abdul Kamara, Proprietor, Yusuf Kamara In-charge)
172 Abdelghary Medical Centre (Dr. Subhy Abdelmoniem Sakr)
173 China and Sierra Leone Friendship Clinic (Dr. Jia Yonghu)
174 Arab (SHAO) Clinic, Mr. Ahmad Sallam, Dr. Yayah Munu
175 Vitality Clinic, Dr. Alhassan Lans Seisay
176 Africa Health Company (SL), Dr. Joseph D. Etoga Etoga, Dr. Alusine M. Dawo
177 Arab Health Centre
178 Arab Clinic (SHAO), Mr. Mohammed Muckson, Dr. Boubacar Balde
179 African Christian Fellowship Clinic (ACF)
180 M&B Hospital, Dr. Mohamed Alieu kargbo
181 Dr. Diallo Clinic, Dr. Abdourahmane Diallo
182 Baba Eye Care Limited, Messrs V. Shashi Kumar and V. Manoj Kumar, Dr. Matthew Jusu Vandy
183 Apex Optics (Optometrists), Mr. Ebrima Bah
184 Perfect Medical Laboratory, Mohamed Mansaray, Dr. Mohamed I. Jalloh
185 Panguma Hospital, Dr Sulaiman jabatie Wau
186 Better Health Clinic, Dr. Kojo A. Carew
187 Vernas Medical Clinic, Dr. Christian A.S. Pratt
188 Grace Clinic, Dr. Christian A.S. Pratt
189 City Garden Clinic, Dr. Salieu M. Turay
190 Amara-Hawa (AH) Hospital, Dr. Brima Osaio Kamara, Dr. Amir A. Taqi
191 Zac Bah Memorial Health Centre, Dr. Abdulai P.F Barbu
192 Shuman medical Centre (Dr. Salim A. Shuman)
193 Arab Egyptian Medical and Development Clinic
194 Singsong Medical Services
195 Caring Hands Health Services
196 Dr. Frazer/Whitfield Clinic
197 Acces Care Hospital and Wellness Centre
198 NASSIT In-House Clinic, Dr. Donald Bash-Taqi
199 U Medicare Clinic, Mohammed S. Koroma
200 St. Anthony Health Clinic for the Poor (Faith Based Mission)
201 Rasha Hamad (Psychologist)
202 Stella Maris Clinic Juba (Faith Based Mission)
203 Christ the King Hospital (Faith Based Mission)
204 Monsignor Daniel Sullivan Health Clinic (Faith Based Mission)
205 St. Hildegard Disease Management Program
206 Health For All Medicals (SL) Ltd
207 Takish Clinic and Laboratory
208 Adonkia Clinic
209 IMS Ukraine Hospital
210 K'S Memorial Hospital
211 Aya Clinic
212 St. John Clinic and Nursing Home

From Raw data to Adjusted HH data

(Record numbers are based on variable 'Record ID'; first column, in raw data displayed as 1-xx. In this overview, only xx is mentioned).

Start 2014 records

Remove empties (19):

34, 60, 64, 66, 74, 87, 91, 106, 305, 307, 309, 311, 314, 438, 470, 710, 863, 992, 995.

Remove empty duplicates (4):

7, 127, 301, 1274

Remove test records (2):

1, 35

1989 records

Remove doubles (28):

13, 23, 100, 172, 185, 299, 432, 433, 434, 435, 436, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 1917, 1918, 1925, 1926, 1927

1807 is copied. 1 version should be removed.

1961 records

Combine two impartial records (6) :

1. combine record 4 (A-B) & 5 (C-D-2 interviews), then remove 5
2. combine record 2 & 18 (move interview HHM2 to record 2), then remove 18
3. combine record 24 & 25 (move interview HHM2 to record 24), then remove 25
4. combine record 32 & 33 (replace interview HHM1&2 to record 32), then remove 33
5. combine record 37 & 38 (move interview HHM1 from 38 to 37), then remove 38
6. combine record 310 & 312 (move interview HHM1 from 312 to interview 2 in 310, then remove 312

1955 records

Remarks

- Record 184 was restored, only to be removed later as part of cluster 71
- Record 232 was considered missing, removed later as part of cluster 72
- Record 499, Section A was restored
- Record 1370, Section A was restored

**Cluster numbers
adapted:**

1-24: empty → 41	1-467: 79 → 74	1-1159: 41 → 42
1-26: empty → 41	1-468: 79 → 74	1-1160: 41 → 42
1-32: 37 → 41	1-469: 79 → 74	1-1179: empty → 14
1-37: 6 → 61	1-497: empty → 24	1-1370: empty → 8
1-40: empty → 60	1-499: empty → 24	1-1447: 1105120 → 11
1-48: empty → 61	1-520: empty → 18	1-1693: 51 → 52
1-72: empty → 67	1-550: 79 → 74	1-1694: 51 → 52
1-92: empty → 67	1-551: 79 → 74	1-1706: 51 → 52
1-105: empty → 61	1-552: 79 → 74	1-1707: 51 → 52
1-107: 6713121 → 67	1-553: 79 → 74	1-1785: 4712190 → 47
1-146: empty → 61	1-561: 79 → 74	1-1802: 4 → 47
1-152: empty → 68	1-562: 79 → 74	1-1938: 13 → 78
1-153: 6113 → 61	1-563: empty → 28	1-1939: 13 → 78
1-169: empty → 60	1-568: 79 → 74	1-1940: 13 → 78
1-176: empty → 71	1-569: 79 → 74	1-1941: 13 → 78
1-181: empty → 71	1-577: empty → 19	1-1942: 13 → 78
1-184: empty → 71	1-625: 69 → 74	1-1943: 13 → 78
1-224: empty → 72	1-629: 69 → 74	1-1944: 13 → 78
1-225: empty → 72	1-763: 48 → 38	1-1945: 13 → 78
1-228: empty → 72	1-790: empty → 21	1-1946: 13 → 78
1-231: empty → 72	1-881: 36 → 38	1-1947: 13 → 78
1-232: empty → 72	1-953: 20 → 32	1-1948: 13 → 78
1-233: empty → 69	1-1031: 41 → 42	1-1949: 13 → 78
1-317: 74 → 63	1-1032: 41 → 42	1-1950: 13 → 78
1-318: 74 → 63	1-1033: 41 → 42	1-1951: 13 → 78
1-332: empty → 64	1-1034: 41 → 42	1-1952: 13 → 78
1-358: empty → 64	1-1035: 41 → 42	1-1953: 13 → 78
1-385: empty → 66	1-1036: 41 → 42	1-1954: 13 → 78
1-400: empty → 75	1-1037: 41 → 42	1-1955: 13 → 78
1-417: 79 → 74	1-1038: 41 → 42	1-1956: 13 → 78
1-418: 79 → 74	1-1039: 41 → 42	1-1957: 13 → 78
1-419: 79 → 74	1-1040: 41 → 42	1-1958: 13 → 78
1-423: 79 → 74	1-1041: 41 → 42	1-1959: 13 → 78
1-424: 79 → 74	1-1042: 41 → 42	1-1960: 13 → 78
1-425: 79 → 74	1-1043: 41 → 42	1-1961: 13 → 78
1-427: empty → 75	1-1045: empty → 43	1-1962: 13 → 78
1-429: 79 → 74	1-1054: 41 → 42	
1-430: 79 → 74	1-1055: 41 → 42	
1-431: 79 → 74	1-1056: 41 → 42	
1-443: 79 → 74	1-1057: 41 → 42	
1-444: 69 → 74	1-1058: 41 → 42	
1-445: 6924240 → 74	1-1059: 41 → 42	
1-451: empty → 25	1-1148: empty → 53	
1-453: empty → 25	1-1155: empty → 42	
	1-1156: 41 → 42	
	1-1157: 41 → 42	
	1-1158: 41 → 42	

Remove clusters:

63: 26 records

71: 29 records

72: 25 records

Total 1875 records:

Non-consent (19):

76

102

197

243

250

254

480

482

490

514

578

583

869

938

1375

1506

1788

1790

1987

(Remark for 1120: at first no consent given, after further explanation: does give consent, see variable A6.3. Does the household really not want to participate in the study?)

Missing (2):

71

303

PREVALANCE STUDY ON SURGICAL CONDITIONS IN SIERRA LEONE 2019

Informed consent

Participant

I, hereby, give informed consent to participate in this study. My personal data can be used as described on the information sheet 'Informed consent'.

Participant's name (in BLOCK

LETTERS): _____

City/Town and date: _____

Signature: _____

Enumerator code:

Village or cluster code:

Guardian's signature if participants is below 18 year or unable to sign/thumb

As guardian

of _____ (full

name), I give informed consent for him/her to participate in this research project.

Guardian's name (in BLOCK

LETTERS): _____

City/Town and date: _____

Signature: _____

Person taking consent

I confirm that I have given information about the research project.

Name (in BLOCK

LETTERS): _____

City/Town and date: _____

Signature: _____

Witness

I confirm that I witnessed the abovementioned has given information about the research project and that the participant has given informed consent without any coercion.

Name (in BLOCK

LETTERS): _____

City/Town and date: _____

Signature: _____

** If there is a wish to withdraw consent after participation, please contact the research team by telephone on 075559939 or send an email to masangaresearch@gmail.com.*

*** Contact details Sierra Leone Ethics and Scientific Review Committee: efoday@health.gov.sl or +23278 3664932*

Appendix 8 - Data analysis in Stata

Table 3

consent	Rural	Urban	Total
No	11	8	19
	57.89	42.11	100.00
	0.88	1.28	1.01
Yes	1,241	615	1,856
	66.86	33.14	100.00
	99.12	98.72	98.99
Total	1,252	623	1,875
	66.77	33.23	100.00
	100.00	100.00	100.00

HH size

. summ total_number_hhm

Variable	Obs	Mean	Std. Dev.	Min	Max
total_number_hhm	1,854	5.205502	2.645721	1	23

Rural mean 5.2433519, median 5

Urban mean 5.1288743, median 5

	Freq.	Percent	Cum.
Rural	6,782	67.81	67.81
Urban	3,219	32.19	100.00
Total	10,001	100.00	

sex	Rural	Urban	Total
Female	3,489	1,727	5,216
Male	3,289	1,490	4,779
Total	6,778	3,217	9,995

Age Category	Freq.	Percent	Cum.
0 to 5	1,662	16.62	16.62
5 to 10	1,525	15.25	31.87
11 to 20	2,126	21.26	53.12
21 to 30	1,668	16.68	69.80
31 to 40	1,157	11.57	81.37
41 to 50	720	7.20	88.57
50 to 60	497	4.97	93.54
Above 60	561	5.61	99.15
.	7	0.07	99.22
.a	78	0.78	100.00
Total	10,001	100.00	

. tab age_cat rural_urban, row column

```

+-----+
| Key |
+-----+
| frequency |
| row percentage |
| column percentage |

```

```

+-----+
      Age |      rural_urban
      Category |      Rural      Urban |      Total
+-----+-----+-----+
      0 to 5 |      1,251      411 |      1,662
      |      75.27      24.73 |      100.00
      |      18.57      12.92 |      16.76
+-----+-----+-----+
      5 to 10 |      1,068      457 |      1,525
      |      70.03      29.97 |      100.00
      |      15.86      14.37 |      15.38
+-----+-----+-----+
      11 to 20 |      1,306      820 |      2,126
      |      61.43      38.57 |      100.00
      |      19.39      25.79 |      21.44
+-----+-----+-----+
      21 to 30 |      1,043      625 |      1,668
      |      62.53      37.47 |      100.00
      |      15.48      19.65 |      16.82
+-----+-----+-----+
      31 to 40 |      775      382 |      1,157
      |      66.98      33.02 |      100.00
      |      11.51      12.01 |      11.67
+-----+-----+-----+
      41 to 50 |      512      208 |      720
      |      71.11      28.89 |      100.00
      |      7.60      6.54 |      7.26
+-----+-----+-----+
      50 to 60 |      352      145 |      497
      |      70.82      29.18 |      100.00
      |      5.23      4.56 |      5.01
+-----+-----+-----+
      Above 60 |      429      132 |      561
      |      76.47      23.53 |      100.00
      |      6.37      4.15 |      5.66
+-----+-----+-----+
      Total |      6,736      3,180 |      9,916
      |      67.93      32.07 |      100.00
      |      100.00      100.00 |      100.00

```

Table 5:

codebook sex

```

-----
-----
      type: numeric (long)
      label: sex_ln

      range: [1,2]
      unique values: 2

      units: 1
      missing .: 6/10,001

      tabulation: Freq.  Numeric  Label
                  5,216      1  Female
                  4,779      2  Male
                  6          .

      sex |      mipyn
      sex |      No      Yes |      Total
+-----+-----+-----+
      Female |      4,674      542 |      5,216
      Male |      4,226      553 |      4,779
+-----+-----+-----+
      Total |      8,900      1,095 |      9,995

      MAPyn |      Freq.      Percent      Cum.
+-----+-----+-----+
      No |      9,861      98.60      98.60
      Yes |      140      1.40      100.00
+-----+-----+-----+
      Total |      10,001      100.00

```


	MAPyn							
	Yes		.5336498	.149327	-2.24	0.025	.3083695	
	_cons		1.425203	.0506673	9.97	0.000	1.329278	
30			(base outcome)					
40	mipyn							
	Yes		.87503	.0897493	-1.30	0.193	.715678	
	MAPyn							
	Yes		1.082569	.2953526	0.29	0.771	.6341993	
	_cons		.7083631	.029961	-8.15	0.000	.6520087	
50	mipyn							
	Yes		.8740166	.1050237	-1.12	0.262	.6906173	
	MAPyn							
	Yes		1.460173	.4214659	1.31	0.190	.8293019	
	_cons		.4377282	.0215983	-16.74	0.000	.3973788	
60	mipyn							
	Yes		.5144321	.0834998	-4.10	0.000	.3742534	
	MAPyn							
	Yes		2.029069	.5984126	2.40	0.016	1.13831	
	_cons		.3199394	.0176957	-20.60	0.000	.2870701	
70	mipyn							
	Yes		.4204534	.0694872	-5.24	0.000	.304118	
	MAPyn							
	Yes		1.498137	.4660543	1.30	0.194	.814239	
	_cons		.3716189	.0194518	-18.91	0.000	.3353845	

Note: _cons estimates baseline relative risk for each outcome.

. tab rural urban mipyn, row column

rural urba	mipyn		Total
	n		
Rural	6,030	752	6,782
	88.91	11.09	100.00
	67.71	68.68	67.81
Urban	2,876	343	3,219
	89.34	10.66	100.00
	32.29	31.32	32.19
Total	8,906	1,095	10,001
	89.05	10.95	100.00
	100.00	100.00	100.00

logistic rural urban mipyn MAPyn

Logistic regression	Number of obs	=	10,001
	LR chi2(2)	=	0.94
	Prob > chi2	=	0.6265
Log likelihood = -6282.8542	Pseudo R2	=	0.0001

rural urban	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]
mipyn	.9559759	.0659508	-0.65	0.514	.8350728 1.094384
MAPyn	1.137538	.2030608	0.72	0.470	.8017124 1.614035


```
cons | .4760892 .0108572 -32.54 0.000 .4552781 .4978516
```

Note: cons estimates baseline odds.

```
. tab district mipyn, row column
```

district	mipyn		Total
	No	Yes	
Bo	700	73	773
	90.56	9.44	100.00
	7.86	6.67	7.73
Bombali	577	62	639
	90.30	9.70	100.00
	6.48	5.66	6.39
Bonthe	300	33	333
	90.09	9.91	100.00
	3.37	3.01	3.33
Falaba	292	42	334
	87.43	12.57	100.00
	3.28	3.84	3.34
Kailahun	504	83	587
	85.86	14.14	100.00
	5.66	7.58	5.87
Kambia	400	41	441
	90.70	9.30	100.00
	4.49	3.74	4.41
Karene	354	37	391
	90.54	9.46	100.00
	3.97	3.38	3.91
Kenema	770	90	860
	89.53	10.47	100.00
	8.65	8.22	8.60
Koinadugu	238	40	278
	85.61	14.39	100.00
	2.67	3.65	2.78
Kono	573	51	624
	91.83	8.17	100.00
	6.43	4.66	6.24
Moyamba	500	69	569
	87.87	12.13	100.00
	5.61	6.30	5.69
Port Loko	764	89	853
	89.57	10.43	100.00
	8.58	8.13	8.53
Pujehun	324	43	367
	88.28	11.72	100.00
	3.64	3.93	3.67
Tonkolili	812	124	936
	86.75	13.25	100.00
	9.12	11.32	9.36
Western Area Rural	343	41	384
	89.32	10.68	100.00
	3.85	3.74	3.84
Western Area Urban	1,455	177	1,632
	89.15	10.85	100.00
	16.34	16.16	16.32
Total	8,906	1,095	10,001
	89.05	10.95	100.00
	100.00	100.00	100.00

mlogit district i.mipyn i.MAPyn, rrr baseoutcome(16)

Multinomial logistic regression	Number of obs	=	10,001
	LR chi2(30)	=	46.04
	Prob > chi2	=	0.0308
Log likelihood =	-26499	Pseudo R2	= 0.0009

district		RRR	Std. Err.	z	P> z	[95% Conf. Interval]	
Bo							
	mipyn						
	Yes	.8578344	.125684	-1.05	0.295	.6437115	1.143183
	MAPyn						
	Yes	.7334061	.3027724	-0.75	0.453	.3265446	1.6472
	cons	.4828799	.0223245	-15.75	0.000	.4410485	.5286788
Bombali							
	mipyn						
	Yes	.8825643	.1373014	-0.80	0.422	.6506151	1.197205
	MAPyn						
	Yes	1.341664	.4819648	0.82	0.413	.6635401	2.712815
	cons	.3946993	.0195676	-18.75	0.000	.3581518	.4349762
Bonthe							
	mipyn						
	Yes	.9055312	.1810605	-0.50	0.620	.6119361	1.339987
	MAPyn						
	Yes	.4235467	.3132435	-1.16	0.245	.0993976	1.80479
	cons	.2078427	.0132215	-24.70	0.000	.1834793	.2354412
Falaba							
	mipyn						
	Yes	1.181592	.2165067	0.91	0.362	.825086	1.692138
	MAPyn						
	Yes	1.275855	.59001	0.53	0.598	.5154297	3.158155
	cons	.1999248	.0129146	-24.92	0.000	.1761494	.2269093
Kailahun							
	mipyn						
	Yes	1.3519	.1929741	2.11	0.035	1.021978	1.78833
	MAPyn						
	Yes	1.575497	.5522188	1.30	0.195	.7926249	3.131609
	cons	.3436583	.0179124	-20.49	0.000	.3102844	.380622
Kambia							
	mipyn						
	Yes	.8423232	.1535455	-0.94	0.347	.5892707	1.204045
	MAPyn						
	Yes	1.131435	.4922639	0.28	0.777	.482269	2.654421
	cons	.2744154	.0155986	-22.75	0.000	.2454843	.3067562
Karene							
	mipyn						
	Yes	.8613367	.1638937	-0.78	0.433	.593209	1.250657
	MAPyn						
	Yes	5.95e-07	.0003268	-0.03	0.979	0	.
	cons	.2467103	.0146388	-23.59	0.000	.2196243	.2771369
Kenema							
	mipyn						
	Yes	.9602502	.1314835	-0.30	0.767	.7342307	1.255846
	MAPyn						
	Yes	1.242706	.415812	0.65	0.516	.6449927	2.39432
	cons	.5274398	.0236722	-14.25	0.000	.4830253	.5759382
Koinadugu							
	mipyn						
	Yes	1.382445	.2606209	1.72	0.086	.9553838	2.000405

-----+-----							
MAPyn							
Yes	.7584323	.4682607	-0.45	0.654	.2261413	2.543629	
cons	.1641223	.0115292	-25.73	0.000	.1430121	.1883485	
-----+-----							
Kono							
mipyn							
Yes	.7318368	.1217813	-1.88	0.061	.5281656	1.014048	
-----+-----							
MAPyn							
Yes	.9128297	.3772464	-0.22	0.825	.4060808	2.051951	
cons	.3942899	.0195607	-18.76	0.000	.3577564	.434554	
-----+-----							
Moyamba							
mipyn							
Yes	1.134776	.1714643	0.84	0.403	.8439056	1.525901	
-----+-----							
MAPyn							
Yes	.8693801	.3777182	-0.32	0.747	.3710133	2.037182	
cons	.3442645	.0179437	-20.46	0.000	.3108321	.3812927	
-----+-----							
Port Loko							
mipyn							
Yes	.9580049	.1316453	-0.31	0.755	.731811	1.254113	
-----+-----							
MAPyn							
Yes	.8304599	.3165524	-0.49	0.626	.3934232	1.752982	
cons	.5263198	.0236436	-14.29	0.000	.4819607	.5747617	
-----+-----							
Pujehun							
mipyn							
Yes	1.090544	.1971489	0.48	0.632	.7651782	1.55426	
-----+-----							
MAPyn							
Yes	1.160949	.5365021	0.32	0.747	.469302	2.871928	
cons	.222186	.0137426	-24.32	0.000	.1968197	.2508215	
-----+-----							
Tonkolili							
mipyn							
Yes	1.255167	.1569403	1.82	0.069	.982361	1.603732	
-----+-----							
MAPyn							
Yes	1.057768	.3613011	0.16	0.869	.5415591	2.066021	
cons	.5576304	.0245785	-13.25	0.000	.5114796	.6079453	
-----+-----							
Western Area Rural							
mipyn							
Yes	.98234	.1801857	-0.10	0.923	.6856937	1.407322	
-----+-----							
MAPyn							
Yes	1.110762	.5131525	0.23	0.820	.449139	2.747016	
cons	.2353784	.0142224	-23.94	0.000	.2090904	.2649714	
-----+-----							
Western Area Urban (base outcome)							
-----+-----							

Note: cons estimates baseline relative risk for each outcome.

Table 6:

		sex			
MAPyn	Female	Male	Total		
No	5,157	4,698	9,855		
Yes	59	81	140		
Total	5,216	4,779	9,995		
Logistic regression				Number of obs	= 9,995
				LR chi2(1)	= 5.74
				Prob > chi2	= 0.0165
Log likelihood = -6915.5774				Pseudo R2	= 0.0004
-----+-----					
sex	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]

```

-----+-----
MAPyn | 1.507013 .2597209 2.38 0.017 1.075028 2.112586
_cons | .9109948 .0183734 -4.62 0.000 .8756861 .9477272
-----+-----

```

Note: _cons estimates baseline odds.

tab age_cat_2 MAPyn, m row column

age cat 2	MAPyn		Total
	No	Yes	
10	3,182	5	3,187
	99.84	0.16	100.00
	32.27	3.57	31.87
20	2,104	22	2,126
	98.97	1.03	100.00
	21.34	15.71	21.26
30	1,636	32	1,668
	98.08	1.92	100.00
	16.59	22.86	16.68
40	1,133	24	1,157
	97.93	2.07	100.00
	11.49	17.14	11.57
50	700	20	720
	97.22	2.78	100.00
	7.10	14.29	7.20
60	478	19	497
	96.18	3.82	100.00
	4.85	13.57	4.97
70	545	16	561
	97.15	2.85	100.00
	5.53	11.43	5.61
.	7	0	7
	100.00	0.00	100.00
	0.07	0.00	0.07
.a	76	2	78
	97.44	2.56	100.00
	0.77	1.43	0.78
Total	9,861	140	10,001
	98.60	1.40	100.00
	100.00	100.00	100.00

. tab rural urban MAPyn, row column

rural_urban	MAPyn		Total
	No	Yes	
Rural	6,691	91	6,782
	98.66	1.34	100.00
	67.85	65.00	67.81
Urban	3,170	49	3,219
	98.48	1.52	100.00
	32.15	35.00	32.19
Total	9,861	140	10,001
	98.60	1.40	100.00
	100.00	100.00	100.00

. . tab district MAPyn, row column

district	MAPyn		Total
	No	Yes	
Bo	765	8	773
	98.97	1.03	100.00

	7.76	5.71	7.73
Bombali	627	12	639
	98.12	1.88	100.00
	6.36	8.57	6.39
Bonthe	331	2	333
	99.40	0.60	100.00
	3.36	1.43	3.33
Falaba	328	6	334
	98.20	1.80	100.00
	3.33	4.29	3.34
Kailahun	574	13	587
	97.79	2.21	100.00
	5.82	9.29	5.87
Kambia	434	7	441
	98.41	1.59	100.00
	4.40	5.00	4.41
Karene	391	0	391
	100.00	0.00	100.00
	3.97	0.00	3.91
Kenema	845	15	860
	98.26	1.74	100.00
	8.57	10.71	8.60
Koinadugu	275	3	278
	98.92	1.08	100.00
	2.79	2.14	2.78
Kono	616	8	624
	98.72	1.28	100.00
	6.25	5.71	6.24
Moyamba	562	7	569
	98.77	1.23	100.00
	5.70	5.00	5.69
Port Loko	843	10	853
	98.83	1.17	100.00
	8.55	7.14	8.53
Pujehun	361	6	367
	98.37	1.63	100.00
	3.66	4.29	3.67
Tonkolili	922	14	936
	98.50	1.50	100.00
	9.35	10.00	9.36
Western Area Rural	378	6	384
	98.44	1.56	100.00
	3.83	4.29	3.84
Western Area Urban	1,609	23	1,632
	98.59	1.41	100.00
	16.32	16.43	16.32
Total	9,861	140	10,001
	98.60	1.40	100.00
	100.00	100.00	100.00

Table 7:

Type minor procedure	Freq.	Percent	Cum.
.	2	0.16	0.16
circumcision (male)	104	8.52	8.68
conservative treatment of fractures	58	4.75	13.43
dressing of wounds	135	11.06	24.49
incision and drainage of an abscess	212	17.36	41.85

normal delivery	244	19.98	61.83
other minor procedure	56	4.59	66.42
punctures	28	2.29	68.71
suturing of wounds	124	10.16	78.87
tooth extractions	240	19.66	98.53
unknown	7	0.57	99.10
urinary catheterization	11	0.90	100.00
Total	1,221	100.00	

Table 8:

tab MAP type ln

Type MAP	Freq.	Percent	Cum.
Abdominal operation, other	1	0.66	0.66
Amputations	2	1.32	1.97
Appendectomy	21	13.82	15.79
Caesarean birth	36	23.68	39.47
Dental operation	2	1.32	40.79
Ectopic pregnancy	1	0.66	41.45
Eye operation	9	5.92	47.37
Fracture reduction, conservative	2	1.32	48.68
Fracture reduction, surgical	4	2.63	51.32
Groin hernia	47	30.92	82.24
Mastectomy/Lumpectomy	1	0.66	82.89
Myomectomy	3	1.97	84.87
OTHER	15	9.87	94.74
Skin grafting	1	0.66	95.39
Stomach/bowel perforation	2	1.32	96.71
Surgical wound debridement	2	1.32	98.03
Tubal ligation	1	0.66	98.68
Unknown	2	1.32	100.00
Total	152	100.00	

Table 9:

Category	Essential			Total
	E	N	unknown	
Dental	240	0	0	240
General Surgery	327	163	0	490
ObsGyn	244	0	0	244
Other	0	56	0	56
Trauma Injury	182	0	0	182
unknown	0	0	9	9
Total	993	219	9	1,221

Category	Essential			Total
	E	N	Unknown	
Dental	0	2	0	2
General Surgery	75	7	0	82
ObsGyn	40	5	0	45
Trauma Injury	9	2	0	11
Unknown	0	0	3	3
Visual	9	0	0	9
Total	133	16	3	152

Table 10:

District Residence	Freq.	Percent	Cum.
Bo	9	5.92	5.92
Bombali	12	7.89	13.82
Bonthe	2	1.32	15.13
Falaba	6	3.95	19.08
Kailahun	14	9.21	28.29
Kambia	8	5.26	33.55
Kenema	16	10.53	44.08

Koinadugu	4	2.63	46.71
Kono	8	5.26	51.97
Moyamba	7	4.61	56.58
Port Loko	11	7.24	63.82
Pujehun	6	3.95	67.76
Tonkolili	15	9.87	77.63
Western Area Rural	8	5.26	82.89
Western Area Urban	26	17.11	100.00
Total	152	100.00	

tab DistrictfacilityMAP

District facility MAP	Freq.	Percent	Cum.
Bo (Bo)	12	7.89	7.89
Bombali (Makeni)	13	8.55	16.45
Bonthe (Bonthe)	2	1.32	17.76
Kailahun (Kailahun)	8	5.26	23.03
Kambia (Kambia)	4	2.63	25.66
Kenema (Kenema)	21	13.82	39.47
Koinadugu (Kabala)	7	4.61	44.08
Kono (Koidu town)	4	2.63	46.71
Moyamba (Moyamba)	4	2.63	49.34
Port Loko (Port Loko)	13	8.55	57.89
Pujehun (Pujehun)	4	2.63	60.53
Tonkolili (Magburaka)	10	6.58	67.11
Unknown	6	3.95	71.05
Western Area Rural (Waterloo)	3	1.97	73.03
Western Area Urban (Freetown)	41	26.97	100.00
Total	152	100.00	

. mlogit DistrictfacilityMAP ln, baseoutcome(1)

Iteration 0: log likelihood = -360.0347

Iteration 1: log likelihood = -360.0347

Multinomial logistic regression	Number of obs	=	152
	LR chi2(0)	=	0.00
	Prob > chi2	=	.
Log likelihood = -360.0347	Pseudo R2	=	0.0000

Districtfacility~n	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Bo (base outcome)						
Bombali						
cons	.0800427	.4003204	0.20	0.842	-.7045708	.8646562
Bonthe						
cons	-1.791759	.7637626	-2.35	0.019	-3.288707	-.2948122
Kailahun						
cons	-.4054651	.4564355	-0.89	0.374	-1.300062	.489132
Kambia						
cons	-1.098612	.5773503	-1.90	0.057	-2.230198	.0329734
Kenema						
cons	.5596158	.3618734	1.55	0.122	-.1496431	1.268875
Koinadugu						
cons	-.5389965	.4755949	-1.13	0.257	-1.471145	.3931523
Kono						
cons	-1.098612	.5773503	-1.90	0.057	-2.230198	.0329734
Moyamba						
cons	-1.098612	.5773503	-1.90	0.057	-2.230198	.0329734
Port Loko						
cons	.0800427	.4003204	0.20	0.842	-.7045708	.8646562
Pujehun						

	cons	-1.098612	.5773503	-1.90	0.057	-2.230198	.0329734

Tonkolili							
	cons	-.1823216	.4281744	-0.43	0.670	-1.021528	.6568849

Unknown							
	cons	-.6931472	.5	-1.39	0.166	-1.673129	.2868348

Western Area Rural							
	cons	-1.386294	.6454972	-2.15	0.032	-2.651446	-.121143

Western Area Urban							
	cons	1.228665	.3282127	3.74	0.000	.5853803	1.87195

Table 11:

Procedures done in district of residence:

tab MAP type ln procedure in district residence

Type MAP	procedure in district residence			Total
	No	Unknown	Yes	
Abdominal operation,	0	0	1	1
Amputations	2	0	0	2
Appendectomy	7	1	13	21
Caesarean birth	6	0	30	36
Dental operation	1	0	1	2
Ectopic pregnancy	1	0	0	1
Eye operation	6	0	3	9
Fracture reduction, c	1	0	1	2
Fracture reduction, s	4	0	0	4
Groin hernia	15	1	31	47
Mastectomy/Lumpectomy	1	0	0	1
Myomectomy	1	0	2	3
OTHER	6	2	7	15
Skin grafting	0	0	1	1
Stomach/bowel perfora	1	0	1	2
Surgical wound debrid	1	0	1	2
Tubal ligation	0	0	1	1
Unknown	0	2	0	2

Total	53	6	93	152

Table 12:

Facility type MAP	Freq.	Percent	Cum.
Government facility	120	78.95	78.95
Private facility	29	19.08	98.03
Unknown	3	1.97	100.00

Total	152	100.00	

Type MAP	Facility type MAP			Total
	Governm..	Private..	Unknown	
Abdominal operation,	1	0	0	1
Amputations	2	0	0	2
Appendectomy	19	2	0	21
Caesarean birth	33	3	0	36
Dental operation	1	1	0	2
Ectopic pregnancy	1	0	0	1
Eye operation	6	3	0	9
Fracture reduction, c	1	1	0	2
Fracture reduction, s	4	0	0	4
Groin hernia	33	13	1	47
Mastectomy/Lumpectomy	1	0	0	1
Myomectomy	2	1	0	3
OTHER	11	4	0	15
Skin grafting	1	0	0	1

Stomach/bowel perfora	2	0	0	2
Surgical wound debrid	1	1	0	2
Tubal ligation	1	0	0	1
Unknown	0	0	2	2
-----+-----+-----+-----				
Total	120	29	3	152

Private facility	Freq.	Percent	Cum.
34 Military Hospital Laboratory (Dr. ..	1	3.45	3.45
Bo - Bo Children's Hospital, Dr. MAS ..	1	3.45	6.90
Bombali - Caring Hands Health Service..	1	3.45	10.34
Bombali - City Garden Clinic (Dr. Sal..	1	3.45	13.79
Bombali - Holy Spirit Catholic Hospital	3	10.34	24.14
Katelena Clinic	1	3.45	27.59
Kenema - Panguma Hospital (Dr Sulaima..	2	6.90	34.48
Marie Stopes	1	3.45	37.93
None of these facilities	9	31.03	68.97
Treasure Health Hospital (Dr. L. M'Ba..	1	3.45	72.41
UMC Eye Clinic	1	3.45	75.86
Unknown	7	24.14	100.00
-----+-----+-----+-----			
Total	29	100.00	

Private facility	Type MAP								Total
	Appendect	Caesarean	Dental op	Eye opera	Fracture	Groin her	Myomectom	OTHER	
34 Military Hospita..	0	1	0	0	0	0	0	0	1
Bo - Bo Children's ..	0	0	0	0	0	1	0	0	1
Bombali - Caring Ha..	0	0	0	0	0	1	0	0	1
Bombali - City Gard..	0	0	0	0	0	0	0	1	1
Bombali - Holy Spir..	0	0	0	0	0	1	1	0	3
Katelena Clinic	0	0	0	0	0	1	0	0	1
Kenema - Panguma Ho..	0	1	1	0	0	0	0	0	2
Marie Stopes	0	1	0	0	0	0	0	0	1
None of these facil..	0	0	0	2	1	6	0	0	9
Treasure Health Hos..	1	0	0	0	0	0	0	0	1
UMC Eye Clinic	0	0	0	1	0	0	0	0	1
Unknown	1	0	0	0	0	3	0	3	7
-----+-----+-----+-----									
Total	2	3	1	3	1	13	1	4	29

Private facility	Type MAP	
	Surgical	Total
34 Military Hospita..	0	1
Bo - Bo Children's ..	0	1
Bombali - Caring Ha..	0	1
Bombali - City Gard..	0	1
Bombali - Holy Spir..	1	3
Katelena Clinic	0	1
Kenema - Panguma Ho..	0	2
Marie Stopes	0	1
None of these facil..	0	9
Treasure Health Hos..	0	1
UMC Eye Clinic	0	1
Unknown	0	7
-----+-----+-----		
Total	1	29