Untreated surgical conditions in Sierra Leone: a cluster randomised, cross-sectional, countrywide survey

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Summary

Background Surgical care is increasingly recognised as an important part of global health yet data for the burden of surgical disease are scarce. The Surgeons OverSeas Assessment of Surgical Need (SOSAS) was developed to measure the prevalence of surgical conditions and surgically treatable deaths in low-income and middle-income countries. We administered this survey countrywide in Sierra Leone, which ranks 180 of the 187 nations on the UN Development Index.

Methods The study was done between Jan 9 and Feb 3, 2012. 75 of 9671 enumeration areas, the smallest administrative units in Sierra Leone, were randomly selected for the study clusters, with a probability proportional to the population size. In each cluster 25 households were randomly selected to take part in the survey. Data were collected via handheld tablets by trained local medical and nursing students. A household representative was interviewed to establish the number of household members (defined as those who ate from the same pot and slept in the same structure the night before the interview), identify deaths in the household during the previous year, and establish whether any of the deceased household members had a condition needing surgery in the week before death. Two randomly selected household members underwent a head-to-toe verbal examination and need for surgical care was recorded on the basis of the response to whether they had a condition that they believed needed surgical assessment or care.

Findings Of the 1875 targeted households, data were analysed for 1843 (98%). 896 of 3645 (25%; 95% CI 22·9–26·2) respondents reported a surgical condition needing attention and 179 of 709 (25%; 95% CI 22·5–27·9) deaths of household members in the previous year might have been averted by timely surgical care.

Interpretation Our results show a large unmet need for surgical consultations in Sierra Leone and provide a baseline against which future surgical programmes can be measured. Additional surveys in other low-income and middle-income countries are needed to document and confirm what seems to be a neglected component of global health.

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Introduction

Although global health efforts increasingly emphasise health-system strengthening, the surgical needs of populations are frequently neglected. Safe and appropriate surgical care is needed to decrease maternal mortality; improve the health of women and children; treat congenital deformities; diagnose, treat, and palliate cancer; and care for people who are injured. Globally, improvement of surgical care is needed to save substantial numbers of lives and reduce or avoid permanent disabilities.

The actual prevalence of surgical conditions is unknown. In its place, estimates of the burden of surgically treatable diseases in low-income and middle-income countries rely on rough approximations and extrapolations from short surveys of physicians, data from high-income countries, or hospital registries. These estimates have helped to raise awareness of the surgical need of populations, but have rarely been robust enough to stimulate development of large countrywide surgical programmes. They have also not been sufficient to firmly convince donors of the magnitude of surgically treatable conditions or to provide policy makers and ministries of health with the requisite data needed to plan interventions. To address these deficiencies, calls for community-level research to quantify the surgical need of populations have been repeatedly voiced.

In an effort to measure the prevalence of surgical conditions and to identify deaths potentially preventable with surgical care, the Surgeons OverSeas Assessment of Surgical Need (SOSAS) was developed for use in low-income and middle-income countries. SOSAS is a population-based household survey that was developed collaboratively by an international group of experts and piloted in Sierra Leone. We aimed to establish the countrywide prevalence of surgically treatable conditions and potentially preventable deaths in a low-income country by administering the survey in Sierra Leone.

Methods

Setting Sierra Leone is a small west African country (population 6 million; area 72 000 km²) and ranks 180 of the 187 nations on the UN Development Index. Health indicators for Sierra Leone are indicative of scarce access to health care: life expectancy at birth is 48 years, an estimated 174 per 1000 children die before their fifth birthday, and maternal mortality rates are among the highest in the world. Sierra Leone was chosen for...
the implementation of SOSAS because of the long-standing collaboration between Surgeons OverSeas and surgeons and the Ministry of Health and Sanitation in the country.14

**Study design**
The total sample size was estimated to be 3745 individuals based on \( n = \frac{Z^2 p(1-p)}{L^2} \), where \( L \) is accepted range around the estimated prevalence of the disorder (1%), \( Z \) is CI (95%–Z is 1·96), and \( p \) is (estimated) prevalence of the condition (7·3%). Estimated prevalence was established in a pilot study of the same survey in Sierra Leone in August, 2011, when 95% of the targeted population were eligible, and the same proportion responded.11 The calculated sample size was multiplied by a small design-factor of 1·3, assuming that surgical conditions are not very clustered. 75 of 9611 enumeration areas, the smallest administrative units in Sierra Leone, were randomly selected for the study clusters, in two-stages with a probability proportional to population size after stratification for districts and urban and rural population distribution. The sample was self-weighted by randomly selecting 25 households in each cluster.15 Random selection of households and individuals was done on the basis of principles established for countries without full population registries.15,16 This method includes a first structure count (house count) of the enumeration area and thereafter random assignment of the structures. If more than one household was living in a house, an extra listing was made. Random assignment of the households was done with a random calculator. Household members were defined as those who ate from the same pot and slept in the same structure the night before the interview. The same definition is used for the Demographic and Health Survey in Sierra Leone.17 Deceased individuals were judged to be household members if they were mainly eating from the same pot and sleeping in the same household in the year before they died.

**Procedures**
The study was done from Jan 9 to Feb 3, 2012. Students from the Sierra Leone Faculty of Nursing and Sierra Leone College of Medicine and Allied Health Sciences and staff from Statistics Sierra Leone were trained to be enumerators. The appendix shows the instruction

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**Figure:** Distribution of cluster points

- Cluster points
- Main roads
- Districts of Sierra Leone
manual for enumerators. Data were collected with handheld tablets. The SOSAS survey (appendix) consists of two parts and has been previously described.11 The first part is administered to a household representative to establish the number of household members, identify deaths in the household during the previous year, and establish whether any of the deceased household members had any of the following conditions in the week before their death: abdominal distension or pain; bleeding or illness during childbirth; injury; mass, growth, or swelling; acquired deformity; or a wound not due to injury or congenital deformity. The second section consists of structured interviews of two randomly selected household members who undergo a head-to-toe verbal examination covering six anatomical regions: face, head, and neck; chest and breast; abdomen; groin, genitals, and buttocks; back; and arms and hands and legs and feet.

The need for surgical care was recorded on the basis of an individual’s response to whether they had a wound, burn, mass, deformity, or other condition needing surgical assessment or care—ie, the respondent decided whether or not they felt they needed surgical care. A surgical procedure was defined as: wound care, suturing, incision, excision, or other manipulation of tissue, in a safe and painless way.18 Procedures were deemed major if they required regional or general anaesthesia and minor if they required local anesthetics or none. Although local enumerators received a stipend, none of the researchers (local and international) received any payment and respondents were not paid.

Collected data were screened every day by the field supervisors and immediate feedback was given to the enumerators; RG gave overall feedback and supervision. Final assessment of the full database was done after data collection to identify inconsistencies and missing items. When clarification by the enumerators was not possible, inconsistent data were coded as missing.

The study was approved by the Sierra Leone Ministry of Health and Sanitation and ethics approval was obtained from the Ethics and Scientific Review Committee of Sierra Leone and the Research Ethics Committee of the Royal Tropical Institute in Amsterdam, Netherlands. Written informed consent was obtained from all respondents, but if the respondent was illiterate, a thumb-print with an additional signature from a literate witness was obtained. For individuals younger than 18 years, a parent or guardian provided written consent.

Statistical analysis
We analysed data with PROC survey logistic, with SAS (version 9.3). Univariate analyses were done and significant variables were included in a multivariable logistic regression model to predict present surgical need (yes or no). Univariate associations were analysed with \( \chi^2 \) tests for contingency tables, \( t \) tests for normally distributed data, and the Mann-Whitney \( U \) test for skewed data. All tests were two-tailed.

Role of the funding source
All authors had access to the complete data file; RSG, MS, TBK, and ALK made the decision to submit for publication. The Thompson Family Foundation did not have any role in data collection or analysis, or writing of the manuscript. Volunteers from Surgeons OverSeas wrote the study protocol, executed the study, and wrote the report, but did not receive any funds for this work.
Results

The figure shows the cluster distribution. 74 of the randomly selected clusters were located and confirmed by global positioning system coordinates. One cluster could not be located and was replaced with a village in the same chiefdom (Kenema district). Of the 1875 total targeted households, we analysed data for 1843 (98%). Data from 25 households were excluded because of inconsistencies, five households had too much missing information (ie, surveys that were not completed to the end of the form, or for which essential data for cluster number, age, and sex were missing), and two households refused to give consent.

In each household, we attempted to interview two household members; thus after the exclusions, the total expected number of interviews was 3686. However, in 41 households (1%), only one household member was interviewed, giving a total of 3645 respondents (table 1). Most (1696) household interviews were completed on the initial visit. 132 households needed two visits and 15 households needed three visits. Of selected household members, 149 (4%) were replaced because the individuals initially chosen were not available for interview even after several revisits. Table 1 shows household characteristics and demographic data for respondents.

Of the 3645 respondents, 1352 (37%; 95% CI 34·8–39·4) indicated that they had a wound, burn, mass, growth, deformity, or other surgical condition at the time of the interview and 896 (25%; 22·9–26·2) indicated that they were in need of surgical care. Because respondents could report having more than one surgical condition, a total of 1585 conditions were reported at the time of the interview (table 2). The anatomical regions with the greatest number of reported conditions were abdomen; head, face, and neck; and arms, hands, legs, and feet (table 3).

575 (31%) households reported at least one household member dying in the previous year, with 709 deaths overall. With the total household members (11 870) as denominator, the crude death rate was 59·7 per 1000 population per year. On the basis of conditions remembered as being present in the week before death, 237 (33%) deaths were associated with one of the seven conditions that we classified as those that might have benefited from surgical care (table 4). Abdominal distension and pain, problems during childbirth, and injury were the most common conditions recalled as occurring before death (table 4). However, of these 237 deaths, household representatives suggested that for 58 (25%) there was no need for a surgical intervention, resulting in 179 (25%; 95% CI 22·5–27·9) deaths for which the deceased individual might have benefited from surgical care.

For the multivariable analysis, urban residency was highly associated with literacy (data not shown), therefore we excluded literacy from the model. Female gender, age older than 45 years, illness in the past year, and urban residency were the reference populations for comparisons. Males were more likely to report a present need for surgical care than were females (appendix; odds ratio [OR] 1·48, 95% CI 1·3–1·7), and respondents in each age group younger than 45 years were significantly less likely to be in need of surgical care than were older respondents (appendix; <5 years OR 0·28, 95% CI 0·21–0·39; 5–15 years 0·38, 0·30–0·48; 15–45 years 0·66, 0·54–0·80). Individuals who reported not being ill in the previous year were also less likely to report a present surgical need than were those who had been ill (appendix; OR 0·37, 95% CI 0·31–0·44). Individuals living in a rural area were more likely to need surgical care than were urban residents (appendix; 2·29, 1·9–2·7).

Discussion

Administration of SOSAS in Sierra Leone shows a high prevalence of untreated surgical conditions. 25% of respondents had a condition possibly needing surgical attention and 25% of deaths in the previous year might have been averted with improved access to surgical services. An extrapolation to the entire population would equate to almost 1·5 million individuals needing—at minimum—a surgical consultation in Sierra Leone today.

The major limitation of our study was that it relied solely on a verbal interview of self-reported conditions. Ideally, a physical examination would be done to corroborate responses; however, in view of the substantial ethical and logistical issues, with financial implications, such a survey could not be undertaken at this point. Surveys can be expensive; costs of training, personnel, transportation, and communication are all important considerations and are country-specific. The total cost of our study was less than US$35 000. The use of handheld

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<td>Abdomen</td>
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<td>Head, face, neck</td>
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<td>Arms, hands, legs, and feet</td>
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<td>Groin, genitals, buttocks</td>
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<td>Chest, breast</td>
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<td>Back</td>
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<td>Total</td>
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Table 3: Anatomical location of conditions needing surgical care

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<tr>
<td>Abdominal distention or pain</td>
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<td>Bleeding or ill during childbirth</td>
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<tr>
<td>Injury</td>
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<tr>
<td>Mass, growth, or swelling</td>
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<tr>
<td>Acquired deformity</td>
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<tr>
<td>Wound not due to an injury</td>
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<td>Congenital deformity</td>
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<td>Total</td>
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Table 4: Conditions of deceased household members that might have benefited from surgical care, recalled as occurring in the week before death
A second limitation is that the respondents’ perception of a surgical condition might not be correct. For example, a head, face, or neck mass caused by Burkitt’s lymphoma would need chemotherapy rather than a surgical procedure. Such conditions might cause an overestimation of the numbers recorded; however, they would still need to be assessed by a health-care professional so that a surgical intervention could be ruled out. The respondents’ perception could likewise result in an underestimation of the prevalence of surgical conditions. However, an important factor is that the need was decided by the respondent; all conditions in which the respondent answered “not in need for surgical care” were excluded from the final analysis. This definition therefore eliminates all minor wounds and masses that the respondent does not judge to be important, and surgical problems that are not regarded as requiring care for cultural reasons (eg, umbilical hernias). This definition also excludes any condition reported by a respondent who had visited a health-care provider and who was assured that they did not need surgery or could not be treated surgically.

A third limitation is that the data collected about household deaths relied on recall from household representatives. Results of research into recall of injuries showed that periods up to 12 months can be safely used for important events. To ensure that the SOSAS data were representative of Sierra Leone, the self-weighted clusters were randomly allocated and stratified for all districts and rural and urban populations. Nevertheless our total crude death rate is of 59.7 per 1000 population per year is 3.1 times higher than WHO’s official rate of 19 per 1000 population per year. This finding might be attributable to the tendency to remember tragic events as being more recent than they actually were or underreporting of deaths in the WHO statistics and should be further investigated. Ideally, future studies will confirm or reject the high number of deaths that could have been prevented with surgery by use of a more detailed verbal autopsy method, such as that used in India to assess cancer deaths.

Another limitation is that although Sierra Leone has 14 official languages, the survey was written in English but administered orally in the local language. Ideally the survey would have been translated into all the local languages; however, because this step was not considered practical, we followed the standard protocol for Sierra Leone’s Demographic and Health Surveys.

Women generally need more operations in a lifetime than do men because of gynaecological disorders; however, our results show a higher prevalence of existing surgical conditions in male respondents than in females. This finding might be partly attributable to the study design, which by definition excluded healthy military personnel and other people not living in situations identifiable as households. Our sample contained more females than males, supporting the notion that men are more likely to work away from the household than are women, and thus are less likely to be captured with a household survey.

Whether surgical diseases are brought to the attention of a health-care professional depends on many variables. Mock and colleagues reported that the severity of an injury is most likely to predict health-care seeking behaviour. Economic constraints and geographic location are also often thought to be important barriers to health care in general and specifically to surgical care. Cultural beliefs and practices probably affect the decision whether or not to undergo surgery as advised by medical personnel. Other medical interventions, such as vaccinations and treatment for epilepsy and tuberculosis, also have specific cultural and behavioural aspects related to health-care seeking behaviour. In these instances, researchers have suggested that favourable outcomes can positively affect societal perceptions of care and can likewise affect timely presentation for an intervention. These points are important to consider when discussing strengthening of the health system and will require not only investment in surgical services, but also in investigations into existing perceptions and barriers to surgical care, and in assurance of safe surgical care with good outcomes.

Sierra Leone is one of the poorest countries in the world and studies have documented its profound lack of surgical capacity. According to the Sierra Leone National Health Sector Strategic Plan 2010–15, at least 20 surgeons should be trained to meet the unmet need; however, with fewer than 30 medical doctors graduating annually and few training opportunities, such goals are unlikely to be achieved soon. In addition to an increase in surgeons, theatres, equipment, and supplies, numbers of paramedic and anaesthesia personnel need to be increased to deliver safe surgical care. Currently most health care in rural areas is provided by community health officers who have few surgical skills.

Panel: Research in context

Systematic review

We searched PubMed with the terms “surgery” and “household survey”, or “burden of surgical disease”. We identified no countrywide surveys of the prevalence of surgical conditions or surgical causes of death in low-income countries. Most existing data from low-income countries documenting the burden of surgical conditions are based on hospital assessments or extrapolations from high-income countries. In countries where medical records are often incomplete or absent, these data probably underestimate the true prevalence of surgical disease and surgically related deaths. Extrapolations based on high-income country data might lead to overestimations of need. We selected only reports published in English between 2000 and 2010, although we also included some older reports from the reference lists of these publications.

Interpretation

Our results suggest that a large proportion of the population in Sierra Leone is in need of surgical care. Therefore, when resources are allocated to assist in strengthening health systems, surgical capacity building should not be excluded.
Further investigations into the high prevalence of untreated surgical conditions are needed to confirm unmet need in other low-income and middle-income countries and to identify the causes. However, as Weiser and colleagues have estimated, a large discrepancy exists in the number of surgical procedures done in high-income versus low-income and middle-income countries, with far more procedures in high-income countries (panel). The high number of untreated cases in low-income and middle-income countries might merely represent a backlog that could be reduced with the assistance of visiting teams; however, other causes such as environmental, genetic, cultural, or occupational factors might result in the large number of affected individuals.

Whatever the underlying cause for the high number of cases might be, these data provide valuable insight and provide a baseline for the health needs of the population, which should assist the Ministry of Health and Sanitation and non-governmental organisations wishing to start surgical programmes in Sierra Leone. Projects can be monitored and assessed against the baseline data. Ideally, data for surgically treatable conditions will be collected in future Demographic and Health Surveys in Sierra Leone to limit the necessity of repeating a full country implementation of SOSAS.

**Contributors**

RSG, ALK, and TBK researched the background of the study; RSG created the figure; SEY, RSG, MS, ALK, and TBK designed the study; MS, RSG, ALK, and K-AS collected the data; RSG, ALK, and LDC wrote the report; and all authors commented on and critically revised the report.

**Conflicts of interest**

We declare that we have no conflicts of interest.

**Acknowledgments**

Funding for logistics was provided by Surgeons Overseas with a donation from the Thompson Family Foundation. The Sierra Leone Ministry of Health and Sanitation, Sierra Leone College of Medicine and Allied Health Sciences, and Connaught Hospital assisted with local transport and administrative issues. We thank personnel from Statistics Sierra Leone for sharing their expertise, the enumerators and field supervisors for their fine work ethic and enthusiasm, and Lucie Blok of the Royal Tropical Institute for her final look through the survey-questionnaire.

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