Surgical need & capacity in low and middle income countries
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Abstract

Background Although great efforts are being undertaken to reduce child morbidity and mortality globally, there is limited knowledge about the need for pediatric surgical care. Some data on surgical need is available from hospital registries, but it is difficult to interpret for countries with limited surgical capacity.

Methods A cross-sectional two-stage cluster-based sample survey was undertaken in Sierra Leone, using the Surgeons OverSeas Assessment of Surgical Need tool. Data were collected and analyzed on numbers of children needing surgical care and pediatric deaths that may have been averted if surgical care had been available.

Results A total of 1,583 children out of 3,645 individuals (43.3 %) were interviewed. Most (64.0 %, n = 1,013) participants lived in rural areas. At the time of interview, 279 (17.6; 95 % confidence interval (95 % CI): 15.7–19.5 %) had a possible surgical condition in need of a consultation. Children in the northern and eastern provinces of Sierra Leone were much more likely to report a surgical problem than those in the urban-west.

Discussion There is a high need for surgical care in the pediatric population of Sierra Leone. While additional resources should be allocated to address that need, more research is needed. Ideally, questions on surgically treatable conditions should be added to the frequently performed health care surveys on the pediatric population.
Household Survey in Sierra Leone Reveals High Prevalence of Surgical Conditions in Children

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Conclusions There is a high need for surgical care in the pediatric population of Sierra Leone. While additional resources should be allocated to address that need, more research is needed. Ideally, questions on surgically treatable conditions should be added to the frequently performed health care surveys on the pediatric population.
Chapter 4 Pediatric Surgical Need

Introduction

Although the needs of children have been on the global health agenda for many years and most prominently include Millennium Development Goal number 4 (MDG4) [1], only recently have the surgical needs of pediatric populations in low and middle income countries (LMIC) received attention [2, 3]. Very few studies have assessed the overall surgical needs of pediatric populations in LMIC, and most epidemiological data on pediatric surgical diseases focus on single conditions such as cleft lip/palate and club foot [4, 5]. More recently, the burden of injuries, particularly road traffic accidents, has been studied as an important and growing contributor to global childhood death and disability [6–8].

At present, the most comprehensive epidemiological data on surgical need in the pediatric population are from hospital-based surveys [9, 10]. Data from a cross-sectional survey in Uganda estimated an annual rate of surgery for children aged 14 years and below to be 180 operations per 100,000 population per year. While an appropriate target number remains unknown, this figure is way below the surgical interventions in the pediatric population in the United Kingdom [10] or the 529 operations per 100,000 children in the United States [11, 12]. To further highlight the challenges for providing surgery for pediatric populations, capacity surveys conducted in sub-Saharan Africa documented the lack of appropriate infrastructure, supplies, and personnel [13–15].

In Sierra Leone, in a bid to reduce the high maternal and child mortality, an initiative was introduced to provide free health care for pregnant and lactating women and children under 5 years [16]. This program has led to a surge of hospital visits by children with surgical conditions and a significant increase in the number of children undergoing surgical procedures [2]. While data from hospital visits can give insight into the epidemiology of surgical disease [9–11], these data provide a limited picture. Thus, to uncover the true surgical need of the population a detailed epidemiologic survey was required.

The objectives of this study were to determine the prevalence of pediatric surgical disease among Sierra Leonean children and to identify those children whose death could have potentially been averted by timely surgical care.

Methods

This study used the Surgeons OverSeas Assessment of Surgical Need (SOSAS) survey tool, the overall results of which are published elsewhere [17]. The subset on the pediatric population of the full database is presented in this study.

Setting

Sierra Leone, a small West African country (area: 72,000 km²) with an estimated population of 5.8 million [18], is one of the poorest countries in the world and ranks 180 of 187 on the 2012 United Nations Development Index [19]. Administratively, Sierra Leone is divided into four regions: North, South, East, and West. These regions are divided into 14 districts, which are further subdivided into 9,671 enumeration areas (EA), which were used for cluster designation [20]. In 2010, the infant mortality rate was 114 per 1,000 and the under-5 mortality rate was 174 per 1,000 [21]. Sierra Leone was chosen as a location for the implementation of SOSAS because of the longstanding relationship between Surgeons OverSeas (SOS), the local surgeons and the Ministry of Health and Sanitation (MoHS) [22].

Study design

The overall study design was a cross-sectional, two-staged cluster-based household survey. Using probability proportional to size cluster sampling methodology, 75 clusters were randomly chosen from the 9,671 EA in Sierra Leone (Fig. 1). The clusters were stratified to get a representative sample of the Sierra Leonean population from the 14 administrative districts and a representative distribution of the rural and urban population. In order to obtain a self-weighted sample, we randomly selected 25 households in each cluster, with two individuals in each household being randomly assigned for the interview. For random assignment of households and individuals, a listing was made, and with the help of a random calculator the household/individual was assigned. The total sample size of 3,745 individuals was calculated based on prevalence data gathered during a pilot study [23]. Via OpenEpi (openepi.com) a sample size of minimal 375 was calculated for the pediatric subsection of the database to get a prevalence of 25%, with 5% range with a 95% CI, including a design-effect of 1.3.

Survey design

The SOSAS survey tool has been described in detail elsewhere [24, 25] and is available as an open-source document at www.surgeonsoverseas.com. Briefly, we interviewed both adults and children. Subjects were sequentially asked about the presence of potential surgical conditions in the head/face/neck (including eye/nose/ear), chest, back, abdomen, groin, and extremities. A potential surgical condition was categorized in: wound, injury, masses, acquired and congenital deformity, with some specific symptoms in need for surgical evaluation per body part.
For the purposes of the study, surgical care was defined as treatment of an injury or disorder through incision, excision, or manipulation of a body part. Minor procedures were defined as those done under local anesthesia, and major procedures were defined as those conducted under general anesthesia. Inclusion criteria for this sub-analysis of the pediatric portion was age below 18. For subjects under the age of 12, a parent or guardian was asked to help answer the questions.

Data collection, handling, and analysis

The survey was digitized using FileMaker Pro 11.0 v2 (FileMaker Inc., Santa Clara, CA, USA). Sixteen (16) trained enumerators collected data via direct computer entry on 3G iPad devices (Apple Inc., Cupertino, CA, USA) loaded with the survey in FileMaker Go 1.1 (FileMaker Inc.). Field supervisors (4) monitored data fidelity during data collection. Statistical analysis was performed with SAS 9.3 and the PROC surveyfreq and Proc surveylogistic procedures because this was a population-based sample. Contingency table data were analyzed with the $\chi^2$ test with a p value B 0.05 considered statistically significant. Children with and without a surgical problem(s) were compared in a multivariate logistic regression model with reported odds ratios and 95 % confidence intervals (95 % CI). Confidence intervals that did not include 1.0 were considered statistically significant.

Ethical considerations

The Sierra Leone MoHS approved the study, and ethical clearance was obtained from the Ethics and Scientific Review Committee of Sierra Leone and the Research Ethics Committee of the Royal Tropical Institute in Amsterdam, the Netherlands. Written consent was obtained from the parent or guardian of all minor subjects, and assent was obtained from subjects themselves. The total cost of the study was less than US$ 35,000.

Results

Demographic data: age gender, geographic region

A total of 3,645 individuals were interviewed (response rate of 98 %), of which 1,583 (43.4 %) were children under the age of 18. Table 1 shows the demographic frequencies of surveyed children, including the age, gender, urban/rural residency, and province distributions. Approximately half the children surveyed (50.8 %; n = 804) were male and the majority (66.7 %; n = 1,056) were under 11 years old. Most (64.0 %; n = 1,013) participants lived in rural areas, consistent with the last Demographic Health Survey (2008) in Sierra Leone [19].
A total of 587 surgical problems were reported for 372 individual children; this figure includes previously treated surgical problems. At the time of the interview, 279 (17.6 %; 95 % CI: 15.7–19.5 %) had a surgical condition in need of an intervention or consultation. Results of a multivariate logistic regression analysis are shown in Table 2. Respondents were 1.5 times more likely to report a surgical condition in male children (95 % CI 1.2–2.0), and 2.2 times more likely in rural children (95 % CI 1.7–3.0); both were statistically significant. The percentage of children with a surgical condition increased with increasing age. When compared to the oldest age group, the odds ratio for having a surgical condition was less than one for all three of the youngest groups and it was statistically significant for the 0–4 and 5–10 year age groups.

The region of residence was not included in the multivariate model because it was associated with rural and urban residence. Therefore it was evaluated univariately (Table 3). Those living in the northern or eastern provinces of Sierra Leone, have more untreated conditions compared to the west (OR 3.5, 95 % CI 2.1–5.6 OR 2.7, 95 % CI 1.6–4.4, respectively).

As stated above, respondents were asked to delineate the anatomic location of each surgical condition. Of 587 reported conditions children had encountered in their lives, 200 (34.1 %) were located in the abdomen, 134 (22.8 %) in the extremities, and 120 (20.4 %) in the head/face/neck (Fig. 2).

Figure 3 shows a breakdown of the types of surgical conditions reported. Of the total 587 surgical problems encountered during the lives of the children, 144 (24.5 %) of the surgical conditions were wounds, 138 (23.5 %) masses, 137 (23.3 %) other deformities, 129 (22.0 %) abdominal distention or pain, and 24 (4.1 %) burns. The abdominal and groin masses were further classified as either soft or solid in order to help identify hernias. Of the 45 groin masses, 38 (84.4 %) were soft and seven were solid. Of the 57 abdominal masses, 50 (87.7 %) were soft and seven were solid. Deformities were further classified as either acquired (103, 75.3 %) or congenital (34, 24.8 %). Of the congenital deformities 16 (47.1 %) were in the face/head/neck area and 12 (35.3 %) were reported to be in the extremities.

Surgically treatable conditions

A total of 295 procedures were reportedly done in this population, of which the majority 272 (91.5 %) were described as minor procedures. No statistically significant difference was noted in the number of procedures performed between age groups and gender.

Table 1: General frequencies of the researched pediatric population

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Number</th>
<th>%</th>
<th>95 % CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>447</td>
<td>28.2</td>
<td>25.8–30.7</td>
</tr>
<tr>
<td>5–10</td>
<td>609</td>
<td>38.5</td>
<td>36.2–40.8</td>
</tr>
<tr>
<td>11–14</td>
<td>278</td>
<td>17.6</td>
<td>15.9–19.2</td>
</tr>
<tr>
<td>15–17</td>
<td>249</td>
<td>15.7</td>
<td>14.0–17.5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>804</td>
<td>50.8</td>
<td>48.0–53.5</td>
</tr>
<tr>
<td>Female</td>
<td>779</td>
<td>49.2</td>
<td>46.5–52.0</td>
</tr>
<tr>
<td>Residency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>1,013</td>
<td>64.0</td>
<td>53.2–74.7</td>
</tr>
<tr>
<td>Urban</td>
<td>570</td>
<td>36.0</td>
<td>25.3–46.8</td>
</tr>
<tr>
<td>Province</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>549</td>
<td>34.7</td>
<td>32.8–36.5</td>
</tr>
<tr>
<td>East</td>
<td>410</td>
<td>25.9</td>
<td>23.7–28.1</td>
</tr>
<tr>
<td>South</td>
<td>386</td>
<td>24.4</td>
<td>22.6–26.1</td>
</tr>
<tr>
<td>West</td>
<td>238</td>
<td>15.0</td>
<td>13.6–16.5</td>
</tr>
</tbody>
</table>

Number of procedures performed in the pediatric population

A total of 295 procedures were reportedly done in this population, of which the majority 272 (91.5 %) were described as minor procedures. No statistically significant difference was noted in the number of procedures performed between age groups and gender.

Discussion

The results of this study show that 17.6 % of the interviewed pediatric population of Sierra Leone had a potential surgically treatable condition at the time of the interview. Until this study, few data were available on the burden of surgical disease in LMIC, and even less was known about surgical needs in neonates, infants, and children [22]. Children constitute a significant portion (46 %) of the population in Africa, and so the need for pediatric surgical services may be greater than in other parts of the world [25]. Furthermore the burden of congenital anomalies would be expected to be higher based on the higher fertility rate, more likelihood of micro deficiencies, and less prenatal screening [26]. In our sample we found 34 cases (2.1 %) with reported congenital deformities with the main affected area the head/face/neck, which probably calls for specialized (reconstructive) surgery.

The similar distribution of gender in children who reported having undergone a surgical procedure was an unexpected result and contradicts another observation in which male children were more likely to present for surgical care before the free healthcare initiative [27]. The fact that the rural areas, as well as the northern and eastern provinces of Sierra Leone, have more untreated conditions is not surprising, as the surgical capacity in those areas is even more sparse than in the rest of the country [14].

In our study a large proportion of soft abdominal masses were found (n = 50), most likely representing umbilical hernias (UH). Umbilical hernias have the potential to resolve in the first years of life and are therefore not in need of immediate repair as long as they are asymptomatic. A large review of UH repairs in the
Table 2  Multivariate logistic regression analysis demographics comparing pediatric respondents with and without a current surgical problem identified

<table>
<thead>
<tr>
<th>Children in SOSAS without any surgical problem identified</th>
<th>Children with at least one current identified surgical problem</th>
<th>Odds ratio</th>
<th>95 % CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>637</td>
<td>167</td>
<td>20.8</td>
</tr>
<tr>
<td>Female</td>
<td>667</td>
<td>112</td>
<td>14.4</td>
</tr>
<tr>
<td>Rural</td>
<td>797</td>
<td>216</td>
<td>21.3</td>
</tr>
<tr>
<td>Urban</td>
<td>507</td>
<td>63</td>
<td>11.1</td>
</tr>
<tr>
<td>0–4 years</td>
<td>382</td>
<td>65</td>
<td>14.5</td>
</tr>
<tr>
<td>5–10 years</td>
<td>508</td>
<td>101</td>
<td>16.6</td>
</tr>
<tr>
<td>11–14 years</td>
<td>221</td>
<td>57</td>
<td>20.5</td>
</tr>
<tr>
<td>15–17 years</td>
<td>193</td>
<td>56</td>
<td>22.5</td>
</tr>
<tr>
<td>Total</td>
<td>1,304</td>
<td>279</td>
<td>17.6</td>
</tr>
</tbody>
</table>

*Statistically significant

Table 3  Univariate analysis of region comparing pediatric respondents with and without a current surgical problem identified

<table>
<thead>
<tr>
<th>Children in SOSAS without any surgical problem identified</th>
<th>Children with at least one current identified surgical problem</th>
<th>Odds ratio</th>
<th>95 % CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>North</td>
<td>406</td>
<td>143</td>
<td>26.1</td>
</tr>
<tr>
<td>East</td>
<td>322</td>
<td>88</td>
<td>21.5</td>
</tr>
<tr>
<td>South</td>
<td>360</td>
<td>26</td>
<td>6.7</td>
</tr>
<tr>
<td>West</td>
<td>216</td>
<td>22</td>
<td>9.2</td>
</tr>
</tbody>
</table>

* Statistically significant

United States revealed that most were repaired around 4 years of age [28], indicating that the UH found in this survey might overestimate the current surgical need. In the mentioned study, 7 % (34 cases) UH were emergent repairs because of (recurrent) incarceration, enteric fistula, strangulation, and evisceration [28]. Cohort studies to determine the ideal age of UH repair are unknown to the authors. For the groin masses, the majority were soft and likely to be inguinal hernias. Therapy for inguinal hernias is mandatory, as incarceration is likely [29]; therefore the 38 cases with a soft inguinal mass likely indicate a definite surgical need.

This population-based data for the need for surgical care in LMIC is important for clinicians, policy makers, and donors. It provides the basis for planning training, logistics, and interventions and assists with monitoring and evaluating programs. However, next to the burden of surgical disease, other components of health interventions need to be considered, like effectiveness and safety of interventions, as well as cost. Nevertheless, data on the epidemiology of diseases might establish the need for surgical capability in LMIC, in effect, advocating for improvement by influencing political and donor agendas.

Fig. 2 Anatomic location of lifetime surgical conditions reported in the pediatric study population of Sierra Leone

Limitations

There are several limitations to this study. First, based on ethical and logistical limitations, the survey was administered as a verbal inventory of self-reported symptoms and medical history. Ideally, a physical examination component would be used to confirm responses. Second, the survey is designed so that respondents make the determination whether they need surgical care or not. There is the possibility
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... that respondents overestimate the need for surgery to include deformities which cannot be surgically corrected. Conversely, surgical need could also be underestimated because of the presence of abdominal tumors that may not be clinically apparent. Third, for children under age 12, information was obtained from the parent or guardian, which may have led to some inaccuracies in the reporting of conditions.

Conclusions

When working on improving healthcare for the pediatric population globally and attaining MDG 4, surgically treatable conditions will have to be addressed. Based on the findings of the present study, we estimated that 17.6 % of the pediatric population of Sierra Leone may need a surgical consultation today. While additional resources should be allocated to address the surgical need, more research is needed. National health registries and accurate mortality registries should be institutionalized for longitudinal data collection. Ideally, questions regarding surgically treatable conditions should be added to the frequently executed health care surveys on the pediatric population of Sierra Leone.

Acknowledgments

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Conflict of interest

The authors have no conflicts of interest relevant to this article to disclose.

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