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Estimating pediatric surgical need in developing countries: a household survey in Rwanda

Robin T. Petroze [a,b], J. Forrest Calland [a], Francine Niyonkuru [b], Reinou S. Groen [c,d], Patrick Kyamanywa [b], Yue Li [e], Thomas M. Guterbock [f], Bradley M. Rodgers [g], Sara K. Rasmussen [g,*]

[a] Department of Surgery, University of Virginia School of Medicine, Charlottesville, VA, USA
[b] Faculty of Medicine, University of Rwanda, Butare, Rwanda
[c] Department of Gynecology and Obstetrics, Johns Hopkins Hospital, Baltimore, MD, USA
[d] Surgeons OverSeas (SOS), New York, NY, USA
[e] Center for Survey Research & Department of Statistics, University of Virginia, Charlottesville, VA, USA
[f] Center for Survey Research & Department of Public Health Sciences, University of Virginia, Charlottesville, VA, USA
[g] Division of Pediatric Surgery, University of Virginia School of Medicine, Charlottesville, VA, USA

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ABSTRACT

Purpose: Surgical services for children are often absent in resource-limited settings. Identifying the prevalence of surgical disease at the community level is important for developing evidence-based pediatric surgical services and training. We hypothesize that the untreated surgical conditions in the pediatric population are largely uncharacterized and that such burden is significant and poorly understood. Furthermore, no such data exist at the population level to describe this population.

Methods: We conducted a nationwide cross-sectional cluster-based population survey to estimate the magnitude of surgical disease in Rwanda. Conducted as a verbal questionnaire, questions included representative congenital, acquired, malignant and injury-related conditions. Pediatric responses were analyzed using descriptive statistics and univariate analysis.

Results: A total of 1626 households (3175 individuals) were sampled with a 99% response rate; 51.1% of all individuals surveyed were younger than age 18. An estimated 50.5% of the total current surgical need occurs in children. Of all Rwandan children, 6.3% (95% CI 5.4%–7.4%), an estimated 341,164 individuals, were identified to have a potentially treatable surgical condition at the time of the interview. The geographic distribution of surgical conditions significantly differed between adults and children ($p < 0.001$).

Conclusions: The results emphasize the magnitude of the pediatric surgery need as well as the need for improved education and resources. This may be useful in developing a collaborative local training program.

Disparities in the availability of surgical services worldwide are profound, but limited population-based data on surgically treatable conditions exist from any low or middle-income country [1–3]. This shortage of data is particularly concerning in the pediatric population. Forty-three percent of the population of sub-Saharan Africa is younger than the age of 15, but surgical services (facilities, materials, and appropriate training) for children are severely lacking in low-resource environments [4,5]. Forty-two low and middle-income countries (LMIC) accounted for 90% of worldwide deaths in children younger than the age of five in 2000. Forty-one percent of these deaths occurred in sub-Saharan Africa [6]. Global health development projects since the creation of the Millennium Development Goals (MDGs) in 2000 have prioritized efforts to reduce child mortality owing to maternal conditions and infectious diseases such as diarrhea, pneumonia, malaria, human immunodeficiency virus (HIV), and malnutrition [7,8].

Rwanda is a low-income, densely-populated country in sub-Saharan Africa. In the early 1990s and 2000s, Rwanda had some of the worst health indicators in the world [9]. Since then, the Rwandan Ministry of Health has taken an aggressive stance on addressing childhood survival; programs include an aggressive malnutrition feeding program, childhood immunization projects, and widespread HIV awareness and antiretroviral therapy. The most recent health indicators show improvement throughout the health sector [9,10]. Table 1 details several key maternal and child health indicators over the past 15 years in Rwanda. This is compared to indicators in the United States to put the changes in Rwanda in perspective.

Currently, health policymakers are beginning to shift efforts towards addressing the noncommunicable disease burden in Rwandan children, including a national pediatric cancer strategic plan and a program for children with kidney disease. The role for pediatric and surgical specialists becomes more critical for these efforts to have

* Corresponding author. Sara K. Rasmussen, Md, PhD at: P.O. Box 800709, Charlottesville, VA 22908–0709. Tel.: +434-982-2796.
E-mail address: skr3f@virginia.edu (R.T. Petroze).

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their maximum potential impact. Yet, Rwanda has a shortage of healthcare professionals with only 5.5 physicians per 100,000 persons and 0.15 general surgeons per 100,000 persons [11]. This is in stark contrast with the recommended minimum of general surgeons per capita in the United States of 6 per 100,000 persons [12]. In the United States in 2006, there was one pediatric surgeon for every 108,305 children [13]. The ratio in Rwanda is startlingly smaller. There is one expatriate pediatric surgeon practicing in Rwanda for 5.6 million children [14] and no established pediatric surgical training program.

Several academic surgical programs in the United States have partnered with the Rwandan government and training institutions to improve surgical training in Rwanda, including physicians, nurses, and ancillary services [15]. In order to influence the development of pediatric surgical training in Rwanda, this study examines the pediatric respondents of a cross-sectional national population survey to describe the prevalence and characteristics of the likely pediatric surgical need [16]. Given the shortage of surgical caregivers and resources in Rwanda, we hypothesize that there is significant untreated surgical need in the pediatric population and that ongoing collaborative training efforts should have a specific focus in the pediatric population.

1. Methods

1.1. Survey design

The Surgeons OverSeas Assessment of Surgical Need (SOSAS) tool is a cross-sectional, cluster-based population survey for use in resource-limited settings. Survey development has been previously described, and the survey tool is available online at www.surgeonsoverseas.org [16–19]. All surveys were conducted as verbal questionnaires in the native language (Kinyarwanda) with a trained interviewer and utilized direct computer entry of data on iPads. The first part of the survey asks a household representative basic demographic information. The household representative answers questions regarding access to care, such as how long it takes them to reach the closest health clinic, district hospital, or referral hospital and if they can afford to do so. The household representative is also asked to report the total number and suspected cause of deaths that occurred in the household within the previous 12 months. All members of the household are listed in the demographic section, and two individuals are randomly selected to complete the detailed survey. The individual portion of the SOSAS survey seeks to identify potential congenital, acquired, malignant, or injury-related surgical conditions that began in any of three timeframes: current, during the past twelve months, or at any point during their lifetime. Questions are asked in each of six defined anatomic areas: face/head/neck, chest/breast, back, abdomen, groin/genitalia, or extremities. A potential surgical condition is defined as a self-reported wound, burn, mass, congenital or acquired physical deformity or prior operation. For example, a participant might be asked, "Have you ever had a wound, burn, mass, deformity, or an operation on your face, head, or neck?" For each category, descriptions of common conditions, such as a goiter or cleft lip are given as examples. For the purposes of this paper, pediatric surgical care is defined as a multifaceted system of care that is adequately equipped to provide the needed interventions in the pediatric population. An individual skilled in providing the procedures is one facet of this complex system.

Table 1
Maternal and child health indicators in Rwanda: comparison to USA.

	Rwanda			United States		
	1995	2000	2010	1995	2000	2010
Life expectancy at birth (years)	30	47	55	76	77	78
Infant mortality rate (per 1000 live births)*	129	106	59	8	7	7
Neonatal mortality rate (per 1000 live births)**	47	42	29	5	5	4
Under-5 mortality rate (per 1000 live births)	254	177	91	10	9	8
Fertility rate, total (births per woman)	6	6	5	2	2	2
Maternal mortality ratio (per 100,000 live births)***	1000	840	340	12	14	21
Measles immunization (% of children aged 12–23 months)	84	74	82	88	91	92

(Source World Bank databank) [9].
* IMR defined as deaths during first year of life proportional to live births.
** NNMR defined as deaths during first month of life proportional to live births.
*** MMR uses the modeled estimate, as found in the World Bank database.

1.2. Sampling

Clusters were defined at the imidugudu, or village, level, which is the smallest administrative unit in Rwanda. We utilized the list of 14,837 villages from the National Institute of Statistics of Rwanda (NISR) and population weighted it according to the 2012 census preparatory frame [20]. We selected 52 clusters through two-stage sampling, where the probability of cluster choice was proportional to the regional population. All 30 districts in all 5 regions were represented in the survey. Fig. 1 depicts the location of the sampled clusters.

Once entering a cluster, interviewers sampled every third household from a central location, with a goal of 30 households in each cluster. At the household level, interviewers took the list of all household members, which was recorded in descending level of age, and used a random number generator on the iPad to select the two interview subjects.

1.3. Study population

Anyone who was a usual resident of the household or who slept in the household the night before the survey was listed as a household member. For the purposes of this study, pediatric patients were identified as all individuals younger than the age of 18. Our analysis used WHO age brackets within the pediatric population.

1.4. Data collection

Ten Rwandan student interviewers were trained and completed data collection over a one-month period (October 2011) [16]. Students first contacted district medical officers or administrators and village chiefs before initiating household visits in each cluster. Parents or guardians provided answers for young children. Interviews were conducted in the native language of Kinyarwanda. Surveys were programmed in FileMaker Pro 11.0v2 (FileMaker Inc., Santa Clara, CA) and uploaded to 3G iPads (iPad 1, Apple Inc., Cupertino, CA) equipped with FileMaker Go 1.1 (FileMaker Inc., Santa Clara, CA).

The study investigator monitored interviewers with frequent download of data and geographic tracking on the iPads. A field supervisor revisited 5% of households (12 of 52 clusters) to validate data collection.

1.5. Statistical analysis

The data were abstracted from the electronic database and analyzed using Statistical Package for Social Sciences (SPSS), version 19 (IBM Corp., Armonk, NY). Estimates are population weighted to the most recent Rwandan population projection [10,14]. Data were also weighted by age and gender so that distribution was similar to the most recent nationwide population survey, the 2010 Demographic and Health Survey (DHS) [10]. Results from the pediatric population, defined utilizing WHO age brackets of 0–4, 5–9, 10–14, and 15–17, were abstracted and analyzed using univariate chi-squared analysis.