

The Heterogeneity of Global Pediatric Surgery: Defining Needs and Opportunities Around the World

Kent Garber¹ · Carla Cecilia Ramírez Cabrera² · Quang-Le Dinh³ · Justin T. Gerstle⁴ · AiXuan Holterman⁵ · Leecarlo Millano⁶ · Nyagetuba J. K. Muma⁷ · Liem Thanh Nguyen⁸ · Hoang Tran⁹ · Son Ngoc Tran¹⁰ · Shant Shekherdimian¹¹

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Abstract

Background The global burden of pediatric surgical conditions continues to remain inadequately addressed, particularly in low- and middle-income countries. Among the many factors contributing to this gap are a lack of access to care secondary to resource shortages and inequitable distribution, underfinancing of healthcare systems, poor quality of care, and contextual challenges such as natural disasters and conflict. The relative contribution of these and other factors varies widely by region and even with countries of a region.

Methods This review seeks to discuss the heterogeneity of global pediatric surgery and offer recommendations for addressing the barriers to high-quality pediatric surgical care throughout the world.

Results There is significant heterogeneity in pediatric surgical challenges, both between regions and among countries in the same region, although data are limited. This heterogeneity can reflect differences in demographics, epidemiology, geography, income level, health spending, historical health policies, and cultural practices, among others.

Conclusion Country-level research and stakeholder engagement are needed to better understand the heterogeneity of local needs and drive policy changes that contribute to sustainable reforms. Key to these efforts will be improved financing, access to and quality of pediatric surgical care.

✉ Shant Shekherdimian
sshekherdimian@mednet.ucla.edu

¹ Department of General Surgery, University of California, Los Angeles, Los Angeles, USA

² Hospital Roosevelt, Guatemala City, Guatemala

³ Children's Hospital 1, HCMC, Vietnam

⁴ Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, NY, USA

⁵ University of Illinois College of Medicine, Chicago, USA

⁶ Department of Surgery, Tarakan District Hospital, Jakarta, Indonesia

⁷ AIC Kijabe Hospital, Kijabe, Kenya

⁸ Vinmec General International Hospital, Hanoi, Vietnam

⁹ Can Tho University of Medicine and Pharmacy, Can Tho Children's Hospital, Can Tho, Vietnam

¹⁰ Saint Paul Hospital, Hanoi, Vietnam

¹¹ Division of Pediatric Surgery, University of California, Los Angeles, Los Angeles, USA

Introduction

In the past decade, there has been a surge of interest in defining and addressing pediatric surgical needs around the globe [1–3]. Since 2007, the number of peer-reviewed articles referencing surgery and pediatric care in low- and middle-income countries (LMICs) per year has more than quadrupled.¹

Nonetheless, country-level data on the supply of and demand for pediatric surgical care in most LMICs are still poor, and there is likely significant heterogeneity among countries in terms of the specific challenges they face [4–6]. These challenges exist both on the demand side, in terms of the volume and type of pediatric surgical care needed, and on the supply side, in terms of the ability and willingness of local health systems and supporting actors to respond to such needs. As stakeholders work toward improving access, utilization, and quality of pediatric surgical care in their respective settings, defining and contextualizing these challenges will be critical for mounting appropriate responses.

Demographics and epidemiology clearly influence demand for care, yet can vary considerably across countries and regions. Some LMICs have particularly large pediatric populations as a percentage of their total population, as shown in Figs. 1 and 2, or persistently high fertility rates that portend continued pediatric population growth. Meanwhile, endemic diseases, patterns of in utero exposure, proximity to armed conflict, road safety, and cultural practices may strongly affect the local epidemiology of pediatric surgical need. Even among neighboring countries in the same global region, pediatric mortality from surgically relevant conditions, such as road traffic injuries and congenital abnormalities, varies widely (Figs. 3 and 4).

At the same time, many LMIC health systems are unable to supply safe pediatric surgical care, for various reasons. In many low-income countries, shortages of surgical personnel, equipment, and supplies are common, particularly in Sub-Saharan Africa [11, 12]. In middle-income countries, where the number of hospitals and medical personnel may be adequate, challenges related to quality and affordability may predominate. Barriers such as distances to care, lack of transportation, and high out-of-pocket costs due to inadequate health financing and financial protection are more pronounced in certain countries, and some countries have made little progress in developing cultures of quality in hospitals or rigorous training programs. Context-specific factors such as armed conflict or epidemic outbreaks can also impair service delivery. Three of the five countries with the highest death rates from preterm birth complications—Afghanistan, Sudan, and Yemen—

are in protracted conflict, raising difficult questions about how pediatric surgical care can be delivered to meet population needs in these environments [10].

As the global pediatric surgical community works to ensure that children are getting appropriate surgical care regardless of where they live, an appreciation of the heterogeneity of need should guide such work. This appreciation will require that pediatric surgeons look beyond addressing physical and human resource deficits and engage with the epidemiological burdens and health system delivery challenges specific to their local contexts, as well as with the actors, attitudes, and political dynamics that define such contexts [13]. Below, we offer perspectives from several global regions, illustrating the diversity of challenges, areas of progress, as well as opportunities for future action and research. Within each region, specific countries are highlighted to provide more in-depth viewpoints. To underscore the diversity of challenges, we also present a set of proxy indicators (see Tables 1, 2, 3, 4, 5, and 6) that speak to supply and demand factors that impact pediatric surgery. Although these factors are not exhaustive, they highlight the heterogeneity of challenges that stakeholders face as they seek to improve surgical care within their local contexts.

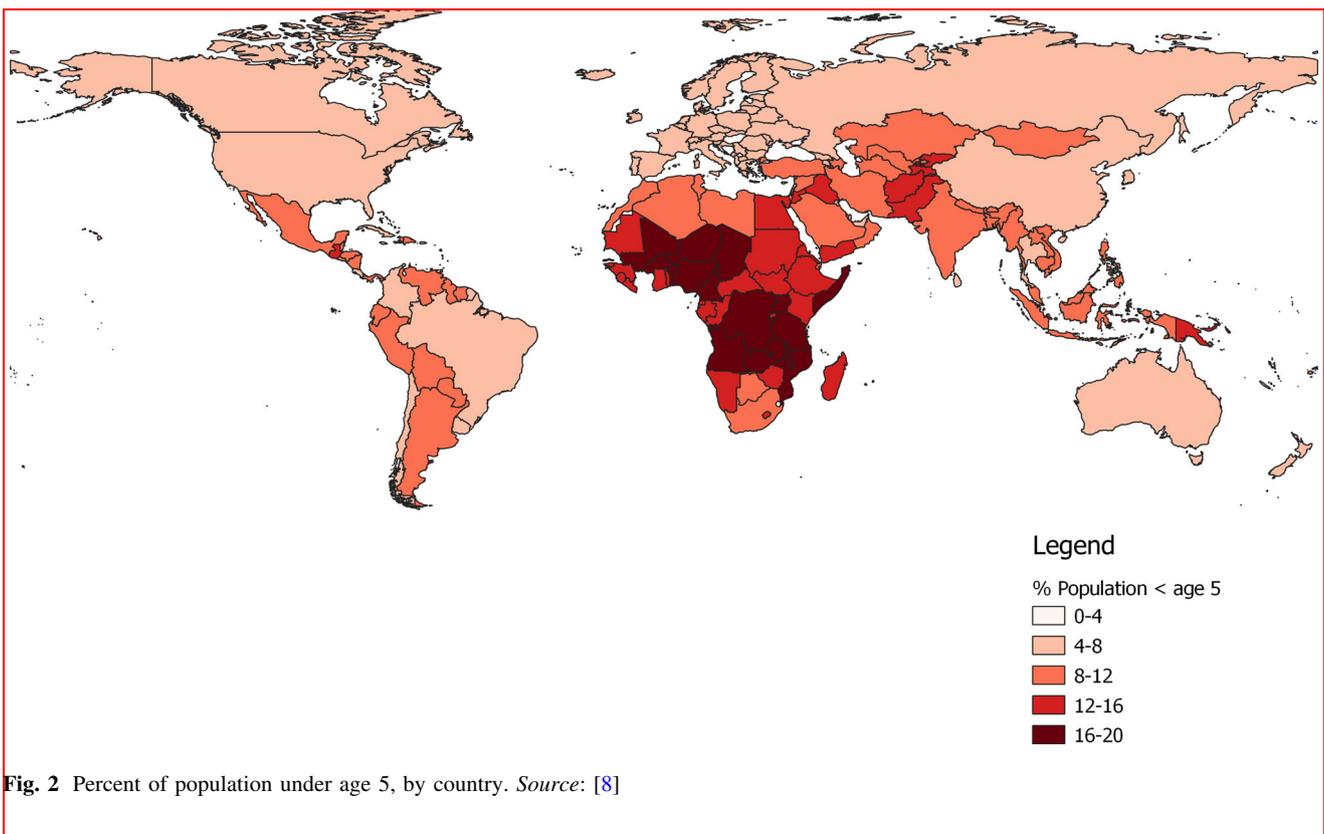
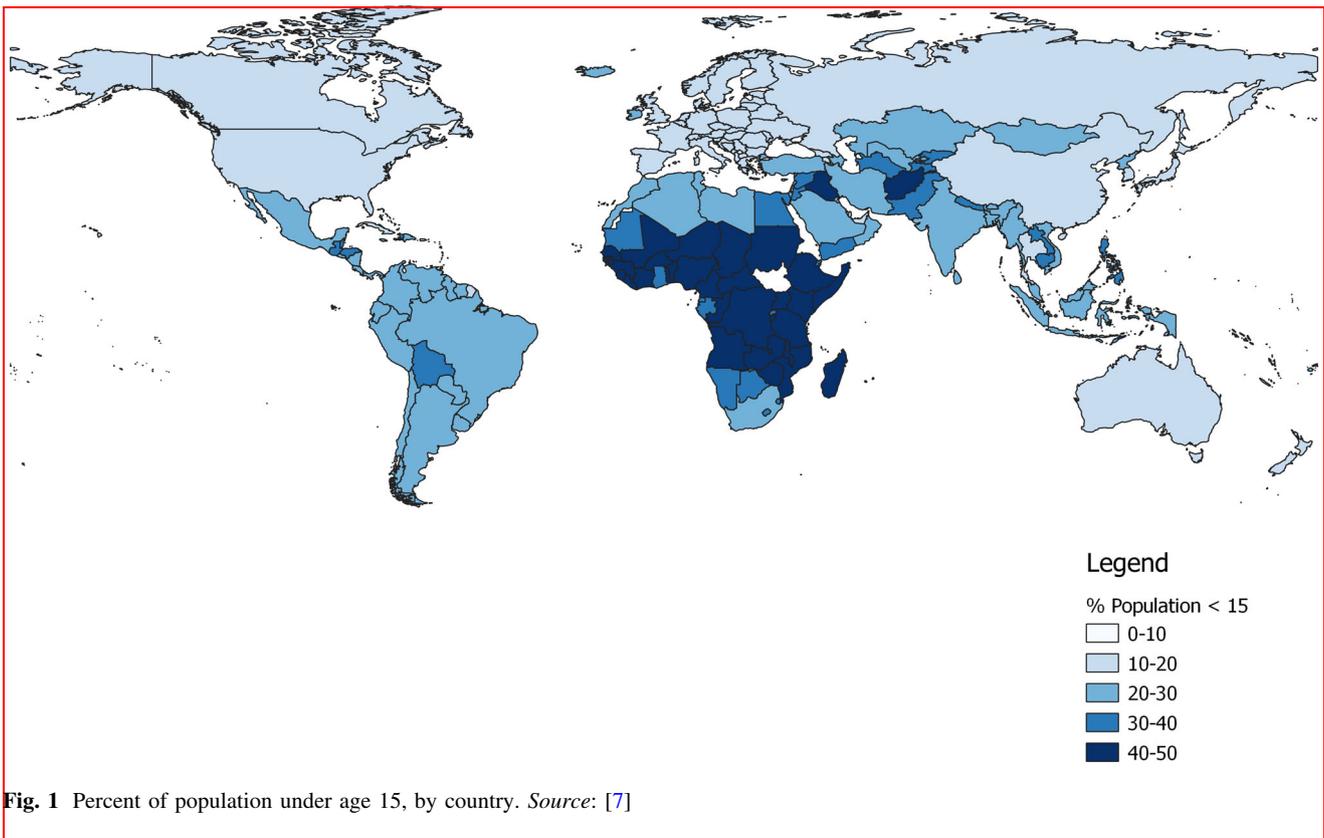
Regional perspectives

Central America

Central America is home to some of the poorest countries in Latin America, including Guatemala, El Salvador, and Nicaragua, where health systems have failed to keep pace with rapidly growing populations. In Guatemala, Honduras, and Belize, more than 30% of the population is under 15 [7]. High teenage fertility rates are common. In Guatemala, most of the mothers outside the city are young, and around 70,000 pregnancies are registered a year in girls between 10 and 17 years old, a pattern that increases mortality not just for the mothers but for the babies, too [14]. Over 50% of people live in poverty and 15% in extreme poverty.

In many of the countries in the region, the public health sector is chronically underfunded. In Guatemala, only two national hospitals offer pediatric surgical care, both in the capital Guatemala City. Because the general pediatric services and ICUs are crowded with children with pneumonia, diarrhea, malnutrition, it remains difficult to accommodate patients with elective surgical needs, as most beds are needed for children with surgical emergencies. Patients arriving from rural areas often find a long waiting list, which means that families often have to spend money on multiple trips to obtain surgical care. Neonates are also

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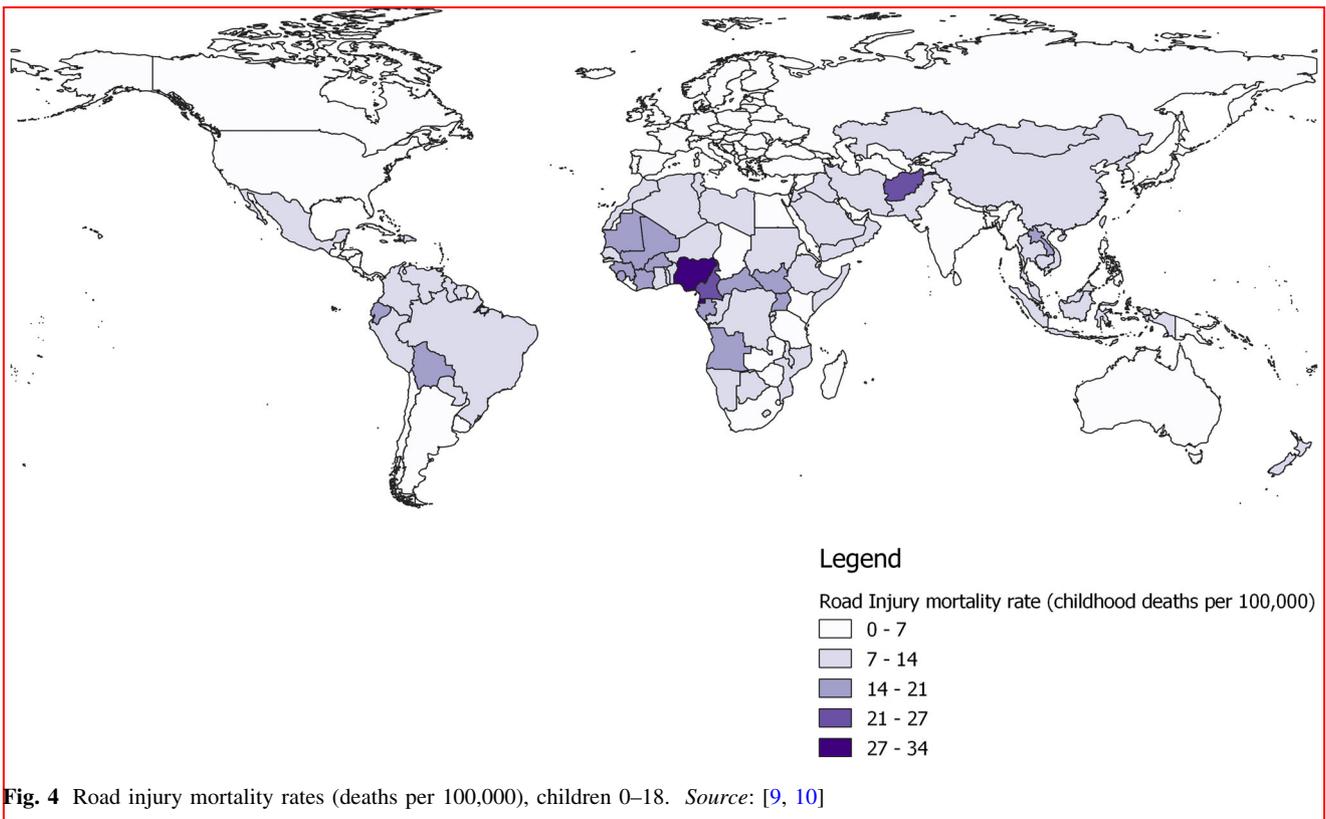
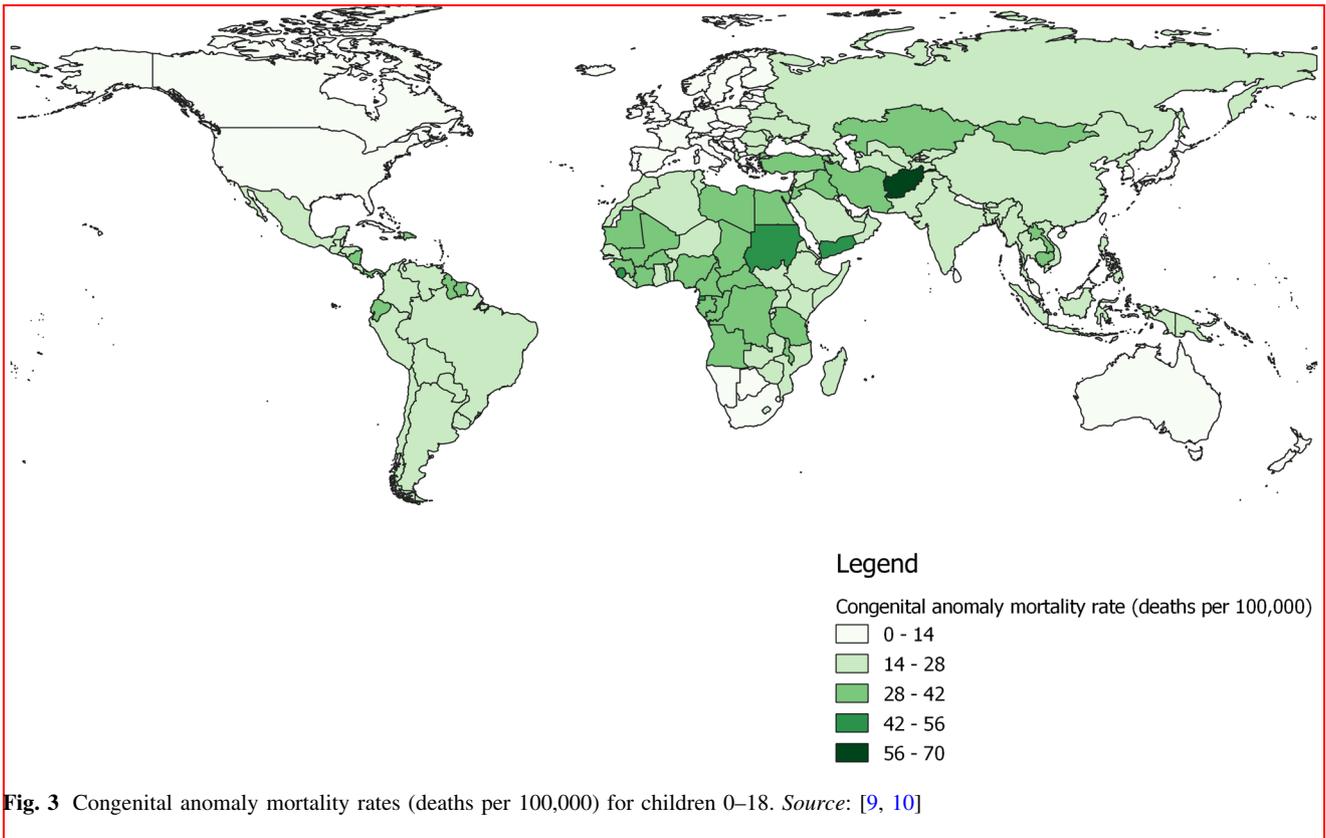


Table 1 Selected supply and demand factors affecting pediatric surgical care, Central America. Sources: [7–10]

Country	Proxy indicators							
	Demand challenges				Supply challenges			
	% Pop. under 5	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Belize	11	31.4	18.9	6.7	10.9	1.1	22.7	6.2
Costa Rica	7.3	21.7	22.1	4.9	22.3	1.2	21.5	8.1
El Salvador	9.2	27.4	25.2	7.6	–	1.1	27.9	6.9
Guatemala	12.3	35.1	15.1	4.5	3.4	0.6	55.8	5.7
Honduras	10.7	31.6	27.0	3.4	13.7	0.7	49.1	7.6
Mexico	9.2	26.7	25.3	7.9	–	1.5	41.4	5.9
Nicaragua	10	29.0	30.1	5.5	15.8	0.9	36.0	7.8
Panama	9.7	27.4	28.5	6.5	26.5	2.2	30.5	7.0

Table 2 Selected supply and demand factors affecting pediatric surgical care, MENA region. Sources: [7–10]

Country	Proxy indicators							
	Demand challenges				Supply challenges			
	% Pop. under 5	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Algeria	11.7	29.3	27.7	10.5	–	–	28	7.1
Egypt	13.2	33.5	38.2	6.5	50.08	0.5	62	4.2
Libya	10.1	28.2	29.6	7.3	–	3.7	–	–
Morocco	9.9	27.4	18.3	8.4	3.74	0.9	53	5.5
Sudan	15.2	40.8	44	7.7	2.67	0.8	63	6.3
Tunisia	9.1	24.0	27.4	9.9	11.61	2.1	40	6.7
Iraq	15.5	40.4	33.9	7	–	1.3	76	3.4
Jordan	13.1	35.5	32.8	7.1	–	1.8	25	6.3
Lebanon	7.9	23.1	27.8	4.5	87.4	3.5	32	7.4
Syria	11.9	36.6	16	4.7	–	1.5	–	–
Yemen	14.9	39.9	45.4	12.9	0.81	0.7	81	6.0

severely affected, as the NICUs have limited beds and many babies with surgical conditions have to wait several days for space. In the absence of access to national hospitals, babies stay within district or regional settings, where they may be treated by general surgeons with limited pediatric expertise. These district hospitals often do not have the equipment to take care of a neonate.

Lack of health sector funding also negatively influences staffing. In Guatemala, the pediatric surgical workforce (physician as well as nursing) is greatly restricted due to limited salary support. Although the pediatric surgery

surgical staff is often well trained, most surgeons have multiple jobs and gain most of their salary support within the private sector, leaving little time to support the majority of children who receive care within the public sector.

In recent years, many of these countries have been profoundly affected by natural disasters, violent crime, and political conflict [15]. Guatemala has experienced both large earthquakes and volcano eruptions. In these cases, local and national hospitals attempted to support the care of burned and injured children, creating further backlogs for scheduled cases. As these natural disasters place severe

Table 3 Selected supply and demand factors affecting pediatric surgical care, South Caucasus and Central Asia. *Source:* [7–10]

Country	Proxy indicators							
	Demand challenges				Supply challenges			
	% Pop. under 5	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Kazakhstan	11.2	27.9	31.3	11.4	88.6	7.2	38.8	3.9
Kyrgyz Republic	12.7	31.8	23	5	50.1	4.8	48.2	8.2
Tajikistan	13.6	35.3	22.9	2.7	55.6	5.5	63.1	6.9
Turkmenistan	12.2	30.9	23.5	5.8	58.8	4	71.1	6.3
Uzbekistan	10.3	28.0	19.8	5.9	50.4	4.4	42.7	6.2
Armenia	7.1	20.0	28.5	5.7	99.0	3.9	81.6	10.1
Azerbaijan	9	23.3	27.5	4.3	67.6	4.7	78.6	6.7
Georgia	7	19.2	11	5.1	125.0	2.6	57.3	7.9

Table 4 Selected supply and demand factors affecting pediatric surgical care, Southeast Asia

Country	Proxy indicators							
	Demand challenges				Supply challenges			
	% Pop. under 5	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Brunei	8	23.02	16.9	6.3	–	2.8	6.0	2.6
Cambodia	11.4	31.28	33.3	11.4	–	0.7	59.4	6.0
Indonesia	9.5	27.36	15.8	9.8	–	0.9	48.3	3.3
Lao	11.6	32.88	33.3	15.9	2.86	1.5	45.4	2.8
Malaysia	8.4	24.31	10.7	7.5	11.43	1.9	36.7	4.0
Myanmar	8.7	26.83	23.1	5.4	–	–	73.9	4.9
Philippines	11.2	31.72	22.9	4.4	9.56	1	53.5	4.4
Singapore	4.8	14.98	4.9	1.3	–	2	36.7	4.3
Thailand	5.6	17.32	15.4	12.9	13.23	2.1	11.8	3.8
Vietnam	8.3	23.06	18.2	10	–	2	43.5	5.7

strain on already limited financial resources, it may take years or generations for Guatemalan national health system to recover.

Novel academic partnerships have shown potential. In recent years, for example, the surgical staff at Roosevelt Hospital has collaborated with Duke University to improve safety culture and improving workplace resilience [16]. Such twinning relationships between institutions—and other types of international cooperatives—have shown results for other aspects of pediatric care in Central America and hold promise for elevating the quality of pediatric surgical care as well [17].

Middle East and North Africa

Across the Middle East and North Africa (MENA) region, countries vary widely in culture, resources, and geopolitical stability. The per capita GDP is as high as \$104,756 in Qatar and as low as \$1354 in Yemen—a 77-fold difference [18]. Many countries, including Syria, Yemen, Iraq, Libya, are in active wars or conflicts, and bordering countries are also intermittently brought into these conflicts. Such instability and differences in resources are important determinants of health in the region and strongly influence

Table 5 Selected supply and demand factors affecting pediatric surgical care, Sub-Saharan Africa

Country	Proxy indicators							
	Demand challenges				Supply challenges			
	% Pop. under 5	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Congo, Dem. Rep.	18.5	42.3	41.1	10.9	–	–	37.4	4.3
Cote d'Ivoire	16.3	42.4	35.4	14.8	3.1	–	36.0	5.4
Ethiopia	14.9	40.6	22.5	9.7	0.5	6.3	37.8	4.0
Ghana	14.6	38.5	24.1	11.5	–	0.9	36.1	5.9
Kenya	14.8	40.5	23.0	5.3	2.4	1.4	33.4	5.2
Liberia	15.7	41.8	25.8	6.4	–	0.8	19.6	15.2
Mozambique	17.3	44.8	20.3	8.6	0.6	0.7	6.8	5.4
Niger	20.4	50.2	25.8	11.5	0.5	–	52.3	7.2
Nigeria	17.2	44.0	33.3	34.2	1.4	–	72.2	3.6
Rwanda	14.9	40.1	22.1	13.3	0.8	–	26.0	7.9
Tanzania	17.5	44.9	28.6	6.6	0.5	0.7	26.1	6.1
Zambia	17.1	44.8	24.3	4.1	1.5	2	27.5	5.4
Zimbabwe	15.9	41.2	17.5	5.8	1.6	1.7	25.8	10.3

Table 6 Selected supply and demand factors affecting pediatric surgical care, worldwide perspective

Region	Proxy indicators						
	Demand challenges			Supply challenges			
	% Pop. under 15	Congenital anomaly mortality rate	Road injury mortality rate	Surgeon density (per 100,000 population)	Hospital bed density (beds per 1000 population)	% Out-of-pocket health spending	Total health expenditure as % GDP
Europe and Central America	21	16.5	5.0	74.6	7.4	32.0	5.3
North America	19	8.6	5.7	52.8	2.9	12.2	15.7
Latin America and Caribbean	25	23.2	7.9	31.6	2.0	31.8	6.7
Middle East and North Africa	31	24.5	8.6	21.6	1.0	35.7	4.8
South Asia	29	19.2	6.9	6.1	0.7	67.7	3.2
Sub-Saharan Africa	43	27.6	11.9	1.8	–	33.7	5.2

the burden of disease and the delivery of healthcare for children.

A recent study by Mokdad et al. [19] suggested that preterm birth complications and congenital anomalies were

among the top ten causes of disability-adjusted life years (DALYs) in the MENA region, third and fifth highest at 4.9% and 4.1%, respectively. Among the top ten risk factors contributing to DALYs were childhood undernutrition

(second, 7.5%) and suboptimal breast-feeding (seventh, 3.5%). Children younger than 5 years make up a substantial portion of the DALYs (33%), with a significant fraction attributable to disease requiring surgery [20]. As has been noted by other authors, many pediatric surgical conditions are congenital in nature with a burden of disease that essentially starts at birth and carries a high mortality and risk of lifelong disability; as such, the disease burden incurred by late access to surgical care potentially increases with each year of delay as surgical outcomes may worsen with advancing age [20]. The relatively high level of DALYs attributed to congenital anomalies in the MENA region suggests that the need for pediatric surgical interventions is high.

War and conflicts have also led to many people being forcibly displaced, either internally or as refugees into other countries. It has been estimated that approximately one million procedures were required in the MENA region for displaced persons, representing an increase of 50% from current unmet surgical need [21]. Countries with the highest surgical burdens for the forcibly displaced in the MENA region included Syria (388,000 procedures) and Iraq (187,000 procedures). Children less than 18 years of age made up 52% of the forcibly displaced, suggesting a very high demand for pediatric surgical care in these countries.

These and other factors also influence the delivery of pediatric surgical care. Many authors have noted that the MENA region is losing its healthcare workers as many physicians and surgeons leave in search of a better life in safer countries [22]. Many conflict-affected countries have witnessed damage to hospital infrastructure and disruptions in delivery of vital medicines and supplies, including anesthetics and pain medicine. Neighboring countries such as Lebanon and Jordan have experienced severe strains on their public health systems as refugees seek care, exacerbating preexisting challenges leading to longer wait times and backlogs [23, 24]. Many patients have reportedly delayed care because they are unable to pay facility user fees. GCC countries, by contrast, face a profoundly different set of challenges. Although historically flush with oil wealth, many continue to underinvest in health workforce training, relying instead upon overseas labor for physicians and nurses. As a result, training programs for surgical specialties remain underdeveloped.

South Caucuses and Central Asia

In many former Soviet countries, healthcare reflects the legacy of the Soviet “Semashko” health system, which was characterized by large infrastructure investments, highly centralized governance, and emphasis on specialty care.

Following the collapse of the Soviet Union, newly independent republics went various directions in developing their healthcare systems, though some common issues remained. These include concentration and often a surplus of healthcare infrastructure and resources in larger cities with inadequate development or upkeep of necessary infrastructure in rural regions. In addition, with the exception of robust vaccination programs, most former Soviet republics have a relative paucity of primary care and preventative infrastructure [25].

These factors, combined with the catastrophic economic impact of the collapse of the Soviet Union and significant underfinancing of healthcare sectors, have, for countries such as Armenia, resulted in a lack of access to quality care (including pediatric surgical care) that is not directly related to shortage of human resources or infrastructure as in many low-income countries [26]. In Yerevan, the capital of Armenia with a population of about 1 million, there are 3 children’s hospitals and at least 24 pediatric surgeons, resulting in a pediatric surgeon density well in excess of that in many high-income countries. In addition, care is fragmented among other facilities that treat children, including an oncology center and an infectious diseases hospital.

While there has been no formal assessment of pediatric surgical care in this region, direct observation and anecdotal evidence would suggest that several system-related issues contribute to shortfalls in delivery of safe, high-quality surgical care, including (1) a maldistribution of resources, with oversupply in larger cities and major deficiencies elsewhere; (2) fragmentation of care within urban settings, with an absence of comprehensive facilities capable of providing high-quality care and sufficient volume to support quality medical training; (3) low public healthcare expenditure combined with the high cost of maintaining redundant infrastructure and human resources, leading to inadequate financing of pediatric surgical care; (4) deficiencies in oversight and regulation of medical education resulting in significant variations in number and quality of pediatric surgical workforce; (5) lack of experience with and cultural openness to measuring outcomes to improve quality of care; and (6) suboptimal health policy performance leading to adverse effects on child health and safety (e.g., seat belt/car seat requirements) [27].

Access to care is further complicated by the lack of financial protection that prevails in this region. Many of the former Soviet countries have among the highest rates of out-of-pocket spending on health in the world; Armenia tops this list with 81% of all spending on health being paid out-of-pocket, with Azerbaijan close behind (78.6%) [7]. Although government insurance schemes in principle cover the cost of pediatric care, informal payments are common. As widening income inequality is seen in many former

Soviet states, such payments are likely to disproportionately burden low-income families when seeking specialist care [28].

Because many former Soviet states are middle-income, this region may provide valuable insight into problems that nations emerging from extreme poverty will face as they try to improve pediatric surgical care. As the above challenges illustrate, adequate numbers of infrastructure and personnel do not ensure access to safe, high-quality care, particularly for low-income and non-urban populations. Systems elements, including adequate financial protection, workforce regulation, and performance monitoring, must be addressed as well.

Southeast Asia

Nearly a third of the population of Lao, Cambodia, and the Philippines is under age 15, as are more than a quarter of Indonesia's 270 million people [7]. Based upon clinician experience and observation, the pediatric disease burden is notable particularly for a high incidence of anorectal disease, solid tumors, and hepatobiliary malformations, although published data are largely lacking. A review of inpatient records at Philippine General Hospital, in Manila, found congenital heart defects, Hirschsprung's disease, atresias, and anal stenosis as the most common congenital defects [29].

Large disparities exist between urban and rural areas in government funding, availability of care, and quality. In Vietnam, there are more than 250 pediatric surgeons, but they are concentrated mostly in urban cities. The country's three large children's hospitals, located in Hanoi and Ho Chi Minh City, are overcrowded, with chronic shortages in manpower and equipment. In Indonesia, most of the country's 150 active pediatric surgeons are likewise in urban areas, and maldistribution of resources is compounded by Indonesia's geographical peculiarities as an archipelago of over 15,000 islands. Standardized training and accreditation programs for pediatric surgery are lacking in many countries, instead relying on informal apprenticeship models, as is the case in Vietnam.

In many Southeast Asian countries, patients from remote provinces and districts face catastrophic costs seeking care in urban cities. In Vietnam, for example, payments of services for children older than 6 years old are predominantly from out-of-pocket expenses. In Indonesia, national health system expenditures are 3% of GDP, with nearly 50% of expenses covered by out-of-pocket payments. Vinluan et al. [30] documented the case of a 6-year-old girl in the Philippines with imperforate anus whose parents had taken out loans, moved to Manila, and started new jobs to afford surgery when she was 2 years old, only to suffer years of additional delays before she received an operation.

Some positive trends are underway. In Indonesia, increases in healthcare budgets are expected, and recent government reforms have included an expansion of public health coverage and construction of new maternal and pediatric hospitals in densely populated provinces. The Indonesian Pediatric Surgical Organization (PERBANI) has organized to provide training standards and certification in three pediatric centers. In Vietnam, organizations such as the Vietnam Association of Pediatric Surgery and IPSAC-VN (International Pediatric Specialist Alliance for the Children) have formed to improve training opportunities and, in the case of the latter, strengthen research and improve policies, including support lower-tier hospitals to promote patient care locally while relieving the volume burden in the cities.

Sub-Saharan Africa

By 2050, Sub-Saharan Africa (SSA) will be home to more than 1 in 3 children worldwide and account for 38% of global births. Although mortality rates among children under 5 years of age in Africa have decreased by more than half, the neonatal mortality rate as a share of under-5 mortality has increased [31]. Injuries are a major source of morbidity and mortality, ranking third in incidence behind diarrhea and malaria at 40,000 episodes and 100 deaths per 100,000 population annually. Congenital abnormalities are another common problem [31]. Extrapolating from other LMIC studies, the cumulative incidence of severe congenital abnormalities in SSA may affect 85 per 1000 children by the age of 5 [32].

Outcomes from pediatric surgical conditions in SSA are generally poor. Gastroschisis, considered a bellwether condition, has been shown to have a near 100% mortality rate in some countries in SSA [33, 34]. These disappointing results are related, among other factors, to limited health infrastructure and resources, poor access to care, high rates of malnutrition, poverty, low literacy, and the presence of other concurrent, potentially lethal medical diseases such as malaria, tuberculosis, and HIV infection. High levels of illiteracy have been implicated as a cause for delay in presentation, and severe acute malnutrition (SAM) has been shown to be as high as 30% in children with surgical diseases [35, 36]. Health financing is also weak: As of 2015, only 8 of 55 SSA member countries had met the goal of allocating 15 percent of their annual budget to healthcare as stated in the Abuja Declaration, ratified in the 2000 [37]. Many countries in SSA, including Democratic Republic of the Congo and Central African Republic, are affected by active conflict, or have recently emerged from conflict, conditions that weaken health systems and complicate the delivery of surgical care.

Without dramatic efforts, population growth will exacerbate the disparity between the number of children and the number of child-focused healthcare workers. Due to the historical dominance of communicable disease as a cause of morbidity and mortality, the prevention and treatment of pediatric surgical diseases have traditionally received little attention. However, there are some signs of change. In the past decade, the number of pediatric surgical training programs in the region has grown. For example, in the past 15 years in Kenya, more than 10 pediatric surgeons have graduated from the country's two formal programs. Significant strides have also been made to include pediatric anesthesia as a part of an overall safe pediatric surgery strategy, including the use of task shifting through training nurse anesthetists and by offering formal sub-specialty pediatric anesthesia training. The growing demands for safe pediatric surgery provision in SSA can be met but only if significant, multifaceted international and collaborative efforts and resources are brought to bear.

Conclusions and future directions

Some challenges to providing safe, timely pediatric surgery appear to be widely shared across global regions. In many LMICs, adequate numbers of trained pediatric surgeons are lacking, and pediatric surgery capabilities, when they exist, are often concentrated in urban areas, with inadequate referral or transport systems from rural areas, limiting access for rural populations. Financial protection for surgical interventions is often weak or absent, leaving poorer families at risk of falling into poverty or having to forego care when needed.

Yet there is also evidence—some anecdotal, some based on surveys and modeling—of significant heterogeneity in pediatric surgical challenges, both between regions and among countries in the same region. This heterogeneity can reflect differences in demographics, epidemiology, geography, income level, health spending, historical health policies, and cultural practices, among others. Issues of quality may predominate in middle-income countries where resources are adequate, whereas lower-income countries likely face a double burden of limited resources and poor quality. In the MENA region, as well as other countries, protracted conflict has created a host of challenges for the delivery of surgical services, as well as increased the demand for certain services as well (e.g., trauma care). In the financing realm, some countries have made much more progress than others in limiting out-of-pocket expenses.

Even in regions that are higher performing, such as North America, challenges remain to ensuring equal access to care for all pediatric surgical patients. Race and

socioeconomic status have repeatedly been shown to have an impact on many aspects of care. Black children, for example, are less likely to be offered surgical management for perforated appendicitis than non-black children [38]. Children from low-income families and those lacking insurance are more likely to present with higher-stage thyroid cancer, and experience greater delays in treatment, than those from higher-income families or those with insurance [39]. Even in Canada, where healthcare coverage is universal, disparities exist for rates of perforated appendicitis by socioeconomic status and geography, underscoring the complex interplay of various health determinants [40].

Amid these global challenges, there are signs of progress. Anecdotally, several LMICs have undertaken recent efforts to develop more formalized pediatric surgery training programs and to increase the number of pediatric surgeons being trained. Several of these efforts have been supported by academic institutions in the USA, Europe, and elsewhere through twinning relationships and other partnerships. Advocates such as the Global Initiative for Children's Surgery (GICS), representing surgical providers from 21 countries, including 18 LMICs, have begun developing pediatric surgery standards and advocating for their inclusion in national policies [41].

What is the way forward? On a research level, there are sizeable gaps not only in the amount of available data but also in the type of data being collected. To build a more complete picture of pediatric surgical challenges, assessments of physical and human resources need to be complimented by country-level investigations into the burden of disease and health system constraints that prevent patients from getting care they need. Stronger efforts should be made to assess access barriers, including cost of care, travel time, and patient perceptions of care, as well as issues related to quality, including provider adherence to guidelines, technical competency, and patient outcomes.

There is also a need to translate research into policy action and sustainable reforms that build upon existing policies and systems. Because specialized pediatric surgical care is almost universally concentrated in urban settings, opportunities for developing context-appropriate referral networks between urban and rural hospitals should be explored, including systems for neonatal and pediatric transport. Efforts to develop data registries for common pediatric surgical conditions can be undertaken that build upon existing health information systems or data collection systems, if they exist. On a medical education level, formalized curriculum and minimum case requirements should be supported. On a financing level, stakeholders can advocate for the inclusion of pediatric surgical conditions under national health insurance programs and work with policymakers to understand the budget implications of such

decisions. Attention also needs to be paid to the downstream impacts of expanded pediatric surgery capabilities. If the number of trained pediatric surgeons grows, are salaries sufficient to keep them in the public workforce, or are financing reforms needed to improve remuneration and prevent brain drain or loss to the private sector? Are additional investments in NICUs, transport, and referral networks needed? How can budget space be created to make such reforms sustainable? These actions will take different forms depending upon the context and must respect local priorities, underscoring the reality that global pediatric surgical needs are fundamentally local ones, experienced by different countries in different ways.

Top 3 public policy recommendations

1. *Access* Undertake assessments at the country level to identify populations with limited access to pediatric surgical care and develop policies to strengthen referral networks to improve timely access
2. *Quality* Support policies to collect data on and monitor the quality of pediatric surgical care at major centers, including provider knowledge, adherence to clinical guidelines, and patient outcomes, to inform quality improvement initiatives
3. *Health financing* At the country level, document the extent which pediatric surgical conditions are covered under existing insurance schemes, explore the impact of lack of coverage on utilization, and identify barriers to expanding coverage

Compliance with ethical standards

Conflict of interest KG has done consulting work for the World Bank on topics related to health system strengthening in the past 3 years.

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