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The Burden of Plastic Surgery in Rural Kenya: The Kapsowar Hospital Experience

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Purpose: Both governmental and nongovernmental training programs are expanding efforts to train the next generation of plastic surgeons who will work in low- and middle-income countries (LMICs). Sufficient training is dependent on acquiring the appropriate skillset for these contexts. Few studies have characterized the spectrum of practice of plastic surgeons in LMICs and their relative disparity.
Methods: We performed a retrospective review on all patients who received plastic surgery at a single institution in rural western Kenya from 2021 to 2023. Data such as diagnoses, procedures, and home village/town of residence were collected. Patient home location was geomapped using an open-access distance matrix application programming interface to estimate travel time based on terrain and road quality, assuming patient access to a private vehicle and ideal traveling conditions. Descriptive statistics were performed.
Results: A total of 296 patients received surgery. Common procedures included treatment of cleft lip/palate (CLP), burn reconstruction, and reconstruction for benign tumors of the head and neck. The average distance to treatment was 159.2 minutes. Increased travel time was not associated with time to CLP repair ($P > 0.05$). Increased travel time was associated with delayed treatment for burns ($P = 0.005$), maxillofacial trauma ($P = 0.032$), and hand trauma ($P = 0.016$).
Conclusions: Training programs for plastic surgeons in LMICs should ensure competency in CLP, flaps, burn reconstruction, and head and neck reconstruction. Our novel use of an application programming interface indicates that international partnerships have been more successful in decreasing treatment delays for CLP patients, but not other reconstructive procedure patients. Expanded commitment from international partners to address these reconstructive burdens in LMICs is warranted. *(Plast Reconstr Surg Glob Open 2024; 12:e6289; doi: 10.1097/GOX.0000000000006289; Published online 8 November 2024.)*

INTRODUCTION

The burden of conditions that require surgical management is greatest in the world's poorest regions, where the least amount of surgical care is available.[1] This disparity in healthcare accessibility in low- and middle-income countries (LMICs) is particularly notable in the field of plastic surgery, whose services could target two-thirds of the disability-adjusted life years that could be surgically managed.[2,3] Although there are relatively few plastic surgeons working in sub-Saharan Africa (SSA), both governmental and nongovernmental organization (NGO)-associated training programs are expanding efforts to provide treatment for these patients.[4] To ensure that training programs adequately prepare practitioners for the contexts in which they will be working, it is beneficial to characterize the spectrum of practice that can be anticipated of a plastic surgeon in SSA.[5,6] However, although numerous studies report on the experience of performing individual plastic and reconstructive procedures in SSA, there have been few works that have reported on the breadth of cases managed by individual plastic surgery departments.[5,7–9] This paucity of published works is especially notable in rural contexts, where the need for reconstructive surgery continues to be greatest.[10]

Kapsowar Hospital is a 140-bed nongovernmental facility set in a rural and largely agrarian community in the highlands of western Kenya. It serves as a catchment for a local population of nearly 300,000 people and draws

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patients from throughout Kenya and neighboring countries. This institution provides surgical coverage in general surgery, obstetrics and gynecology, and orthopedics and is the only facility in SSA that is served full-time by 2 surgeons who are certified by the American Board of Plastic Surgery. As such, we are uniquely positioned to share our experience in providing plastic and reconstructive surgical care in a rural, low-resource setting.

This study has dual objectives: to characterize the burden of plastic surgery at a single nongovernmental institution in an underserved area of an LMIC and to determine if varying proximity to that institution affects treatment delay. The information gathered from these objectives is intended to help inform the structuring of training programs for plastic surgeons in rural contexts as well as the efforts of international NGOs who collaborate with such physicians. To accomplish these objectives, we used the novel use of a geospatial mapping application programming interface to assess the accessibility to plastic surgery care for our patient population and to identify the extent that healthcare scarcity affects the patients who present to our facility.

METHODS

This study was jointly coordinated by faculty at Weill Cornell Medicine and Kapsowar Hospital and approved by the institutional review boards associated with both. A retrospective chart review was conducted on all patients who received surgical treatment from the department of plastic surgery between 2021 and 2023. Patients who received plastic and reconstructive surgery from either of our institution's plastic surgeons were included. As both senior surgeons are also trained in general surgery, procedures performed outside of the purview of plastic and reconstructive surgery were excluded. Charts were reviewed assessing for the following parameters: age, sex, home village or town, relevant medical history (ie, smoking history, diabetes, human immunodeficiency virus), details of incident, diagnosis, procedures performed, complications encountered, surgical revisions, and length of hospital stay. We hypothesized that increasing distance from the hospital would correlate with delays in patient treatment. To test this hypothesis, the patient's home location was geomapped using Google Maps. The TravelTime open-access distance matrix application programming interface, which calculates travel time based on terrain and road quality, was then used to estimate how long it would take a patient to reach our facility given access to a private vehicle and ideal traveling conditions. In a secondary analysis, we assessed the rate of patients coming to our facility from within and beyond a 2-hour catchment radius. Statistical analysis was conducted using Microsoft Excel (version 16.66.1). Demographic data were evaluated using descriptive statistics. Continuous variables were reported as mean ± SD and compared via 2-tailed *t* tests.

RESULTS

A total of 497 procedures were performed on 296 patients who met the inclusion criteria [191 men (64.5%)]. A summary of initial diagnoses is provided in Table 1. The most common diagnoses encountered were cleft lip/palate (CLP), followed by neoplasms, hand traumas, lacerations, and burn sequelae. A summary of patient anatomic distribution is provided in Table 2. A summary of procedures performed is provided in Table 3. The most common procedure performed was the repair of CLP (n = 104, 21.10%), followed by skin grafts (n = 60, 12.17%), flap creation (n = 55, 10.55%), and reconstruction for neoplasm (n = 45, 9.13%). A summary of the rate of complications encountered by procedure type is provided in Table 4. A summary of the complications encountered is

Takeaways

Question: What is the plastic surgery experience at a limited-resource hospital in rural Africa?

Findings: Our study demonstrates the capability of practicing plastic surgery in rural settings. We provide evidence for the efficacy of partnerships between nongovernmental organizations and local practices in low- and middle-income countries in the treatment of cleft lip/palate. Expanded commitment to providing reconstructive surgical care to other patient populations should be pursued.

Meaning: Partnerships to prepare plastic surgeons for practice in rural African settings should prioritize competency in cleft lip and palate, flaps, burn reconstruction, and head and neck reconstruction.

Table 1. Diagnoses

Diagnosis	Number (Percentage of Total)	No. Male (Percentage Male)
CLP	92 (28.9)	58 (63.0)
Neoplasm	36 (11.3)	18 (50.0)
Fracture (hand)	30 (9.4)	20 (66.7)
Laceration	23 (7.2)	12 (52.2)
Burn	24 (7.2)	8 (33.3)
Acute	6 (1.6)	3 (50)
Amputation	3 (0.9)	0 (0.0)
Chronic wound	3 (0.9)	3 (100.0)
Contracture	13 (4.1)	3 (23.1)
Soft-tissue defect	17 (5.3)	15 (88.2)
Hypospadias	15 (4.7)	15 (100.0)
Urethral stricture	15 (4.7)	15 (100.0)
Fracture (maxillofacial)	8 (2.5)	7 (87.5)
Infection	8 (2.5)	3 (37.5)
Amputation	5 (1.6)	3 (60)
Human bite	4 (1.3)	1 (25.0)
Noma	4 (1.3)	2 (50.0)
Abscess	3 (0.9)	3 (100.0)
Dislocation (hand)	3 (0.9)	3 (100.0)
Surgical site infection (other surgical service)	3 (0.9)	3 (100.0)
Syndactyly	3 (0.9)	2 (66.7)
Ankylosis of temporomandibular joint	2 (0.6)	1 (50.0)
Cyst	2 (0.6)	1 (50.0)
Skin tag	2 (0.6)	1 (50.0)
Other	13 (3.9)	5 (38.5)

Table 2. Anatomic Distribution and Proximity to Hospital (n)

	Breast and Torso	Urogenital	Hand	Head, Face, and Eyes	Lower Extremity
<2 h	4	11	50	39	20
>2 h	3	20	19	92	14
Unspecified	2	0	4	16	2
Total	9	31	73	147	36

Table 3. Procedures Performed

Category	Number	Percentage
CLP repair	104	21.10
Skin graft	60	12.17
Split-thickness	39	7.91
Full-thickness	21	4.26
Excision and reconstruction	45	9.13
Flap	52	10.55
Pedicled	33	6.69
Free	19	3.85
Wound closure	23	4.67
Open reduction external fixation	21	4.26
Open reduction internal fixation	18	3.65
Urethroplasty	18	3.65
Debridement	18	3.65
Contracture release	15	3.04
Hypospadias repair	16	3.25
Incision and drainage	14	2.84
Amputation	12	2.43
Tendon repair	12	2.43
Chordee repair	9	1.83
Ear reconstruction	8	1.62
Nerve repair	6	1.22
Hand fracture reduction	4	0.81
Bone graft	4	0.81
Flap division	4	0.81
Artery repair	3	0.61
Flap debulking	3	0.61
Syndactyl release	3	0.61
Incisional biopsy	2	0.41
Nasal reconstruction	2	0.41
Hardware removal	2	0.41
Other	19	3.85

provided in Table 5. A total of 127 patients (41.1%) were trauma victims, most commonly burn victims (18.9%). Excluding international patients and those for whom home location could not be ascertained, geospatial mapping was performed for 273 patients. The results of this analysis are summarized by diagnosis type in Table 6. Geospatial representation of the average travel time to Kapsowar Hospital based on patient home residence as well as a heatmap illustrating the distribution of patient density is provided in Figure 1. Patients seeking reconstructive care resided, on average, 159.3 minutes from our facility if traveling in a private vehicle under ideal conditions. Increased travel time from the hospital was found to be associated with increased delay in treatment for patients with burn contractures ($P < 0.01$), lacerations ($P < 0.01$), hand trauma ($P < 0.01$), and maxillofacial fractures ($P < 0.01$). Increased travel time was not associated with treatment delay for CLP, acute burn care, or lower extremity soft-tissue defects (all $P > 0.05$). Secondary analysis identified that 71.1% of patients came from beyond a 2-hour catchment radius, including 38.1% of all patients with trauma.

DISCUSSION

In LMICs, where infrastructure shortages make distance to treatment facility a poor indicator of accessibility,[11] geospatial mappings capable of assessing terrain, road speed capabilities, and the incorporation of multimodal transport have been used to investigate healthcare access for a wide variety of conditions, including obstetrics, infectious diseases, and essential surgery.[12–15] Geospatial mapping has also been used in both high-income countries (HICs) and LMICs to estimate factors related to institutions' experiences in treating individual plastic surgery conditions, such as CLP.[16–18] We believe that our study is the first to harness this technology to aid in the characterization of the scope of plastic and reconstructive surgery burden facing a rural institution in SSA.

In addition to being the single largest cohort treated at our institution (27.3% of all patients), patients who underwent CLP traveled the greatest amount of time to our facility. These patients traveled, on average, 231.3 minutes

Table 4. Rates of Complications Requiring Further Surgical Intervention

Procedure	No. Procedures with ≥1 Complication	Procedures	Complication Rate, %
Flap free	13	19	68.42
Hypospadias repair	6	16	37.50
Flap pedicled	12	33	36.36
Vessel repair (nerve/vein/artery)	2	10	20.00
Skin graft (full-thickness)	3	21	14.29
Others	4	35	11.43
Urethroplasty	2	18	11.11
Excision	3	45	6.67
Skin graft (split-thickness)	2	39	5.13
Cleft palate	3	104	2.88%

Table 5. Frequency of Complications Requiring Further Surgical Intervention

Complication	Number
Surgical site infection	20
Soft-tissue necrosis	12
Fistula	8
Dehiscence	7
Graft failure	4
Hardware extrusion	2
Hematoma	2
Pressure ulcer	2
Others	7

to receive treatment, which is nearly 2.5 hours farther than those who received treatment for other causes. This increased travel time likely reflects the scarcity of surgeons capable of performing this procedure in our region of Kenya.[19] Despite patients with CLP facing increased travel times, this did not seem to be a barrier in their receiving treatment. The age at which patients from within a 2-hour travel radius of our hospital and those from beyond this catchment received care is nearly indistinguishable (2.04 versus 2.01 years, respectively). We believe that this provides evidence of the success of our hospital's partnership with an NGO that is committed to treating patients who underwent CLP.[20]

Our findings of a rural sub-Saharan hospital having a high burden of CLP is in contrast to those of a recent report from a plastic surgery department in rural Gabon which found that orofacial cleft treatment comprised a small portion of their practice.[8] Those authors attributed the infrequency with which they treat patients with CLP to their rural location and lack of understanding of their hospital's capacity to provide such surgical service. Our partnering organization funds campaigns both in our community and beyond it that educate patients and families about the importance of CLP repair and the capability of our hospital to provide it. We believe that these advertising campaigns have been effective in extending our catchment of timely repair for patients with CLP.

Although access to surgical care at our hospital is more timely than in many other SSA contexts,[21] we continue to combat a shortage of ancillary staff necessary to provide comprehensive cleft treatment. Our current infrastructure allows us to provide some forms of multidisciplinary care for patients with CLP, such as nutritional counseling. Many of the valuable team members responsible for optimizing outcomes for these patients in urban centers and HICs, such as speech–language pathologists, orthodontists, and psychologists,[22] are not present in our rural setting. Further investment in these ancillary services is warranted.

Although travel time did not constitute a barrier to care for patients who underwent CLP, our study found evidence that it was a barrier for patients requiring reconstructive care for burn sequelae, including chronic wounds, extremity amputations, and burn contractures ($P < 0.01$). Contracture was the most common burn sequelae treated, comprising nearly half (48.0%) of our burn reconstruction practice. The average burn contracture patient presented 3.5 years after the accident and traveled 139.0 m to reach our institution. In contrast, there was no association between travel time and treatment for primary burn reconstruction patients ($P = 0.07$). These patients resided closer to our hospital (64.8 minutes) and presented more quickly (4.5 days) after injury. Our findings suggest that increased travel time from the hospital is a risk factor for the development of disfiguring burn sequelae. This is particularly concerning given that burn injury has been identified as a leading cause of morbidity and disability throughout SSA.[23,24] The importance of reconstructive surgery in the management of these patients is reinforced by the experience of Guzman et al[25] in urban Mozambique who reported that more than 44% of their patients receiving plastic and reconstructive surgery were burn patients.

Compared with individuals in HICs, individuals in LMICs are at increased risk of sustaining a burn injury.[26] One recent report on the incidence of burns in Ethiopia, found that 6.2% of children had sustained at least 1 burn in the previous year, most typically related to open-fire cooking.[27] The relatively low number of patients in our cohort (n = 24) who received reconstructive surgery for burn wounds, as well as the significant delay in time from injury to presentation, suggests that many patients within our catchment who would benefit from reconstructive surgery do not seek help. Denekew et al,[28] reporting on the perception of burns in Ethiopia, found more than half (63.6%) of participants disagreed or strongly disagreed that burns could cause scarring. We believe similarly low health literacy rates, and financial constraints, contribute to the relatively low number of patients who present to our institution with not only burn injuries, but also neoplasms, lacerations, and needs for lower extremity reconstruction.

Associations between increased travel time and delayed treatment were statistically significant for other patients with trauma, such as hand trauma ($P < 0.01$) and trauma to the head and neck ($P = 0.02$). Although access to treatment after trauma within 1 hour of injury is considered the gold standard for maximizing patient outcomes,[29] following the recommendations regarding access to essential surgical care put forward by the 2015 Lancet Commission

Table 6. Time to Presentation (d)

Diagnosis	Reside within 2-h Catchment	Reside beyond 2-h Catchment	Average Time	Increased Travel Time and Increased Time to Treatment (*P*)
Burn (contracture)	547.5	1508.0	1316.0	0.0034
Burn (primary)	4.2	N/A	4.3	0.0651
Hand	7.3	9.0	29.1	0.0029
Head and neck	0.4	735.4	2.9	0.0169
Lower extremity	56.8	9.0	86.9	0.3789

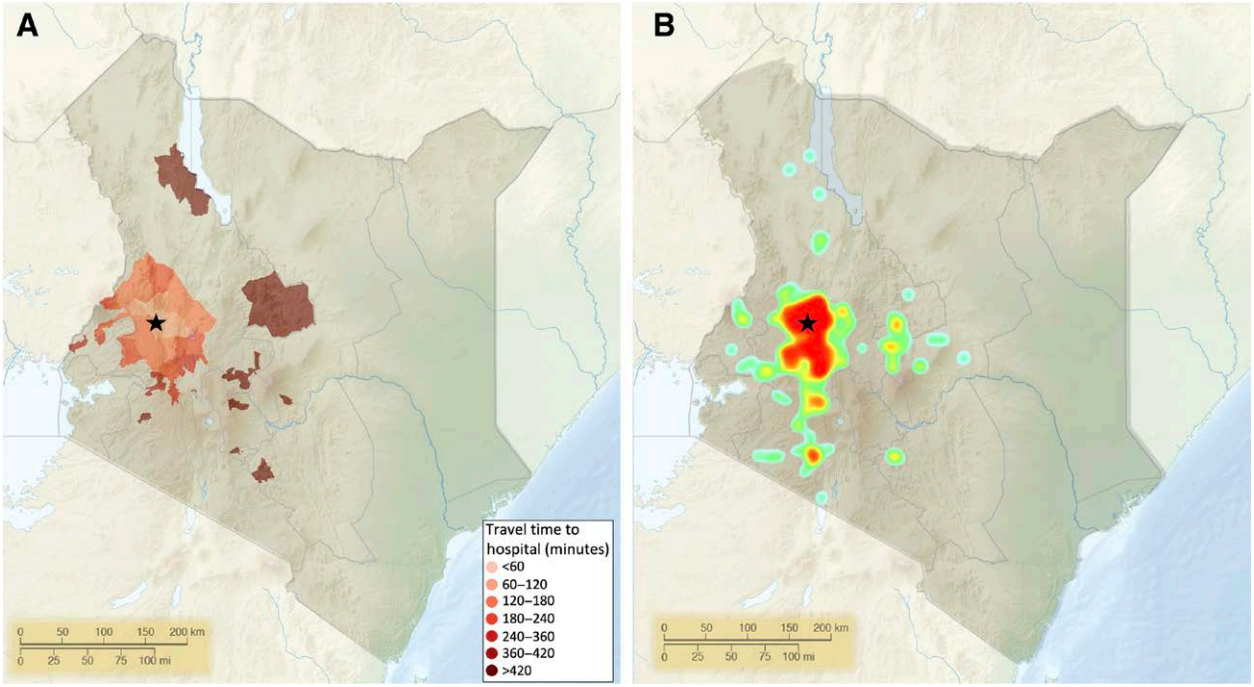

Fig. 1. Catchment area of Kapsowar Hospital. A, A geospatial representation of travel times to our institution. B, A heatmap demonstrating patient distribution by home residence. Adapted from https://commons.wikimedia.org/wiki/File:Kenya_relief_location_map.jpg. Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no invariant sections, no front-cover texts, and no back-cover texts. A copy of the license is included in the section GNU Free Documentation License.

on Global Surgery, a 2-hour catchment has frequently been used in trauma studies in the LMICs of SSA.[30,31] In our secondary analysis, we charted patients against a 2-hour threshold and found that 25.0% of patients with hand trauma and 46.2% of patients with head and neck trauma reached our facility from beyond this catchment radius. This percentage is greater than that found in a recent report using geospatial data in an urban Ugandan setting in which 98.4% of patients with trauma originated from within a 2-hour ideal drive to their facility.[32] The increased rate of patients coming from far distances further illustrates the relative scarcity of surgeons capable of providing reconstructive care in rural settings compared with urban environments.

No association was found between travel time and treatment delay for lower extremity trauma. However, patients with lower extremity soft-tissue defects remain an important part of our practice. Representing only 5.3% of patients seen, they comprise nearly 9% of all procedures performed by our plastics teams. In HICs, microsurgical free tissue transfer is often considered the standard of treatment for many soft-tissue defects requiring reconstruction.[33,34] Unfortunately, microsurgical capabilities are still lacking for the majority of plastic surgeons working in SSA.[35,36] At our institution, we have successfully used a variety of pedicled flaps to close soft-tissue defects in the past.[37,38] In the last year of practice reviewed in this study, advancements in our institution's surgical capacity allowed us to begin performing free flap procedures. Although the challenges to performing microsurgery in low-resource settings are well documented,[39,40] we have found the use of free flaps has decreased our reliance on pedicled flaps and improved our ability to provide reconstructions that allow for both quicker return to functionality and improved cosmesis, even in our low-resource setting.

Flap monitoring has been cited as the leading obstacle to the performance of microsurgery in SSA settings.[36] We do not have access to advanced monitoring devices, such as implantable Doppler or tissue oximetry infrared devices. We have had success with a local protocol that necessitates nursing staff to perform serial clinical exams for skin warmth and visual inspection as well as hourly Doppler sonography for the first 3 days after surgery.

Unlike our patients with CLP, whose discharge timing at our institution is similar to that found in HICs, we often delay discharge for our more complex reconstruction patients. As the long travel times often make it difficult for reliable follow-up appointments, we often prefer these patients to stay on the wards until approximately the time that they would be receiving their first follow-up appointment in the United States where these surgeons are trained. This practice allows us to better ensure safe and satisfactory outcomes than would otherwise be possible in our setting.

The year ending 2023 saw a nearly 4-fold increase in the presentation of road traffic accident (RTA) victims to our facility over the years 2021 and 2022. This is consistent with other studies that have noted that, whereas RTA-related morbidity and mortality have decreased HICs due to road safety initiatives, the burden of RTAs continues to

increase in LMICs.[41,42] In the past, our institution primarily received trauma from work accidents that reflect our agrarian setting; however, RTAs have become the leading cause of trauma at our center. Most commonly, these accidents involve commercial motorbikes. As in other studies from LMICs, we have found that these patients are typically young men.[43] In our population, they typically present with combinations of fractures, lacerations, and soft-tissue defects. These patients also frequently require urogenital reconstruction.[44] The development of high-speed commercialized roads throughout SSA is expanding.[45,46] As such, we anticipate that the increased rates of RTA-related trauma that we have seen will be reflected in the presentation of patients to other institutions.

CLP and trauma reconstruction represent just more than 70% of our total practice. The second most common presentation in our practice is excision and reconstruction for neoplasms (11.3%). These are often benign tumors such as gland tumors, lymphangiomas, lipomas, squamous cell carcinomas, and ameloblastomas. Imaging of all suspected tumor masses is the standard of care before surgery.[47] However, like the majority of surgical centers in SSA, our institution does not have on-site computed tomography or magnetic resonance imaging capabilities.[48,49] To aid in these patients' surgical planning, we are fortunate to have a hospital in our nearest city (2 hours away) with diagnostic imaging capabilities. Although the out-of-pocket cost of such imaging is prohibitive for many patients, our institution's charitable reconstructive surgery fund can offset the costs for both imaging and transportation.

Our use of geospatial mapping identified disparities in care for burn victims, patients with hand trauma, and others based on travel time distance from our hospital. Although nonprofits are working to combat other reconstructive needs in LMICs,[50–52] to this point, the greatest attention and allocation of resources expended in the field of global plastic and reconstructive surgery have been in support of patients with CLP.[53] Given that there remains a backlog of ~4,000,000 individuals with CLP worldwide, these efforts should be continued.[54] In addition, we believe that our findings of disparity for patients who need burn, hand, and facial reconstruction support calls for an even greater commitment to expanding global plastic surgery partnerships and resource coordination for these and other conditions.[55,56]

Despite the utility of geospatial mapping to identify disparities in treatment, we recognize its limitations. First, transit difficulty is only 1 of the 3 delays that are widely recognized as summarizing the major barriers to global healthcare delivery.[57] Future studies would benefit from considering further barriers that prevent seeking and receiving care in rural contexts of LMICs.[58] Second, geospatial modeling has been shown to underestimate actual travel time in some SSA contexts.[59] Our geospatial mapping provides a relative assessment of the relationship between travel time and treatment. Future prospective studies would do well to survey patients on means of transport and precise travel time. Finally, we recognize that the scope of our practice is informed, not only by our surgical capabilities but by what is known of them in our surrounding community. Future studies would benefit from a multicenter design which could further typify the plastic surgery practice experience in rural SSA.

CONCLUSIONS

This study demonstrates the spectrum of diagnoses and the treatment modalities that are possible in a low-resource setting. We find that there is a high burden for CLP repair, burn reconstruction, head and neck reconstruction, and the performance of local and free flaps in a rural, SSA population. Our use of geospatial mapping suggests that with our current local infrastructure, there is no delay in treatment for patients with cleft lip and palate based on their distance from our facility. However, significant disparities exist in treatment delay based on proximity for patients who need other reconstructive procedures. We believe that expanded commitment to partnerships between NGOs and local practices in LMICs should be pursued. The findings of this study can be used to help guide both public health policy regarding reconstructive surgery modalities as well as the development of future global surgery training programs intended to help alleviate the growing disparities in healthcare delivery.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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