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Reconstructive

Quantifying Inequitable Access to Rapid Burn and Reconstructive Care through Geospatial Mapping

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Summary: Time-critical pathologies, such as the care of burn-injured patients, rely on accurate travel time data to plan high-quality service provision. Geospatial modeling, using data from the Malaria Atlas Project, together with census data, permits quantification of the huge global discrepancies in temporal access to burn care between high-income and low-resource settings. In this study, focusing on the United Kingdom and Ghana, we found that a 3-fold population difference exists with, respectively, 95.6% and 29.9% of the population that could access specialist burn care within 1-hour travel time. Solutions to such inequalities include upscaling of infrastructure and specialist personnel, but this is aspirational rather than feasible in most low- to middle-income countries. Mixed models of decentralization of care that leverage eHealth strategies, such as telemedicine, may enhance quality of local burns and reconstructive surgical care through skills transfer, capacity building, and expediting of urgent transfers, while empowering local healthcare communities. By extending specialist burn care coverage through eHealth to 8 district hospitals in rural Ghana, we demonstrate the potential to increase specialist population coverage within 1-hour travel time from 29.9% to 45.3%—equivalent to an additional 5.1 million people. *(Plast Reconstr Surg Glob Open 2020;8:e3069; doi: 10.1097/GOX.0000000000003069; Published online 25 August 2020.)*

INTRODUCTION

The Global Burden of Disease 2017 study suggests that burns account for 8,991,468 injuries and 120,632 deaths.[1] Low- and middle-income countries (LMIC) are disproportionately represented, accounting for 90% global deaths. Little focus has been given to travel times to burn centers in LMIC, despite time taken to reach definitive burn care impacting negatively on outcomes.[2] Previous studies examining similar time-critical pathologies in resource-poor health systems have proposed a "3-delays" model, characterizing access to care in terms of decision to seek care, arrival at a health facility, and provision of adequate care.[3] "Access" has been described as a nuanced term, not limited simply to geographical resource distribution and travel time, but involving a complex interplay of financial, political, procedural, logistical, and cultural factors,[4] although, in burn care, traditional healers are rarely reported.[5] Quantifying temporal access to burns center care is the first step in establishing high-quality burn health systems in resource-poor settings. Yet until recently, it has been impossible to accurately assess population travel times to burns centers.

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LEVERAGING GEOSPATIAL MAPPING FROM THE MALARIA ATLAS PROJECT

With the advent of geospatial maps created for the Malaria Atlas Project, using data sources provided by Open Street Map and Google to capture transportation networks, travel times can be quantified at a spatial resolution of approximately 1 × 1 km.[6] Together with 2015 census data, geospatial modeling demonstrates previously unquantifiable, vast global inequalities in burn care access. In high-income countries such as the United Kingdom, 95.6% of the population can access a burns service within 1 hour of overland travel (Fig. 1). This is in stark contrast to resource-poor settings such as Ghana, where the equivalent figure is 3-fold lower (29.9%; Fig. 2). Further regional inequalities exist, with the wealthiest and most educated living closest to major cities where burns centers are colocated.[6] Rapid access to care is implicated in mortality-to-incidence global inequalities—with Western

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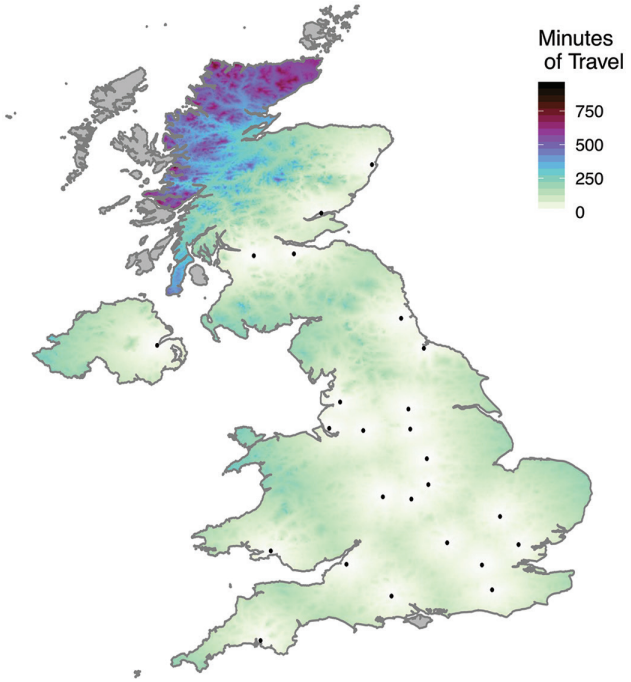

Fig. 1. Geospatial mapping of travel times to burns services in the United Kingdom.

sub-Saharan Africa having the third highest mortality-to-incidence ratios worldwide.[1,7] Yet access to care is not simply a factor critical to mortality of major burns but impacts on treatment-seeking behaviors for more minor burns. In Ghana, the greatest negative predictor of healthcare utilization is distance.[8] Thus, the greatest health and socioeconomic impacts of improving rural access may be in secondary surgical care, such as burns contracture release. The global burden of secondary burns morbidity is significant, with 8,463,273 disability-adjusted life years globally and some of the highest age standardized rates in sub-Saharan Africa.[1] Failure of burn patient healthcare engagement and utilization may therefore result in significant disabilities and socioeconomic losses. With the main burns centers in Ghana located in the main cities of Accra and Kumasi, this marginalizes rural and most disadvantaged populations. Similarly, Surgeons OverSeas Assessment of Surgical Need survey of 13,763 burn injuries in Nepal, Rwanda, Sierra Leone, and Uganda found that 2.8%–65.6% did not seek treatment due to a lack of availability of local skilled healthcare workers.[9]

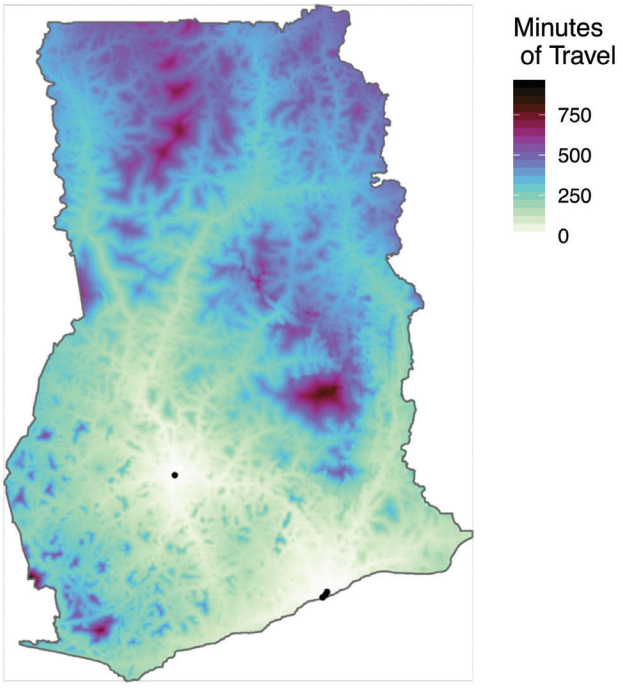

Fig. 2. Geospatial mapping of travel times to burn centers in Ghana.

REDUCING INEQUITABLE ACCESS TO CARE: ROLE OF WORKFORCE PLANNING, DECENTRALIZATION, AND EHEALTH

Effecting change through upscaling infrastructure, with specialist rural burns provision, and workforce planning is aspirational but unfeasible in most resource-limited LMIC. Ghana has 16 plastic surgeons servicing a population of 28.8 million—over an order of magnitude less than the 1 per 100,000 suggested in the United Kingdom. Alternative models include decentralization of care, which may overcome multiple barriers (including healthcare specialist availability and distance),[10] but at the potential expense of high-quality care. In the aforementioned 3-delays model, access to care is not just limited to decisions to seek care and arrival at a health facility but to provision of definitive, high-quality care.[3] For burns, superior outcomes have been consistently found in burns centers rather than in peripheral hospitals,[11] with UK guidelines recommending transfer of major burns to specialist centers. A mixed model approach incorporating decentralization of critical care services, but leveraging eHealth solutions such as telemedicine, may mitigate this situation by providing direct round-the-clock access to specialist expertise.[12] Telehealth oversight from Accra's National Reconstructive Plastic Surgery and Burns Centre may thus enhance quality of local burn care through skills transfer, capacity building, expedite urgent transfers, and incentivize patient healthcare utilization. Such a system can also provide a platform for cross-fertilization, dissemination of knowledge, governance, and empowerment of local communities. By extending specialist burn care coverage through eHealth to district hospitals in rural Ghana, we illustrate the potential to increase specialist population coverage within 1-hour travel time from 29.9% to 45.3% and 3-hour travel time from 57.9% to 75.7% (Fig. 3)—equivalent to an additional 5.1 to 5.9 million people coverage, respectively (Table 1).

However, even in high-resource healthcare settings, the design and evaluation of interventions to improve rapid access to care have proven difficult.[13] A National Institute for Health Research Global Health Research Meeting in 2019 proposed that the solution to these problems may lie in international research partnerships and collaborations that could provide a cross-disciplinary, cross-context

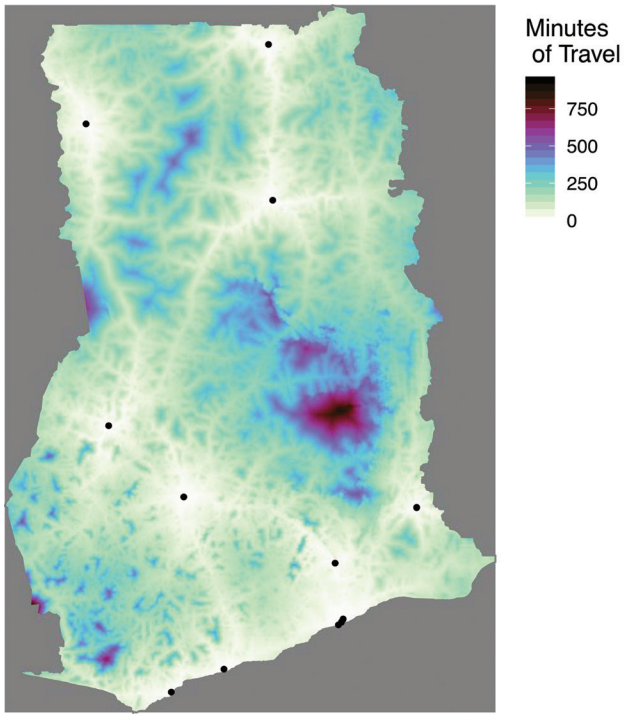

Fig. 3. Potential improvement in travel times in Ghana, with the proposed telemedicine network providing round-the-clock access to specialist care at selected district hospitals.

basis for academic exploration of these problems while developing mutual research capacity.[4,14] In this regard, we have incepted an academic and industrial collaboration to coaddress the current profound inequalities in access to high-quality burns and reconstructive care in Ghana. Our group is currently collaborating with the Ministry of Health in Ghana, to infuse a novel form of immersive telemedicine into the existing National Telemedicine infrastructure, to effect such changes.

CONCLUSIONS

The Lancet Commission on Global Surgery 2015 highlighted the critical nature of temporal access to surgical care, with benchmark indicators including access to essential surgery within 2 hours, setting a time-bound target of 2030 for 80% country coverage.[15] At the time of the Lancet Commission in 2015, no accurate data were available to quantify these indicators in low-resource settings. Geospatial modeling has transformed our understanding of population access to care, laying the foundation for infrastructure, workforce, and eHealth strategic planning not only in burn care but in all other aspects of time-critical specialist healthcare provision. Our research team is currently quantifying access to burns and reconstructive surgical care at a global level.

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Table 1. Population Coverage Stratified by Travel Time (60, 120, and 180 minutes) to Burn Centers in the United Kingdom and Ghana

	Travel Time (min)	Population Coverage	Percentage Coverage
UK burn units	60	61,646,260	95.6
	120	64,349,907	99.8
	180	64,408,957	99.9
Ghana burn units	60	9,990,303	29.9
	120	15,126,485	45.3
	180	19,322,369	57.9
Ghana-proposed eHealth coverage	60	15,111,737	45.3
	120	21,859,053	65.5
	180	25,268,405	75.7

The proposed telemedicine network in Ghana with corresponding increase in population coverage.

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