Physical accessibility of hospitals in sub-Saharan Africa

Marcel Reinmuth, Alexander Zipf

HeiGIT gGmbH
Berliner Str. 45
D-69120 Heidelberg
reinmuth@heigit.org

Using hospital locations and the OpenRouteService Isochrone service, we have created a method for comparing physical access towards hospitals in Sub-Saharan Africa by country. Hospital locations were derived from OpenStreetMap and compared against another free available dataset. Results indicate strong similarity in both hospital datasets; however, the uncertainty of our method requires further evaluation.

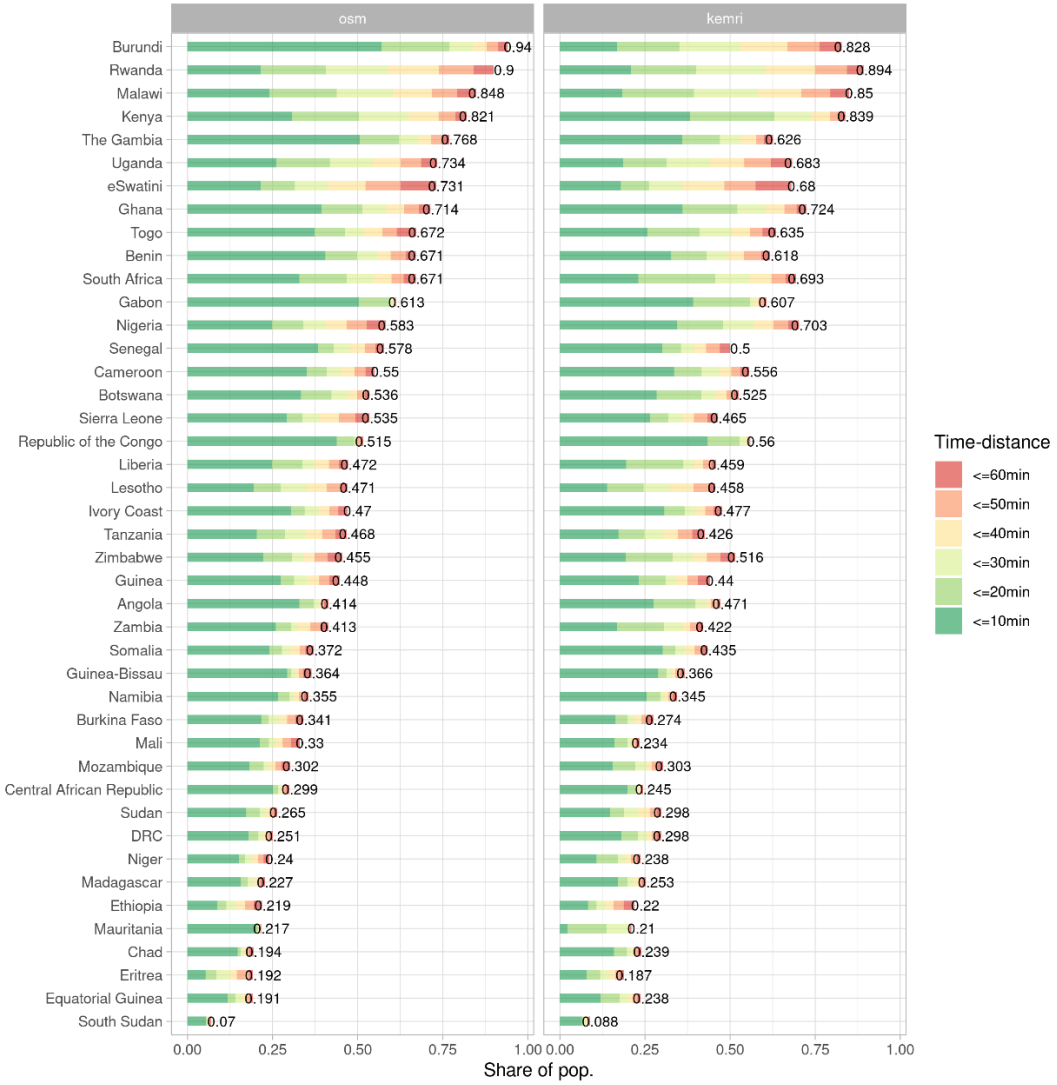

Figure 1Per country comparison of reached population by 10 min interval for healthcare facilities exported from OpenStreetMap(osm) and from an archive assembled by a team at the KEMRI-Wellcome Trust Research Programme

Introduction

Since the beginning of the COVID-19 pandemic we have seen the virus traveling around the world. Starting from Wuhan, China in December 2019, Europe became epicentre of the crisis in March 2020 and was shortly followed by the US. In June, WHO declared Latin America the new epicentre. COVID-19 in Africa received little media coverage until now. The pandemic reached the continent in late February and spread to every country until mid of May. Officially no African country suffered a major outbreak like northern Italy or New York City. But chances are an outbreak could occur undetected for a while[1]. In the global race for virus gear, African countries lack the economic power to compete for medical resources for response and testing efforts[2]. Therefore, the structure of health systems will presumably play a key role in coping with the pandemic.

Methods

We analyse the structure of healthcare systems in Sub-Saharan African (SSA) using a proxy – physical accessibility of hospitals. With the combination of freely available hospital locations, the travel-time estimates by OpenRouteService[3] Isochrone service and population data from the WorldPop project[4], we are able to determine catchment areas of hospitals and the respective reached population per country (figure 1). For hospital locations we relied on two distinct datasets: OpenStreetMap (OSM) and an archive assembled by a research group at the KEMRI-Wellcome Trust Research Programme[5]. The first dataset is driven by volunteers and is a popular source of volunteered geographic information, the second is based on official master facility lists of health ministries, updated in July 2019. For each country we requested 1hour travel time isochrones using a car-driving profile. Afterwards, we merged the isochrones and extracted population information from a 1km raster grid by WorldPop.

Results

Although both datasets differ significantly in the number of hospitals represented, we found that disparities are rather marginal when used for an accessibility analysis (figure 1). The country with the least reached proportion of inhabitants for both datasets is South Sudan (OSM: 6.99%; KEMRI: 8.81). The best performing country for OSM is Burundi, for KEMRI it is Rwanda. KEMRI provides 4,831 hospitals for SSA, whereas in OSM with 13,460 almost three times as many hospitals are available. The mean difference in reached population is 5% and ranges from 0.06% in Ethiopia to 14.9 % in the Gambia. Overall, there is a strong correlation of population reached by both data sources indicated by a Pearson r of 0.973.

Limitations and Future Work

Despite the differences of mapped hospitals per dataset we measure similar population proportions reached. However, we did not account for hospital capacity in our analysis. These discrepancies can have diverse causes. Nigeria for instance is represented with 2,907 hospitals in OSM and 887 in KEMRI. Regardless of OSM overestimating the amount of hospitals by far, reached proportion of population for Nigeria differs only about 11.9%. Although disagreeing on the amount of hospital facilities, OSM follows a similar distribution like KEMRI and vice versa. But how do patterns of facility distribution like we see for Nigeria emerge? The central north is densely covered by hospitals. A bit of research revealed data imports in the region. In Kano and Bauchi, two states next to each other were subject to an import of ca. 1,500 facilities in 2014[6,7]. For Borno state, located north east ca. 500 facilities were imported in 2015[8].

Further research on the reliability of the results is needed. The accuracy of both KEMRI and OSM is questionable and requires robust assessment. The underlying model of the isochrone service uses the OSM road network. Completeness and accuracy of OSM can vary across regions. Additionally, the isochrone model is built for global coverage, therefore the time distance estimates must be treated with caution, especially in regional contexts where we assume travel speed and travel modes to differ from estimates in more motorized settings. Tools and services like the OpenStreetMap History Analytics platform ohsome[9] and ohsomeHEX[10] will help us to better understand OSM data and its evolution in this and other contexts.

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