

Geospatial database of Ghanaian health facilities based on publicly available government datasets

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Abstract

Access to high-quality spatial data of health facilities can have a major impact on healthcare access, delivery, and policymaking. The last geocoded dataset for Ghana was made publicly available by the Ghanaian government in 2016. This study aims to provide an updated geocoded database of health facilities in Ghana by combining three publicly available government datasets. The database of health facilities was obtained through data from the Ghanaian Health Facilities Regulatory Agency (HeFRA), the Ghanaian National Health Insurance Agency (NHIA), and the Ministry of Health of Ghana (MoH). This data was procured, compiled, standardized, and cleaned using Python 3.10.8 and geocoded via Google, Bing, or OpenStreetMap API. Finally, the results went through a process of data validation via Quantum GIS 3.28.1. The result was a combined database of 6,710 health facilities in Ghana. Study limitations include difficult access to accurate and robust health facility data and general geospatial information about Ghanaian infrastructure. This database provides a publicly available list of combined public and private health facilities in Ghana.

Background & Summary

Access to up-to-date information about health facility location and capabilities is crucial for effective healthcare delivery, equitable resource allocation, and evidence-based policymaking[1]. This is particularly relevant in low- and middle-income countries (LMIC) like Ghana, where access to updated hospital database and other specific challenges related to health and data accessibility are in abundance[2–4]. Understanding the importance of comprehensive health facility data and the role it plays in achieving universal healthcare coverage is essential for addressing these challenges and ensuring improved healthcare outcomes[5].

Ghana, like many other LMIC countries, faces unique health accessibility issues that underscore the need for reliable and accessible health facility data[3, 4]. The country has a diverse healthcare landscape, encompassing both urban, peri-urban and rural areas with varying levels of infrastructure and services[6, 7]. This geographic diversity poses challenges in ensuring equal access to quality healthcare for all citizens[8, 9]. Furthermore, factors such as limited transportation infrastructure, inadequate healthcare funding, and disparities in healthcare delivery contribute to inequities in healthcare access and outcomes[10–12].

In addition to health accessibility challenges, data accessibility has been a significant hurdle in Ghana[2, 13, 14]. Previous efforts such as the Ghana Open Data Initiative (GODI), a partnership between the World Wide Web Foundation and Ghana's National Information Technology Agency, attempted to fill this need by working with Ghana's Ministry of Health (MoH) to make health facility location data available on their website[15]. However, the last health facility database was posted by the MoH in 2016, and the project and website have both recently been suspended[13]. One other study used this data and similar data from other countries to create a combined database of 96,395 Sub-Saharan African health facilities[16]. However, both databases only reference one dataset that was made available by GODI in 2016.

This limited access to up-to-date information hindered informed decision-making by patients, healthcare providers, and policymakers alike. The lack of a reliable and geographically referenced database presents challenges to the distribution of healthcare resources, identification of gaps in healthcare coverage, and effective resource allocation[17]. A 2025 article published in *BMC Medicine* entitled "Putting health facilities on the map: a renewed call to create geolocated, comprehensive, updated, openly licensed dataset of health facilities in sub-Saharan African countries" further highlights the call to action of making health facility data in Sub-Saharan Africa more accessible for healthcare providers, patients, and researchers[18]. One promising initiative is a new HeFRA program launched in 2024 to update Ghana's National Health Database, however this database has not been made publicly available[19].

To address these critical issues, this study aimed to compile and integrate data from key Ghanaian government agencies. Additionally, the secondary aim of this study was to produce these datasets using free and publicly available resources to demonstrate how these tools can be leveraged to create other high-impact, country-wide databases. All analyses were done in either Python, a programming language that is free to download, or QGIS, a publicly contributed and sourced geospatial analysis software. Google API, Bing Maps API, and OpenStreetMaps Nominatim API were used to generate geocoded locations. By combining these datasets and employing publicly-available geocoding techniques, the study sought to develop a comprehensive, national-level database of geocoded Ghanaian health facilities categorized by care level and type.

The creation of a comprehensive, geocoded database of Ghanaian health facilities addresses the unique health and data accessibility challenges faced in Ghana. By integrating data from multiple government agencies, this study contributes to improving healthcare decision-making, resource allocation, and policy formulation. The availability of up-to-date and geographically referenced health facility data enhances accessibility for patients, emergency medical service providers, and policymakers, ultimately working towards achieving universal healthcare coverage in Ghana[20].

Methods

Data Procurement

The study reviewed multiple databases. The final database set selection was based on being publicly accessible, government verified institution, completeness of the data and depth of details collected. Three databases were used for this study. Three datasets were used for this study. The first was from a 2016 MoH's publication on GODI's website[13]. GODI is a project that was born out of a collaboration between the Ghanaian National Information Technology Agency and the World Wide Web Foundation to make government data more publicly accessible. This dataset was chosen because it represented the last known publication of a geocoded health facilities database by the Ghana MoH. The dataset included information on the name, type of facility, region, district, ownership, and geospatial information

(longitude and latitude). This dataset represented Ghana in a 2019 publication outlining a geocoded database of health facilities throughout Sub-Saharan Africa[16].

The second dataset was from the list of providers on the website of the Ghana National Health Insurance Agency (NHIA) (<https://www.nhis.gov.gh/>). This dataset consisted of all facilities in Ghana where the National Health Insurance Scheme card is accepted. The dataset was chosen because the NHIA is a government-run agency that provides a detailed credentialing process to add facilities to its provider list. The dataset includes information on the name, type of facility, town, district, and region. Longitude and latitude values were not included. The facilities are organized into the following types: pharmacy, ultrasound centre, dental clinic, eye clinic, physiotherapy centre, laboratory, diagnostic centre, maternity home, reproductive health centres, primary hospitals, secondary hospitals, and tertiary hospitals.

The third dataset was from the list of accredited institutions on the Ghana's Health Facilities Regulatory Agency (HeFRA) website that had been updated as of late 2022 (<http://hefra.gov.gh/>). The HeFRA dataset was chosen because HeFRA is a government-run organization that specializes in the accreditation of health facilities throughout Ghana. HeFRA and the NHIA work closely to ensure that quality accreditation standards are met in both public and private health facilities throughout the country. The facility list features both privately and publicly run facilities. The dataset includes information on the name, type of facility, town, district, and region. No longitude and latitude values were included in the original source. Their health facility dataset is organized into the following broad categories: audiology centre, diagnostic centre, imaging centre, laboratory, dental clinic, clinic, eye clinic, health centre, health post, primary hospital, tertiary hospital, and multiple specialty care centres (neurosurgery, paediatrics, rehabilitation, nephrology, obstetrics and gynecology, and internal medicine).

Data Cleaning

The field names were standardized across the datasets to include name of facility, type of facility, town, district, region, latitude and longitude (if available), and data source (either MoH, NHIA, or HeFRA). After standardizing field names, the MoH, NHIA, and HeFRA datasets were combined. Region and district names were checked for errors and corrected. Duplicates were screened and removed in two iterations. In the first iteration, true duplicates were screened by comparing the region and facility name for each entry. Next, all fields were compared using token set ratio fuzzy logic. After duplicates were identified, each potential duplicate was manually reviewed and removed if deemed to be a duplicate entry. When a duplicate entry was removed, the longitude and latitude value was always preserved, while the other relevant, recent information was kept from the other datasets.

Facility types were standardized according to the HeFRA definition of health facilities (<http://hefra.gov.gh/index.php/downloads/>). The following health facility categories were used: clinics, health centres, community health and planning services (CHPS), primary hospitals, pharmacies, maternity homes, diagnostic centres, reproductive and child health services (RCH), district health

directorates, training institutions, optometry centres, dental clinics, secondary hospitals, nutrition centres, polyclinics, eye clinics, tertiary hospitals, rehabilitation centres, municipal health directorates, regional health directorates, physiotherapy centres, research institutions, psychiatric clinics, metropolitan health directorates, and ear centres. While training institutions, research institutions, and district, municipal, metropolitan, and regional health directorates do not offer health services, they were retained in the final database as they represent important aspects of the health system structure and may be beneficial to future studies. Data cleaning was performed using Python 3.10.8.

Geocoding Remaining Data & Data Validation

Only facilities from the MoH dataset were initially geocoded with longitude and latitude values. After cleaning and standardizing the initial dataset, the remaining data entries from the NHIA and HeFRA datasets were geocoded using OpenStreetMap Nominatim API, Google API, or Bing Maps API. Usage limits were abided to for each service and were used free of charge. GeoNames, Google Earth, and Fallingrain were also explored as geocoding tools but were determined to be inaccurate for the remaining entries.

The remaining data was geocoded, each entry was checked using Quantum Geographical Information System (QGIS 3.28.1) to confirm that the listed national and region values matched the location of the newly geocoded data. National administrative boundaries were assessed using a shapefile from Humanitarian Data Exchange's (HDX) Common Operational Datasets Administrative Area series provided through the United Nation's Office for the Coordination of Humanitarian Affairs' Regional Office for West and Central for Africa (ROWCA). Original datasets (MoH, HeFRA, and NHIA) used the 10 region administrative divisions that were in place in Ghana prior to the change to a 16-region system in 2018, so the newly geocoded values were compared against these divisions. Regional administrative boundaries from the 10-region system were assessed via a data set derived from Global Administrative Areas[21]. If the entry's latitude and longitude values fell outside of its set administrative boundaries, then the entry was geocoded again and rechecked until all values matched their listed regional values.

Updating Spatial References

The entry's district and region were updated to correspond with the current 16 regions and 260 district administrative divisions that were introduced in Ghana in 2018. Updated district and region values were assigned using ROWCA's updated regional and district boundaries.

Data Records

Health facility data was procured and compiled from three organizations: the MoH, the National NHIA, and HeFRA. 3,756 health facilities were collected from the MoH dataset, 3,593 were gathered from the NHIA dataset, and 1,307 were procured from the HeFRA dataset. These 8,656 health facilities were then

compiled into one dataset, standardized, and cleaned. During cleaning, 1,946 facilities were identified as duplicates, which left 6,710 health facilities in the final dataset. When screening duplicates between the MoH dataset and NHIA or HeFRA datasets, addressing and facility type information was kept from the NHIA or HeFRA datasets since these datasets were newer. Geospatial information (latitude and longitude) was preserved in 3,547 (52.8%) entries from the MoH dataset since that was the only dataset that originally had this information listed. Therefore, out of the 6,710 entries in the final dataset, 1,294 (19.3%), 3,183 (47.4%), and 2,233 (33.3%) retained their facility type and addressing information from the HeFRA, NHIA, and MoH datasets, respectively. Figure 1 summarizes the output of the steps required to create, geocode, and validate the database while Fig. 2 describes the health facility distribution by the original data source.

After the combined data was standardized and cleaned data entries that did not initially have spatial information were geocoded. While 3,547 (52.8%) of the data entries contained longitude and latitude values derived from the MoH dataset, the remaining 3,163 (47.1%) were geocoded using a combination of Google API, Bing Maps API, and OpenStreetMap Nominatim API. Other geocoding sources were explored, but these three sources were the most consistent and accurate during data exploration. Out of these 3,163 health facilities, 2,762 (87.3%) facilities were geocoded using Google Maps API, 278 (8.8%) were geocoded using data from OpenStreetMap, and 145 (4.6%) were geocoded using Bing Maps API. Figure 3a shows the original distribution of health facilities by geocoded source prior to data validation.

Each entry in the final database of 6,710 Ghanaian health facilities features information on its facility name, facility type, town, district, region, country, latitude, longitude, data source, and geocoded data source. There are 25 different facility types in the database: clinics, health centres, CHPS, primary hospitals, pharmacies, maternity homes, diagnostic centres, reproductive and child health services (RCH), district health directorates, training institutions, optometry centres, dental clinics, secondary hospitals, nutrition centres, polyclinics, eye clinics, tertiary hospitals, rehabilitation centres, municipal health directorates, regional health directorates, physiotherapy centres, research institutions, psychiatric clinics, metropolitan health directorates, and ear centres. Table 1 displays the amount of each facility type and its respective percentage representation in the final dataset. In Fig. 3, the final health facility database was plotted with the facilities grouped into three categories: hospitals (primary hospitals, secondary hospitals, and tertiary hospitals) (n = 785), non-hospital healthcare facilities (CHPS, clinics, health centres, and polyclinics) (n = 4,123), healthcare related facilities (dental clinics, ear centres, eye clinics, maternity homes, rehabilitation centres, physiotherapy centres, psychiatric clinics, diagnostic centres, RCHs, optometry centres, and nutrition centres) (n = 1,618), and training or administrative facilities (district, regional, metropolitan, and municipal health directorates, research institutions, and training institutions) (n = 184).

Table 1
Number of facilities per facility type (n = 6,710).

Data Source	Count	Percentage
Clinic	1448	21.6%
Health Centre	1336	19.9%
CHPS	1317	19.6%
Primary Hospital	754	11.2%
Pharmacy	549	8.2%
Maternity Home	518	7.7%
Diagnostic Centre	271	4.0%
RCH	134	2.0%
District Health Directorate	95	1.4%
Training Institution	71	1.1%
Optometry Centre	61	0.9%
Dental Clinic	34	0.5%
Secondary Hospital	23	0.3%
Nutrition Centre	23	0.3%
Polyclinic	22	0.3%
Eye Clinic	10	0.1%
Tertiary Hospital	8	0.1%
Rehabilitation Centre	8	0.1%
Municipal Health Directorate	7	0.1%
Regional Health Directorate	6	0.1%
Physiotherapy Centre	6	0.1%
Research Institution	3	0.0%
Psychiatric Clinic	2	0.0%
Metropolitan Health Directorate	2	0.0%
Ear Centre	2	0.0%

Technical Validation

Figure 4. Distribution of 6,710 health facilities in Ghana after the first round of geocoding. (a) shows original database of geocoded health facilities where blue points represent entries geocoded with Bing Maps API (n = 145), yellow points represent entries geocoded with Google API (n = 2,762), green points represent points geocoded with the MoH database (n = 3,547), and orange points represent entries geocoded with OpenStreetMap API (n = 278). (b) shows the same plot with the entries flagged during data validation flagged with a red 'x' (n = 508). OpenStreetMap is used as the base map for this figure (© OpenStreetMap contributors 2019; distributed under a Creative Commons BY-SA License).

Following the completion of the first round of geocoding, the geospatial information for all data entries entry was then compared to the national level and the former 10 regional-level boundaries in Ghana to confirm that the listed regional assignment matched its corresponding latitude and longitude values. Seventeen (0.3%) health facilities fell outside of Ghana, and 491 (7.3%) were plotted in the incorrect region. All 17 health facilities that fell outside of Ghana were from the MoH dataset. Out of the 491 values that were geocoded in the incorrectly listed region, 310 (63.1%) were from Google API, 133 (27.1%) were from the MoH dataset, 60 (12.2%) were from OpenStreetMap Nominatim API, and 6 (1.2%) were from Bing API. Figure 4b shows the original geocoded dataset with the 508 health facilities with incorrect longitude and latitude values highlighted.

After identifying the 508 health facilities that fell outside of Ghana or their listed region, these facilities were geocoded again to their listed district via Google API. The entire dataset was then checked again to ensure that all 6,710 health facilities fell in the appropriate administrative areas. After validation, 3,413 (50.9%) health facilities were geocoded with information from the MoH dataset, 2,939 (43.8%) were geocoded with Google API, 218 (3.2%) were geocoded with OpenStreetMap Nominatim API, and 140 (2.1%) were geocoded with Bing Maps API. Figure 4 shows the total number of health facilities that were geocoded for each source. Once the validation of data confirmed that each facility was placed in the correct region, the listed district and region information for each entry was updated to the current 16-regions and 260-districts.

Usage Notes

The primary aim of this project was to generate a current and publicly available database of Ghanaian health facilities through compiling several government agency datasets. It was assumed that government agencies represented the highest levels of quality and reliability and that these agencies provided the public with their most up-to-date datasets. However, since the methods used to create these datasets are not publicly available, there is no way to know how this data was initially compiled, which represents a key limitation of this study. The data validation phase highlighted the impact of this limitation as 150 values either fell outside of Ghana or their listed regional boundary. But, it is important to note that these facilities represent less than 4% of the 3,756 facilities in the original MoH dataset. Additionally, the HeFRA and NHIA datasets used the 10-region boundaries for assigning regional designations as well as a combination of the current 260-district boundaries and previous district boundaries to assign district designations in their database, despite the datasets listing publish dates in

2022[22]. Further research could explore other tools to analyze the final database or its input datasets to identify further duplicates or invalid entries.

Geocoding the database also proved difficult due to Ghana having a relatively unestablished postal addressing system and poor documentation of public infrastructure. Future field studies documenting the geospatial location of public infrastructure, including health facilities, could offer a major benefit to the accessibility of essential services in Ghana. Previous studies have attempted to quantify health facility accessibility on a limited scale in Ghana by using information from regional or district health directorates, but no study has attempted to analyze this on a national level[3,25,26]. Additionally, health facility types were assigned via a variety of metrics from the MoH, NHIA, and HeFRA that were not consistent across datasets. Therefore, follow-up field studies could validate both the location and resources at a particular facility to authenticate facility type. This would also require the establishment of standardized health facility capability requirements for Ghana.

Declarations

Declaration of Competing Interest

The authors declared no conflicts of interest.

Author Contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content. DD conducted all data procurement, data cleaning, data validation, data analysis, and manuscript drafting phases. NSAQ served as co-clinical mentor and contributed to data analysis and manuscript editing. JB served as co-clinical mentor and contributed to data procurement and manuscript editing. BAOA contributed to data analysis and manuscript editing. SD served as technical mentor and contributed to data analysis and manuscript editing. JA contributed to manuscript editing. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

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Data Availability

The final database has been shared with the three major Ghanaian partner organizations: SnooCODE RED, Emergency Medicine Directorate at Komfo Anokye Teaching Hospital, and the Global Health and Infectious Diseases Research Group at the Kumasi Center for Collaborative Research into Tropical Medicine. The initial databases can be found in Supplementary Material (1-3), and the final database can also be found in Supplementary Material (4). The source and final output data is shared via Zenodo as well (<https://doi.org/10.5281/zenodo.21728952>) [23]. Upon publication, the final dataset will be posted on the Humanitarian Data Exchange to maximize its impact and reach.

Code Availability

This data was procured, compiled, standardized, and cleaned using a combination of Excel and Python 3.10.8. Then, facilities were geocoded using Google, Bing, or OpenStreetMap API. Finally, the results went through a process of data validation via Quantum GIS 3.28.1 to confirm if the data was georeferenced appropriately.

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Figures

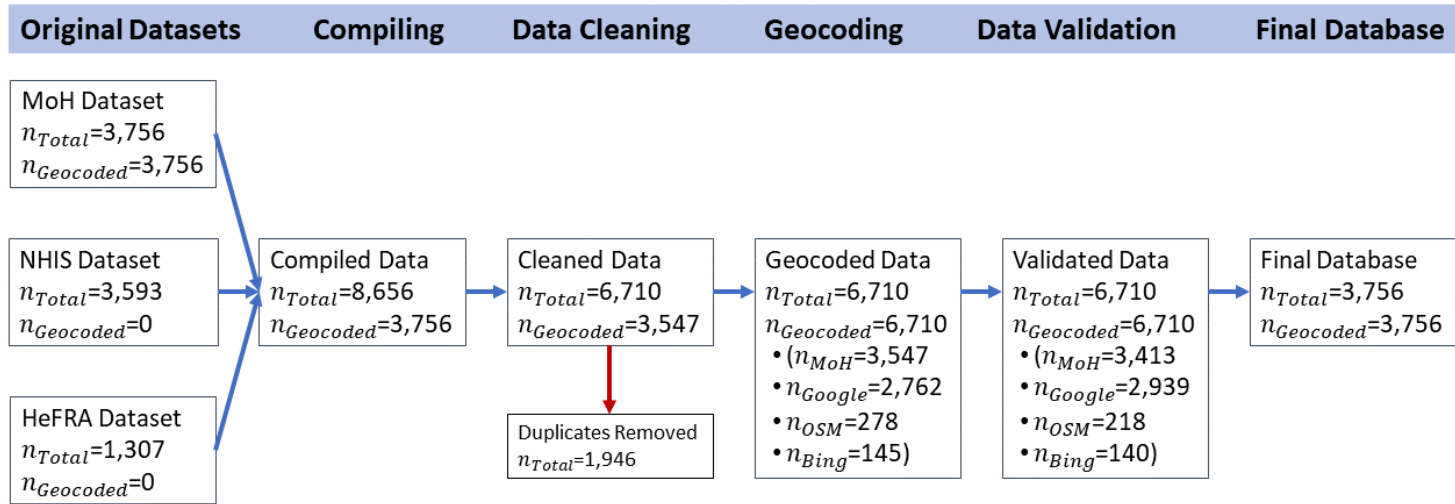


Figure 1

Overview of steps to produce the database of 6,710 geocoded health facilities in Ghana with results of data validation.

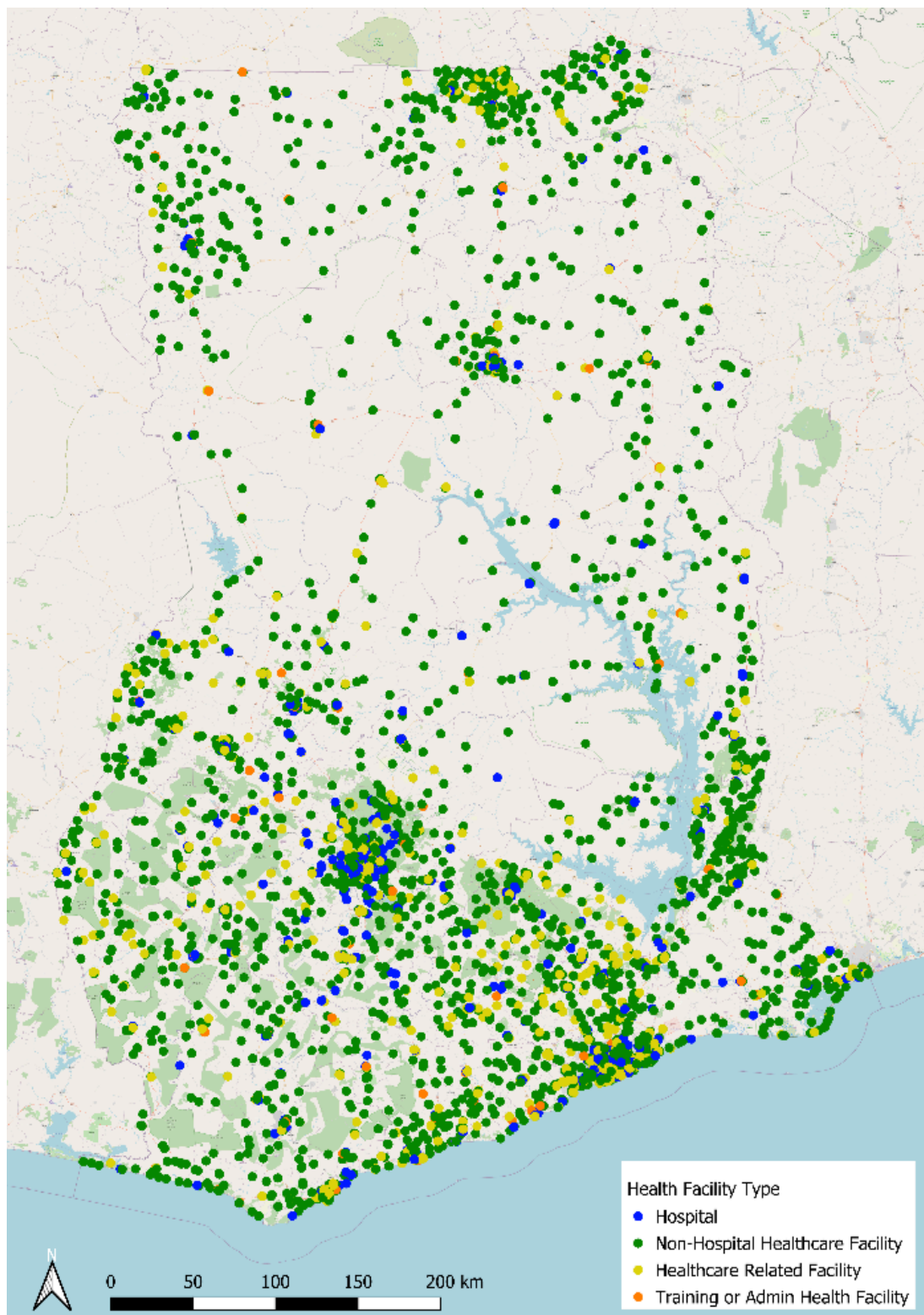


Figure 2

The distribution of 6,710 health facilities in Ghana. Blue dots represent hospitals (primary hospitals, secondary hospitals, and tertiary hospitals) (n=785), green dots represent non-hospital healthcare facilities (CHPS, clinics, health centres, and polyclinics) (n=4,123), yellow dots represent healthcare related facilities (dental clinics, ear centres, eye clinics, maternity homes, rehabilitation centres, physiotherapy centres, psychiatric clinics, diagnostic centres, RCHs, optometry centres, and nutrition

centres) (n=1,618), and orange dots represent training or administrative health facilities (district, regional, metropolitan, and municipal health directorates, research institutions, and training institutions) (n=184). OpenStreetMap is used as the base map for this figure (© OpenStreetMap contributors 2019; distributed under a Creative Commons BY-SA License).

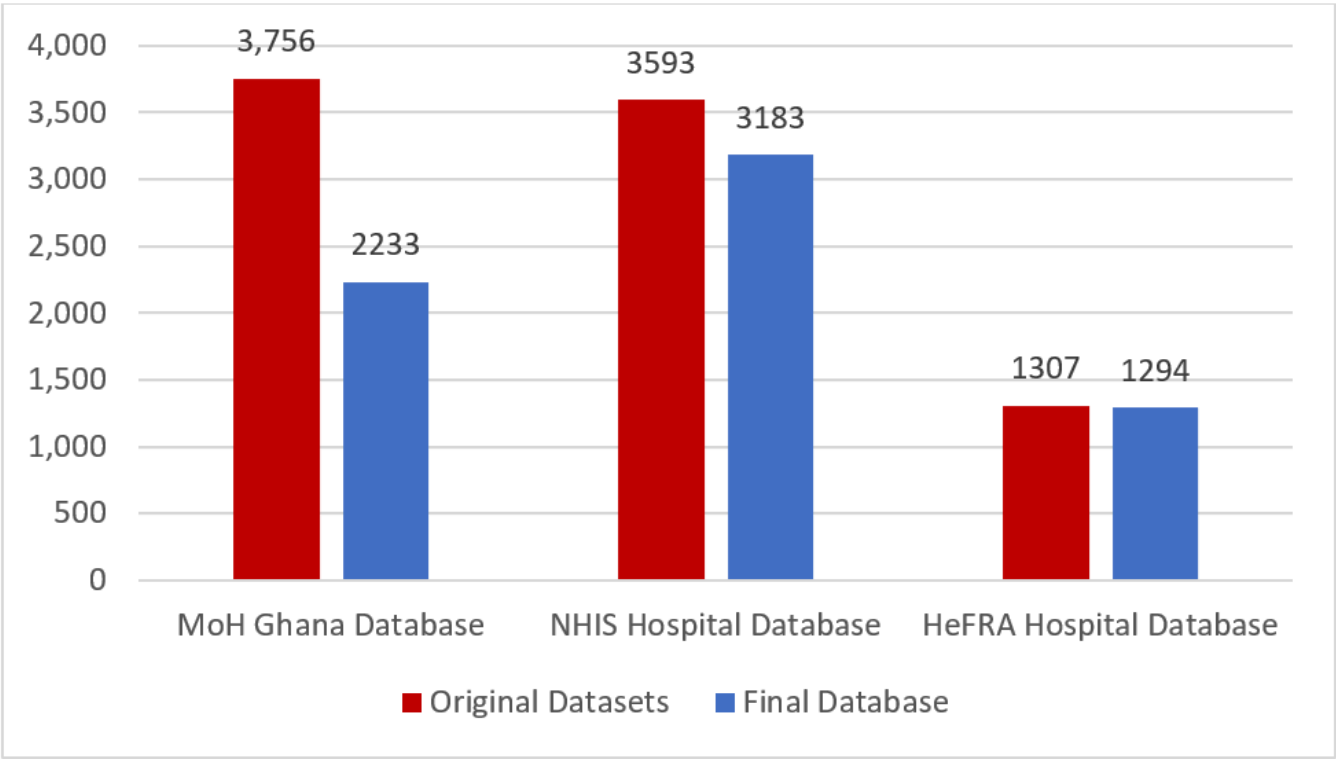


Figure 3

Comparison of number of facilities by data source of original datasets (red) compared to final database (blue).

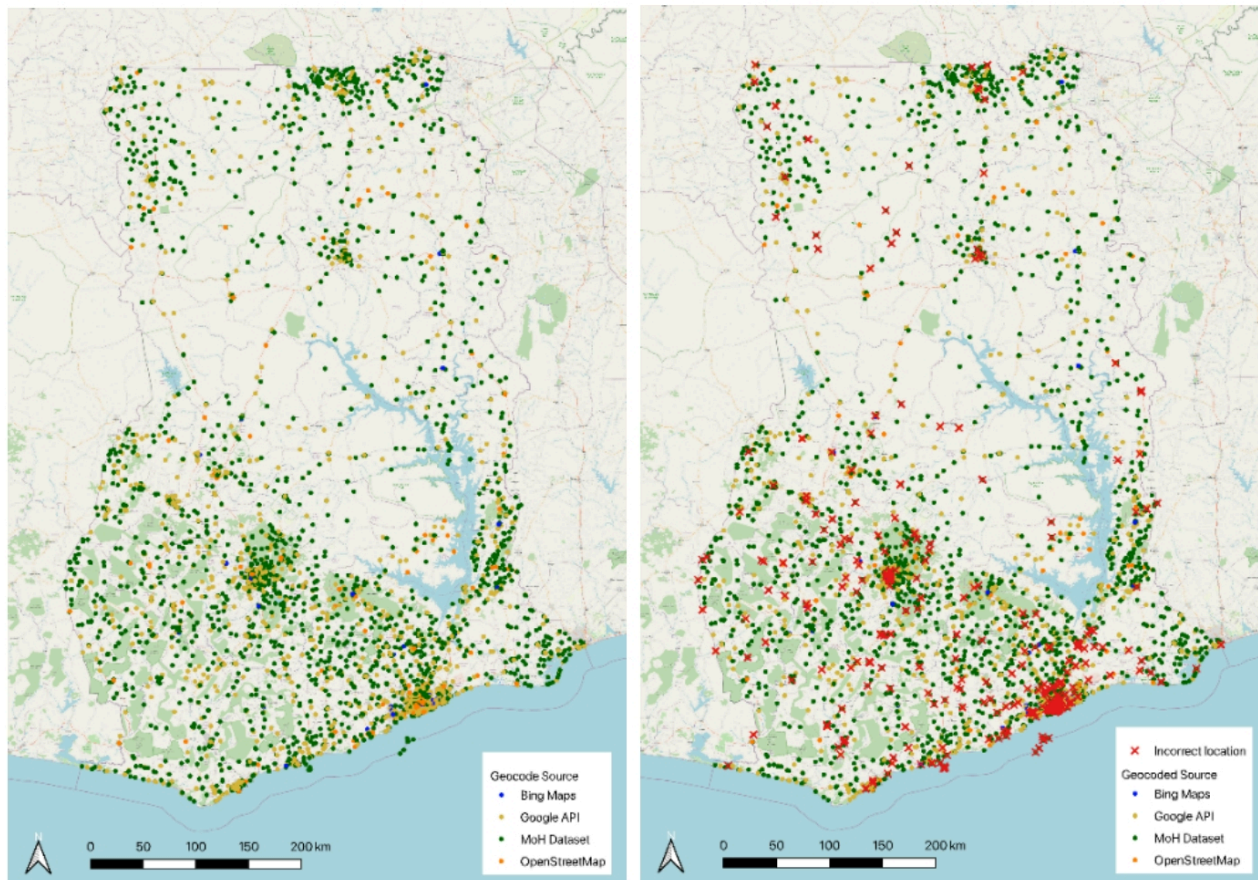


Figure 4

Distribution of 6,710 health facilities in Ghana after the first round of geocoding. **(a)** shows original database of geocoded health facilities where blue points represent entries geocoded with Bing Maps API (n=145), yellow points represent entries geocoded with Google API (n=2,762), green points represent points geocoded with the MoH database (n=3,547), and orange points represent entries geocoded with OpenStreetMap API (n=278). **(b)** shows the same plot with the entries flagged during data validation flagged with a red 'x' (n=508). OpenStreetMap is used as the base map for this figure (© OpenStreetMap contributors 2019; distributed under a Creative Commons BY-SA License).

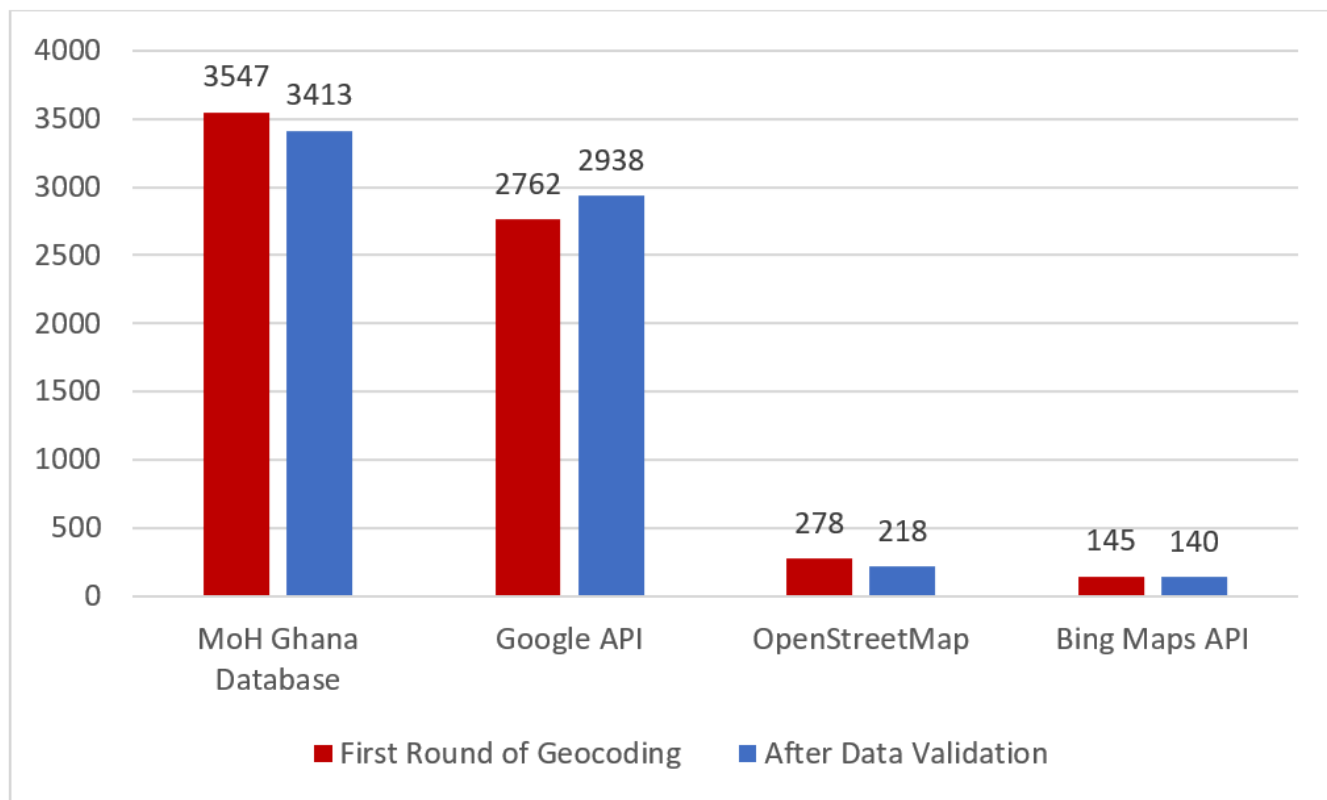


Figure 5

Summary of health facility distribution in the final dataset by the geocoded data source.