STUDY PROTOCOL

The nexus between water sufficiency and water-borne diseases in cities in Africa: a scoping review protocol [version 1; peer review: awaiting peer review]

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Abstract

Introduction: Currently, an estimated two thirds of the world population is water insufficient. As of 2015, one out of every five people in developing countries do not have access to clean sufficient drinking water. In an attempt to share the limited resource, water has been distributed at irregular intervals in cities in developing countries. Residents in these cities seek alternative water sources to supplement the inadequate water supplied. Some of these alternative sources of water are unsafe for human consumption, leading to an increased risk in water-borne diseases. Africa contributes to 53% of the diarrheal cases reported globally, with contaminated drinking water being the main source of transmission. Water-borne diseases like diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus are a major public health concern. The main objective of this scoping review is to map the available evidence to understand the sources of water among residents in cities in Africa and the relationship between clean water sufficiency and water-borne diseases in urban Africa.

Methods and analysis: The search strategy will identify studies published in scientific journals and reports that are directly relevant to African cities that have a population of more than half a million residents as of 2014 AND studies on the ten emerging water-borne diseases, which are diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus.

Ethics and dissemination: This scoping review did not require any formal ethical approval. The findings will be published in a peer-reviewed journal.

Keywords

Water-borne diseases, water insufficiency, scoping review, African cities, water supply
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Competing interests: No competing interests were disclosed.

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Introduction
By 2050, the population in sub-Saharan Africa is projected to double, with cities experiencing an annual growth rate of more than 4%\textsuperscript{1}. However, the fast rate of urbanization has not been reflected in the rate of infrastructure growth and this has affected the capacity of most cities to provide basic amenities, leading to challenges including water insecurity, poor housing and inadequate social amenities\textsuperscript{2}. Water is an important natural resource which lies at the nexus of food security, poverty reduction, economic growth, energy production and human health\textsuperscript{3}. Urbanization will accelerate demand for water\textsuperscript{4,5}.

The 2030 United Nations Sustainable Development Goal 6 aims to attain sustainable management and availability of sufficient clean water and sanitation for all\textsuperscript{6}. Currently, an estimated 40% of the global population is water insufficient\textsuperscript{7}. The minimum water access requirement per person per day is 50 litres\textsuperscript{8}. However, as of 2015, one out of every five people in developing countries do not have access to clean sufficient drinking water\textsuperscript{9}. In an attempt to share the limited resource, water has been distributed in cities in developing countries at irregular intervals\textsuperscript{10}. To cope with the irregular supply, residents in the cities have responded to these challenges by seeking alternative sources of water, some of which are unsafe for human consumption, leading to an increased risk of water-borne diseases\textsuperscript{11-13}.

Africa contributes to almost half (53%) of the diarrheal cases reported globally, with contaminated drinking water being the main source of transmission\textsuperscript{14,15}. Water-borne diseases like diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus are a major public health concern\textsuperscript{12,14}. As of 2010, cholera contributed to two deaths per 100,000 people and in 2014, diarrhea contributed to 20 deaths per 100,000 children under the age of five years, with unsafe water being a key risk factor\textsuperscript{13,15}.

The main objective of this scoping review is to map the available evidence to understand the sources of water among residents in cities in Africa and the relationship between clean water sufficiency and water-borne diseases in urban Africa. This will be achieved by synthesising findings of studies that have been written or published on: a) water sufficiency in cities within Africa; b) consequences of rapid urbanization on water sufficiency in African cities; and c) the linkages between water sufficiency and water-borne diseases in Africa. This scoping review will primarily seek to answer the following question: “what is the water sufficiency in cities in Africa and what is the correlation with water-borne diseases?”

This scoping review will identify the knowledge gaps and areas that need further research and contribute towards informing policies that help Africa achieve one of its Agenda 2063 aspirations on urban populations with adequate basic necessities\textsuperscript{16}.

Protocol
The scoping review will use the Joanna Briggs Institute methodology guidance for scoping reviews\textsuperscript{17} and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension guidelines for conducting scoping reviews\textsuperscript{18,19}.

Inclusion criteria
We will include the following types of papers:
1) Studies describing the water sufficiency or water situation in cities (urban areas with greater than half a million residents) in the African Union member states. Since the classification of a city and urban environments is not standardized\textsuperscript{2}, we use the population number of areas with >0.5 million people to be consistent with the UN report that estimates one in every three people will reside in cities with at least half a million inhabitants by 2030\textsuperscript{20}. The list of the cities that meet this criterion have been selected from the United Nations World Urbanization Prospects of 2014\textsuperscript{21}. Figure 1 shows a map of countries in Africa with the number of cities with a population >0.5 million.

2) Studies on water-borne diseases in cities in the African Union member states. We will focus on the ten emerging water-borne diseases, which are diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, cyclosporiasis, giardiasis, guinea worm and rotavirus\textsuperscript{12,14}.

3) Studies published in scientific journals or grey literature from government or non-governmental organizations.

Exclusion criteria
1) Studies conducted in rural areas or cities that have a population less than 500,000
2) Studies conducted in other continents other than the member states of the African Union
3) Studies not written in the English or French language
4) Systematic reviews

![Figure 1. Member countries in the African Union and the number of cities with a population greater than half a million residents as of 2014. Source of data: United Nations World Urbanization Prospects, 2014\textsuperscript{22}.](image-url)
Information sources and search strategy

Comprehensive literature searches will be done in Embase, MEDLINE, Web of Science and Google Scholar databases. The four databases have been identified as the optimal combination of databases that will guarantee adequate coverage of studies for literature searches.

The search strategy will take a three step process. The first step will involve carrying out a limited search in MEDLINE, Embase and Web of Science databases to analyse the text words and index terms that are used to describe the articles. The second step will then include a search in all the databases using the keywords and the index terms. In the final step, we will go through the references to identify key articles that might have been missed in the first two steps. The search terms used in the study are seen in Table 1.

Study selection

Once searches have been done in the databases, the title and abstracts will be extracted from the articles. Duplicates will be removed, and the review team will screen the studies using two levels: initial screening and full-text screening. During the initial screening process, three reviewers will read the abstracts of the studies captured by the search terms and weigh them using the inclusion criteria. To ensure consistency in the inclusion criteria, 10% of all the studies will be randomly selected and independently reviewed by two other reviewers. Any inconsistency between the primary and secondary reviewers will be discussed and a consensus reached.

Full text articles will be obtained for the studies that pass the initial screening stage. A Microsoft Excel version 16.36 spreadsheet will be used to store the data that will be extracted. Of the data extracted, 10% will be randomly selected and independently reviewed by two other reviewers. Any consistencies among the reviewers will be discussed and an agreement will be reached.

The relevance of the studies in answering the research objective will be identified and studies that are not relevant will be removed and a reason for excluding the study will be recorded. In this stage, another 10% of the studies will be sampled and shared with the secondary reviewer who will exclude or include the studies based on their relevance to the study objective. Consensus will be reached for any discrepancies in the studies among the four reviewers.

Presentation of results

If there are enough studies designed in a similar way reporting on effect of water deficiency on health outcomes in a consistent manner, we will then be able to calculate heterogeneity ($I^2$) for the subset of included studies that follow a similar design. The index of heterogeneity ($I^2$ statistic) will be calculated from the sum of the squared deviations of the estimate of each study from the overall estimate and weighted by the influence of the study on the calculation of the overall estimate. We will look at the risk bias in the study level and characterize whether the metrics of water scarcity and health are a representative of the whole urban population or only a subgroup. We will use R software version 3.6.1 to carry out the analysis.

Cluster analysis will be performed to bring similar studies together using agglomerative hierarchical clustering using Ward’s method, which is used in other scoping reviews. The optimal number of clusters will be chosen to ensure the inner homogeneity and external heterogeneity of a cluster is balanced.

### Table 1. Search terms that will be used to select studies from the different electronic databases and research repositories.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Huambo OR Luanda OR Cotonou OR “Abomey-Calavi” OR “Abomey Calavi” OR Ouagadougou OR Bobo-Dioulasso OR “Bobo Dioulasso” OR Bunjumbura OR Younde OR Yaounde OR Douala OR Bangui OR Ndjarnena OR Brazzaville OR Pointe-Noire OR “PointeNoire” OR Abidjan OR Bouake OR Kinsasha OR Cairo OR “Al Qahirah” OR Al-Qahirah OR Alexandria OR “Al-Iskandariyah” OR “Al Iskandariyah” OR “Port Said” OR “Bur Said” OR “Addis Ababa” OR Libreville OR Banjul OR Accra OR Kumasi OR Conakry OR Nairobi OR Mombasa OR Monrovia OR Antananarivo OR Lilongwe OR “Blantyre-Limbe” OR “Blantyre Limbe” OR Bamako OR Nouakchott OR Casablanca OR “Dar el-Beida” OR “Dar el Beida” OR Rabat OR Nampula OR Tete OR Maputo OR Matola OR Niamey OR Lagos OR Kaduna OR Akure OR Ikorodu OR Uberlandia OR Capetown OR Durban OR Pretoria OR “Port Elizabeth” OR Bloemfontein OR “Dar es Salaam” OR Arusha OR Mbeya OR Lome OR Kampala OR Khwe OR Lusaka OR Harare OR Bulawayo OR “Benin City” OR “Enugu OR Ibadan OR Ikorodu OR Ikorin OR Jos OR Maiduguri OR Nnewi OR Onitsha OR Oshogbo OR Owerri OR “Port Harcourt” OR Sokoto OR Umuahia OR Oyo OR Warri OR Zaria OR Hargeysa OR Merca OR Mogadishu OR Mogadisho OR Johannesburg OR Soshanguve OR Vereeniging OR Khartoum OR “Al-Khartum” OR “Al Khartum” OR Nyala OR Salafs OR Tunis OR Mwanza OR Zanzibar OR Ndola OR Algiers OR “El Djazair” OR Wahrani OR Oran OR Bukuav OR Kananga OR Kisangani OR Lubumbashi OR “Mbui-Mayi” OR “Mbui Mayi” OR Tshikapa OR Djibouti OR “Al-Mansurah” OR “Al Mansurah” OR “As-Suways” OR “As Suways” OR Asmara OR Sekondi Takoradi OR Banghazi OR Misratah OR Tarabulus OR Tripoli</td>
</tr>
<tr>
<td>Exposure</td>
<td>water AND (scarc* OR intermittent OR break* OR ratio* OR deficit OR deficien* OR unavailab* OR continu* OR interrupt* OR stress OR supply OR sufficien* OR insufficien*)</td>
</tr>
<tr>
<td>Outcome</td>
<td>“water borne” OR “water-borne” OR cholera OR typhoid OR diarrhoea OR diarrhoea OR amoebiasis OR dysentery OR gastroenteritis OR cryptosporidii OR cyclosporiasis OR giardiasis OR “guinea worm” OR “guinea worms” OR rotavirus</td>
</tr>
</tbody>
</table>
The study locations will be geocoded, and the data will be presented using digital maps that will depict the water sufficiency in these different cities and compare this with the World Resource Institute Aqueduct Global map, which depicts water stress for the countries in our study. Hotspot maps of the number of studies that have been carried out on waterborne diseases in the different cities will be presented and this will be compared with the water sufficiency maps to observe whether the same cities that have high cases of waterborne diseases are the same cities that have high water insufficiency. These maps will enable researchers to identify areas that have gaps in knowledge and identify future research needs.

### Ethics and dissemination

The study did not require any ethical approval. The findings will be published in a scientific peer-reviewed journal.

### Study status

Currently, we are doing the literature searches in the MEDLINE, Embase, Web of Science and Google Scholar databases and extracting the titles and abstracts from the articles which will be used in the initial screening process.

### Data availability

No data are associated with this article.

### Table 2. Variables to be extracted from the articles for full-text screening.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Authors</td>
<td>Authors of the article</td>
</tr>
<tr>
<td>2 Publication type</td>
<td>Thesis, article</td>
</tr>
<tr>
<td>3 Title of the article</td>
<td>Full title</td>
</tr>
<tr>
<td>4 Year of publication</td>
<td>Year the article was published or written</td>
</tr>
<tr>
<td>5 Geographical scope of the study</td>
<td>City / cities the study was conducted</td>
</tr>
<tr>
<td>6 Study type</td>
<td></td>
</tr>
<tr>
<td>7 Duration of the study (if applicable)</td>
<td>Metric, population of the city</td>
</tr>
<tr>
<td>8 Rate of urbanization</td>
<td>Main water source, main water distributor, water demand</td>
</tr>
<tr>
<td>9 Water demand / supply</td>
<td>Frequency of water sufficiency, water rationing</td>
</tr>
<tr>
<td>10 Water sufficiency</td>
<td>Diarrhea, cholera, typhoid, amoebiasis, dysentery, gastroenteritis, cryptosporidium, giardiasis, guinea worm, rotavirus</td>
</tr>
<tr>
<td>11 Water-borne diseases</td>
<td></td>
</tr>
<tr>
<td>12 Water-borne disease cases</td>
<td>Lab-confirmed / self-reported / clinically diagnosed</td>
</tr>
<tr>
<td>13 Main source of water scarcity metric</td>
<td>Metric, proportion of urban population with sufficient water supply, proportion of urban population with insufficient water supply</td>
</tr>
<tr>
<td>14 Proportion of population with water-borne diseases</td>
<td>Metric</td>
</tr>
<tr>
<td>15 Area proposed for future research</td>
<td></td>
</tr>
</tbody>
</table>

### References


7. Gleick PH: Basic water requirements for human activities: Meeting basic