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Review article

Temperature-related morbidity and mortality in Sub-Saharan Africa: A systematic review of the empirical evidence

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ABSTRACT

Background: Sub-Saharan Africa (SSA) contributes very little to overall climate change and yet it is estimated to bear the highest burden of climate change, with 34% of the global DALYs attributable to the effects of climate change found in SSA. With the exception of vector-borne diseases, particularly malaria, there is very limited research on human health effects of climate change in SSA, in spite of growing awareness of the region's vulnerability to climate change.
Objectives: Our objective is to systematically review all studies investigating temperature variability and non-vector borne morbidity and mortality in SSA to establish the state and quality of available evidence, identify gaps in knowledge, and propose future research priorities.
Methods: PubMed, Ovid Medline and Scopus were searched from their inception to the end of December 2014. We modified the GRADE guidelines to rate the quality of the body of evidence.
Results: Of 6745 studies screened, 23 studies satisfied the inclusion criteria. Moderate evidence exists to associate temperature variability with cholera outbreaks, cardiovascular disease hospitalization and deaths, and all-cause deaths in the region. The quality of evidence on child undernutrition is low, and for diarrhea occurrence, meningitis, Ebola, asthma and respiratory diseases, and skin diseases, very low.
Conclusions: The evidence base is somehow weakened by the limited number of studies uncovered, methodological limitations of the studies, and notable inconsistencies in the study findings. Further research with robust study designs and standardized analytical methods is thus needed to produce more credible evidence base to inform climate change preparedness plans and public health policies for improved adaptive capacity in SSA. Investment in meteorological services, and strengthening of health information systems is also required to guarantee timely, up-to-date and reliable data.

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1. Introduction

Anthropogenic climate change, manifesting mainly as intensification of extremes of ambient temperature and increases in the mean (McMichael and Lindgren, 2011) is now incontrovertible (Watts et al., 2015). Several epidemiological studies conducted mostly in high income countries, Europe and North America in particular, have found extreme temperatures to be associated with increased risk of illness and death (Basu and Samet, 2002; Basu, 2009; Kovats and Hajat, 2008; O'Neill and Ebi, 2009; Ye et al., 2012). A recent multi- country study has however shown the whole temperature range and not just the extremes to be important in understanding temperature-mortality dependencies (Gasparrini et al., 2015).

Climate change has been estimated to be responsible for the loss of over 150,000 lives and 5,500,000 disability adjusted life years (DALYs) globally in 2000 (Campbell-Lendrum et al., 2003; McMichael et al., 2004; Costello et al., 2009). Although Sub-Saharan Africa (SSA) contributes very little to overall climate change (Kula et al., 2013), the region is estimated to bear the highest burden of climate change, with 34% of the global DALYs attributable to the effects of climate change found in SSA (Costello et al., 2009; WHO, 2008). According to Byass (2009), with the population of SSA representing only 11% of the global population, the proposed estimate reflects a three-fold population-based risk for adverse effects of climate change among Africans compared with the global population. The recent Intergovernmental Panel on Climate Change (IPCC) assessment report made similar observations when it pointed out that Africa is one of the most vulnerable continents to climate change due to its high exposure and low adaptive capacity (Niang et al., 2014).

With the exception of vector-borne diseases, particularly malaria, there is very limited research on the human health effects of climate change in SSA, in spite of growing awareness of the region's vulnerability to climate change. Byass (2009), asserted that, in Africa, given the predominance of research on the effects of climate change on malaria transmission, it might be construed as the major climate change-related health problem in the region, when other relatively underdocumented effects are likely to have a numerically greater impact. Byass (2009), further stated that, on the African continent, where a large number of people are regularly exposed to extremes of high temperature, physiological effects of heat might equally be an important public health concern and worth investigating.

We therefore conducted a systematic review of all studies examining the relation between temperature variability and non-vector borne morbidity and mortality in SSA to establish the state and quality of available evidence, identify gaps in knowledge, and propose future research priorities. Documenting the effects of temperature variability is important for predicting the impact on health of climate change. According to Wilkinson et al. (2003), meteorological variables such as temperature are perhaps the most important exposure indicators for assessing the effects of climate on human health.

2. Methods

We searched Ovid Medline, PubMed, and Scopus databases, from their inception to the end of December 2014, with no language restrictions imposed for relevant studies. The search statement applied in the databases was {climate OR climatic OR weather OR temperature} AND {mortality OR death* OR morbidity OR illness* OR disease* OR sickness* OR infection* OR malnutrition OR undernutrition OR diarrhea OR cholera} AND africa.

We initially screened the articles for eligibility, based on the title and abstract with studies considered for inclusion in the review, if they were (a) original studies, (b) conducted in a human population in any Sub-Saharan African country and (c) investigated any health outcome with the exception of vector-borne diseases. Climate change impact on vector-borne diseases, especially malaria, has been widely investigated in Sub-Saharan Africa with several studies also reviewing the available evidence, hence the decision to exclude these outcomes from our study. Selected articles were retrieved in full and further assessed for eligibility. We also reviewed the reference list of all included studies to identify additional eligible studies.

The following information was extracted from eligible studies: location and study period, study design and statistical analysis, study population and size, temperature variable(s) and health outcome(s) and their data sources, control of confounding, and study findings.

We modified the GRADE (Grading of Recommendations Assessment, Development and Evaluation) guidelines (Balshem et al., 2011) to rate the quality of the body of evidence. GRADE assesses the quality of a body of evidence based on five criteria - study limitations (risk of bias), publication bias, imprecision of effect estimates, inconsistency of results and indirectness of evidence, and specifies four categories; high and moderate for evidence from randomized controlled trials, and low and very low for evidence from observational studies. Because of the difficulty in assessing publication bias qualitatively, we decided to exclude the publication bias criteria from our modified checklist. In the area of temperature variability/climate change and health research, observational designs are the only approach for generating evidence to inform policy decisions. Durrheim and Reingold (2010), suggested the evaluation of additional epidemiological domains and provision of a set of ratings to ensure that the GRADE framework which according to them addresses one evidence domain, remains relevant for the use of comprehensive public health evidence in informing policy making. Our modified GRADE guideline thus also specifies four categories - high, moderate, low and very low in spite of the evidence generating from observational designs. With the exception of study limitations, each of the other three criteria were assessed by assigning a score of 0 to "no" and a score of −1 to "yes". For study limitations, "no" attracted a score of 0, with "yes, serious" attracting a score of −1 and "yes, very serious" getting a score of −2. The scores were then summed up with summary scores of ≥−1 deemed as high quality, −2 as moderate quality, −3 as low quality, and ≤−4 as very low quality. We developed a checklist which was applied in rating the body of evidence for each study outcome (Appendix A).

3. Results

A flowchart of the study selection process is reported in Fig. 1. A total of 23 studies were included in the review.