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The need for robust research methodology when studying climate and health in developing countries: Comments on Trickey et al. (AIDS Behav. 2024;28:1752–1765)

Significance:

A paper recently published in *AIDS and Behavior* on 20 February 2024, authored by Trickey et al.[1], argues that drought potentially increases HIV (Human Immunodeficiency Virus) transmission in sub-Saharan Africa. They established a positive correlation between drought, poverty, sexual behaviour, and HIV contraction. The study's methodology is problematic, and does not consider key confounding factors, utilises data which is subject to biases, and utilises inappropriate means to define drought. We do not dispute the possibility that links exist between these variables, but assert that the data and methods used in this study are insufficient to support such a claim.

Introduction

Research on the impact of climate change on disease transmission in developing countries is of great value to policymakers, and to the scientific community at large. The value inherent in such research requires that, when undertaking this research, the researchers utilise carefully considered methodology, consider and adjust for confounding factors, and engage critically with the data used in the study. In this Commentary, we argue that, given the significance of their findings, the methodology utilised by Trickey et al.[1] in their study investigating the associations between drought, poverty, high-risk sexual behaviours, and HIV incidence in sub-Saharan Africa, should be more robust, and that the study fails to engage with several important factors that may have impacted the study findings.

Trickey et al.[1] hypothesise that drought increases poverty, and that increased poverty may lead individuals to engage in risky sexual practices – such as transactional and/or intergenerational sex, and sex without the use of contraception – leading to higher rates of HIV (Human Immunodeficiency Virus) transmission. To test this hypothesis, data on HIV prevalence, socio-economic status, age, gender, and sexual behaviour were compiled from five Population-Based HIV Impact Assessment (PHIA) surveys conducted in 2016 in Eswatini, Lesotho, Tanzania, Uganda, and Zambia.[1] The survey data were then geospatially compared with gridded precipitation data for each area for 2014 to 2016, which was acquired from the Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS).[1] Multivariable logistic regression was then used to examine the associations between drought and poverty, wealth quantile and sexual behaviour, sexual behaviour and recent contraction of HIV, and drought and recent HIV contraction. While we do not dispute that drought has a significant impact on poverty[2,3], the logical steps that follow this require far more robust analysis. We unpack the issues inherent in this methodology.[1]

Defining drought and poverty

Curiously, Trickey et al.[1] did not utilise a drought index to define drought, and instead chose to classify drought conditions by comparing the precipitation data for 2014-2016 to rainfall levels for historical 2-year periods ranging from 1981 to 2016. Trickey et al.[1] justify the decision as a measure of the threshold below which a deficit in rainfall becomes severely detrimental to agricultural production and yield.[4] We argue that an official drought index, such as the standardised precipitation index (SPI), would have been more appropriate. The SPI would work well for such a study as the only climatic input variable it requires is precipitation, and the index is suitable for monitoring drought over a 2-year timescale.[5] Furthermore, the World Meteorological Organization (WMO) recommends that the SPI be used for classifying drought events.[6,7] Trickey et al.[1] do not provide clear justification for not having used a well-established drought index.

A key variable in this study – poverty – is a multidimensional concept, which must be clearly defined to be accurately measured.[8] Several issues make measuring poverty difficult[8], but Trickey et al.[1] do not sufficiently explain how these issues were addressed. Such a complex and important variable requires greater engagement.

Internal validity

The internal validity of the study is compromised by the failure to account for key confounding factors.[9] Trickey et al.[1] define and examine drought periods in their research, but do not control for non-drought periods, as they do not outline the HIV prevalence, poverty rates, and sexual behaviour of the population during periods without drought. Thus, a baseline is not established against which to compare the study findings, so that conclusions about the significance of the findings can be formed. A stronger correlational relationship could have been developed if non-drought periods were considered as a control variable, strengthening the internal validity of the study.

The study also does not consider the lag period between the onset of a drought event and the impact of drought on the population.[10] A lag period is critical to establish for a study of this nature, because the effects of drought would not occur immediately, but would develop over time.[10] A decrease in rainfall would not instantaneously cause food shortages, nor would the population's response to food shortages – such as turning to transactional

sex to access resources – occur as soon as food shortages begin. Additionally, the study does not account for the lag period between an individual contracting HIV and being tested for HIV, weakening the notion that the study examines HIV incidence as opposed to prevalence. While it is possible to calculate a lag period between the onset of a drought event and the agricultural and socio-economic effects of the drought[11], it is much more difficult to establish an average lag period between contracting and testing for HIV. Furthermore, an increase in reported HIV cases does not necessarily reflect an increase in HIV incidence, but is more likely a symptom of increased testing in the region. Research on complex issues such as extreme weather events and disease transmission should consider as many confounding variables as is practical, so that the research methodology – both the data collection and analysis – can be designed to address these variables appropriately.

Statistical analysis

Having explained the need to establish a lag period between the onset of drought and the impacts of drought on the human population[10], one can then understand why a multivariate logistic regression model is not the most appropriate method for analysing the impact of drought on HIV, poverty, and sexual behaviour, and why a distributed lag non-linear model (DNLM) would be more appropriate. DNLMs are statistical models which can be used to examine statistical correlations between variables, where one variable has a delayed effect on another variable – i.e. where a lag period is involved.[12] DNLMs are appropriate for research within climate and health, where environmental stressors (a drought) often present a delayed effect on human health (HIV).[12,13] Utilising a DNLM would allow for a better handling of the complexity of this research, its multiple variables, and confounding factors. The authors do not provide a clear rationale for the use of more simplistic statistical approaches, as opposed to the methods used currently within the discipline of climate and health.

Flaws within the data set

While the data analysis of this research study could be improved, we also argue that certain elements of the data are problematic. The study utilises cross-sectional data, which is inadequate for testing a causal hypothesis, as it does not account for time intervals.[14] Trickey et al.[1] also utilise gridded precipitation data from CHIRPS for Eswatini, Lesotho, Tanzania, Uganda, and Zambia, but have conducted no ground validation or further independent analysis[6] of the climate of these topographically diverse and climatically distinct regions. The data utilised for this study, and as a result the study findings, could be made more reliable if the precipitation data acquired from CHIRPS were supported by independent climatological analysis, validating the data set, and displaying a comprehensive engagement with the data and the study sites.

Data on HIV prevalence, socio-economic status, sexual behaviour, age, and gender were acquired from PHIA surveys, and accompanying HIV tests were conducted by the survey staff.[1] The aim of the study is to examine the relationship between drought and HIV incidence, but the authors use data on positive HIV tests, which does not reflect incidence. It is suggested that, through the HIV tests, it is possible to recognise when a person has recently contracted HIV based on the individual's optical density and the suppression of their viral load, but the study does not provide any way to conclusively state when any of the participants contracted HIV, which weakens the reliability of the correlational analysis the study attempts to establish, due to the aforementioned uncertainties in the lag period.

Furthermore, self-reported survey data are subject to several biases which weaken their reliability[15], and Trickey et al.[1] acknowledge that social desirability bias and recall bias may have influenced survey responses. Due to the sensitive nature of the survey questions – with questions focusing on HIV and sexual practices – we argue that social desirability bias would be a major concern.[15] Trickey et al.[1] also suggest that some participants may not have fully understood certain concepts – such as transactional sex – or may not have viewed these concepts in the same manner as they were defined in the study, further weakening the validity of the data set used in this study.

Conclusion

Scientific rigour is important in such research because of the impact of the research on the populations studied. The populations of sub-Saharan Africa are highly vulnerable to the adverse effects of climate change, and to the threat of diseases such as HIV, and are thus an important population to study – but this research must maintain scientific rigour if it is to be beneficial. In this Commentary, we have highlighted the ways in which a study can fail to engage comprehensively and critically with the data being collected and analysed, the sites being studied, and the models and methods being used to develop the research findings. When engaging in research with the potential to influence policy decisions and future research, it is the responsibility of the researcher to ensure that the research is conducted correctly, and with consideration for the population under study. If there is a perception that HIV infections decrease under non-drought conditions, it is possible that this perception may profoundly impact human behaviours that affect HIV transmission, healthcare preparedness, and policy interventions.

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Declarations

AI was not used in the writing of this manuscript. Both authors read and approved the final manuscript.

Competing interests

We have no competing interests to declare.

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