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Standards for Official statistics on Climate-Health interactions

Malnutrition (stunting): introduction

Alpha Phase document

Publication date: 12 November 2024

We welcome users' views and expertise on the alpha version of the statistical framework to further develop our work. Please email us at climate.health@ons.gov.uk.

Contents

Introduction to the SOSCHI project

The impacts on health of rising temperatures, wildfires, extreme weather events and other direct and indirect effects of climate change are a major global concern. The most significant hazards and their impacts differ between countries and regions, as do the possibilities and priorities for climate change adaptation. National and local governments and other stakeholders need to have regular, reliable and comparable data to monitor climate impacts and inform adaptation strategies, based on a transparent and globally generalisable statistical framework. The SOSCHI project, led by the UK Office for National Statistics and funded by Wellcome, is developing a framework of indicators based on state-of-the-art statistical methods to measure climate-related health risks. To support global reporting and monitoring, we are also developing a knowledge-sharing platform, open-source tools, and R code. Our findings will also help highlight data gaps and help set the agenda for future improvement of data sources and methods.

Project partners

African Institute for Mathematical Sciences, Kigali, Rwanda
Cochrane Planetary Health Thematic Group, University of Alberta, Edmonton, Canada
Office for National Statistics, Newport, United Kingdom
Regional Institute for Population Studies, University of Ghana, Accra, Ghana
UK Health Security Agency, London, United Kingdom
United Nations Global Platform, New York, United States of America

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Important notes

This document has been published as part of the alpha version of the SOSCHI statistical framework. Therefore, this should be read as a draft document, which does not necessarily represent the final state of the framework. We welcome users' views and expertise to further develop our work.

Please email us at climate.health@ons.gov.uk

Abbreviations

D	DEFRA	Department for Environment, Food and Rural Affairs (UK)
L	LMICs	Low- and Middle-Income Countries
O	ONS	Office for National Statistics (UK)
R	RIPS	Regional Institute for Population Studies, University of Ghana, Legon
U	UK	United Kingdom of Great Britain and Northern Ireland
U	UNGP	UNGP UN Global Platform

1. Acknowledgments

We would like to express our heartfelt appreciation to the individuals and organizations who supported the team in developing this topic introduction.

We extend our heartfelt gratitude to the members of our Expert Advisory Group, led by Professor Sir Andy Haines from the London School of Hygiene and Tropical Medicine. Their profound expertise in climate and health has been invaluable in shaping the decisions for this topic and the broader SOSCHI project.

Special thanks to Dr Simon Lloyd (Global Climate and Health Expert) whose expert insight into the topic area has been very helpful. To refine the scope of this topic, we intend to have further engagements with identified experts.

As part of upcoming beta phase developments, we are seeking expert feedback to support the development of this topic. Please contact climate.health@ons.gov.uk if you would like to contribute to this work.

2. Malnutrition and climate change

2.1 Introduction

Malnutrition refers to a condition resulting from an imbalance in dietary intake, where nutrients are either insufficiently consumed or overly consumed, leading to adverse health effects[1]. According to the World Health Organization (WHO), malnutrition consists of three key conditions: (1) undernutrition, which includes wasting, stunting, and underweight; (2) micronutrient-related malnutrition, characterized by either deficiencies or excesses of vital vitamins and minerals; and (3) overweight, obesity, and diet-related noncommunicable diseases[2]. Additionally, prolonged malnourishment, particularly among children can lead to several health and physical consequences, including delayed physical growth and motor development, lower intellectual abilities, increased behavioural issues, poor social skills, and a heightened vulnerability to diseases[3,4]. Additionally, malnutrition is linked to impaired immune systems, reduced adult work performance and productivity over the life course, and an increased chances of giving birth to undernourished babies[5,6].

The 2024 State of "Food Security and Nutrition in the World" shows that global targets, particularly pertaining to Zero hunger remain very daunting[7]. Over the past three years, there has been no improvement in the global number of undernourished people. Around 20% of the population faces hunger, with approximately one in 11 people globally and one in five in Africa affected. While hunger continues to rise in Africa, it has stabilized in Asia, and progress has been made in Latin America and the Caribbean.

While the report and others identify conflict, climate change, the COVID-19 pandemic, and economic slowdown as major drivers of the current food security and nutrition situation, is it worth mentioning that climate change and its associated variability and extremes exacerbate all the other drivers. Rising temperatures and extreme weather events such as drought and dry spells adversely affect crop productivity and ultimately food and nutrition security[8]. Conversely, other climate sensitive environmental factors such as nature of land area and soil fertility as well as socio-economic conditions, including household poverty increased the risk of food security which increases the likelihood of malnutrition, particularly among vulnerable groups such as women and children under five years.

2.2 Definition and Scope

Malnutrition is determined by several anthropometric and biomedical measures. Table1 summarizes the various forms of malnutrition, highlighting their sources, how they are measured, their implications, and their sensitivity to climate change.

- Wasting (Acute Malnutrition): This condition is measured by a child's weight-for-height ratio, and it indicates severe, short-term malnutrition. Wasting leads to a higher risk of mortality, infections, and delayed physical development. It is highly sensitive to climate change, as extreme weather events like droughts or floods can lead to sudden food shortages.
- Stunting (Chronic Malnutrition): Stunting is assessed by height-for-age and reflects long-term malnutrition. It results in lasting consequences, such as impaired cognitive and physical development and reduced productivity in adulthood. Stunting is also highly sensitive to climate change, particularly through its effects on agriculture and food security over extended periods.
- Underweight: Measured by weight-for-age, underweight status can signal both acute and chronic malnutrition. It increases vulnerability to infections, reduces energy, and slows growth in children. Climate change moderately impacts this condition by reducing food availability, which affects body weight, especially in regions heavily reliant on agriculture.
- Micronutrient Deficiencies: These deficiencies (e.g., iron, vitamin A) are typically diagnosed through blood tests or clinical signs. They weaken the immune system, impair development, and elevate mortality rates. Climate change has a moderate effect here, as extreme weather can lead to a reduction in the diversity and nutritional value of food, making it harder to meet dietary micronutrient needs.
- Overweight & Obesity: These conditions are measured by body mass index (BMI) and indicate overnutrition, leading to a higher risk of non-communicable diseases (NCDs) such as heart disease, diabetes, and stroke. Although less directly influenced by climate change, changing food systems may lead to shifts in diet patterns, exacerbating overweight and obesity in populations.

- Protein-energy Malnutrition: This type of malnutrition results from inadequate intake of calories and protein and is measured through dietary assessments. It leads to muscle wasting, weakness, and increased susceptibility to infections. Climate change poses a high risk, as it can disrupt food supplies, particularly in regions already facing food insecurity, leading to a decline in protein-rich food availability.

Table 1: Table of Malnutrition, Measurements, Implications, and Sensitivity to Climate Change

Type of Malnutrition	Measurement	Implication	Sensitive to Climate Change
Undernutrition (e.g., wasting, stunting)	Weight-for-height (wasting), height-for-age (stunting)	Increased mortality, impaired cognitive development, and poor health	Highly sensitive (crop failure, food insecurity)
Micronutrient Deficiencies (e.g., iron, vitamin A)	Blood tests, clinical assessments	Anaemia, blindness, weakened immunity, developmental delays	Highly sensitive (reduced crop diversity, decreased food nutrient content)
Overnutrition (e.g., obesity, overweight)	Body Mass Index (BMI)	Increased risk of non-communicable diseases (diabetes, heart disease)	Moderately sensitive (climate-related shifts in food systems)
Protein-Energy Malnutrition (PEM)	Mid-Upper Arm Circumference (MUAC), Weight-for-Age	Muscle wasting, immune system suppression, high mortality risk	Highly sensitive (impacts on livestock, fisheries, and food production)
Hidden Hunger (Subclinical deficiency)	Dietary surveys, biochemical markers	Long-term health issues (reduced productivity, chronic diseases)	Moderately sensitive (climate impacts on food supply and diversity)

Overall Wasting and stunting are the most sensitive to climate change, primarily because extreme weather events (like droughts and floods) can severely disrupt food production and supply, leading to acute food shortages

In this work we settle on stunting as the indicator of choice based because is it known as the best overall indicator of children's well-being and provides an accurate marker of inequalities in human development[9]. Its effects are often irreversible and unfortunately affecting millions of children (reference). Stunting is currently among the six global nutrition targets for 2025 that the World Health Assembly adopted in 2012 (WHO 2012), and it has been proposed as a leading indicator for the post-2015 development agenda[10]. Increased international attention is the result of greater awareness of the significance of stunting as a major public health problem.

2.3 Impact pathway

The conceptual framework (Figure1) illustrates the intricate relationships between climate change childhood nutrition. Variations in precipitation and temperature can influence child undernutrition, specifically stunting through two alternate pathways. Firstly, through agricultural and secondly through the environment.

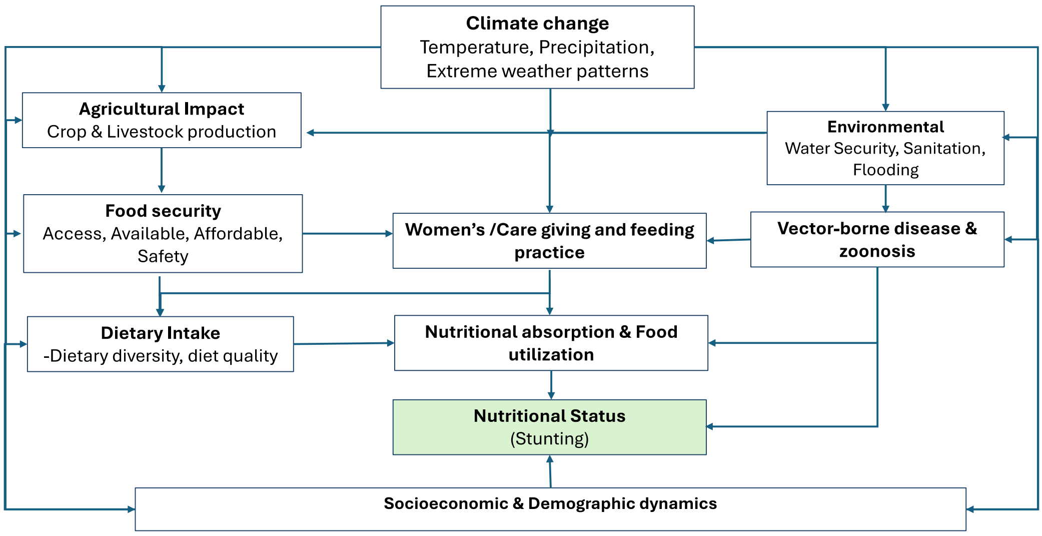

Figure 1: Conceptual Pathways between Climate Variables and Childhood Stunting

Agriculture: Both rainfall/precipitation and temperatures directly influence agricultural productivity by affecting crop yields and livestock production, which in turn affects food security [8].

Agricultural production forms a major pillar for food security, particularly in sub–Saharan African countries where a significant proportion of the population is still reliant on local, small-scale and rain-fed agriculture as the primary source of food and income[11]. Varied agricultural production can improve food security by improving 1) the availability and accessibility of diverse foods, and 2) increasing household incomes both of which are essential for a well-balanced diet. In other words, as food security diminishes, there is a reduction in dietary diversity and quality, leading to compromised dietary intake[12]. The above could lead to reduced nutrient absorption and food utilization, contributing to deteriorating nutritional status, with stunting being a key outcome.

Environment: Climatic factors such as precipitation and temperatures may impact on environmental conditions, leading to compromised water quality and sanitation, which have direct consequences on public health [13] .Rising temperatures and altered precipitation patterns can lead to water scarcity and contamination, compromising sanitation infrastructure. This environment fosters the proliferation of disease vectors like mosquitoes, increasing the incidence of diseases such as malaria and dengue[14,15]. Climate change alters the patterns of vector-borne diseases and zoonotic infections, exacerbating health and nutritional challenges. These health challenges disproportionately affect children, who are more vulnerable to infections and malnutrition. Poor health and frequent illness can hinder a child's ability to absorb nutrients, exacerbating malnutrition and stunting growth[16].

While the framework recognizes the role of women in caregiving and feeding practices, which are impacted by changes in food security and health conditions, it also acknowledge the significant part sociodemographic and economic factors play in this climate and malnutrition nexus.

Agricultural productivity and environmental factors are all closely linked with various socioeconomic determinants that collectively influence health outcomes such as stunting. Besides food availability, higher agricultural yields and favourable environmental conditions can lead to greater financial stability, thereby improving access to healthcare and nutrition. Conversely, families with lower socioeconomic status may be disproportionately affected by adverse environmental conditions and lower agricultural productivity, exacerbating health disparities[17].

3. Health impacts

The health outcome of interest is childhood stunting. The selection of stunting as the outcome of interest is due to the following 1) Stunting reflects chronic malnutrition and provides insights into the cumulative effects of climate change on food security and living conditions[18]; 2) it has significant implications for cognitive and physical development, affecting educational outcomes and economic productivity [19]; 3) stunting is also particularly sensitive to climate and environmental changes, including food availability and disease prevalence [20], addressing stunting can have a ripple effect on other health outcomes and finally there is often comprehensive data available of stunting in most nutrition and health surveys comparable to a nutritional indicator such as anaemia. It is widely agreed that the definition of stunting is reliable and universally applicable as an indicator of human growth. Furthermore, there's consensus on a crucial period—from conception to the first two years of life—where linear growth is highly sensitive to environmental factors like nutrition, infections, and psychosocial care [9]

4. Framework indicators

4.1 Headline outcome indicators

Main dependent and explanatory/independent variables: Our dependent variable or nutritional outcome of interest is the height-for-age Z-scores (HAZ) of children aged one to five years. HAZ is a standard measure widely utilized to evaluate child stunting and acts as an indicator of chronic malnutrition in children.

The topic focuses on the impact of climate change and variability on nutritional outcomes. Our framework includes the following indicators:

- **C1:** The incidence of stunting attributable to extreme precipitation or rainfall[i]
- **C2:** The incidence of stunting linked to extreme temperature
- **C3:** The incidence of stunting associated with drought

The climatic variables of interest are temperature (mean, minimum and maximum temperatures) and precipitation (precipitation and rainfall).

Other control variables: Variables controlled for included both demographic, economic and biological determinants of malnutrition such as child's age and sex, household determinants such as wealth status, household size, and access to improved sanitation and drinking water [21] .

Extant scholarship highlights several factors that contribute to childhood stunting. Boys are generally more prone to stunting than girls, potentially due to biological factors like higher susceptibility to infections and illnesses that can impede growth[22,23]. The child's age is also critical, with the first 1,000 days of life—from conception to age two—being particularly crucial for growth and development[24]; inadequate nutrition during this period can lead to irreversible stunting, and the prevalence of stunting tends to

[i] Temporary indicator numbers have been assigned for reference during the development of the SOSCHI framework and will change in the final version.

increase as children age in early childhood. Household size is another influential factor; larger households often face resource constraints, leading to less food and attention per child, which can result in poorer nutritional outcomes[25]. Household wealth plays a significant role as well; children from poorer households are more likely to be stunted due to limited access to nutritious food, healthcare, and sanitation facilities, whereas wealthier households can afford better nutrition and healthcare, reducing the risk of stunting [26,27]. Additionally, poor water, sanitation, and hygiene (WASH) practices are major contributors to stunting, as contaminated water and inadequate sanitation can cause repeated infections and diarrheal diseases, impairing nutrient absorption[28,29]. Improved WASH practices, on the other hand, are associated with lower stunting rates. Finally, a child's dietary intake is crucial in preventing stunting. Diets lacking in essential nutrients, such as proteins, vitamins, and minerals, increase the risk of stunting, while a diverse diet rich in necessary nutrients, including specific food groups like dairy and eggs, significantly reduces this risk. Other child characteristics considered were episodes of diarrhoea and fever within a specified period. Additionally, children's Dietary diversity was evaluated based on the number of food groups a child ate in the past 24 hours[30].

Why indicators from the Demographic and Health Survey: The use of indicators in the Demographic and Health Survey (DHS) is crucial for several academic reasons. Indicators provide standardized measures that allow for meaningful comparisons across different populations and time periods, facilitating the identification of trends, disparities, and progress in health and demographic outcomes. They simplify complex data into concise, manageable metrics, making large-scale data collection more accessible for analysis and interpretation. Moreover, indicators are often aligned with global health and development goals, such as the Sustainable Development Goals (SDGs), making DHS data highly relevant to policymakers. The consistency with international standards ensures that DHS data can be integrated into global datasets, contributing to a broader body of knowledge. Furthermore, indicators serve as common reference points across various disciplines, enhancing the utility of DHS data for multidisciplinary research. Finally, they allow for the assessment of health interventions and programs over time, helping researchers evaluate the effectiveness of policies and identify areas where further efforts are needed.

4.2 Supplementary outcome indicators

Besides stunting being our outcome variable, other nutrition indicators that maybe explored include wasting, and underweight (Table 1).

4.3 Other relevant measures

Other measures which could be considered as part of future analysis within this topic in household food security. From the conceptual framework (figure 1), We see that as climate change alters weather patterns, it may lead to extreme weather events like droughts, floods, and heatwaves, which disrupt agricultural production and food supply chains. This disruption can result in reduced food availability and increased food prices, making it difficult for households to access sufficient and nutritious food. Thus, households may experience food insecurity, which negatively impacts their health due to inadequate nutrition.

This measure is currently not explored given it unavailability in Ghana's Demographic Health Survey (our primary source of data).

5. Proposed beta phase developments

At the beta phase additional work will be done to merge data sources from other sub-Saharan African countries to explore the effect of climatic variables on the outcome of interest (stunting). Methods will be developed using robust statistical techniques including sensitivity analysis to validate the linkages explored.

Other data sources that could provide a country level food security measure will also be explored.

Expected outcomes at the beta phase:

- Merge Data Sources: Integrate data from other sub-Saharan African countries to examine the impact of climatic variables on stunting.
- Develop Robust Statistical Techniques: Create and publish advanced statistical methods, including sensitivity analysis, to validate the linkages between climatic variables and stunting.
- Explore Additional Data Sources: Identify and incorporate other data sources that can offer a country-level measure of food security.
- Comparison of proposed indicators to existing frameworks

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