RESEARCH ARTICLE

The paradox of food production, consumption, poverty and malnutrition in Tanzania: an ecological study design [version 1; peer review: 2 approved with reservations]

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Abstract

Background: There have been claims amongst nutrition stakeholders in Tanzania that the food basket regions, are the regions most affected by stunting among children. However, this study could not find evidence that combines food production and stunting levels, to substantiate this claim. Therefore, this study aims to compare data on stunting, food production and consumption within administrative regions of the Tanzania mainland.

Methods: The study used an ecological study design to show the relationship between stunting, poverty, food production and consumption across administrative regions in Tanzania. The study used data from three national wide surveys: 2017/2018 Household Budget Survey (HBS), Tanzania National Nutrition Survey (TNNS) 2018 and Agriculture Statistics for Food Security report 2018/2019.

Results: The study showed that there is a positive relationship between the prevalence of stunting and food production ($r=0.43$, $p=0.03$), while there is a negative relationship between stunting and the level of both the average monthly household consumption expenditure ($r = -0.48$, $p = 0.01$) and average monthly household food consumption expenditure ($r = -0.509$, $p = 0.01$). It was further found that some regions which have higher levels of stunting such as Njombe, have the lowest level of basic need poverty.

Conclusion: The study found a positive relationship between food production and the prevalence of stunting using data across regions in mainland Tanzania. This is an indication that regional food security may not entail nutrition security, hence a call for more advocacy on nutrition-sensitive agriculture.

Open Peer Review

Approval Status ? ?

	1	2
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1. Joyce Kinabo , Sokoine University of Agriculture, Morogoro, Tanzania		
2. Nahomi Imaeda , Shigakkan University, Aichi, Japan		
Any reports and responses or comments on the article can be found at the end of the article.		

Keywords

Stunting, Food Production, Basic Need Poverty and Household Consumption

This article is included in the **Agriculture, Food and Nutrition** gateway.

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Author roles: **Tesha N:** Conceptualization, Formal Analysis, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Tungu M:** Conceptualization, Formal Analysis, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; **Kagaigai A:** Conceptualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Yohana B:** Methodology, Validation; **Paulo HA:** Methodology, Visualization

Competing interests: No competing interests were disclosed.

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Introduction

Stunting, defined as being too short for one's age, is among the important indicators to track children's malnutrition.¹ Globally, the number of stunted children is decreasing, however, its prevalence level is still unacceptable. In the past 18 years, the number of stunted children globally, decreased by 49.2 million. It has been reported that in 2018, over 149 million (21.9%) children were estimated to have stunted growth globally, compared to 198.2 million children in 2000.² Most of the stunted children live in developing countries, especially in Asia and Africa with 55% and 39% of children suffering from stunting, respectively. Africa is the only region where the number of cases is increasing; rising from 50.3 million in 2000 to 58.8 million in 2018 with disparities existing at the sub-national level.^{2,3}

The prevalence of stunting in Tanzania decreased by 18% from the 1990s, from 50% of children to 32% in 2018.⁴ This rapid change was due to the different strategies taken by the government, in collaboration with development partners, including implementation of the National Nutrition Strategy 2011/2012 to 2015/2016⁵ and the National Multi-Sectoral Nutrition Action Plan 2016 – 2021.⁶ However, this level is still high as per the World Health Organization (WHO) recommended thresholds ($\geq 30\%$). WHO defines levels of stunting in four levels: low ($<20\%$); Medium (20 – 29%), High (30 – 39%) and very high ($\geq 40\%$).^{13,14} Despite the decrease in the prevalence level, the number of stunted children is increasing. It increased from 2.5 million in 2005 to 3 million in 2018.⁷ The disparity exists across regions in Tanzania Mainland. Out of 26 regions, 15 regions have a stunting prevalence of above 30%, among them, six regions have above 40%. The regions with the highest stunting levels are Njombe (53%), Rukwa (47.9%), Iringa (47.1%), Songwe (43.3%), Kigoma (42.2) and Ruvuma 41%.⁸

The reviewed literature has shown that under-five stunting can be explained by different immediate and intermediate factors. Some of the factors include income levels, family size, education level of the mother, sex of the baby, age of the baby, feeding practices, food preparations, overall health status, types of occupation of the mother, weight of the baby and age of the mother at birth.^{9–12} The underlying factors of stunting are government policies, pricing of food, access to social services, farming practices and economic status of the household.⁶ Household poverty level and other factors related to poverty are also cited as determinates of stunting at household levels.^{11,12,14}

In Tanzania, some regions that are leading in food production and with a small prevalence of poverty, are also leading in the prevalence of stunting. For example, Njombe has the highest level of stunting (53%) and yet, it is the region with the third lowest rate of poverty (13.2%), just above are Dar es Salaam and Kilimanjaro with 8% and 10% levels respectively.^{4,15} Similarly, in 2018, Ruvuma was the highest region in terms of food production but it had a stunting level of 41%. There has been a debate amongst nutrition stakeholders (those working in the government, United Nations Agencies and donor countries supporting nutrition interventions, academia and non-governmental organization in nutrition), on the controversy on regions with both high food production and stunting levels. However, to the best of our knowledge, we have not found previous research conducted to investigate this. Therefore, this study aims to compare data on stunting, food production and consumption across administrative regions of Tanzania.

Methods

Study design and data source

This is an ecological study design using secondary data compiled from three sources: Tanzania Household Budget Survey (HBS) 2017/2018,¹⁵ Tanzania National Nutrition Survey (TNNS) 2018⁴ and Agriculture Statistics for Food Security report 2018/2019.¹⁶ Both HBS and TNNS are national-wise cross-sectional data organized by the Ministry of Finance and Planning and Ministry of Health respectively, while Agriculture Statistics for Food Security report 2018/2019 was prepared by the Ministry of Agriculture.

Study setting

Data for this study was sourced from 26 Tanzania mainland administrative regions. The regions were chosen because currently, aggregated data are representative at the regional level. Similarly, regions were chosen to determine whether food production could be a determinant of stunting at the regional level and hence answering the paradox.

A sampling of the Household Budget Survey and Tanzania National Nutrition Survey

The 2017/18 HBS had a sample of 9,552 individuals, which allowed disintegration of the results at the regional level. The data set adopted a two-stage cluster sample design. The first stage involved the selection of enumeration areas, Primary Sampling Units, (PSUs) from the 2012 Population and Housing Census Frame.¹⁵ The second stage involved systematic sampling of households from the updated PSUs list. All household members, regardless of their age, who were the usual members of the selected households and all the visitors who were present in the household on the night before the survey, were eligible.

TNNS used two-stage cluster sampling using Probability Proportional to Size (PPS), a representative at the regional and national level. The first stage sample of clusters was drawn independently for each domain. The second stage of sampling consisted of selecting households within each selected cluster, by using a systematic random selection procedure. Data were collected from the sample of 17,524 children aged 0-59 months and 9,426 women aged 15-49 years old.

Variables

The outcome variable of this study is the regional prevalence of stunting. Children were reported to be stunted if their height-for-age is more than two standard deviations below the World Health Organization's Child Growth Standards median.¹⁶ The exposure variables were the regional food production (cereal and non-cereals food crops in metric tons), the proportion of basic need poverty, monthly household average consumption expenditure and average monthly household food consumption expenditure.

Data management and analysis

Data were cleaned and analyzed using Microsoft Excel and STATA version 15. Mean and standard divisions were used to summarize the numerical variables. Correlation coefficients and scatter plots were used to determine the linear relationship between outcome (regional prevalence of stunting) and exposure variables (food production, average monthly food consumption expenditure, average household monthly consumption expenditure and proportion of regional basic need poverty). Findings were presented using tables, figures and narrations. The significance level was set at 5%.

Results

Summary statistics of the variables

The overall prevalence of stunting for the Tanzania mainland is 33.5%, ranging from 20% in Kilimanjaro to 53.6% in the Njombe region. Basic need poverty stands at 27.5%, ranging from 8% in Dar es Salaam to 45% in the Rukwa region. On the other hand, the average food production is 977,544.80 Metric tons per year and the mean average monthly household consumption expenditure in Tanzania shilling is 399,439 ranging from 268,041 in Rukwa Region to 720,946 in Dar es Salaam and the mean average monthly household food consumption expenditure is 47,986 ranging from 34,354 in Kigoma to 70,966 in Dar es Salaam (see Table 1).

Comparison of basic needs poverty, food production and average monthly household consumption among regions with highest prevalence of stunting

Four regions in Tanzania that have stunting above 40%⁴ are in the top six regions that produce the highest levels of food in the country.¹⁶ The region which is the first in food production in the country being among them¹⁶; Rukwa and Kigoma are only two regions with the highest levels of poverty¹⁵ which have also higher levels of stunting.⁴ However, there was no region with the highest levels of household monthly consumption expenditure¹⁵ in the top regions with highest levels of stunting.⁴ Furthermore, half of the regions with the highest monthly household consumption expenditure,¹⁵ have the lowest prevalence of stunting.⁴ It is only Lindi that has the lowest level of stunting⁴ and the lowest level of monthly household consumption expenditure.¹⁵

Stunting and food production

There is a significant positive linear relationship between the prevalence of stunting and the level of food production ($r = 0.43$, $p = 0.03$) i.e. the higher the level of food production the higher is the prevalence of stunting (Figure 1).

Stunting and average monthly household consumption Expenditure

The result indicated that there is a significant negative relationship between the prevalence of stunting and the average monthly consumption expenditure levels per household per month ($r = -0.48$, $p = 0.01$) i.e. the higher the average monthly household consumption expenditure, the higher is the prevalence of stunting (see Figure 2).

Table 1. Summary statistics of the variables (n = 26).

Variable	Mean/prevalence	Standard deviation
Stunting (overall prevalence)	33.5	8.8
Food production (metric tons)	977,544.8	434,201.7
Basic need poverty	27.6	9.0
Average monthly household consumption expenditure (TShs)	399,439.3 (USD 173.2)	93,700.4 (USD 40.6)
Average monthly household food consumption expenditure	47,986 (USD 20.8)	8,603 (USD 3.7)

Figure 1. Prevalence of stunting and food production in mainland regions of Tanzania.

Figure 2. Prevalence of stunting by average monthly household consumption expenditure in mainland regions of Tanzania.

Stunting and average monthly household food consumption expenditure

It was observed that there is a negative relationship between average monthly household food consumption expenditure and prevalence of stunting ($r = -0.509$, $p = 0.01$) (see Figure 3).

Relationship Between Stunting and Basic Need Poverty

The relationship between stunting and basic needs poverty indicated that Njombe, which is the region with the highest level of stunting in the country (53%), is the region with the third lowest level of poverty (13.2%), next to Kilimanjaro (8%) and Dar es Salaam (10.5%). The prevalence of basic need poverty in Njombe, Iringa and Songwe, with stunting levels above 40%, is lower compared to other regions. However, the level of poverty and stunting in Rukwaa and Geita do not show notable differences (see Figure 4). This trend is also observed for the regions with the lowest levels of stunting which are Kilimanjaro, Dar es Salaam and Morogoro (Figure 5).

Discussion

Findings show that regions with the highest food production had a high prevalence of stunting. This result concurs with the study done in Bukombe, Tanzania, which found that children from very low income households were more likely to be stunted compared to other occupations.¹⁷ This might be true because food-producing regions entail a great deal of work, often done by mothers in their small scale farms, and hence little time is given for them to take care of and feed, their

Figure 3. Stunting and average monthly household food consumption expenditure.

Figure 4. Stunting prevalence and basic need poverty among eight regions with highest prevalence of stunting in Tanzania Mainland.

Figure 5. Comparison of prevalence of stunting and basic need poverty in eight regions with lowest levels of basic need poverty.

children. This indicates that food security may not entail nutrition security. This may mean that very low income households spend the majority of their time on the farm, producing and consuming one type of food and are thus severely affected by seasonal household food security. Low income households may be food secure in the harvest season and food insecure in other seasons of the year while other occupations' household may buy their food and hence have more food diversity.^{17,18} However, these findings contrast other studies that have found households with food insecurity and small

cultivation size, were more affected by stunting, compared to those who are food secure and those with large cultivated areas.^{9,19}

Our study found that some regions like Njombe, which are among the regions with the lowest levels of poverty, have higher levels of stunting. The findings are contrary to several studies done on the determinants of stunting in developing countries across the globe, which shows that poverty is positively associated with stunting.^{9–11,20} The reason for this might be that mothers in regions like Njombe, are involved in several economic activities to earn their income.¹⁷ Due to this, they may have limited time with their children.^{17,18} In addition, labour laws in Tanzania, gives women only about three months' maternity leave.²¹ Therefore, due to mothers works in the farms or as employee in the government or private institutions they do not have enough time to breastfed their children, take them to hospitals and feed them accordingly.^{17,18}

In addition, the results of the study show that regions with higher monthly household consumption expenditure, had lower levels of stunting. This means that higher consumption means increased purchasing of a variety of foods, which reduces malnutrition. This finding concurs with a study done in Tanzania, which showed that families which were not dependent on farming their own food, bought a variety of food for their families, unlike those which produce their food.¹⁷

Conclusion and Recommendations

There has been the claim that higher food production regions in Tanzania paradoxically have a higher prevalence of stunting. However, no study was previously found to substantiate this at a national level. This study has found that the more the region produces food, the more likely it is to have higher levels of stunting. In addition, it has found that some regions with the lowest levels of poverty have higher levels of stunting. However, regions with higher monthly household consumption expenditure do not have higher levels of stunting. Therefore, this indicates that food production and a lower level of poverty, might not lead to nutrition security. This study provides a picture of the relationship between food production; consumption, poverty and stunting. However, it is based on secondary data aggregated from different sources. Therefore, it provides the foundation for further studies in this area. Similarly, this information can enlighten policymakers on rethinking how to make agriculture nutrition-sensitive, so that Tanzania can attain the Sustainable Development Goals (SDGs) goal of ending malnutrition in all its forms.²²

Limitations of the study

This study faced a few limitations, one of them being that the study used secondary data of which some of the variables were missing, limiting our analysis. Furthermore, data were aggregated at the regional level rather than individual level, which limited the interpretation of factors associated with malnutrition.

Data availability

Underlying data

Dryad: The Paradox of Food Production, Consumption, Poverty and Malnutrition in Tanzania

<https://doi.org/10.5061/dryad.gxd2547n9>

This project contains the following underlying data:

- Data_for_Regional_Stunting__Food_Production__Consumption_and_Poverty_Levels_-_Tanzania.xls

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

Acknowledgements

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Version 1

Reviewer Report 10 August 2022

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Nahomi Imaeda

Department of Nutrition, Shigakkan University, Aichi, Japan

Despite the need for epidemiological studies targeting developing countries, there are still few publications. In this context, an ecological study design that allows low-cost analysis would be beneficial. I read this paper with great interest.

Ecological studies cannot prove causality, but the author should choose appropriate parameters to clarify the relationship with the prevalence of stunting. The author describes it as a paradox that the food production value is positively correlated with stunting, but the indicators observed are not appropriate. The author should observe in more detail what food groups are produced. For example, the production of coffee beans would not be directly related to an increase in nutrient intake.

Furthermore, for mothers in Region Njombe, the author should show statistical data on longer hours of work in comparison with other areas.

In Figures 1-3:

- The graphs presenting the 26 regions should show approximate equations. In addition, for those regions that had large residuals from the equation, the reasons should be discussed.
- The figures should be drawn squares with numbers like [1], [2] - [26], indicating the name of the region, rather than a square black box, so that the stunting situation and economic situation in Tanzania can be understood.

Since most of the readers have unknown area names in Tanzania, I suppose that as possible as simple maps should be shown with transport infrastructure (road network or ocean ports). In this peer review, I was able to get some Tanzania information by the administrative regions of Tanzania map (referred [Tanzania National Nutrition Survey 2018.pdf, page 7, Figure 1](#)), or the Tanzania transport map (website: <https://www.tanzaniainvest.com/transport>). The figures of present paper did not provide enough information about regions in Tanzania.

In Figures 4 and 5, only 8 regions were observed, so the explanation is not sufficient.

The keyword "basic needs poverty" should be changed to "basic human needs" and "poverty"? or "basic needs poverty line"? And according to the PubMed Mesh, the keyword "**stunting**" is included in Growth Disorders. I recommend you refer to the PubMed Mesh to increase the number of web-search hits.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: public health, dietary surveys, nutritional epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 14 March 2022

<https://doi.org/10.5256/f1000research.78033.r123223>

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Joyce Kinabo

Department of Food Technology Nutrition and Consumer Sciences, College of Agriculture, Sokoine University of Agriculture, Morogoro, Tanzania

Commendation:

I would like to commend the authors for coming up with this paper in which they have attempted

to provide some answers about the paradox relationship between food production, stunting, expenditure, and poverty in Tanzania. They have correctly pointed out that high food producing regions are also leading in the prevalence of stunting.

Suggestion: change the title to read “the paradox of food production, expenditure, poverty, and stunting in Tanzania....” To reflect what is described in the paper.

Methodology:

- Sampling procedure for the Household Budget Survey and Tanzania National Nutrition Survey has been described but not for the agriculture statistics. The authors should explain how the data on agriculture production is collected. It would also be useful to indicate when these various surveys were carried out (date and month). This information has implications on the relationships of the variables and therefore interpretation of the results.
- Provide the definition of average consumption. The household budget survey presents proportion of food and non-food expenditures, it would be more logical to look into these categories and assess how they relate to stunting instead of just looking at the average expenditure and expenditure on food only. In addition, what are the kinds of foods that are accessed by households? Do they add to the diversity of nutritious foods?

Results:

- Add lines of fit on the correlation graphs (scatter plots) to assist the reader to get a clear picture of the relationship between the variables.
- Stunting and average monthly household consumption expenditure (AMHCE): the authors have stated that there was a significant negative relationship between stunting and AMHCE; but explained that as AMCHE increased, stunting also increased. Is this the meaning of a negative relationship? This area needs clarification.
- Stunting and AMHFCE: authors observed a negative relationship, but did not elaborate further on this relationship the way they have done for other relationships. There is a need for consistency.
- Stunting and basic need poverty: what is the basis of selecting only eight regions. It is better to present data for all regions to give the reader a full perspective of the data you have analysed and single out the eight regions in the description of the results. In the current analysis, the Njombe region should appear in both figures 4 and 5. However, it would also be interesting to identify regions that appear in both figures 4&5.
- It would also be more informative to present data on the relationship between stunting and monthly food and non food expenditures to show how the two types of expenditure contribute to stunting. Nevertheless, this is not a very strong indicator since it does not tell us what types of foods are purchased and consumed by children.

Discussion

- “This indicates that food security may not entail nutrition security” This is a statement in the discussion, but not explained fully. Authors should be cautious when using these terminologies. In this particular study, they assessed the relationship between food production or availability and stunting and not food security, which has four pillars. It would be better to say that food availability may not entail food consumption and related

outcomes; rather than using words such as food and nutrition security, which were not assessed in this study.

- Page 7 para 3 is more speculative and not supported by the available data. It should be revised to provide more information about expenditure and what kinds of foods are purchased and actually fed to children. It would also be more logical to consider other variables such as minimum acceptable diet (MAD) for children and household dietary diversity score (HDDS).

Conclusion:

- The authors have not been able to explain the paradox. The conclusion is the same as introduction. It was expected to get an explanation about the paradox and how that can be corrected.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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