Assessing the Relationship of Aflatoxin Exposure and Stunting in Children 6-59 Months of Age in 10 Districts of Nampula Province, Mozambique

Background

Tackling poor nutrition among children under five years in Mozambique is a policy priority for Mozambique. According to the latest Demographic and Health Survey (2011), 43% of Mozambican preschoolers were stunted. There was little change in levels of stunting in the previous decades, with rates of 49% in 1997, 50% in 2001, 47% in 2003, and 44% in 2008.[1] Nampula province has the highest provincial rate of stunting in the country, with a prevalence of 55% in children under five.[1] It also has the highest percentage (44%) of the country's poor,[2] with approximately 52% of households in Nampula concentrated in the lowest two nation-wide wealth quintiles.[1] It has been shown in several low income country settings that poverty is typically linked to poor quality diets, and that low diet quality is closely associated with undernutrition.[3] Diet quality involves adequate calories and a diversity of nutrients, but it also requires food to be safe from all forms of toxins.

Aflatoxins are mycotoxins, a colorless and odorless toxin produced by the mold *Aspergillus*. These molds contaminate staple crops such as maize, groundnuts, and cassava before, during, and after harvest. Aflatoxins are known to cause liver cancer and may be associated with stunting.[4] Aflatoxin contamination may impair nutrient absorption, particularly of key nutrients like iron and protein that are critical for normal growth and development of children.[4] It has been recently documented in Uganda and Nepal that high levels of aflatoxin carried in the diet can lead to poor birth outcomes and also to linear growth retardation (stunting) among infants.[5,6]

Study Rationale

Given the rates of stunting in Nampula, the lack of change in levels, and that the population is highly dependent on staple crops that are likely to be contaminated, there was a need to assess the relationship of aflatoxins and stunting in children under five years of age.

Methods

A cross-sectional study to assess the relationship of aflatoxin and stunting in children under five years of age in Nampula province was conducted. This study was supported by USAID Mozambique through the USAID Feed the Future Innovation Lab for Nutrition.

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[2] USAID. (2011). *Mozambique: FY 2011–2015 Multi-Year Strategy* (p. 52). USAID, Mozambique.
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[4] IFPRI/BMGF. (n.d.). Aflatoxin: Impact on Stunting in Children and Interventions to Reduce Exposure. Co-organized by International Food Policy Research Institute and the Enteric and Diarrheal Diseases, Agriculture and Nutrition.
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The objectives of the study were as follows:

1) Determine the levels of aflatoxin in the blood in two groups of children:
    a) Infants and young children aged 6 to 23 months (under 2 years of age)
    b) Children aged 24 to 59 months of age (2 to 5 years of age)
2) Examine differences in aflatoxin levels by age group
3) Describe linear growth and stunting by age group
4) Enumerate the association between aflatoxin and linear growth adjusting for confounders

Data collection was conducted from November to December 2018 in 10 districts in Nampula province: Angoche, Larde, Malema, Meconta, Mecuburi, Mogovolas, Moma, Monapo, Murrupula, and Rapale.[7] Data were collected on child and maternal health status, diets, food security, household variables, socio-economic status, agriculture, and food processing practices. Anthropometry measurements of children and biological mothers were taken, in addition to a finger prick to test for anemia and malaria, and a venous blood draw to test aflatoxin levels. Aflatoxin levels in serum were assessed at the University of Georgia.

The final sample size was 989 households, with a total of 890 complete child data points (311 children 6 to 23 months and 678 children 24 to 59 months of age).

Aflatoxin Results

Aflatoxin (serum AFB1-lysine adducts in pg/mg albumin) was detected in 89.7% of the serum samples (Figure 1). The arithmetic mean ± SD aflatoxin concentration was 7.7 ± 25.6 pg/mg albumin while the geometric mean was 2.2 pg/mg albumin (95% CI: 2.0, 2.5 pg/mg albumin). The highest concentration was 401.7 pg/mg albumin and the median was 2.4 pg/mg albumin.

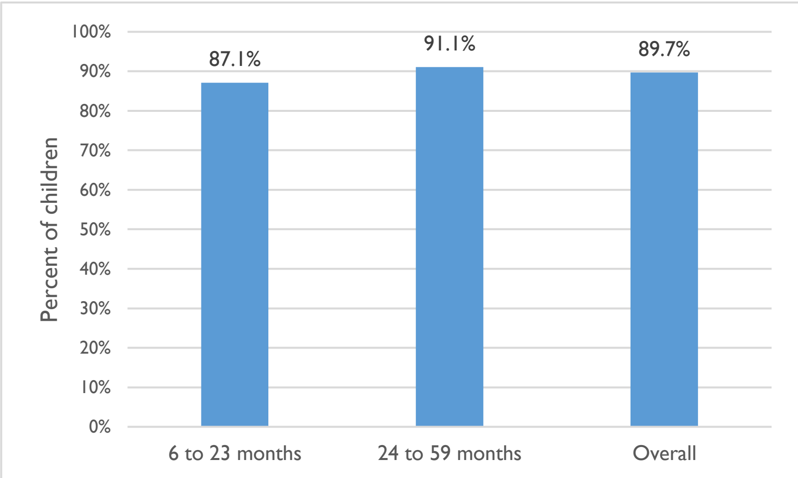

Figure 1. Detection rates of aflatoxin by age group

[7] These districts were identified as priority districts by the Feed the Future initiative in Mozambique.

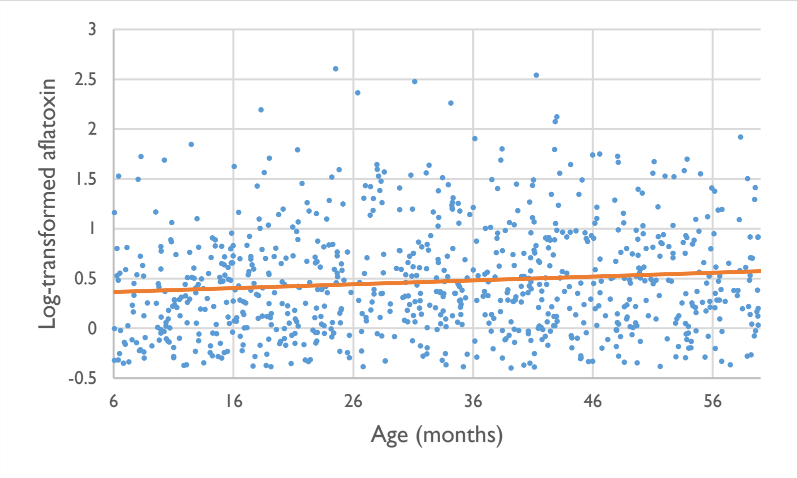

Figure 2. Log-transformed aflatoxin levels by age

Difference in Aflatoxin by Age

A linear trend was observed in log-transformed AFB1 by child's age in months, as seen in Figure 2. Furthermore, the 6 to 23 month age group had significantly lower levels of aflatoxin exposure than the 24 to 59 month age group. Statistical analyses showed significant differences in median AFB1 levels ($p<0.0001$) and mean log-transformed AFB1 ($p<0.0001$) between children in the two age groups.

Stunting and Linear Growth

Overall, the prevalence of stunting was 48%. At 56%, the prevalence of stunting was much higher in the 24 to 59 month age group compared to the 6 to 23 month age group (34%) (Figure 3). Similarly, height-/length-for-age z-scores (HAZ) were significantly lower for children in the 24 to 59 month age group (Figure 4).

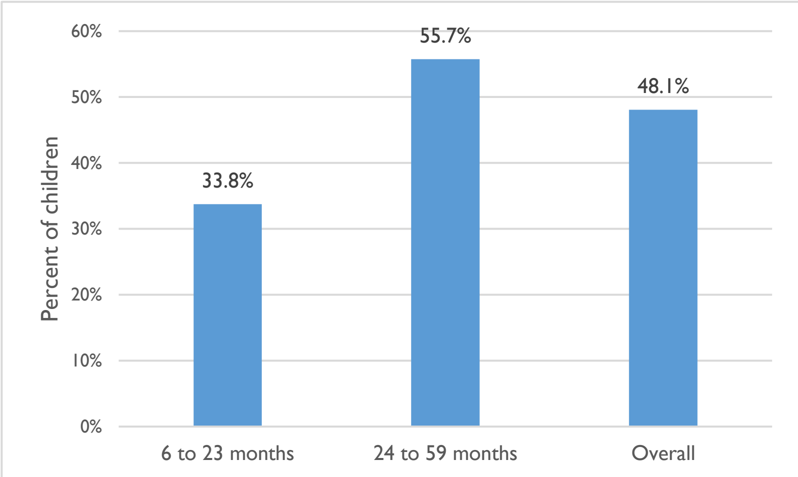

Figure 3. Stunting prevalence by age group

Association between Stunting and Aflatoxin Levels

There is a significant and negative association between child growth and serum aflatoxin after adjusting for other parameters, including the child's weight-for-length/height (WHZ), age, sex, anemia status, and any detectable levels of

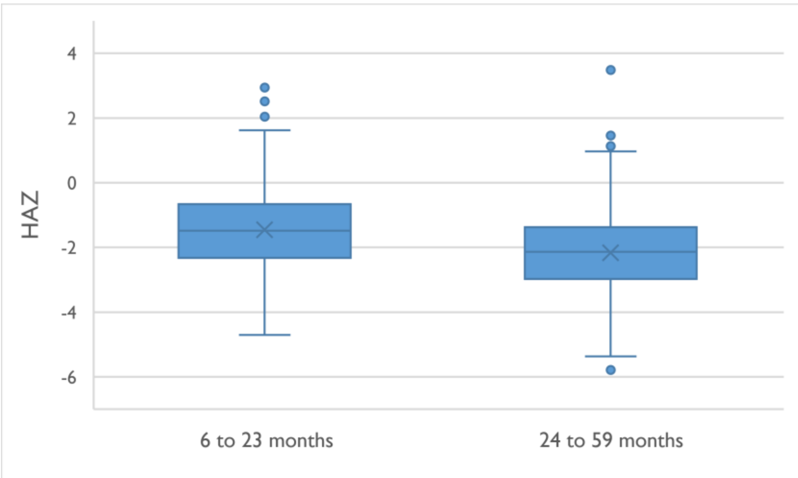

Figure 4. HAZ by age group

aflatoxin.[8] For every one unit increase in logged aflatoxin level standardized by child's weight, a child is 60% more likely to be stunted (logistic regression findings).[9,10]

There was similarly a significant and negative association between HAZ and aflatoxin level (linear regression analysis findings). In other words, a strong statistically significant association was found between stunting and levels of dietary aflatoxin exposure across Nampula province.

Conclusion

This study used an intentionally designed household survey to assess the association between serum AFB1-lysine adduct concentrations in children's blood and their linear growth. The analysis shows a significant association between stunting and aflatoxin exposure. The high prevalence of aflatoxin exposure in children (89.7%) represents a public health concern that will require remediating actions across a range of sectors, including agriculture, trade, and public health. This study confirms widespread exposure to aflatoxin, and our findings add to the growing body of evidence showing a link between aflatoxin exposure and negative growth outcomes in children.

Study Collaborators

To achieve these objectives, the Nutrition Innovation Lab worked closely with USAID/Mozambique and members of government and non-governmental institutions, including the Mozambican National Institute for Health, the Mozambican National Institute for Statistics, the University of Lúrio in Nampula province, the Association for Food and Nutrition Security (ANSA), and the Central Hospital of Nampula. The study team interacted with the provincial and district level health officials and all clinical data were collected at health facilities under the supervision of district health officials.

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[8] Detectable levels are those above 0.4 pg/mg albumin. 10% of the sample had levels less than detectable and were included in the analysis.
[9] Multi-variable logistic regression adjusted for clustering and child sample weights. Covariates are child's WHZ, age, age^2, sex, and detectable AFB1 dummy.
[10] Two sets of multi-variate logistic and linear models were analyzed. The first included only children with detectable AFB1-lysine adduct concentrations, and the second set included children with detectable and undetectable AFB1-lysine adduct concentrations, along with a "detectable AFB1" dummy variable. The multi-variate models were analyzed with and without a variable to control for the child's anemia status. All models control for the child's WHZ, child's age in months, child's age^2 (months^2), and child's sex. All models produced the same significant and negative association between AFB1-lysine adduct concentrations and HAZ or stunting.