Dietary aflatoxin exposure and impaired growth in young children from Benin and Togo: cross sectional study

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Fetal and early childhood environment, including the nutritional status of the pregnant mother and the infant, are considered critical for growth and risk of disease in later life. Many people in developing countries are not only malnourished but also chronically exposed to high levels of toxic fungal metabolites (mycotoxins). One family of mycotoxins, the aflatoxins, are carcinogenic and immunotoxic and cause growth retardation in animals. Aflatoxins contaminate staple foods in West Africa, particularly maize and groundnuts, as a result of hot, humid storage conditions that promote fungal growth. High exposure to aflatoxins occurs throughout childhood in the region, suggesting that growth and development could be critically affected. We assessed exposure to aflatoxins in relation to anthropometric measures in children in Benin and Togo.

Methods and results

We studied 480 children (aged 9 months to 5 years) from 16 villages in four geographic zones (four in each zone): Sudan savannah, north Guinea savannah, south Guinea savannah, and coastal savannah. The Ministries for Health in Benin and Togo gave ethical approval, and parents gave informed consent. We determined...
Aflatoxin-albumin concentration (trend test: F = 15.19, P = 0.0001, \( r^2 = 0.3766 \); and F = 8.48, P = 0.0038, \( r^2 = 0.3680 \)).

Concentrations of aflatoxin-albumin adduct categorised into four groups for height for age and weight for age z scores on the basis of the WHO classification of malnutrition (z score \( \leq 2 \)) and severe malnutrition (\( < -3 \)). Geometric mean adduct concentrations are shown, with 95% confidence intervals, adjusted for weaning status, agro-ecological zone, and socioeconomic status. Height for age and weight for age z scores were significantly associated with aflatoxin-albumin concentration (trend test: F = 15.19, P = 0.0001, \( r^2 = 0.3766 \); and F = 8.48, P = 0.0038, \( r^2 = 0.3680 \)).

We detected aflatoxin-albumin adducts in 475/479 (99%) samples (one sample missing), with a geometric mean concentration of 32.8 (range 5-1064) pg/mg albumin. Aflatoxin-albumin concentration increased with age up to 3 years, after which it reached a plateau. In the 302 children aged 3 years or under, the mean concentration was 2.5-fold higher in fully weaned children (45.6 pg/mg; 95% confidence interval 38.8 to 53.7) than in those still partially breast fed (18.0 pg/mg; 15.2 to 21.3). In a multivariable model adjusting for age, sex, socioeconomic status, and agro-ecological zone, weaning status was significantly associated with aflatoxin-albumin concentration (P = 0.0001).

Prevalence of malnutrition was 33% for stunting (height for age z score \( \leq 2 \)), 29% for being underweight (weight for age z score \( \leq 2 \)), and 6% for wasting (weight for height z score \( \leq 2 \)). Children with stunting or who were underweight had 30-40% higher mean aflatoxin-albumin concentrations. After adjustment as above, the negative correlation between individual aflatoxin-albumin concentration and each of the three growth parameters was highly significant (P = 0.001 for height for age, P = 0.005 for weight for age, and P = 0.047 for weight for height). In a categorical analysis, the association with aflatoxin-albumin concentration was again significant, with clear dose-response relations with height for age and weight for age z scores (figure).

Comment

This study reveals a striking association between exposure to aflatoxin in children and both stunting (a reflection of chronic malnutrition) and being underweight (an indicator of acute malnutrition). In West Africa, people are chronically exposed to high levels of aflatoxins starting in utero and continuing throughout life. In this study, children still partially breast fed had lower exposure, almost certainly reflecting lower toxin levels in milk than in weaning and family foods. Thus growth faltering occurs at a time of change to solid foods, when there is co-exposure to aflatoxin and a plethora of infectious hazards (for example, malaria, diarrhoea, respiratory infections). Whether the association between aflatoxin exposure and impaired growth is a direct result of aflatoxin toxicity or reflects consumption of fungus-affected food of poor nutritional quality cannot be confirmed from the cross sectional design. However, these observations emphasise the need to investigate this question and to develop strategies to reduce exposure to aflatoxin, possibly involving interventions targeted at the post-weaning period in African children.

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Contributors: YYG, KC, AH, PCT, AJH, and CPW were all responsible for the design of the study. KC, AH, SE, and AJH took part in the fieldwork; YYG, PCT, and CPW were responsible for the laboratory analysis. YYG and SE computed the data and conducted the statistical analysis. All authors contributed to writing the manuscript. CPW is guarantor for the paper.

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