INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

PROJECT NOTE 02 | NOVEMBER 2014

MITIGATING AFLATOXIN EXPOSURE TO IMPROVE CHILD GROWTH IN EASTERN KENYA

MTID PROJECT SPOTLIGHT

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An estimated 165 million children worldwide under age five have stunted growth (Black et al., 2013). Growth retardation in young children is associated with delays in cognitive development, lower school achievement, and lower earnings in adulthood. Data from the 2008-2009 Demographic and Health Survey in Kenya suggest that 35 percent of children under age five in Kenya are stunted. What is intriguing is that the same data show that the former Eastern Province of Kenya has less poverty and lower prevalence of childhood illness than five of the other seven provinces in the country (KNBS and ICF Macro, 2010), yet stunting in this region is 20% higher than the national average. This suggests factors beyond poverty and illness are in affecting child growth here.

Eastern Kenya is recognized as a hotspot for aflatoxin exposure. A naturally occurring by-product of certain species of the Aspergillus fungi, which can thrive on staple crops such as maize if not properly dried and stored, aflatoxin is a known carcinogen and fatal to humans in large doses. Acute exposure can lead to liver disease, liver failure, and death from aflatoxicosis (Kensler et al., 2010). Outbreaks of acute aflatoxicosis were reported in this region in 1981, 2004, 2005, and 2006, with widespread contamination reported in 2010 (Ngindu et al., 1982; Nyikal et al., 2004; Azziz-Baumgartner, 2005; Daniel et al., 2011; BBC, 2010). Aflatoxin itself is colorless and odorless and can only be detected through specific testing for its presence. In addition, the observable presence of the Aspergillus fungus does not necessarily mean that there is aflatoxin, while the apparent absence of fungal growth cannot be taken as an indication that there is no aflatoxin. Meanwhile, testing for aflatoxin in most countries in Africa remains largely limited to crops produced for export markets and crops sourced for food aid. Testing is currently expensive for most stakeholders, though efforts are being made to develop cheaper testing methods. Currently, testing in local markets and in maize and groundnuts produced for home consumption is almost non-existent.

A growing literature has highlighted an association between aflatoxin exposure and child growth; but since none of the studies used a controlled intervention methodology, it is not clear if the association between aflatoxin and child linear growth was confounded by factors such as household socioeconomic status, child illness and dietary intake (Leroy, 2013). **The objective of this study is to establish whether a causal relationship between aflatoxin exposure and linear child growth exists.** The hypothesized direct pathway is a biological one: human and animal studies indicate that aflatoxin causes immunosuppression (which in turn can lead to repeated infections and, consequently, growth retardation in young children); it also impairs protein synthesis, and causes changes the hepatic metabolism of micronutrients (Khlangwiset, Shephard, and Wu, 2011). In addition, chronic systemic immune activation and malabsorption of nutrients are hypothesized as possible outcomes of consuming aflatoxin combined with other mycotoxins commonly found in maize and groundnuts. The present study is designed to detect a biological impact that is distinct from any potential indirect economic impact that may result from post-harvest losses or quality deterioration due to fungal growth; confirmation of the exact biological pathway through which aflatoxin affects child growth, if this study establishes a causal relationship, will depend on further research.

PROJECT APPROACH

For this study, households are randomly assigned to a treatment group with reduced exposure to aflatoxin, keeping constant income, food availability, and other factors affecting linear growth in children. Exposure in this group is achieved through two parallel interventions, implemented by Caritas Kenya under contract to IFPRI:

1. Monthly swapping visits, during which maize stored by the household is tested and replaced with aflatoxin-safe (<10 ppb) maize if found to contain in excess of 10 ppb aflatoxin. Households are visited at least bi-monthly by trained Caritas staff and offered rapid aflatoxin testing of any stored maize that the household plans to consume over the next two months. A sample of maize is taken from the identified maize and an aflatoxin test is then conducted on the spot. Households are provided with tested maize meeting the regulatory standard ("aflatoxin-safe" maize) in compensation for the maize used in testing, and any maize found to contain over 10 ppb aflatoxin is replaced with an equal amount of aflatoxin-safe maize.

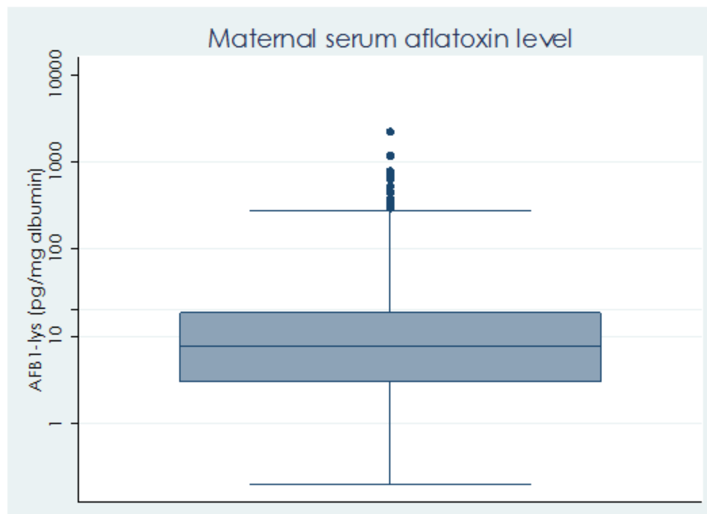
2. Stocking of a local shopkeeper (stockist) with a supply of whole maize grains and flour, which has been tested for aflatoxin and found to be below the regulatory limit of 10 ppb. Study households are encouraged to purchase tested, aflatoxin-safe maize from the village stockist. The tested maize is offered at the current market price of maize in the village. If multiple brands of flour are available, tested flour is offered at the price of the least expensive brand.

Both treatment group and control group households receive identical information on the causes and health consequences of aflatoxin contamination, as well as recommendations on post-harvest practices to reduce the chance of contamination.

Based on dietary analysis using data collected at baseline (Table 1), we estimate that 95% of dietary aflatoxin exposure in the study population is through maize.

Based on the current evidence, the largest impact of aflatoxin exposure on child height for age (the main measure of nutritional status) is expected to be observed in children who have been exposed to lower levels of aflatoxin from early pregnancy up to 24 months of age. The study focuses on children in the last trimester of gestation to 24 months of age, with women enrolling in the study between the fifth and final month of pregnancy. Growth faltering occurs primarily during this period (Victora et al., 2010), and the greatest benefits of nutritional interventions are seen at the youngest ages (Burger, 1993; Schroeder et al, 1995; Rivera and Habicht, 1996, 2002). Two years after enrollment in the study, blood samples will collected from all mothers and children as well as anthropometric information for each study child.

Figure 1: Maternal serum aflatoxin level



Even though aflatoxin contamination of maize was relatively low during the first year of the study, aflatoxin was found in the blood of all of participants tested at the baseline (Figure 1). Median serum aflatoxin level was 7.8 pg/mg albumin (mean: 26.3 pg/mg albumin). Those levels of exposure

Table 1: Estimated dietary aflatoxin by source

	Grams / adult equivalent / day	Aflatoxin contamination (ppb)	Estimated % of dietary aflatoxin	Source of contamination estimate
Maize, all sources	196.2	24.20	92.8%	IFPRI data, maize all sources
Sorghum grain or flour	17.1	13.66	5%	Mpuchane et al. (1997)
Groundnut	2.40	50.18	2%	Ndung'u et al. (2013)
Milk	173.50	0.095	0%	Lindahl and Grace (pers. comm.)
Sample size	508			

were comparable with those observed in other populations for which a strong association between aflatoxin exposure and impaired child growth has been shown.

EXPECTED IMPACT

Survey data collected at the time of study enrollment indicate that farmers in the study area have a high level of awareness that problems can arise from inadequate drying of maize, though they may not be able to name or define aflatoxin specifically. Most farmers take measures to avoid fungal damage to their grain. Despite this, many believe their stored maize could be contaminated with aflatoxin. This explains the high level of demand observed for both the maize testing and swapping service, and for the aflatoxin-tested maize products available through stockists in treatment villages. Based on monitoring data from 2014, the swapping service is currently offered to 90% of treatment households at least once every two months. However, over the first year of the intervention, 40% of the households had no maize in store when the service was offered each month due to a poor harvest. On the other hand, treatment households purchased 65% of maize flour from aflatoxin-safe stockists during the first few months this component of the intervention was offered.

Based on previous studies, dietary aflatoxin exposure in the treatment group would need to be reduced by at least 35% for an impact on child growth to be detectable. This means exposure through maize would need to be reduced by at least 37%. Preliminary calculations of impact show that the intervention is achieving a reduction in aflatoxin exposure of *fifty percent* for the treatment group. This study will provide the first experimental evidence of the impact of aflatoxin exposure on child growth. Whether or not a relationship is found, the results will have implications for the prioritization of aflatoxin testing and mitigation efforts by governments in affected regions as well as international donors.

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