# Does Exposure to Aflatoxin Constrain Efforts to Reduce Stunting in Zambia?

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**Abstract** On 8 June 2013, the Vice President of Zambia stated that his government 'is fully committed to reducing chronic undernutrition by 50 per cent in the next ten years…' What are the challenges to meeting this goal? Zambia has both a high consumption of groundnuts and high levels of aflatoxin contamination of this commodity. Recent studies indicate an association between stunting and aflatoxin exposure. If the association exists, then Zambia faces serious challenges to reaching its target of 50 per cent reduction in chronic undernutrition. Recent efforts to identify atoxigenic strains for biocontrol in maize and groundnuts give cause for cautious optimism. Nonetheless, the challenges ahead demand both a high level of political will to achieve effective multisectoral collaboration and the willingness of the agricultural and health sectors to undertake rigorous monitoring of aflatoxin contamination and growth of young children, as well as the agricultural sector's commitment to reduce substantially levels of aflatoxin contamination and to promote agricultural diversification.

## 1 Introduction

The prevalence of chronic malnutrition (stunting) in Zambian children is very high: 45 per cent among children under five years of age (ZDHS 2009). On 8 June 2013, the Vice President of Zambia stated that his 'government is fully committed to reducing chronic undernutrition by 50 per cent in the next ten years…'.[1] Is this achievable? What are the challenges to meeting this goal?

The consequences of chronic malnutrition during childhood have serious implications for national development. A child that suffers early linear growth retardation is likely to suffer also from poor cognitive development and poor performance at school. Poor school achievement can lead to a lowered ability to earn an adequate income. A short child is likely to become a short adult, with reduced physical productivity and, in women, a greater risk of poor pregnancy outcomes, including low birth weight babies. Moreover, an adult who is short because of nutritional insults experienced during foetal or early childhood is at greater risk of obesity, coronary heart disease, diabetes and hypertension, especially when exposed to relative affluence later in life (Barker 1997). This has major implications for the cost of health care in countries undergoing economic transition.

Data on the length of newborns in Zambia are sparse. However, while the prevalence of stunting is highest among children aged 18–23 months, it is notable that 18 per cent of children under six months are already chronically malnourished (ZDHS 2009). This suggests that linear growth retardation is likely to have occurred either during pregnancy or during early infancy, or both.

A high prevalence of chronic malnutrition is linked to poor nutrition and high morbidity. Hence interventions focused on improving child feeding practices, increasing access to a more diverse weaning diet, and improving hygiene practices and access to health care are of paramount importance. But there is now growing interest in the link between stunting and exposure to aflatoxin. It seems that even with full coverage of a wide range of health and nutrition interventions, only 36 per cent reduction in stunting is achievable (IFPRI and BMGF 2012). In Zambia, with its high consumption of maize and groundnuts, a significant proportion of the remaining 64 per cent may be attributed to the impact of exposure to aflatoxin-contaminated foods.

This article discusses: (1) findings of studies linking aflatoxin exposure to linear growth retardation in young children; (2) aflatoxin contamination levels in maize and groundnuts in Zambia, and mitigation strategies; and (3) the need for a multisectoral approach in order to reduce aflatoxin exposure, improve diet diversity and reduce the prevalence of stunting among Zambian children.

## 2 Aflatoxins and malnutrition

Aflatoxins are fungal metabolites, and toxic contaminants of a wide range of food crops. In Africa generally, and in Zambia especially, key dietary crops at risk of contamination, largely as a result of climatic conditions and poor storage practices, are maize and groundnuts. The role of aflatoxins as potent inducers of liver cancer and as causative agents of impairment of the immune system is well established (Wild and Gong 2010).

Studies from the early 1970s established the association between aflatoxin exposure and growth impairment in animals (Khlangwiset, Shephard and Wu 2011). Beginning in the early 1980s, a number of small studies investigated links between kwashiorkor (a form of severe malnutrition) and aflatoxin exposure in young children (Lamplugh and Hendrickse 1982; Oyelami *et al*. 1997; Khlangwiset *et al*. 2011). These studies concluded that while a link existed, it was likely that impaired liver function in children with

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kwashiorkor led to differences in how aflatoxins were metabolised, rather than the aflatoxins themselves causing kwashiorkor (Lamplugh and Hendrickse 1982).

More recently, studies from Africa and the Middle East have strongly suggested a close link between exposure to aflatoxins and growth impairment in neonates and young children (Gong *et al*. 2002, 2003, 2004; De Vries, Maxwell and Hendrickse1989; Abdulrazzaq *et al*. 2003, 2004). Aflatoxins have been detected in maternal blood, cord blood and breast milk, and associations have been demonstrated with birth weights and birth lengths.

In Kenya, aflatoxins were found in the blood of more than half the mothers studied, and the mean birth weight of the infants born to these mothers was significantly lower than that of infants born to non-contaminated mothers (De Vries *et al*. 1989). In Benin and Togo, aflatoxins were detected in the blood of almost all study children (aged 9–60 months), with the level of contaminant showing regional variation (Gong *et al*. 2003; 2004). In these studies, blood aflatoxin levels rose significantly up to the age of three years, were higher in children who had stopped breastfeeding, and were correlated with maize consumption but not with groundnut consumption. There was a strong dose-response relationship between blood contamination levels and the degree of stunting. Stunted children (with height-for-age z-scores less than -2 SD below the median reference value) had 30–40 per cent higher contamination levels than non-stunted children.

In summary, recent studies, mostly from Africa and the Middle East, suggest that children's exposure to aflatoxins can be high during pregnancy from maternal exposure, followed by exposure in infancy and early childhood through contaminated breast milk and complementary foods. While a causal link between aflatoxin exposure and stunting has not yet been fully established, a strong association between the two conditions seems very likely. Further studies are needed to investigate more fully the nature and mechanism of the association, but there is sufficient evidence to indicate the need for appropriate interventions.

## 3 Aflatoxin contamination and mitigation in Zambia

Research on aflatoxin contamination of food commodities started around the 1970s with variable levels reported, ranging from 0ppb to >900ppb in maize (Marasas *et al*. 1977; Njapau, Muzungaile and Changa1998; Kankolongo *et al*. 2009; Mukanga *et al*. 2010). Currently, under the US Agency for International Development (USAID) Feed the Future aflatoxin mitigation project, the International Institute of Tropical Agriculture (IITA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in partnership with other stakeholders are undertaking research on monitoring and mapping the prevalence of aflatoxins in maize and groundnuts in Eastern Province, Zambia. Preliminary results indicate that aflatoxin contamination of maize at harvest is low, ranging from 0–11ppb with 99 per cent of maize samples having aflatoxin levels below the acceptable international standard of 4ppb. However, aflatoxin levels were higher in samples that had been stored for up to three months, and varied with the types and conditions of storage and storage facilities. Nevertheless, the exposure of people is likely to be high in spite of the low contamination levels found in maize in a single year sampling. This is because maize consumption is substantial in most parts of Zambia (121–140g maize/person/day) leading to high exposure despite low contamination levels.

The situation with groundnuts, however, is more serious. Levels of contamination of groundnuts are much higher: in peanut butter samples from supermarkets a mean of 53ppb were found as compared to a mean of 12ppb in grain samples from local markets (ICRISAT n.d.). Levels as high as 1,000ppb have been found in peanut butter, while levels up to 5,350ppb were observed in peanut samples collected at harvest (IITA n.d.). Again, in most cases the contamination levels found in the pre-harvest groundnut samples tend to rise during storage. Sorting of groundnuts to identify and reject bad nuts can reduce human exposure to aflatoxins, but the discarded nuts are often fed to chickens and other animals, thus re-entering the food chain. Moreover, in poorer households these non-marketable nuts may be consumed by the family.

Clearly, aflatoxin contamination of maize and groundnuts has wide-ranging national and household-level economic and food security implications for Zambia, in addition to its implications for health and nutrition. Standards for permissible aflatoxin levels vary across countries, regions and food commodities. Those imposed in Europe, the most important region for exports for many African countries, are among the most stringent (Wu *et al*. 2011). A World Bank study estimated that application of the European standards costs Africa US$750 million each year (Fapohunda 2009). Efforts to reduce contamination are thus important for a number of reasons.

Trials are under way, in Zambia and elsewhere, to search for optimal approaches to mitigation. These include better cropping and harvesting practices, improved storage facilities, sorting (of groundnuts) in conjunction with public education (regarding disposal of rejected nuts), rigorous application of the accepted standard of contamination by international and local commercial markets, switching to resistant varieties, and detoxification of foods (Waliyar *et al*. 2013). The use of aflatoxin biocontrol agents is an approach that has considerable potential. Biocontrol technology uses the ability of native atoxigenic strains to outcompete aflatoxin-producing strains (Bandyopadhyay and Cotty 2013). Further research is needed into the potential of crop rotation in aflatoxin control (ICRISAT n.d.).

Groundnuts are an important source of protein and a number of vitamins and minerals for children in Zambia. In 2007 (ZDHS 2009), for example, 40.5 per cent of children aged 6–23 months had consumed groundnuts on the day before the survey. Asking mothers to withhold groundnuts from their children's diets is therefore not an acceptable solution nutritionally, unless we are able to offer an appropriate alternative commodity that is equally nutritious and low in cost.

While a causal link between exposure to aflatoxins and foetal, infant and young child linear growth retardation has not been fully established, there is enough evidence of an association to propose the need for appropriate action. Moreover, interventions to improve young child feeding practices, especially by increasing access to a more diverse diet for complementary feeding, can also make an important contribution to reducing stunting. Such actions demand the close collaboration of, at the very least, the agricultural and health sectors.

If even universal coverage of a comprehensive package of health and nutrition interventions can only achieve a 36 per cent reduction in the prevalence of stunting, then clearly Zambia's target of a 50 per cent reduction will not be achieved by 2023 (IFPRI and BMGF 2012). Can agriculture help us to reach the target, by reducing exposure to aflatoxins and by improving access to a more diverse diet for complementary feeding?

The current situation of Zambia in relation to nutrition is mixed. On the one hand, nutrition in general, and the challenge of stunting in particular, is enjoying unprecedented attention from donors and from the government. An early signatory to the Scaling Up Nutrition initiative, Zambia is currently implementing the First 1000 Most Critical Days Programme. At the recent Nutrition for Growth Event in the UK in 2013, the Vice President of Zambia pledged to:

- Reduce stunting by 50 per cent by 2023;
- Resolve human resource and financial gaps in key line ministries;
- Increase government expenditure on nutrition to reach the estimated US$30 per child under five;
- Encourage private sector involvement to enable access to affordable and appropriate nutritious foods; and
- Strengthen the governance and coordination mechanisms of the nutrition sector by direct oversight of progress by the Vice President's office – and strengthen line ministries' and the National Food and Nutrition Commission's functioning and accountability.[2]

However, important though these public pronouncements are, Zambia's human resources available to implement national nutrition programmes and policies are woefully inadequate. And this inadequacy may ultimately be the single most important constraint to successful multisectoral collaboration and nutrition interventions.

There are two important recent initiatives in relation to human resources for nutrition. Firstly, the UK's Department for International Development (DFID) has recently funded a nutrition workforce planning consultancy, an action welcomed by relevant government officials. The report of the consultancy will provide up-to-date figures on nutritionists in Zambia, their levels of training and their tasks. Hopefully, this will be seen as an opportunity to rationalise the roles and qualifications of nutritionists, and raise the profile of nutrition in Zambia.

Secondly, in 2011, the University of Zambia began the BSc in Human Nutrition, the first degree level programme in human nutrition in Zambia. The University is also preparing to offer an MSc in Human Nutrition. Both the BSc and the planned MSc demand considerable financial support and commitment from donors and from the University itself in order to become fully established and sustainable.

A recent review of the readiness of Zambia to move forward with significant efforts to address its food and nutrition problems, states that:

> Zambia is an ideal candidate for a country that could make a significant impact on its malnutrition problem. With the emergence of the Scaling Up Nutrition (SUN) movement in the country, nutrition has received some high-level political attention, and the multisectoral nature of nutrition is recognised in overarching development policies and strategies. However, political attention has not moved into concrete action, and nutrition strategies, policies, and plans are essentially wish lists noting best practice, confined mainly to the health sector, created with substantial input from external actors, and without the backing of political commitment, budgetary or human resources, or capacity; implementation of these grand ideas is severely lacking (Harris and Drimie 2012).

## 4 Reducing exposure to aflatoxins and reducing stunting in Zambia: a holistic approach?

Turning back to the question of aflatoxin contamination of groundnuts and maize, and its likely impact on child growth, we need to consider how Zambia can effectively address the issue. The first requirement is that the health and agriculture sectors accept the recent findings of aflatoxin levels in maize and groundnuts in Zambia, and the likely association between aflatoxin contamination and stunting demonstrated in other countries. Certainly confirmation of these findings in Zambia is an important area of further research, as are other research areas such as exposure assessments and pilot studies to assess whether reducing aflatoxin exposure can indeed prevent stunting. We need also to further test ways to reduce the aflatoxin contamination, so as to identify the most cost-effective strategies.

Ultimately though, if we are to achieve a significant impact on childhood malnutrition, we need a holistic approach, an approach that brings together a range of relevant interventions, not all of which concern aflatoxin contamination:

- Reducing the level of aflatoxin contamination of maize and groundnuts;
- Updating legislation that controls the level of permissible contamination of groundnut and maize products in the commercial markets, and strong enforcement of such legislation;
- Conducting public awareness and education campaigns to improve compliance with recommendations for reducing aflatoxin contamination, improving child nutrition and reducing morbidity.

In addition to aflatoxin control, if stunting levels are to be significantly reduced, it will be vital to address the other underlying determinants of stunting:

- Improving economic and physical access to a more diverse diet, especially by poorer households;
- Improved breastfeeding and child feeding practices;
- Improving water supplies and sanitation, and upgrading programmes to reduce morbidity.

Another important component of any holistic approach is the rigorous monitoring and impact evaluation of the interventions. The Ministry of Agriculture and Livestock must undertake to test aflatoxin levels in pre-harvest and post-harvest groundnut samples and products on a regular basis, and the Ministry of Health and the Ministry of Community Development and Maternal and Child Health must adequately monitor the growth of children. Currently, Zambia's growth monitoring programme measures only the weights of children. Difficult as it may be, the programme must be expanded to include the measurement of lengths and heights. Concerns with aflatoxin contamination aside, it is unacceptable that in a country which claims to want to halve its seriously high level of stunting, stunting is not even recognised as a condition requiring attention by health staff in district health centres. By measuring only weight, health staff are failing to recognise the onset of stunting and may be offering inappropriate advice to mothers. Stunting is irreversible; it needs to be recognised early and prevented, not treated.

The holistic approach described above is daunting for a country facing the major human resource constraints that challenge Zambia. It requires serious commitment by the agriculture, health and education sectors to achieve the essential collaboration. A substantial number of nutrition projects or nutrition-sensitive health and agricultural projects are under way, mostly conducted by non-governmental organisations (NGOs) or international agencies. One approach would be to add components to these existing intervention projects to achieve the desired holistic approach. Another possibility, a phased approach in selected districts and provinces, is strongly recommended, with intersectoral collaboration promoted at community and district levels, and not just at national levels. In line with this approach, DFID is supporting the development of multisectoral nutrition plans in the 14 first phase districts of Zambia's Scaling Up Nutrition First 1000 Most Critical Days Programme.

However the reduction of exposure to aflatoxins and the reduction in the prevalence of stunting are to be achieved, efforts must be accompanied by substantial investment in capacity building at all levels. Access by all Zambians to a nutritionally adequate and safe food supply is a human right, and an essential prerequisite for successful and equitable national development.

**Notes**

1 Nutrition for Growth Event held in 2013, hosted by DFID, the Government of Brazil, and the Children's Investment Fund Foundation.

2 *Ibid*.

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