

Review Article

**Ignored Aetiologic Factors of Growth Faltering/Stunting In
Sierra Leonean Children: Aflatoxin and Ochratoxin A**

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ABSTRACT

Growth stunting is a major burden in developing countries, affecting ~147 million children. In Sierra Leone, 40% of children are known to be stunted. Several factors, especially the incidence of diarrhoeal diseases and the socio-economic status of these children have been cited as contributing factors to stunting. Until recently, the role of aflatoxins as a causative agent of stunting was never explored.

Recent studies carried out in Benin, Togo and The Gambia have implicated aflatoxin in the aetiology of stunting/growth faltering in children. Studies carried out in the Southern province (Bo and Njala) have demonstrated that children not only have a high frequency of detection of aflatoxins but in some instances very high levels too, in the various body fluids examined.

Similarly, a lesser known but equally deleterious mycotoxin – ochratoxin A, was detected in all body fluids examined.

Suggestions for a primary intervention strategy have been given.

Key words: Stunting, aflatoxin, ochratoxin, children, Sierra Leone

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INTRODUCTION

It has been estimated that 4.5 million children in Sub-Saharan Africa (SSA) die each year under the age of 5 years, making child death rates about 30% higher than in industrialized nations (Black et al., 2003). According to Caulfield and colleagues (2004a, 2004b), growth faltering and malnourishment could be the cause of death in about 50% of under-five children. Stunting is a major burden in developing countries, affecting ~147 million children (de Onis et al., 2004)

Sierra Leone has a high incidence of malnutrition in children. It has been reported that growth faltering/ stunting in children is a major health issue in Sierra Leone as 40% of children are stunted, another 31% Underweight (moderately) and 8% severely underweight (www.sl-undp.org/Goal4.htm)

Several factors such as the environment in which the child grows up, the nutritional status of the pregnant woman and the infant have all been suggested as possible causes of growth faltering in children. Using the infancy-childhood-puberty (ICP) growth model in their study of 425 infants born from September 1984 to March 1987, Lui and colleagues (1998) concluded that the incidence of diarrhoeal diseases and being born in a warm season are particular risk factors for growth faltering in early life. General socio-economic status was also found to be a high risk factor for growth faltering. One can simply conclude that the causes of growth faltering are multifactorial and often include insufficient food intake as well as frequent episodes of diarrhoeal disease and other infections.

However, recent studies have demonstrated the relationship between mycotoxins (aflatoxins) ingestion and growth faltering in children (Turner et al. 2007; Gong et al. 2002, Gong et al. 2004) Mycotoxins are secondary metabolites produced by fungi commonly known as mould on storage grains, nuts, oil seeds, crops and various other foodstuffs. It has been well documented that mycotoxins (especially aflatoxins) pose serious constraints to the improvement of health and well being of African people, particularly children.

Aflatoxins are naturally occurring mycotoxins which frequently contaminate staple foods such as groundnuts and maize. Aflatoxins are known to be carcinogenic, mutagenic, teratogenic and immunosuppressive (Bondy and Pestka, 2000).

There are four major aflatoxins B₁, B₂, G₁ and G₂ named according to their violet blue and blue green fluorescence respectively, under UV light (De Iongh et al., 1962). Of these, aflatoxin B₁ is considered most potent. When Cows are fed aflatoxin contaminated peanut meal, the presence of the monohydroxy derivatives of aflatoxins B₁ and B₂-aflatoxins M₁, M₂, commonly termed milk toxins are detected (De Iongh et al., 1962). In Sierra Leone, aflatoxins have been detected not only at high frequencies but most times at very high levels in the various body fluids of infants and children (Jonsyn, 1994).

For instance, aflatoxins were detected in 91% cord and 75% maternal blood samples at concentration levels of between 0.4 to 9.0 ng/ml and 0.04 to 8.8ng/ml cord

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and maternal blood respectively (Jonsyn et al., 1995a).

Breast milk samples also contained 88% aflatoxins at concentration ranges of 0.05 – 372ng/ml (Jonsyn et al., 1995b).

Serum, urine and stool specimens of infants were shown to contain aflatoxins in 94%, 100% and 94% respectively, at various concentration ranges (Jonsyn, 1999).

Urine samples of school children ages between 5 – 14 were shown to be contaminated with aflatoxins in 99% at levels of 0.5 – 374ng/ml M1 (dry season) and 98% at levels of 0.08 – 127ng/ml B1 (rainy season) (Jonsyn-Ellis, 2001). One can simply conclude that during the dry season harvested crops such as peanuts and maize have undergone further contamination during the drying and storage periods, thus the detection of such high frequencies and levels of toxins in urine samples.

Comparatively, the frequencies and levels of detection of aflatoxins in serum samples of these school children were much lower. Aflatoxins were detected in 57% at concentration ranges of 0.2- 74ng/ml AFB1 (Jonsyn-Ellis, 2007) as avers 98% and 0.08- 127 ng/ml AFB1 in urine samples. (Jonsyn-Ellis, 2001).

The aflatoxins have been implicated in diseases such as Reyes Syndrome (Nelson et al., 1980), primary liver carcinoma (IARC, 1993) and Kwashiorkor, a nutritional disease still prevalent in Africa. Exposure to aflatoxins was first implicated in the aetiology of Kwashiorkor by Hendrickse and colleagues (1982) and subsequently by several investigators (Maxwell, 1984; Coulter et. al. 1986; de

Vries et. al., 1990). This disease has remarkable similarities with the notable symptoms of aflatoxin toxicity in animals. These include inhibition of protein synthesis, hypoalbuminaemia, inhibition of lipid transport resulting in fatty liver, depletion of liver glycogen and immunosuppression (Coulter et. al., 1986). Studies conducted in Sudan (Maxwell, 1984, Coulter et. al., 1986), South Africa (Ramjee et. al., 1992) and Sierra Leone (Jonsyn, 1994) have all shown that aflatoxins were detected more frequently in sera of Kwashiorkor than in the other nutritional groups.

Studies on humans have suggested that the high frequency and levels of aflatoxin exposure could significantly enhance susceptibility to infectious diseases (Turner et. al. 2003)

IMPAIRED GROWTH, STUNTING AND UNDERWEIGHT

It has been clearly demonstrated in studies in The Gambia (Turner et. al., 2007) Benin and Togo (Gong et. al., 2002; Gong et. al., 2004) that high levels of aflatoxin exposure in children can result in growth faltering/underweight of infants and young children. The Gambian, Benin and Togo studies, have highlighted a strong association between in utero and post natal aflatoxin exposure and the negative effect on Height for Age Z-scores (HAZ) and Weight for Age Z- scores (WAZ) in these children. Thus indicating that maternal aflatoxin exposure during pregnancy could translate to in utero toxicity for the child.

In our studies in Sierra Leone, apart from the aflatoxins, another equally deleterious mycotoxin- ochratoxin A (OTA) was also

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elucidated in all body fluids examined. This is not surprising as local foodstuffs examined so far, have been shown to be contaminated with *Aspergillus ochraceus* and *Aspergillus flavus* the producers of OTA and aflatoxins respectively (Jonsyn 1988, 1989; Jonsyn and Lahai, 1992; Jonsyn and Maxwell, 1993).

OTA is a potent nephrotoxin, teratogen, mutagen carcinogen and an immuno-suppressant to most animal species and is now classified as a 2B – a possibly human carcinogen by the International Agency for Research on Cancer (IARC, 1993).

Ochratoxin A is thought to impair the immune system especially in poultry. It was found that IgA, IgG and IgM were all reduced by about 38% when birds were fed OTA. The cellular components of immunity are also impaired during ochratoxicosis. Mean phagocytosis (bacteria phagocytised per phagocyte) is impaired during ochratoxicosis (Dwivedi and Burns, 1984). Heterophils from chickens fed ochratoxin were deficient (Chang and Hamilton, 1980).

Needless to say that the aflatoxins have enjoyed considerable attention worldwide and also in Sub Saharan Africa thus their role in the aetiology of certain diseases have been well defined, this cannot however, be said of OTA. With the exception of some North African countries, comprehensive studies on ochratoxin levels in human body fluids have only been conducted in Sierra Leone (West Africa). Recently, Sangare-Tigori and colleagues (2006) examined human sera in Abidjan, Ivory Coast for ochratoxin A.

The co-occurrence of aflatoxins and OTA in body fluids of Sierra Leonean children, begs the question as to the role of mycotoxins in the aetiology of certain childhood diseases

LOW BIRTHWEIGHTS:

Animal experiments have shown that the administration of AFB₁ and OTA singly and in combination, resulted in depressed weight gains. Even though very few human studies have been conducted, there is evidence that combination of various aflatoxins and/or OTA, induce weight depression (Jonsyn, 1998). De Vries and colleagues (1987) revealed a 225g difference in mean birth weight of female infants with prenatal exposure to aflatoxins. Similarly, a mean birth weight difference of 210g between boys and girls predisposed to mycotoxins was recorded in Sierra Leone (Jonsyn, 1998).

With such high levels of exposure to aflatoxins and ochratoxin A, it is not surprising to note that growth faltering/stunting in children in Sierra Leone is 40%, Underweight 31%(moderately) and 8% severely underweight (ref).

Another important factor that is to be taken into consideration is that aflatoxin and ochratoxin A are both immunosuppressive agents, thereby predisposing children to infectious diseases; therefore it is mandatory to address the issue of mycotoxins in the food chain.

What must be done?

1. Reduction of the exposure rates of pregnant women and infants to these mycotoxins

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2. Implementation of methods to eradicate or reduce contamination rates of foodstuffs and animal feedstuffs by mycotoxins
3. Proper investigation of the role of mycotoxins in the aetiology of certain childhood diseases, cancers and attendant health problems

How can it be done?

Suggestions for a Practical Primary Intervention

Awareness Creation

It must first of all be recognized that in most countries of the developing world, particularly Africa, there is lack of awareness of mycotoxins and the health consequences by:

- Farmers
- Traders
- Processors
- Consumers

It is easy to observe in Sierra Leone, that the crop market is not oriented to rejecting contaminated produce as such quality of the crop is not a hindrance for its sale in the market. Mass awareness campaigns are required to educate everybody on the dangers of mycotoxins (aflatoxin & ochratoxin ingestion - educating them on good food hygiene and processing techniques, such as:

- Discarding any mouldy foodstuffs
- Hand- sorting out of peanuts, maize and cereals to remove mouldy, discoloured or shrivelled ones before processing
- Preferably wet milling and fermenting of maize for weaning foods

- Constant smoke-drying of foodstuffs like “ogiri” (fermented sesame seeds) and fish during storage.
- Avoid feeding mouldy foodstuff or feeds to domestic farm animals to prevent toxin residues in their tissues.

Since there is substantial evidence of the early exposure of infants to mycotoxins while they are still in the womb and through breast milk, it is therefore imperative:

- a) To create awareness among pregnant and lactating women, mothers of infants; health personnel generally, but especially, those in the under-five and ante-natal clinics, on the deleterious effects of mycotoxins on everybody, especially children.
- b) Conduct a baseline survey of the human exposure rates in the other three regions of Sierra Leone where growth faltering /stunting is prevalent.
- c) Give guidelines on methods to prepare mycotoxin- free weaning formula
- d) Establish a cohort study to test the effectiveness of the weaning formula and the prevalence of stunting.

The Ministry of Health could promote health intervention strategies, such as the use of certain tried and proven anti-adsorbents that could prevent absorption or modify metabolism of the toxins such as Oltipraz, clay, chlorophyllin and Vitamin C to all pregnant women.

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