

# Awareness of Aflatoxin Health Risks Among Parents with Children Aged Between 6-23 Months in Central Tanzania

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**Abstract:** In Tanzania, aflatoxin contamination and exposure in complementary foods was very high. However, it remains unknown whether the extent of the risks of exposure is linked to the levels of awareness among parents especially mothers who prepare and feed infants with cereal based complementary foods. This study was a cross-sectional study designed to assess the levels and factors of awareness of aflatoxin health risks among parents or caregivers with children in Central Tanzania. Data for the study were collected using an interview schedule which was administered to 364 households with parents/caregivers of children aged between 6-23 months, and focus group discussions (FGDs) with 121 (105 females and 16 males) participants. The results show that 82% of the parents/caregivers were not aware of aflatoxin contamination in complementary foods and their health effects. The odds [odds ratio (OR)=0.3, 95% Confidence Interval (CI): 0.1-0.6] of a parent with low (less than US\$ 22.8) monthly income to be aware of aflatoxin contamination and its effects, was significantly ( $p<0.05$ ) less compared with that of a parent whose monthly income was high (more than US\$ 22.8). An employed participant (OR=13.5, 95% CI: 1.7-105.2) is significantly ( $p<0.05$ ) more likely to be aware of aflatoxin contamination than a farmer. The findings were complemented by results of the FGDs which showed that people were not aware of aflatoxin contamination in complementary foods. The FGD showed that participants were only aware of the presence of fungi in cereal type of foods, which leads to changes of taste and imparts unpleasant smell in foods. It is concluded that the level of awareness about aflatoxin contamination and health risks is very low in the study community. As such, there is an urgent need to raise awareness and educate parents/caregivers on aflatoxin risks associated with complementary foods in Central Tanzania.

**Keywords:** Aflatoxin, Awareness, Complementary Foods, Parents

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## 1. Introduction

Aflatoxins are toxic secondary metabolites produced by molds; mainly those of the species *Aspergillus flavus* and *Aspergillus parasiticus* [1]. These toxins are common contaminants in cereals and nuts such as maize and groundnuts where they exist in four main forms: aflatoxin B1 (AFB1), B2 (AFB2), G1 (AFG1) and G2 (AFG2). AFB1 is among the

most potent carcinogenic compounds found in human and animal foods [2]. Consumption of foods containing aflatoxins has been associated with liver cancer, weakened immune systems, impaired child growth and death [3-4]. The health outcomes such as liver cancer and immune suppression can be exacerbated when such foods are deficient in essential nutrients as is the case in developing countries where the majority of people depend on cereal-based diets [5]. Acute

toxicity of aflatoxin is exemplified by the aflatoxicosis which occurred in Kenya in 2004. In that year, 317 people including children became ill and 125 of them died after consuming aflatoxin contaminated cereals [6-8].

Aflatoxin contamination in crops is possible along the food chain: during plant growth, maturation, harvesting, storage and processing [9-11]. Fungi infection can be induced when maturing crop is under drought conditions and during prolonged periods of hot weather [10, 12]. Contamination during storage of the crop can occur if moisture and relative humidity, oxygen availability, temperature, time, and damaged or broken grain kernels are allowed to go to critical levels [13-15]. Crops grown in warm climate conditions have high chances of infection by aflatoxin producers and in some areas, infection occurs only when temperature rises in connection with drought [10]. A climatic change influences not only the amount of aflatoxins, but also the types of aflatoxin producers present in the area [10]. Thus, drying, proper storage, and appropriate transportation are of prime importance in prevention [3].

Factors promoting aflatoxin contamination in developing countries include poor pre- and post-harvest handling of crops, low consumer education programmes, limited numbers of qualified personnel, inadequate surveillance programmes and enforcement of regulations [16]. The wide range of food products which are contaminated with aflatoxins include cereals like maize, sorghum, pearl millet, rice and wheat; oilseeds such as groundnuts, soybean, sunflowers and cotton; spices like chillies, black pepper, coriander, turmeric and zinger; tree nuts such as almonds, pistachio, walnuts and coconuts; milk and milk products [17-19]. Maize is probably the commodity of greatest worldwide concern because it is grown in climates that are likely to influence perennial contamination with aflatoxins, and it is the staple food in many countries [20]. Besides, in the preparation of complementary foods, most of the people living in rural areas use local products, mainly cereals like maize, and groundnuts, which come with an added risk of exposure to aflatoxins [16].

Contamination and exposure of aflatoxins are often unavoidable because the levels of awareness and knowledge of aflatoxins are low among the majority of people in rural areas who rely on own grown food that cannot be subjected to regulatory controls [7, 10]. This explains why over 5 billion people in developing countries worldwide are at risk of chronic exposure to aflatoxins through contaminated foods [5]. Aflatoxins are not visible, neither do they have a particular flavour hence it is not easy to convince consumers about their existence in food. A review of literature shows an association between lack of awareness and inadequate knowledge about aflatoxins contamination with high rate of exposure to aflatoxins [19, 21-22]. In Ghana, it has been reported that women had high levels of awareness on aflatoxins than men and such education levels played a great role in addressing the problem and how to overcome the situation [19]. The information gap of aflatoxin risks can be reduced through awareness campaigns [19].

In Tanzania, aflatoxin contamination and exposure in complementary foods has been reported to be very high [23-25]. In addition, studies in the country have reported high exposure of infants and young children to aflatoxins through direct consumption of maize based diet as well as through breast milk of mothers whose main diet is maize [26-28]. However, it remains unknown whether the parents especially mothers who prepare and feed infants with cereal based complementary foods in Tanzania are aware of the aflatoxin problem or not. Such understanding is important to develop workable measures to mitigate the problem in the country. This study, therefore, assessed the level and factors of awareness of aflatoxin health risks among parents with children in Central Tanzania.

## 2. Materials and Methods

### 2.1. Study Areas

This study was carried out in four randomly selected districts of Chamwino and Bahi in Dodoma Region and Manyoni and Ikungi districts in Singida Region, in Central Tanzania. These regions experience low rainfall and short rainy seasons which are often erratic with long periods of drought. The regions were selected because of the semi-arid condition which is characterized by high temperature during the day (up to 35°C) and cool (to 10°C) during the night. Both temperature and humidity favour the growth of fungi which signaling possibility of aflatoxins production in improperly stored crops [10].

### 2.2. Study Population

The study population consisted of males and females who were parents/caregivers of children aged between 6-23 months found in the household and who reside in the randomly selected villages, streets, or hamlets in the study areas.

### 2.3. Study Design

The study design is cross-sectional study which involves the data collection at one point (households). The cross-sectional design also allows one to either use the entire population or a subset. Therefore, data were collected from a few individuals to help answer research questions. Hence, this design was considered to be capable of providing some base-line information that could be used for future studies in the country. Both quantitative and qualitative approaches to data collection with pre-tested questionnaires and structured interviews were used. The pre-tests were carried out in an area not selected for the study. A multistage sampling technique was used to select 364 households. The households with children aged 6-23 months were identified after which the sampling was done. Awareness variables were derived by computing the awareness test index (ATI). A suitable scale was developed to measure parents' or caregivers' awareness of aflatoxins. The respondents' responses were recorded as correct/incorrect or yes/no against each statement of awareness. A unit score was given to correct/yes answer and zero to incorrect/no answer. The total scores obtained by a

respondent for all the statements were summed up to obtain the individual respondent's score. The awareness test index (ATI) was created by summing up the number of correct responses, with a possible score ranging from 0 to 9. The generated ATI was then recorded to generate a binary variable with two levels (aware or not aware). Respondents having an ATI of 1 and above were considered to be aware of aflatoxins contamination and health risks while those with ATI equal to zero (0) were classified as not aware. All components of the study received University Research and Publication approval Ref: SUA/CB/26.

#### 2.4. Data Collection Procedure

Six research assistants were selected by the principal researcher (PR) to aid in data collection. Research assistants were selected based on previous experience in research work in communities and ability to understand and write Kiswahili and English languages. They were trained by the PR to understand the objectives of the study, the purpose and the procedure of the interview process; in order to have a common understanding of the questions in the interview schedule, and also to ask the questions to ensure that participants understand them. The questions were translated from English to Kiswahili language by the PR and were explained to the participants for data collection.

Quantitative data were collected by administering an interview to a random sample of 364 households with parents/caregivers of children aged between 6 to 23 months. The interview contained both open and close-ended questions developed and used to gather basic information on respondents' demographics and awareness levels of aflatoxin contamination in complementary foods as well as associated health effects after consumption.

Qualitative data were collected by using the Krueger methodology for conducting focus group discussions (FGDs) [29]. The questionnaire was developed after pre-tested through conducting a focused group discussion and interview involving parents or caregivers. The Focus Group Discussions were carried out after setting appointments with stakeholders (parents or caregivers) to be interviewed. The FGDs were conducted by using a checklist of the semi-structured, open-ended questions to allow the researcher guide the sessions and obtain the participants views. Participants (including parents or caregivers with children aged between 6 to 23 months) in Focus Group Discussion (FGD) were purposefully selected from the four randomly selected districts. These were the criterion that was used in inclusion and exclusion of participants. The research assistants had been trained on how to probe for specific issues when running FGDs. One pair of assistants (male and female) facilitated the FGDs by using a discussion guide and the principal researcher (PR) served as the assistant moderator. Another pair took notes during the FGDs. Information was collected by research assistants through 17 Focus Group Discussions (FGDs) with 121 participants (105 females and 16 males). The composition of all 17 FGDs was six (6) participants except six groups which had nine

participants each and one group which had seven participants. The discussions were held nearby primary school class rooms, office of village leaders or office of ward executive officer. The information collected was on awareness of the crops mostly contaminated by aflatoxin or fungi, its causes, and health effects to the adults or children and also personal experiences about aflatoxin contaminations in complementary foods. The interview lasted for approximately 40 minutes for each session. All the interviews were audio recorded, after obtaining the consent from participants and then the tapes were transcribed and translated into English by principal researcher.

#### 2.5. Data Analysis

The Statistical Package for Social Sciences (SPSS) program 21.0 version was used to analyze the data after cleaning. A 5% level of significance was used throughout the study and an independent variable with a p-value less than 0.05 was considered as statistically (significant) associated with outcome variable. For the qualitative part, coding was done using NVivo 7 software. The NVivo package has the ability to code and sort narrative data, interface with SPSS, and has good modelling facility and is user friendly [30]. It also combines best the NUD\*IST computer software package with much more flexibility [30]. The FGDs were analysed by using Thematic Content Analysis method.

### 3. Results

#### 3.1. Socio-demographic Characteristics of the Respondents

Table 1 shows the distribution of parents/caregivers by socio-demographic characteristics. Generally, majority of the respondents were aged below 34 years, earned monthly income less than US\$ 22.8, had primary education, were farmers, and were in marital union.

**Table 1.** Distribution of Parents/Caregivers by Socio-Demographic Characteristics.

Characteristics	Number	(%)
Age Group (Years)		
≤34	270	(74.2)
> 34	94	(25.8)
Monthly income (US\$)		
≤22.8	256	(70.3)
> 22.8	108	(29.7)
Level of education		
Never been to school	64	(17.6)
Partial primary	49	(13.5)
Primary	204	(56)
Partial secondary	18	(4.9)
Secondary	29	(7.9)
Respondent's occupation status		
Farmer	287	(78.8)
House wife	32	(8.8)
Employee	10	(2.7)
Petty trader	35	(9.6)
Marital status		
In Union	272	(74.7)
Not in Union	92	(25.3)

### 3.2. Awareness of Aflatoxin Contamination

The majority of respondents (82%) were not aware of

aflatoxin contamination and their health effects. They scored 0 out of 9 statements while those who were aware scored the mean of 0.67 out of a scale of 1 to 9.

**Table 2.** Distribution of Parents/Caregivers According to their Level of Awareness of Aflatoxins Contamination (n=364).

Attribute	Number(n)	Affirmative Yes (%)
Ever heard of a mould toxin that may be present in crops	55	(15.1)
Ever heard of a mould toxin that may be present in food	56	(15.4)
Ever heard of the word “aflatoxin”	13	(3.6)
Aware that aflatoxins can contaminate crops on farm	21	(5.8)
Aware that aflatoxins can contaminate crops in storage	28	(7.7)
Aware that aflatoxins can contaminate food	23	(6.3)
Aware that aflatoxins can contaminate complementary food	26	(7.1)
Aware that aflatoxins can affect human health	19	(5.2)
Aware of one or more health effects of aflatoxins	5	(1.4)

Number “n” is the number of respondents who gave an affirmation to the asked question.

Multiple logistic regression models were employed to find out the demographic characteristics associated with awareness on aflatoxin contamination. The parameter estimates and associated odds ratios (OR) of the fitted models for awareness are presented in Table 3. Respondents with less or equal to US\$22.8 monthly income (OR=0.3, 95% CI: 0.1-0.6) were 0.3 times, significantly ( $p<0.05$ ) less likely to be aware of

aflatoxin contamination compared to respondents whose monthly income was higher than US\$22.8. An employed participant (OR=13.5, 95% CI: 1.7-105.2) was significantly ( $p<0.05$ ) 13.5 times more likely to be aware of aflatoxin contamination than a farmer. Age, education level, and marital status were not statistically significantly associated with low awareness of aflatoxin contamination or health risks.

**Table 3.** Multiple Logistic Regression Models for Awareness of Aflatoxin Contamination.

Variable	Parameter Estimate (se)	OR	95% CI	P-Value
Age (Years)				
≤ 34	Reference	Reference	Reference	Reference
> 34	-0.9 (0.3)	0.9	(0.5, 1.8)	0.8
Monthly Income (US\$)				
>22.8	Reference	Reference	Reference	Reference
≤ 22.8	-1.4 (0.4)	0.3	(0.1, 0.6)	0.001
Education Level				
Never been to School	Reference	Reference	Reference	Reference
Partial Primary	-0.5 (0.5)	0.6	(0.2, 1.6)	0.3
Primary	-0.3 (0.4)	0.8	(0.4, 1.5)	0.4
Partial Secondary	-0.1 (0.7)	0.9	(0.2, 3.9)	0.9
Secondary	-0.6 (0.8)	0.6	(0.1, 2.9)	0.5
Occupation Status				
Farmer	Reference	Reference	Reference	Reference
House wife	0.5 (0.5)	1.6	(0.6, 4.1)	0.3
Petty trader	-0.4 (0.7)	0.7	(0.2, 2.6)	0.6
Employed	2.6 (1.1)	13.5	(1.7, 105.2)	0.01
Marital Status				
Not in Union	Reference	Reference	Reference	Reference
In Union	0.01 (0.3)	1.01	(0.5, 1.9)	0.97

### 3.3. Themes and Sub Themes of Awareness of Aflatoxin Contamination

Coded texts were categorized into three sub themes as shown in Table 4.

**Table 4.** Sub themes: Describing Awareness of Aflatoxin Contamination from Focus Group Discussion Participants.

Sub theme	Message/finding
Crops which are mostly contaminated by aflatoxins (fungi/mouldy)	Cereal type of crops
Causes of aflatoxins (fungi) found in crops or grains that are used as food for adults or infants	Fungi ( <i>ukungu</i> ) when stored in moist conditions
Effects of aflatoxins (fungi) found in crops or grains that are used in preparation of food for adults or infants	Change of taste and unpleasant smell of the food, get stomach ache or flatulence

### 3.4. Awareness of the Crops Mostly Contaminated with Fungi

During FGDs, various crops were mentioned as being vulnerable to fungal contamination. The mostly mentioned as vulnerable crops were cereals mainly maize. Participants were not aware about aflatoxin. This was testified by participants who stated that, regarding these mould/fungus (aflatoxins); for them who cultivate sorghum, maize and millet/finger-millet, these crops are the most vulnerable to the “*uvundouvundo*” moist-like condition and most of the time fungi come when crops are growing, but they are not aware if it is aflatoxin “(*sumu kuvu*)”.

### 3.5. Awareness of the Causes of Fungi Found in Crops or Grains that are Used as Food for Adults or Infants

In FGDs, most of the participants mentioned moisture as the most common cause of fungal contamination. Most of them explained that when crops are either stored for a long time or when is stored not fully dry; they always develop moulds or fungus. Participants said that in most cases, it is moisture that causes this fungus to develop or when you store crops which are not fully dry and also when these crops stay in the “*ghala*” grains store for a very long time. Also, participants were quoted saying when the cloud is heavy with

signs of rainfall; storing crops during such time precipitates a high chance for the crops to be contaminated with fungus. Other participants were quoted saying, it is a thing caused by lack of seriousness when stored crops like maize. When stored these kind of crops, the place should be dry because if there is even little moist then these (fungi) develop.

### 3.6. Awareness of the Health Effects of Fungi Found in Crops or Grains

Participants who were aware of fungus mentioned change of taste and unpleasant smell of the food as the effects of mouldy contamination. The participants were able to link these effects to human health like stomach-ache or flatulence. Participants explained that its effect is change of taste to the food and sometimes the smell becomes abnormal. Thus, it is normally important to wash the contaminated grains very well in order to reduce the smell. Also, others said that honestly, they were not aware of the health effects but what they know is that when you use such crops which have stayed for a very long time, even if you wash them the flour taste becomes sour.

Many of the qualitative themes are aligned with quantitative data. The merged responses about awareness are shown in Table 5.

Table 5. Qualitative and Quantitative Information about Awareness of Aflatoxin or Fungi Contamination.

Qualitative findings (n=121)	Quantitative findings n=364)	Number	(%)
Aware that moulds infect cereal type of crops	Aware that aflatoxins can contaminate crops at the farm	21	(5.8)
Aware that fungi infect foods when stored in moist conditions	Aware that aflatoxins can contaminate crops in storage	28	(7.7)
Change of taste and unpleasant smell of the food	Aware that aflatoxins can contaminate food	23	(6.3)
Change taste of flour and becomes sour	Aware that aflatoxins can contaminate complementary food	26	(7.1)
Aware that contaminated food can cause health problem	Aware that aflatoxins can affect human health	19	(5.2)
Stomach ache or flatulence	Aware of one or more health effects of aflatoxins	5	(1.4)

## 4. Discussion

This study investigated the level and factors of awareness of aflatoxin health risks among parents who prepare and feed infants with cereal-based complementary foods in Central Tanzania. The study showed that 82.0% of parents were not aware of aflatoxin contamination in complementary foods and their health effects. The finding from this study is similar to those reported in Malaysia [31] and Ethiopia [32], Benin, Ghana, and Togo [33]; and India [34]. As it was previously reported about Kenya and Mali; awareness and knowledge of potential danger posed by aflatoxin contamination in foodstuffs is extremely low [35]. Also, in Uganda, the majority of farmers, traders and consumers are not aware of the aflatoxin contamination in foods [36]. However, these results contradict the finding of another study from Malawi where the level of awareness was higher, 65% [22, 37] and Lower Eastern Kenya where the level of awareness was 59% [20, 38]. The higher level of awareness in Malawi and Kenya was attributed to high literacy levels of the communities and many outbreaks experienced in the countries. Also in

Malawi, 80% of the farmers had experienced aflatoxin problems in their households [21].

The study also sought to explore whether people who were aware of aflatoxins know the types of crops which are highly susceptible to aflatoxin or fungal/mouldy contamination. Of the Parents or caregivers who were aware, 5.8% showed that cereal type of crops are the most vulnerable to fungal or mould. Participants in the FGDs who indicated that they were aware mentioned cereal type of crops as the most vulnerable to fungus/mould (aflatoxin) contamination including maize, sorghum, and millet. Similar finding was reported by a study conducted in Kenya where farmers were found to be aware of the main crops mostly affected by aflatoxins namely maize, sorghum, cassava, and millet [20]. In Kenya, however, farmers were highly aware of the aflatoxin problem and knew that the contamination in maize was caused by *Aspergillus* spp arising from high moisture content either during harvesting or in storage [20]. Of the parents or caregivers who were aware, 7.7% were aware that crops could be contaminated during storage in moist conditions. In general, most people in the FGDs explained that when crops were either stored

for a long time or when stored not fully dried, they always developed moulds or fungus. These results are similar to those reported by studies performed in other developing countries [3, 37] which revealed that farmers were aware that *Aspergillus spp* growing in maize arise from high moisture content either during harvest or in storage. In addition, the findings [38] confirm that high levels of humidity, temperature and poor aeration during storage are important factors that may contribute to aflatoxin contamination. In another study done [39] further emphasizes that aflatoxin contamination can occur when food commodities are stored under high moisture and temperature conditions. Of the parents who were aware of the effects of aflatoxin in foods or complementary foods, 6.3% and 7.1% of the parents respectively, were aware that change of the taste and unpleasant smell of foods were due to aflatoxin or mouldy or fungi contamination; and the minority 1.4% were aware that their health could be effected if they consumed such foods as they reported during FGDs that it could lead them to abdominal ache. This is consistent with past studies conducted [40] who reported that bad smell and decay might be due to activities of *Aspergillus* fungi which normally lead to food decomposition, and that members of *Aspergillus* genus are more heat tolerant and xerophilic than other fungal species. In addition, [3] reported that chronic dietary exposure to low doses of aflatoxins is a risk factor for liver cancer and may also affect protein metabolism and immunity, hence worsening infectious diseases and malnutrition. Consuming highly contaminated foods with aflatoxin results in acute exposure known as aflatoxicosis and the symptoms include vomiting, jaundice and abdominal pain, and can lead to liver failure and death. No specific treatment has been found for acute aflatoxicosis [3].

With regard to demographic factors associated with awareness of aflatoxin contamination, the study found that parents with lower monthly income were less likely to be aware of aflatoxins contamination compared to respondents whose monthly income was higher. These results are similar to those from a study in Ghana [19] and Malaysia [31] which found that the respondents with higher income were more aware of aflatoxin contamination and its health risks than those with lower income. During focus group discussions, low household income was identified as a factor responsible for food insecurity. The parents in the current study believed that low household income was responsible for food insecurity. Another important predictor of awareness of aflatoxin contamination was occupation. Employed participants were significantly more likely to be aware of aflatoxin contamination than farmers. These results are similar to those of the study done in Ghana [19] which revealed that employed (health and agricultural professionals) perceived that there were significant economic and health benefits to be obtained from reducing the level of aflatoxin contamination and were more likely to discuss the problem of aflatoxin with colleagues and subordinates.

Generally, awareness of aflatoxin contamination of crops

and foods used in the preparation of complementary food and the relationship of its health effects was low among parents in the study areas. Parents' unawareness on aflatoxin contamination in this study area could be a danger to their food security and health because it creates possibilities for them and their livestock to consume aflatoxin contaminated foods. Therefore, there is a need to create public awareness of the potential harmful effects of aflatoxin. Awareness raising campaigns can be carried out through appropriate media such as radio, television, newspapers and drama, existing system of government extension workers, health workers, and existing community groups in the study areas.

## 5. Conclusion

It is concluded that the level of awareness on aflatoxin contamination and health risks is very low in the study community. Parents/caregivers with lower (less than US\$ 22.8) monthly income were less likely to be aware of aflatoxin contamination compared to those whose monthly income was higher (more than US\$ 22.8). Employed parents were significantly more aware of aflatoxin contamination than farmers. Inconsistent and low awareness of aflatoxin contamination among parents or caregivers put the children at increased health risks in the community. As such, there is an urgent need to raise awareness and educate parents on aflatoxin risks associated with complementary foods in Central Tanzania. Awareness raising campaigns can be carried out through appropriate media such as radio, television, newspapers and drama, existing system of government extension workers, health workers and existing community groups in the study areas.

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