MOULDS, MYCOTOXINS AND CHILDREN'S HEALTH

unicef for every child

Executive summary

Moulds and mycotoxins are among the most widespread and under-recognized threats to food safety and child health worldwide. Produced naturally by fungi that grow on staple crops such as maize, groundnuts, rice and wheat, mycotoxins contaminate food before harvest, during storage and along the food supply chain. They are invisible, odourless and resistant to cooking, making them difficult to detect or remove.

For millions of children, exposure occurs daily through the foods they eat and the environments in which they live. The Food and Agriculture Organization estimates that roughly one quarter of the world's cereals, nuts and spices are contaminated with mycotoxins in any given year, placing billions of people at risk. The burden falls disproportionately on low- and middle-income countries where warm, humid climates favour fungal growth, food safety systems are under-resourced and households depend heavily on a limited number of staple crops. Children also may be exposed to moulds and mycotoxins through the indoor air in homes and schools. Compared with adults, they consume more food per kilogram of body weight and are undergoing rapid development of the immune system, lungs and brain. Exposure to mycotoxins may begin in pregnancy and continue through infancy and early childhood, affecting organs during sensitive windows of growth.

A growing body of evidence links chronic mycotoxin exposure with impaired child growth, weakened immunity and developmental risks. Aflatoxin exposures are associated with stunting and reduced vaccine responses, while fumonisins are linked to neural tube defects and ochratoxin A is linked to nephropathy. Aflatoxin B_1 is a known human carcinogen, and early-life exposure combined with hepatitis infection markedly increases lifetime liver cancer risk. Acute outbreaks of illness after consumption of heavily contaminated food can cause severe illness and deaths in children. Together, these impacts contribute to malnutrition, infection, lost learning potential and premature mortality.

Mycotoxin exposure is preventable. Effective, affordable solutions exist across the food system. Improved agricultural practices, biological control methods and resistant crop varieties can reduce contamination in the field. Rapid drying, hermetic storage and simple sorting practices can limit toxin formation after harvest. Food processing techniques and diversified diets further reduce intake. Strengthening food safety standards, testing and surveillance can protect consumers, while integrating risk communication into health and nutrition services empowers families to adopt safer practices. Despite this evidence, mycotoxin prevention remains under-prioritized in many countries. Monitoring is inconsistent, laboratory capacity is limited and food safety policies are rarely linked to child health, nutrition or school feeding programmes. As a result, contaminated foods often reach children.

Protecting children requires coordinated action across sectors. Governments and partners should adopt and enforce Codex-based standards, integrate mycotoxin testing into public food programmes, expand surveillance and laboratory capacity, invest in safe storage technologies for smallholder farmers, and embed prevention messaging within maternal and child health services. Governments can play a catalytic role by incorporating mycotoxin risk reduction into nutrition, water, sanitation and hygiene (WASH), early childhood development and food systems programmes. Reducing exposure to mycotoxins in foods and moulds in the indoor air of homes and schools has a potential impact on child growth and survival. Through multisectoral action across agriculture, health and social systems, countries can protect children's right to safe food and healthy environments and advance progress towards the United Nations Sustainable Development Goals.

Healthy Environments for Healthy Children

Introduction

Moulds are naturally occurring fungi that grow on crops, foods and building materials, particularly in warm and humid environments. Under certain conditions, some moulds produce toxic chemical by-products known as mycotoxins. These toxins are invisible, tasteless and chemically stable, meaning they persist through harvesting, milling, cooking and storage. As a result, contamination can occur at any point along the food chain (WHO, 2002; Bullerman & Bianchini, 2007).

Mycotoxins are recognized globally as an important food safety and environmental health issue. The Food and Agriculture Organization (FAO) estimates that approximately one quarter of the world's food crops are contaminated with mycotoxins above recommended safety limits each year, exposing billions of people to chronic dietary intake (Park et al., 1999). Some important groups for human health include aflatoxins, fumonisins, ochratoxin A, deoxynivalenol and zearalenone. These toxins have been classified by the International Agency for Research on Cancer (IARC) and the World Health Organization (WHO) as carcinogenic, nephrotoxic, immunotoxic or endocrine-disrupting contaminants (IARC, 1993; WHO, 2002; IARC, 2012a). Historically, mycotoxins have been addressed primarily as an agricultural or trade problem, with concern focused on crop losses and export standards. However, a growing body of evidence shows that they also represent a significant and under-recognized threat to child health and development. Exposure begins early in life (often before birth) and may continue daily through ingestion of common foods such as maize, groundnuts, wheat, rice and milk, as well as through inhalation of spores in damp indoor environments (WHO, 2023; FAO, 2025).

Children are uniquely vulnerable to moulds and mycotoxins for several biological and behavioural reasons. Infants and young children consume more food and fluids relative to their body weight than adults, resulting in higher toxin doses per kilogram. Early childhood is characterized by rapid growth of the brain, immune and respiratory systems and other organs. Toxic exposures during critical developmental windows can have lifelong consequences. Chronic mycotoxin exposure is linked to stunting, immune suppression, reduced vaccine effectiveness, neurodevelopmental harm and increased risk of certain cancers later in life (FAO, 2025a; Gong et al., 2008; Turner et al., 2007; Gong et al., 2002; Githang'a, 2019a; UNEP, 1990). Clinicians in many parts of the world still learn little about moulds and mycotoxins during their training and may not recognize illnesses caused by mycotoxins when children are evaluated in clinic or hospital settings. There is a clear need for awareness-raising among clinicians who care for pregnant women and children (Etzel, 2006).

The burden of exposure is not evenly distributed. Mycotoxins disproportionately affect children in low- and middle-income countries, particularly in tropical and subtropical regions where heat and humidity favour fungal growth. In many of these settings, families rely on a small number of locally produced staples and have limited access to testing, safe storage or alternative foods (Falade, 2022; Wild, 2016). Food safety systems and regulatory enforcement may be weak, and contaminated commodities rejected from export markets may be consumed domestically (Ezekiel, 2019). Consequently, children living in rural communities, informal settlements and food-insecure households face the highest and most sustained exposures to contaminated foods. Climate change is expected to intensify these risks. Rising temperatures, drought stress followed by heavy rainfall, increased flooding and pest pressures create ideal conditions for fungal infestation of crops, water damage and dampness in homes and schools. Modelling studies suggest that aflatoxin contamination zones are expanding into new geographic areas as average temperatures rise (UNEP, 2016; Battilani, 2016). Without adaptation measures, climate variability may increase both the frequency and severity of contamination events, further threatening child nutrition and food security.

Reducing mould and mycotoxin exposure aligns directly with core priorities in child survival, nutrition, early childhood development, education and climate resilience. Mycotoxins contribute to stunting, infection risk and poor learning outcomes, undermining progress towards the Sustainable Development Goals, particularly those related to ending malnutrition (SDG 2), ensuring healthy lives (SDG 3) and building resilient communities (SDG 13) (United Nations, 2017). Mould and mycotoxin exposure is largely preventable. Affordable strategies such as improved crop drying and storage, biological controls, food testing, dietary diversification and raising public awareness about keeping homes dry, can substantially reduce contamination of foods and indoor environments.

This report provides a practical synthesis of the evidence on moulds and mycotoxins and child health. It outlines exposure pathways, summarizes health impacts across the life course, identifies global hotspots and policy gaps, and presents feasible interventions that governments, health systems and country teams can integrate into existing programmes. This report aims to support safer food systems and healthier environments for every child.

Sources and exposure pathways

Children are exposed to moulds and mycotoxins through multiple pathways that span the entire food system and the environments in which they live, learn and play. Food contamination typically begins during crop production, increases during storage and processing, and ultimately reaches children through everyday foods. Children also may be exposed through inhalation of spores in contaminated air in damp, mouldy buildings. Because mycotoxins are invisible, odourless and resistant to cooking or milling, exposure often occurs without obvious warning. Understanding where contamination arises is essential for identifying effective points of prevention.

Agricultural contamination

Mould and mycotoxin contamination of foods frequently originates in the field before crops are harvested. Fungi that produce toxins infect plants during growth, particularly when crops are stressed by drought, high temperatures, insect damage or poor soil fertility. These stresses weaken plant defences and allow fungal invasion. When followed by periods of humidity or rainfall, conditions become ideal for fungal growth and toxin production. In tropical and subtropical regions, *Aspergillus* species, especially *A. flavus* and *A. parasiticus*, commonly infect maize and groundnuts and produce aflatoxins. These moulds proliferate under hot, dry conditions followed by moisture, a pattern increasingly observed with climate variability (FAO, 2025b). In temperate and semi-temperate zones, *Fusarium* species infect maize and wheat and produce fumonisins and deoxynivalenol (DON). These toxins are widely detected in cereal crops and processed grain products (FAO, 2017). Because mycotoxins are produced within the grain itself, contamination that occurs before harvest cannot be completely removed later. Contamination often intensifies after harvest. If crops are not dried rapidly to safe moisture levels (generally below 12–14 per cent), fungi continue to grow during storage (Noomhorn, 1992). In many low-resource settings, grains are dried slowly on soil or bare ground and stored in woven sacks or poorly ventilated rooms, where warmth, humidity and insect damage promote further fungal proliferation. Under such conditions, aflatoxin concentrations can increase substantially (FAO, 2025b; Wild, 2007). For families who store food between harvest seasons, this post-harvest phase is a major contributor to chronic exposure.

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Food chain and diet

Dietary ingestion is the primary pathway of exposure for most children. Mycotoxins contaminate staple foods, particularly maize, groundnuts, rice and wheat, that form the basis of daily diets. Surveys conducted in many parts of sub-Saharan Africa and South Asia report that a substantial proportion of these staples exceed Codex Alimentarius guideline levels for aflatoxins and fumonisins (CAC, 2025a).

Infants and young children may be at particular risk during the transition to complementary feeding. Porridges and cereal blends made from maize or other grains frequently are used as initial foods. If prepared from contaminated grain, these products may deliver significant toxin doses relative to a child's small body weight. Young children also tend to consume more food per kilogram of body weight than adults, increasing effective exposure. Furthermore, young children may ingest visibly mouldy groundnuts or other damaged foodstuffs that adults would not, heightening their risk. In food-insecure households, families may be reluctant to discard mouldy or damaged grain, and lower-quality or rejected lots may circulate in informal markets, further increasing risk (Wild & Gong, 2010).

Mycotoxins also can enter the diet indirectly through animal products. Livestock that consume contaminated feed metabolize aflatoxin B_1 into aflatoxin M_1, which is excreted into milk. This metabolite has been detected in fresh milk, powdered milk and infant formula in multiple regions. Although concentrations are typically lower than in grains, milk is consumed frequently by infants and young children, making it a relevant exposure pathway. Eggs and meat also may contain low levels depending on feed contamination (FAO, 2017).

Indoor exposure

Children also may be exposed to moulds and mycotoxins through the indoor air in homes and schools. Damp housing, water leaks and flooding create conditions that favour mould growth on walls, ceilings, bedding and stored foods. Mould spores and fragments can become airborne and inhaled. Mycotoxins on the surface of these spores are lipid-soluble and readily absorbed by the airways. Although inhalation is less well studied as a route of exposure than dietary intake, exposures to dampness and mould may be especially relevant in informal settlements, temporary housing and schools with poor ventilation, where children are indoors for many hours each day.

Maternal and early-life transfer

Exposure may begin even before birth. Several mycotoxins cross the placenta, exposing the fetus during critical stages of development. After delivery, metabolites such as aflatoxin M_1 have been detected in breast milk in regions with high dietary contamination (Benkerroum & Ismail, 2022). Although breastfeeding is strongly recommended because of its overwhelming health benefits, contamination of maternal diets can indirectly affect infants. As children transition to complementary foods, exposure often increases because cereal-based foods are introduced in larger quantities.

Co-exposures and amplifying risks

Mould and mycotoxin exposures often occur alongside other vulnerabilities that amplify their effects. Undernutrition can impair immune responses, increasing susceptibility to toxin-related harm, while mycotoxins themselves may worsen growth and nutrient absorption. Infectious diseases can further increase risk; for example, co-exposure to aflatoxin and hepatitis B virus markedly raises the risk of liver cancer later in life (Qian et al., 1994; IARC, 2012b). Poor housing, limited dietary diversity and weak food safety systems tend to cluster within the same communities, resulting in repeated and overlapping exposures throughout childhood.

Health impacts in children


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Children are particularly vulnerable to the health effects of moulds and mycotoxins because exposure often begins early in life and continues daily through food and living environments (Adaku Chilaka & Mally, 2020). Even low concentrations consumed repeatedly over months or years can disrupt critical developmental processes. Unlike acute food-borne illnesses that present with obvious symptoms, the impacts of chronic mycotoxin exposure are frequently subtle and cumulative, affecting growth and immune function. These effects may go unrecognized at the individual level but contribute substantially to population-level burdens of malnutrition, infection and long-term disease. Health risks vary according to the type of toxin, dose and timing of exposure.

Acute toxicity and outbreaks

Although chronic low-dose intake is the most common pattern of exposure, acute outbreaks of severe poisoning occur when heavily contaminated foods are consumed, and these events illustrate the most dramatic consequences of inadequate food safety. Outbreaks have been documented in several countries and are characterized by the sudden onset of vomiting, abdominal pain, jaundice, acute liver failure and high case-fatality rates. Children are particularly vulnerable. In Malaysia, a severe aflatoxicosis outbreak led to an epidemic of acute hepatic encephalopathy, with children among those severely affected (Lye et al., 1995). A large acute aflatoxicosis outbreak in Kenya in 2004 resulted in a significant number of deaths (Azziz-Baumgartner et al., 2005). More recently, in Rajasthan, India in 2022, a cluster of acute-onset seizures and deaths among children was investigated and linked to contaminated food (Dhoundiyal et al., 2023). These events highlight critical weaknesses in food surveillance and regulatory systems and underscore the need for routine testing and rapid response mechanisms. They also demonstrate that the health consequences of mycotoxin contamination can be severe and rapid.

Impaired growth and undernutrition

Growth faltering is among the most consistently reported child health outcomes associated with aflatoxin exposure. Several longitudinal and cross-sectional studies conducted in Africa and Asia demonstrate that children with higher levels of aflatoxin biomarkers in blood or urine are more likely to be stunted, underweight or experience slower linear growth. In West Africa, children with elevated aflatoxin-albumin adduct concentrations were more likely to be stunted by early childhood (Gong et al., 2002; Gong et al., 2008). Similar associations have been observed in Tanzania (Shirima et al., 2015). Multiple biological mechanisms may explain these findings. Aflatoxins can damage the intestinal lining, impair nutrient absorption and alter gut integrity. They also may suppress appetite and interfere with protein synthesis and liver function, reducing the body's ability to utilize nutrients effectively. At the same time, immune suppression may increase susceptibility to repeated infections, further contributing to poor growth. These interacting pathways suggest that mycotoxins may undermine the effectiveness of nutrition programmes if the contamination of staple foods is not addressed.

Immune dysfunction and infection risk

Mycotoxins also affect the immune system. Experimental and human studies show that aflatoxins impair both cellular and humoral immunity, reducing the body's ability to respond to infections and vaccines. Children with higher aflatoxin exposure may produce weaker antibody responses to routine vaccines (Githang'a et al., 2019b). This has important public health implications in settings where vaccine-preventable diseases remain prevalent. Immune suppression also may increase vulnerability to common childhood illnesses such as diarrhoeal disease and pneumonia. In populations already facing high burdens of infectious disease, these effects can contribute to a cycle of illness, undernutrition and delayed development. Protecting children from mycotoxins therefore supports not only food safety but also broader infection control and immunization goals.

Liver toxicity and cancer risk

The liver is a primary target organ for aflatoxins. Aflatoxin B_1 is classified by the IARC as a Group 1 human carcinogen, indicating sufficient evidence of carcinogenicity in humans. Chronic exposure damages liver cells, causes DNA mutations and increases the risk of hepatocellular carcinoma. The risk is particularly elevated when aflatoxin exposure occurs in combination with hepatitis B virus infection, a common co-exposure in many low- and middle-income countries (Kew, 2003).

Exposure to aflatoxins was included in WHO estimates of the global burden of food-borne diseases due to 42 enteric (diarrhoeal and invasive non-diarrhoeal), parasitic, and chemical hazards (Lake et al., 2026, Jakobsen et al., 2026). For 2021, aflatoxin B_1 was estimated to cause 14,000 food-borne illnesses (95 per cent uncertainty interval 5920–28000), 13,200 food-borne deaths (95 per cent UI 5570–26400) and 412,000 food-borne disability-adjusted life years (95 per cent UI 179000–813000). The illnesses and deaths occurred among adults. Although liver cancer typically presents in adulthood, early-life exposures are important because they may initiate long-term carcinogenic processes. Preventing childhood exposure therefore represents a long-term cancer prevention strategy as well as an immediate child health intervention.

Kidney toxicity and other organ effects

Ochratoxin A primarily affects the kidneys. Epidemiologic studies have linked chronic exposure to kidney disease in certain regions (Hult et al., 1982), and animal studies demonstrate direct toxicity to renal tubular cells. Long-term exposure is associated with chronic nephropathy and hypertension in adults, suggesting potential risks for children exposed over many years (EFSA et al., 2020). Although paediatric data are more limited, protecting children from sustained exposure is prudent given the essential role of kidney function in growth and development. Other mycotoxins also may affect endocrine and reproductive systems. For example, zearalenone has oestrogenic activity that may disrupt hormonal regulation. Although the full implications for child development are still being studied, these findings underscore the need for precaution.

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Neurodevelopmental effects and birth outcomes

Exposure during pregnancy and early-life may affect brain development. Fumonisins disrupt sphingolipid metabolism, a process critical for cell membrane integrity and neural development. Epidemiological investigations along the Texas–Mexico border and in Mexico have reported associations between maternal fumonisin exposure and neural tube defects such as spina bifida (IARC, 2012; Missmer et al., 2006; Gelineau-van Waes, 2009). Animal studies support these observations, demonstrating impaired neural development following prenatal exposure, and experimental work has shown that folic acid supplementation can prevent fumonisin-induced neural tube defects in animal models (Gelineau-van Waes, 2009; Sadler et al., 2002). These findings have direct clinical relevance: all women who may become pregnant should take 400 µg folic acid daily, both as a general preventive measure and because folic acid supplementation may help counteract the teratogenic effects of fumonisin exposure (Sadler et al., 2002; Barry et al., 2023). Other mycotoxins, including ochratoxin A, have been associated with neurotoxicity in experimental models (Malir et al., 2013). Although human data are still emerging, the potential for developmental harm during critical periods of brain growth reinforces the importance of minimizing exposure among pregnant women and young children.

Respiratory effects

Damp and mouldy indoor environments are consistently associated with respiratory symptoms, asthma exacerbations and other respiratory illnesses among children (Heseltine & Rosen, 2009). During the first six months of life, when their lungs are growing very rapidly, infants living in water-damaged, mouldy environments appear to be uniquely susceptible to acute pulmonary haemorrhage (Etzel et al., 1998). Indoor mould exposures may compound risks from dietary exposure and contribute to children's cumulative health burdens.

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Global prevalence and hotspots

Mycotoxin contamination of foods is a global challenge that affects countries at all income levels. Because moulds that produce toxins are widespread in nature and thrive under common agricultural and storage conditions, contamination occurs across diverse climates and crop systems. The magnitude of exposure and its consequences for children vary substantially between regions, however, reflecting differences in climate, staple diets, infrastructure and regulatory capacity. The Food and Agriculture Organization (FAO) estimates that approximately one quarter of the world's cereals, nuts and spices are contaminated with mycotoxins at levels that may exceed recommended safety limits in any given year – translating into billions of people experiencing some degree of chronic dietary exposure (Eskola et al., 2020). Although contamination can occur anywhere, the burden falls disproportionately on low- and middle-income countries where warm and humid conditions favour fungal growth, where food safety systems are under-resourced, and where households depend heavily on a small number of staple crops.

Sub-Saharan Africa

Sub-Saharan Africa is among the most affected regions. Maize and groundnuts, two staples that are highly susceptible to aflatoxin contamination, form the basis of many children's diets. Surveys in several African settings report that a substantial proportion of maize and groundnut samples exceed regulatory limits for aflatoxins, in some cases affecting one third or more of samples, with substantially higher levels detected in local markets and during drought years (Eskola et al., 2020; Mutegi et al., 2009). Biomarker studies provide further evidence of widespread exposure: in several high-risk settings, aflatoxin metabolites are detectable in the urine or blood of 50–60 per cent or more of young children, indicating continuous dietary intake (Turner et al., 2007; Gong et al., 2002; Githang'a et al., 2019). These exposures coincide with high rates of stunting, undernutrition and infectious disease, suggesting that mycotoxins may contribute to persistent growth faltering despite nutrition and health interventions. Limited drying infrastructure, inadequate storage and informal market systems make it difficult for families and smallholder farmers to prevent or identify contaminated food. In addition, food lots rejected for export due to high toxin levels may be diverted to domestic markets, further concentrating risk among poorer populations.

South Asia

In South Asia, rice and wheat are major dietary staples, and contamination with aflatoxins, fumonisins and other toxins has been reported in cereals across the region. Surveys have documented contamination of rice, wheat and maize products in certain areas, although levels vary widely by commodity, location and storage conditions (Reddy et al., 2010). Because young children often consume cereal-based complementary foods several times per day, these contamination patterns translate into repeated low-dose exposure during critical stages of growth and development. Rapid urbanization and expansion of informal food markets can complicate oversight and testing, while climate variability including floods and prolonged humidity creates favourable conditions for fungal growth during both cultivation and storage.

Latin America and the Caribbean

In Latin America and the Caribbean, maize remains a central staple and is frequently contaminated with fumonisins and aflatoxins (Foerster et al., 2024). In some areas, a large proportion of maize samples contain levels above recommended thresholds. Ochratoxin A contamination also has been reported in coffee and other commodities important for both domestic consumption and trade (WHO, 2002). In rural communities where home-grown maize is stored for extended periods, children may experience sustained dietary exposure. Epidemiological studies from the region have linked fumonisin exposure with adverse birth outcomes, including neural tube defects, highlighting the importance of maternal exposure during pregnancy (Missmer et al., 2006).

Europe and North America

Mycotoxins are present even in high-income countries with stronger regulatory systems. Low levels of ochratoxin A, deoxynivalenol and fumonisins are regularly detected in grain products and processed foods. Although surveillance systems generally prevent severe contamination from reaching consumers, climate-related changes are shifting risk patterns. Warmer temperatures and altered rainfall are enabling fungal species traditionally confined to warmer climates to expand into temperate zones, increasing the likelihood of contamination events in new areas (Battilani et al., 2012). These trends underscore that mycotoxins are a universal concern, though impacts are mitigated where monitoring and control systems are robust.

Climate change and emerging risks

Climate change is expected to intensify and redistribute mycotoxin risks globally. Higher average temperatures, prolonged droughts followed by heavy rainfall, increased flooding and greater pest pressures create ideal conditions for fungal infestation of crops (Yan et al., 2026). Modelling studies suggest that even modest increases in temperature could significantly expand areas at risk for aflatoxin contamination of maize and other staples and post-harvest losses may also increase as extreme weather events disrupt drying and storage systems (Battilani et al., 2012; Medina et al., 2015). For many smallholder farmers, these changes reduce both food security and food safety simultaneously. As climate variability intensifies, new hotspots of exposure may emerge, particularly among rural and marginalized populations. Across all regions, mycotoxin exposure closely tracks patterns of poverty and inequity. Communities that have the least access to safe storage, testing services, diversified diets and healthy housing, may experience the highest contamination levels. The same children who are most exposed to contaminated food are often those who are undernourished, living in damp, mouldy housing and affected by infectious diseases that amplify toxicity. Consequently, mycotoxin exposures compound existing disadvantages and may undermine progress towards child survival, nutrition and education goals.

Policy and regulatory landscape

Over the past several decades, governments and international agencies have increasingly recognized moulds and mycotoxins as important food safety and public health concerns. A range of global, regional and national standards has been developed to limit contamination in foods and animal feeds. Although regulatory frameworks exist on paper in many countries, however, implementation and enforcement remain uneven. As a result, children in high-risk settings often remain insufficiently protected despite the presence of formal standards.

International frameworks

At the global level, the primary reference point for food safety standards is the Codex Alimentarius Commission (CAC), jointly established by FAO and WHO. The CAC sets maximum levels for key mycotoxins including aflatoxins, ochratoxin A, fumonisins and deoxynivalenol in cereals, nuts, milk and derived products. These limits are designed to reduce exposure while balancing food availability and trade considerations. CAC codes of practice also provide guidance on prevention and control measures across the food chain, from agricultural production through storage and processing (CAC, 2025a).

Scientific risk assessments underpinning these standards are conducted by the FAO/WHO Joint Expert Committee on Food Additives (JECFA). JECFA evaluates toxicological evidence and establishes health-based guidance values, including tolerable daily or weekly intakes where appropriate. These assessments inform national regulations and provide the scientific basis for international trade decisions (WHO, 2008; CAC, 2025b).

Regional and national frameworks

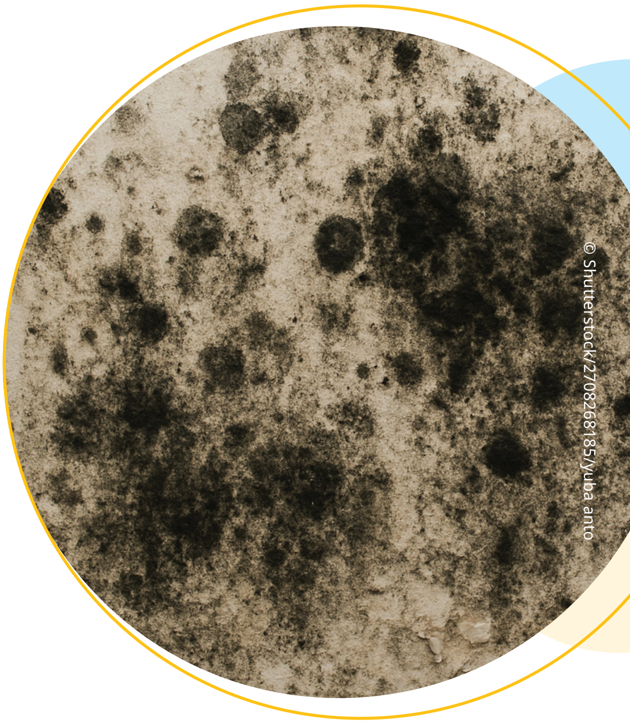
Many regions have translated CAC guidance into binding regulations. The European Union enforces maximum contaminant levels for multiple mycotoxins under Regulation (EU) 2023/915 of 25 April 2023, including particularly strict limits on foods for infants and young children, reflecting children's increased vulnerability (Vitalini et al., 2026). In contrast, regulatory coverage is often more limited in low- and middle-income countries. Although more than 60 countries have established national limits for aflatoxins, far fewer regulate other common mycotoxins such as fumonisins or ochratoxin A. Even where standards exist, routine testing and enforcement may be constrained by limited laboratory infrastructure, staffing and funding (Van Egmond, 2004). The African Union has adopted standards on aflatoxin control and supports coordination through regional economic communities (PACA, 2016). Implementation varies widely among Member States, however. In many settings, food safety systems focus primarily on export commodities, while foods destined for local consumption receive less oversight. As mentioned, this can result in contaminated batches rejected for export being diverted to domestic markets, disproportionately affecting poorer consumers, including children.

Implementation challenges and system gaps

Several persistent gaps limit the effectiveness of current regulatory approaches. Fewer than half of countries systematically include mycotoxin testing in national food-control plans or public health surveillance systems and testing often occurs only during outbreaks or research studies rather than as part of continuous oversight. Laboratory capacity requiring specialized equipment and trained personnel is frequently lacking at subnational levels, limiting access to reliable testing, delaying identification of contaminated food and reducing the feasibility of enforcement. Human biomonitoring such as measuring aflatoxin biomarkers in blood or urine is rarely integrated into routine health or nutrition surveys, limiting the understanding of children's true exposure levels. Food safety policies are often disconnected from child health and nutrition programmes. School feeding programmes, supplementary feeding initiatives and emergency food distributions may not consistently include mycotoxin testing, while maternal and child health, WASH and early childhood development programmes rarely incorporate risk communication or preventive measures related to mould and mycotoxin exposure. In many countries, families rely on locally produced or traded foods that bypass formal inspection even when standards exist.

Implications for protecting children's health

From a child health perspective, these gaps mean that regulatory frameworks are insufficient. Standards must be accompanied by practical measures to strengthen implementation, build laboratory capacity, integrate monitoring into nutrition and health systems, and support smallholder farmers and local markets. Aligning food safety policies with child-focused programmes such as school feeding, immunization and community health outreach can help translate regulations into meaningful reductions in exposure. Strengthening policy coherence across the agriculture, health, environment and trade sectors is therefore critical. By embedding mycotoxin control within broader food system and maternal and child health strategies, governments and partners can move from reactive responses to proactive prevention and ensure that regulatory protections reach the children who need them most.



Intervention and mitigation strategies

Mould and mycotoxin exposure can be substantially reduced through practical, evidence-based interventions implemented at multiple points along the food system. Because contamination often begins before harvest and accumulates through storage, processing and household use, no single solution is sufficient. Instead, effective control requires a combination of preventive measures across agriculture, markets, food preparation and public health services. Many of these interventions are low-cost and well suited to low-resource settings, making them feasible for integration into existing food security, nutrition and child health programmes (IARC, 2012c). Prevention is far more effective and affordable than attempting to manage health consequences after exposure has occurred.

Pre-harvest controls

The most sustainable approach to mycotoxin prevention is to reduce fungal infection before toxins are produced. Good agricultural practices, including timely planting, appropriate irrigation, crop rotation, improved soil fertility and effective pest control, reduce plant damage and create less favourable conditions for toxin-producing moulds. These measures have been shown to lower aflatoxin and fumonisin contamination while also improving yields (Semple et al., 1992). Biological control approaches using atoxigenic strains of *Aspergillus* are increasingly being adopted in several African countries, while research institutions are also developing crop varieties that are more resistant to fungal infection and toxin accumulation (Bandyopadhyay et al., 2016).

Kenya and Nigeria: Scalable agricultural interventions can improve food safety

Field studies in Kenya and Nigeria demonstrate the potential of biological control approaches to reduce aflatoxin contamination in staple foods. In Kenya, application of Aflasafe KE01, a biological control product containing atoxigenic strains of *Aspergillus*, at the Galana Kulalu Irrigation Scheme resulted in maize meeting Kenyan aflatoxin standards, with most samples also meeting stricter European Union thresholds. Similar approaches have been used among sorghum and groundnut farmers in Kenya, reducing the rejection of produce due to aflatoxin contamination. In Nigeria, a large-scale public–private partnership supporting farmer training and the distribution of Aflasafe between 2013 and 2018 demonstrated substantial reductions in aflatoxin contamination in maize and groundnuts. These programmes illustrate that scalable agricultural interventions can improve food safety, strengthen market access and reduce potential dietary exposure among children and households relying on staple grains (Kaptoge et al., 2024).

Post-harvest handling and storage

Contamination often increases rapidly after harvest, so improvements in drying and storage are among the most cost-effective interventions available to households and smallholder farmers. Rapid drying of crops to safe moisture levels within a few days of harvest is critical to prevent fungal growth. Solar dryers, raised drying platforms and simple mechanical dryers can significantly shorten drying time compared with traditional ground drying (Oni, et al., 2022). Hermetic storage technologies, including airtight containers and triple-layer storage bags, can substantially reduce fungal growth, insect damage and aflatoxin accumulation during storage (Baoua et al., 2014). Simple household practices such as sorting and discarding visibly mouldy or damaged grains before storage or cooking can also reduce exposure.

Kenya: Better storage practices prevent aflatoxin

Post-harvest storage is a critical stage for aflatoxin prevention, particularly in settings where crops are stored for long periods under warm and humid conditions. Studies in Kenya have shown that hermetic storage technologies, including Purdue Improved Crop Storage (PICS) bags, can substantially reduce fungal growth and aflatoxin accumulation in stored maize (Williams et al., 2014). In Makueni County, hermetic storage was associated with marked reductions in aflatoxin levels and *Aspergillus* contamination after three months of storage. Longer-term studies demonstrated that aflatoxin concentrations remained stable in hermetic bags, while contamination increased several-fold in conventional storage bags. These technologies offer a practical and relatively low-cost strategy to improve household food safety, reduce post-harvest losses and limit chronic dietary exposure among children in smallholder farming communities.

Food processing and detoxification

Food processing methods can further reduce mycotoxin exposure. Cleaning, hulling and sorting remove portions of grain where toxins tend to concentrate, while traditional alkaline processing methods such as nixtamalization can substantially lower aflatoxin and fumonisin levels in maize products (Dombrink-Kurtzman, 2000). Chemical detoxification methods, including ammonization and ozone treatment, can effectively degrade certain toxins, but often require specialized equipment and careful quality control, limiting their applicability outside commercial settings. Emerging biological approaches, such as probiotic or enzyme-based additives that bind toxins in the gastrointestinal tract, are under investigation. Although promising, these methods remain complementary strategies and should not substitute for the reduction of contamination at source.

Rwanda and Kenya: Traditional food processing methods can reduce mycotoxins

Traditional food processing practices may help reduce mycotoxin exposure when appropriately adapted and scaled. Nixtamalization, an alkaline maize-processing technique widely used in Latin America, has been shown to substantially reduce aflatoxin contamination. A study in Rwanda reported reductions of up to 88 per cent in aflatoxin levels following nixtamalization of contaminated maize (Twagiramungu et al., 2024), while studies in Kenya found that cooking maize with Magadi soda and ash reduced aflatoxin concentrations by more than 90 per cent (Kirui et al., 2024). Efforts are underway in Kenya to support small- and medium-scale food vendors to adopt nixtamalization techniques and develop safer maize products. These approaches demonstrate how culturally relevant food-processing practices can contribute to safer complementary foods and reduced dietary exposure for children and families.

Nutrition and public health measures

Because children's vulnerability is shaped not only by contamination levels but also by diet and health status, nutrition and public health interventions play an important supportive role. Dietary diversification reduces reliance on a single contaminated staple and can lower overall toxin intake. Promoting alternative grains such as sorghum or millet, alongside legumes, fruits and animal-source foods, improves both nutrient intake and food safety resilience. These approaches align closely with existing maternal, infant and young child feeding programmes. Risk communication is another critical strategy. Integrating mould and mycotoxin awareness into routine maternal and child health services, immunization visits, community health worker outreach and school programmes can help families recognize mould risks, adopt safer storage practices and avoid feeding visibly contaminated food to young children.

Integrated, system-wide approaches

Experience from different countries shows that combining interventions across the food system yields the greatest impact. Coordinated strategies that link agriculture extension services, market regulation, school feeding programmes and community health platforms can address multiple risk points simultaneously. School feeding programmes that procure tested, safely stored grain not only protect children directly but also create market incentives for safer production and storage practices. Integrating mould and mycotoxin prevention into nutrition, agriculture, WASH and climate resilience programmes offers an efficient and scalable pathway to reduce exposure. Public awareness campaigns can inform families about the risks to children's health from water-damaged home and school environments.

Recommended actions

Reducing children's exposure to moulds and mycotoxins requires coordinated action across agriculture, food safety, health, nutrition and environmental sectors. The following priority actions provide a practical road map for policymakers seeking to translate evidence into measurable improvements in child health.

Regulatory frameworks and enforcement

- Adopt or update national regulations in line with Codex Alimentarius maximum levels for priority mycotoxins, including aflatoxins, fumonisins, ochratoxin A and deoxynivalenol with enforceable limits covering cereals, nuts, milk and foods specifically intended for infants and young children (CAC, 2025b).
- Mandate routine testing within publicly funded programmes such as school feeding programmes, supplementary feeding programmes, emergency food distributions and social protection programmes.
- Consider market-based approaches such as certification programmes, quality grading systems and alignment with regional or international trade standards to reward producers who meet safety thresholds while discouraging the circulation of contaminated products in domestic markets.

Surveillance and laboratory capacity

- Integrate mycotoxin surveillance into national food-control plans and link with existing nutrition, agriculture and health information systems.
- Routinely test staple foods in markets, storage facilities and processing plants to provide early warning of contamination trends.
- Incorporate mycotoxin biomarkers into national nutrition or health surveys to help quantify risk and evaluate the effectiveness of interventions.
- Invest in regional reference laboratories equipped with chromatography, ELISA* and rapid test technologies, alongside training for laboratory technicians and food inspectors.
- Build decentralized capacity at subnational levels to reduce delays in detection and enable more timely responses (Turner et al., 2009).

* ELISA (enzyme-linked immunosorbent assay) is a laboratory test that uses antibodies to detect and measure specific substances in a sample.

Infrastructure and technologies

- Support access to practical technologies such as solar or mechanical dryers, raised drying platforms and hermetic storage systems with government subsidies, revolving funds or cooperative purchasing schemes to make these tools affordable for smallholder farmers.
- Promote research and innovation to expand long-term solutions, including scaling biological control products, developing resistant crop varieties and improving low-cost detoxification methods (Bandyopadhyay et al., 2016; Kumar et al., 2016).

Actions by caregivers

- Promote exclusive breastfeeding for the first six months of life as recommended by health authorities, while also taking steps to reduce maternal exposure during pregnancy and breastfeeding.
- Introduce nutritionally adequate and safe complementary (solid) foods at 6 months of age together with continued breastfeeding up to at least 2 years of age.
- Reduce consumption of mouldy appearing nuts and grains, especially from regions with known contamination.
- After flooding or water leaks, dry damp or wet items in the home or school within 24–48 hours.
- Avoid exposing infants to damp or mouldy home environments or childcare settings.

Public engagement and awareness

- Promote understanding of children's unique vulnerability to mould and mycotoxins and steps families can take to reduce risk through mass media and public awareness campaigns.
- Encourage community health workers to integrate mould and mycotoxin risk messaging into maternal and child health services, immunization visits, growth monitoring, school health programmes and community outreach to increase awareness and empower caregivers to make safer food choices.
- Promote effective prevention steps at household or farm level such as rapid drying, sorting mouldy kernels and safe storage.
- Encourage agricultural extension services, farmer organizations and women's cooperatives to play a central role in disseminating practical guidance.
- Prioritize women, who are often responsible for food preparation and storage, in training and outreach efforts.
- Following floods or home water leaks, raise awareness about the risks to children of exposure to water-damaged home and school environments.

Clinical practice of paediatrics and obstetrics

- Increase the capacity of health care workers to routinely counsel families about reducing mould and mycotoxin exposure, and facilitate their access to continuing education.
- Include content on the health impacts of mould and mycotoxins, particularly their effects on fetal development and child growth, in medical education curricula and continuing professional development.
- Integrate mould and mycotoxin information and exposure-reduction counselling into reproductive health and antenatal care training programmes, to reduce adverse birth outcomes including neural tube defects (Hassen et al., 2024).
- Address aflatoxin exposure during the periconceptional period and pregnancy (Hassen et al., 2024).
- Advise all women who may become pregnant to take 400 µg folic acid daily, both as standard practice for preventing neural tube defects and because folic acid supplementation may help offset the teratogenic effects of fumonisin exposure (Sadler et al., 2002; Viswanathan, 2023).
- Link these recommendations to existing antenatal care and family planning services.

Cross-sectoral coordination

- Establish national or subnational mycotoxin task forces that bring together agriculture, health, food safety, trade and environment authorities to harmonize standards, share surveillance data and align investments across sectors.
- Integrate mycotoxin prevention into programmes linked to WASH, nutrition, school feeding, early childhood development and climate resilience initiatives to ensure that food safety considerations are embedded within broader child health strategies.

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UNICEF acknowledges the following contributors for their participation in developing this document:

Research and writing: David Githang'a, Kenya Paediatric Association; Ambrose Agweyu, Kenya Medical Research Institute, Nairobi, Kenya and Wellcome Trust Research Programme and London School of Hygiene and Tropical Medicine

Guidance: Abheet Solomon, Ruth Etzel, UNICEF

Additional review: Charity Mutegi, Rootooba, Nairobi, Kenya and Katelyn Greer, UNICEF

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United Nations Children's Fund

3 United Nations Plaza
New York, NY 10017, USA

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