

# APPLICATION OF MATHEMATICAL MODELS TO MYCOTOXINS CHILDREN RISK ASSESSMENT: A CASE STUDY OF PORTUGUESE CHILDREN EXPOSURE TO CO-OCCURRING MYCOTOXINS IN PROCESSED CEREAL-BASED FOODS

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## Background

- People, animals and the environment can be exposed to **single** and **multiple chemicals** at once from a variety of sources.
- Risk assessment is usually carried out based **on one chemical substance at a time**.
- Mycotoxins
  - fungal secondary metabolites that are known to potentially cause **toxicity and carcinogenic** outcomes;
  - commonly found in a variety of foods including those intended for consumption by **infants and young children**, namely in **processed cereal-based foods available in the Portuguese market**<sup>1</sup>.
- The use of **mathematical models**, including probabilistic approaches using **Monte Carlo simulations**, constitutes a prominent issue in human health risk assessment.

## Aims

- Characterize**, for the first time, the **risk** associated with the **exposure of Portuguese children to single and multiple mycotoxins** present in **processed cereal-based foods (CBF)**:
    - Food consumption data
    - Contamination data
    - Exposure assessment
- Risk Characterization**

## Methodologies

- Food consumption data**  
Food consumption data of children (0-3 years old) from Lisbon region (n=103) were collected using a 3 days food diary.
- Contamination data**  
Aflatoxins and ochratoxin A were quantified in 20 CBF samples marketed in 2014 and 2015 in Lisbon. Analysis were performed by HPLC-FLD<sup>1</sup>.
- Exposure assessment**  
Daily exposure of children to mycotoxins was performed using deterministic and probabilistic approaches. Different strategies were used to treat the left censored data (mycotoxin levels < limit of detection, LOD)<sup>2</sup>.

## Results

### Processed cereal-based foods consumption

- Approximately 47% of the studied children consumed CBF at least one time in these 3 days.
- 27% of consumers were aged < 1 year old and 73% aged between 1 and 3 years old.

### Contamination of processed cereal-based foods

- 75% of analyzed CBF were contaminated with, at least, one mycotoxin.
- OTA presented the highest contamination level.
- All samples revealed levels of AFB<sub>1</sub> and AFG<sub>2</sub> below the LOD value.

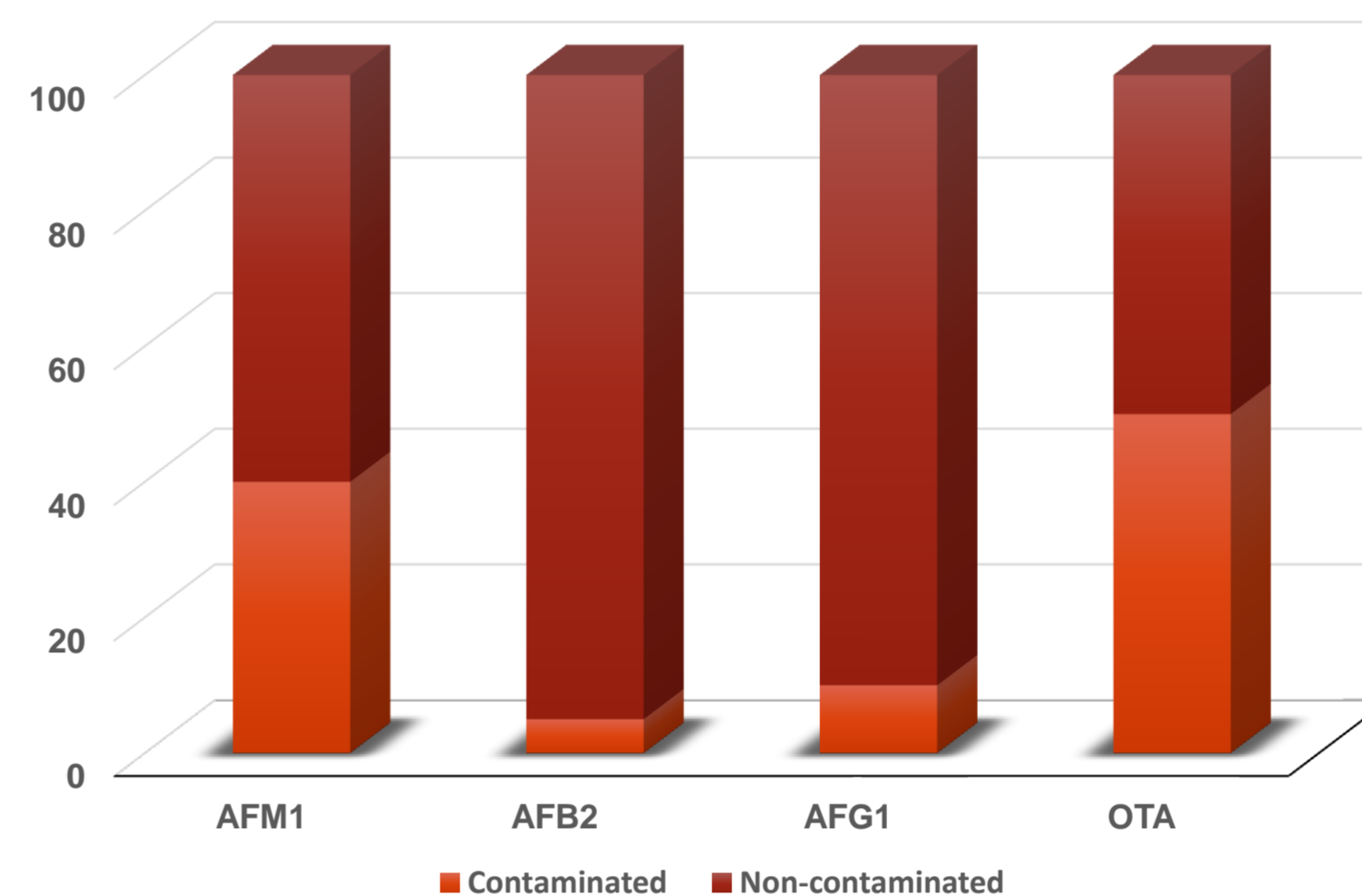


Fig. 1: Percentage (%) of contaminated samples, considering each mycotoxin (n=20).

### Exposure assessment & Risk characterization

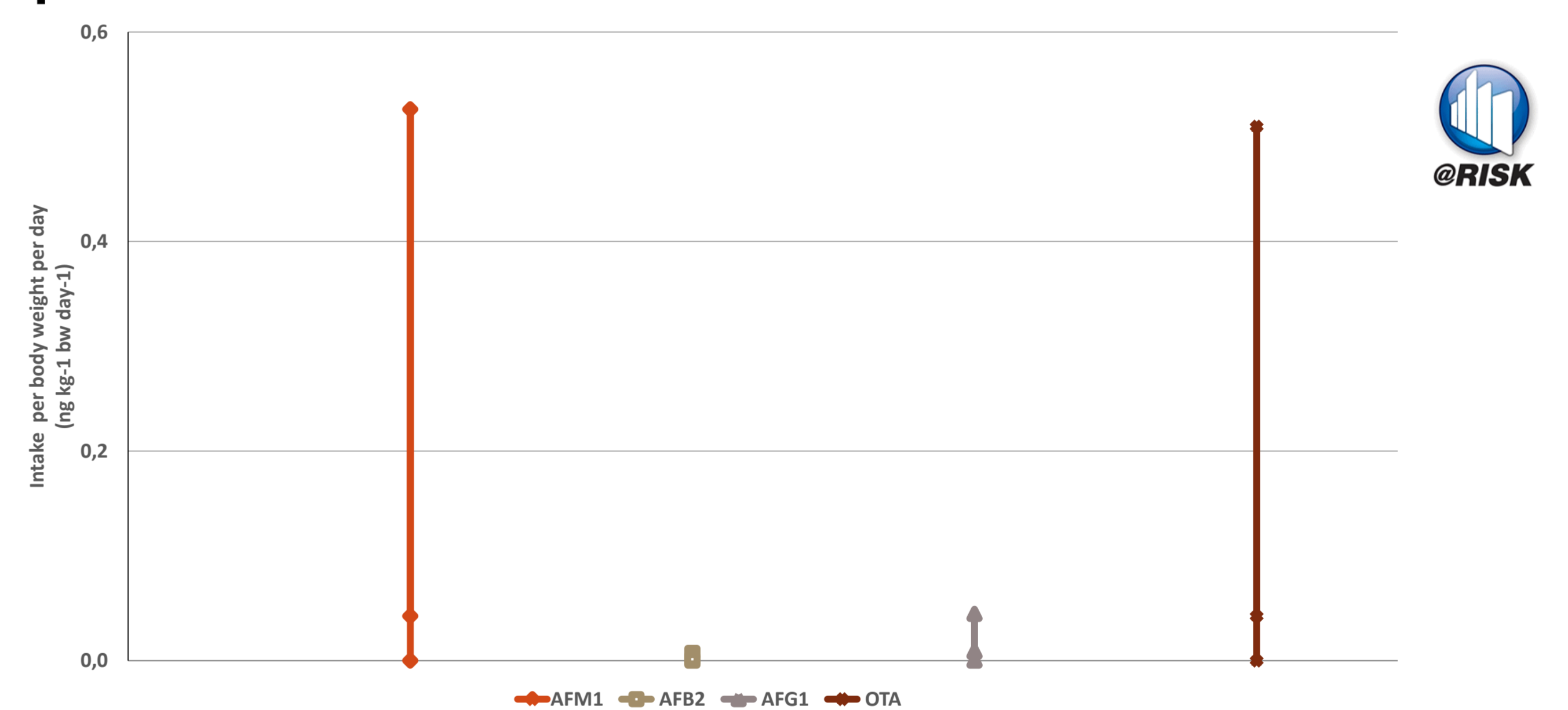
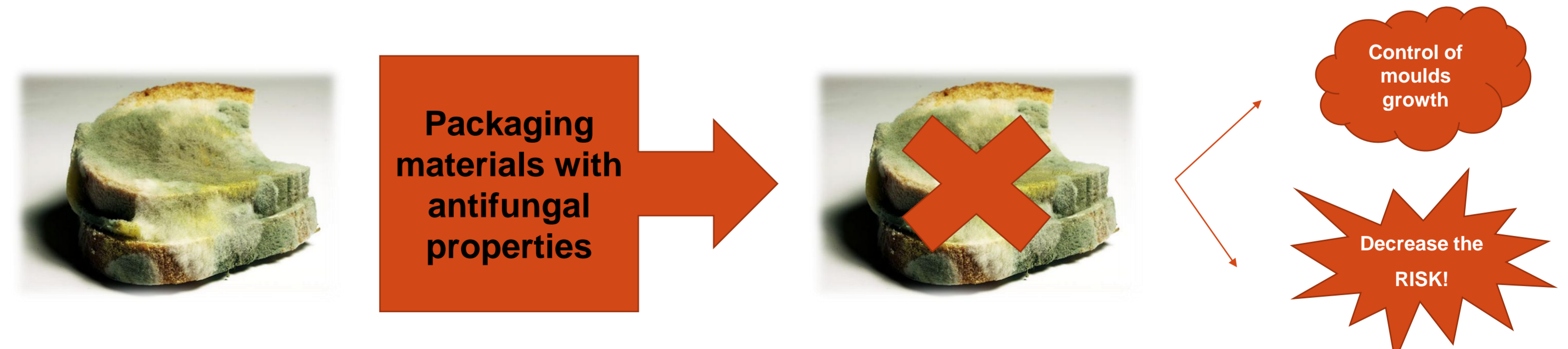


Fig. 2: Results of deterministic (central mark, mean value) and probabilistic approaches (top and down marks for P1 and P99) to estimate children exposure to aflatoxins M<sub>1</sub>, B<sub>2</sub>, G<sub>1</sub> and ochratoxin A, through ingestion of processed cereal-based foods (ng.Kg<sup>-1</sup> bw.day<sup>-1</sup>). Results show fourth scenario (<LOD = uniform distribution with min=0 and max=LOD). Remaining scenarios followed the same pattern.

- AFM<sub>1</sub> revealed a margin of exposure (MoE) below 10000 suggesting potential health concern for the higher percentiles of intake ( $\geq$  P75). MoE of the remaining aflatoxins were above 10000 for all percentiles<sup>3</sup>.
- OTA presented a hazard quotient (HQ) below 1 for all percentiles, suggesting no potential health concern<sup>3</sup>.
- Considering the co-occurrence of aflatoxins, and applying the concentration addition concept, combined margin of exposure (MoET) was below 10000 for  $\geq$  P75 and this fact constitutes a potential health concern<sup>3</sup>.



**Children** are a particularly **vulnerable population group** to food contaminants and the present results point out an **urgent need to establish legal limits and control strategies** regarding the presence of multiple mycotoxins in children foods in order to protect their health. The development of **packaging materials with antifungal properties** is a possible solution to control the growth of moulds and consequently to reduce mycotoxin production, contributing to guarantee the **quality and safety of foods intended for children consumption**.