MALAWI

IFPRI

Market demand for and nutrient and mycotoxin levels in commercially-sold premixed cereals for complementary feeding of infants in Malawi

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Presentation overview

1. Quick overview of the study design
2. Background and motivation for the study
3. Methodology
4. Valuation results
5. Contamination and quality results
6. Conclusions and policy recommendations

Study Design for USAID-funded project with Tufts University

1. Market-intercept survey to elicit:
   - Willingness to pay (WTP) using random-price auctions for real infant foods
   - Substitution for other foods using a hypothetical choice experiment
   - Respondent characteristics

2. Collection and testing of infant cereal samples

3. Key informant interviews with food producers and policy actors

Background – child health and complementary foods

- Stunting rates declining, but remain high in Malawi (37%)
- Most growth faltering happens during weaning period (4-24 months)
- Need for nutrient-dense, safe complementary foods

Background – porridges in Malawi

- Most homemade porridges are:
  - Bulky with low nutrient density
  - Low bioavailability of iron and zinc
  - Contamination with pathogens and/or mycotoxins

- Commercially-sold premixed cereals (CPC) can offer
  - Consistent and appropriate macro- and micronutrient densities
  - Can reduce risk of contamination and reduce fuel use when precooked
  - Can save caregivers time

- DHS 2015-16: Only 5% of infants and young children (6-35 months) received *likuni phala* in past 7 days

Background – food quality & mycotoxins

- Mycotoxins
  - Aflatoxin
  - Fumonisin
- Carcinogenic and acutely toxic in high concentrations
- Particularly concerned about children's intake
  - Linked to stunting and immune system suppression
  - Body cannot excrete or destroy them
  - Exposure begins in utero and is cumulative over lifetime
  - Effects potentially enhanced by co-exposure

Aflatoxin in maize. (Photo credit: Blair Fannin, Texas A&M).

Aflatoxin in groundnuts. (Photo credit: IITA).

Background – food quality labeling & standards

- DMS90 for high-protein cereal-based foods for infants and young children
  - Updates MS90 for high protein baby foods (1988)

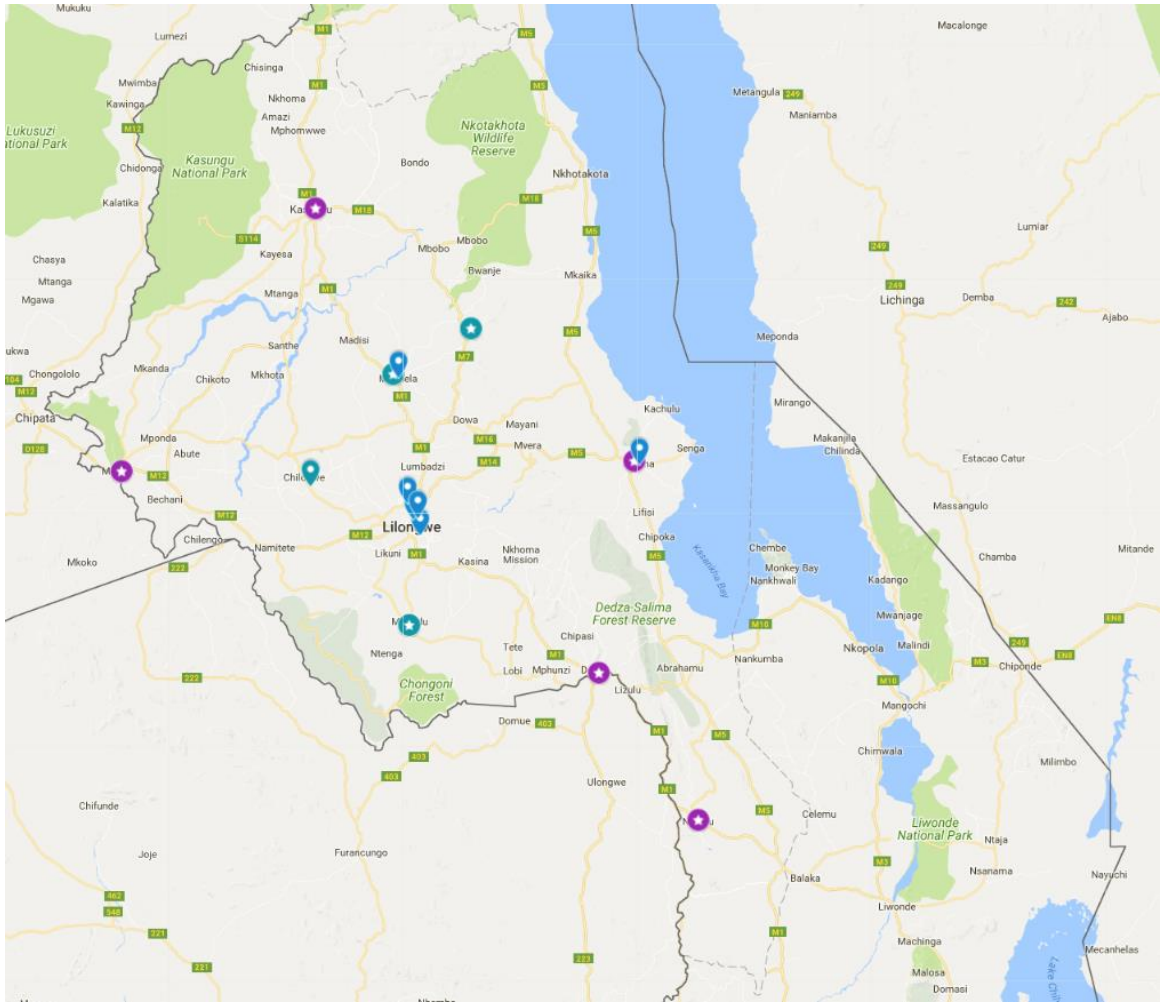
- Considerable evidence globally of both inaccurate labeling

- Also considerable evidence of variable, insufficient nutrient content in baby foods (Dimaria et al. 2018, Masters, Nene, and Bell 2017)

MARKET DEMAND & VALUATION

Market-intercept surveys

- 9 markets, 7 supermarkets
- Mothers and caregivers of children 6-23 months
- Interviewed in market, at point of sale



Current and ideal infant feeding foods

Table 1. Current and ideal infant feeding practices

	Current diet [a] %	Ideal feeding [b] %
At-home porridge	74	81
Maize flour	92	91
Groundnut flour	64	83
Soybean flour	49	86
Bean flour	9	20
Other	17	15
Fortified, premixed porridge	7	52

Child has consumed	Past 7 days %	Ever in their life %
Fortified, premixed porridge	12	37
Fortified nut butters	3	12
Infant formula	1	6
Micronutrient sprinkles	0	1
None of the above	85	58

Note: [a] Current diet reflects the proportion of children who consumed this food in the past 24 hours. [b] Ideal feeding reflects the proportion of caregivers who reported the item as part of the best combination of foods they could offer their child in a typical week.

- Caregivers rely primarily on at-home porridges made of maize, and either groundnuts or soy
- Considerable interest in fortified, premixed porridge relative to actual use

Preferences between cereals and family foods

- Series of 12 hypothetical choices
- In each choice, respondent has to decide between a portion of one food in exchange for a portion of another:
  - Plain maize porridge
  - Cereal like *likuni phala*
  - Family food/*ndiwo (3 types)*

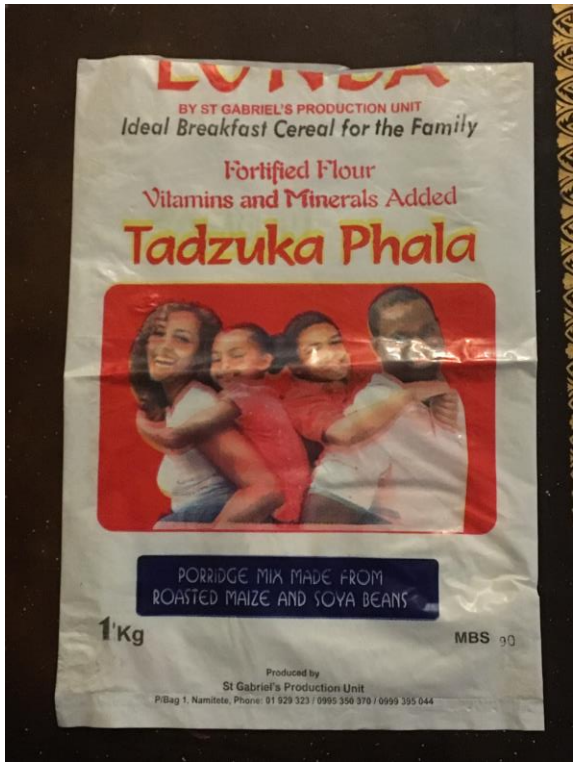
Preferences between cereals and family foods

- Respondents chose the *likuni phala* over plain maize porridge 84% of the time.
- When choosing between *likuni phala* and *ndiwo* (vegetables/beans/family foods), 81% of the time respondents chose *likuni phala* over *ndiwo*
- Most commonly, respondents chose the *likuni phala* **over both plain maize porridge and family foods.**

Willingness to pay

- Becker-DeGroote-Marshak auctions
  - Revealed preferences – not hypothetical
  - Maximum amount **willing and able** to pay
- Respondents have 2,000 MWK with which to buy, given at beginning of survey
- Practice rounds conducted with soap

Cereals auctioned



Willingness to pay v. observed supply cost

Table 2. Mean willingness to pay versus observed minimum market prices (MWK/100g).

	WTP			Observed minimum			Diff=	Ha: diff > 0	Ha: diff ≠ 0
	Mean	SD	N	Min	SD	N	Obs	p-value	p-value
Lunda Likuni Phala	93.46	66.52	338	58.00	7.60	5	35.5	0.00	0.00
Lunda Tadzuka Phala	72.36	50.46	338	74.80	0.00	3	-2.4	0.81	0.37
Rab's Sunshine	110.34	81.02	338	75.00	22.53	18	35.3	0.00	0.00
Nestlé Cerelac	338.43	234.14	338	799.60	110.54	16	-461.2	1.00	0.00

Notes: SD is the standard deviation of the mean. Observed minimum prices are used as a proxy for supply cost. Observed market prices are from a convenience sample and not necessarily representative of national average prices. P-values are from *ttest* assuming unpaired samples with unequal variances.

- Customers only WTP above the supply cost for Lunda LP and Rab's Sunshine
- Highest WTP was for Cerelac, but WTP was well below minimum observed price
- Consumers WTP more for Lunda Likuni Phala than for Tadzuka Phala – identical cereals, diff. package

Selected WTP regression results

- Information treatment had no impact on WTP
  - “Made especially for babies, with more nutrients than regular maize.”
  - “Made especially for babies, with most of the nutrients in beans, greens, fruits and vegetables”
- Brand is the most important predictor of WTP
- Wealth was an important predictor of WTP
  - Wealth and brand interactions can tell us something about how to market/target these cereals
- Education level of the caregivers was not a significant predictor, but comprehension of the auction was
- Knowledge of aflatoxin did not show a significant impact on WTP for cereals
- Market type – WTP was significantly higher in *bomas*/large marketplaces

Willingness to pay – respondent and household determinants

CATEGORIES	VARIABLES	(1) FINAL OLS REGRESSION	(2) CONTROLS ONLY
Information treatment	Many nutrients in fruits & vegetables	-1.49	5.99
Omitted = more nutrients than maize			
	BDM comprehension is above median score	-43.57***	
	Adult equivalents	-1.27	
	Age in months of youngest child between 6-23 months	-1.24**	
	Infant's dietary diversity score (max = 7)	7.38**	
	Knowledge of aflatoxin	-1.64	
Education category	Primary (Standards 1-8)	7.76	
No school = omitted	Secondary (Form 1-4 & Certificate)	17.79*	
	Higher ed.	16.50	
Wealth (asset-based)	Wealth quintile 2	16.87**	
Poorest (quintile 1) = omitted	Wealth quintile 3	-3.99	
	Wealth quintile 4	2.38	
	Wealth quintiles 5	-1.32	
Brand	Brand 1: Likuni (Lunda)	41.68***	68.68***
Brand 0: Maize flour = omitted	Brand 2: Tadzuka (Lunda)	30.03***	48.14***
	Brand 3: Rab's	57.84***	85.53***
	Brand 4: Cerelac	178.53***	317.42***

Notes: Robust standard errors were used. *** p<0.01, ** p<0.05, * p<0.1.

Willingness to pay – brand interactions

CATEGORIES	VARIABLES	(1) FINAL OLS REGRESSION	(2) CONTROLS ONLY
Brand * Wealth quintiles			
Lunda LP * Wealth quintiles	Likuni (Lunda) * poorest	0.00	
	Likuni (Lunda) * wealth cat. 2	14.13	
	Likuni (Lunda) * wealth cat. 3	26.74**	
	Likuni (Lunda) * wealth cat. 4	9.69	
	Likuni (Lunda) * wealthiest	28.12**	
Lunda TP * Wealth quintiles	Tadzuka (Lunda) * poorest	0.00	
	Tadzuka (Lunda) * wealth cat. 2	0.58	
	Tadzuka (Lunda) * wealth cat. 3	13.38	
	Tadzuka (Lunda) * wealth cat. 4	9.48	
	Tadzuka (Lunda) * wealth cat. 4	24.98**	
Rab's * Wealth quint	Rab's * poorest	0.00	
	Rab's * wealth cat. 2	6.28	
	Rab's * wealth cat. 3	44.52***	
	Rab's * wealth cat. 4	19.31	
	Rab's * wealthiest	22.29*	
Cerelac * Wealth quint	Cerelac * poorest	0.00	
	Cerelac * wealth cat. 2	58.76*	
	Cerelac * wealth cat. 3	141.28***	
	Cerelac * wealth cat. 4	76.80***	
	Cerelac * wealthiest	206.40***	
Brand * Comprehension			
Lunda LP * Comprehension	Likuni (Lunda) * Poor	0.00	
	Likuni (Lunda) * Avg-good	22.71***	
Lunda TP * Comprehension	Tadzuka (Lunda) * Poor	0.00	
	Tadzuka (Lunda) * Avg-good	16.71**	
Rab's * Comprehension	Rab's * Poor	0.00	
	Rab's * Avg-good	18.45**	
Cerelac * Comprehension	Cerelac * Poor	0.00	
	Cerelac * Avg-good	85.99***	

Notes: Robust standard errors were used. *** p<0.01, ** p<0.05, * p<0.1.

Willingness to pay – controls

CATEGORIES	VARIABLES	(1) FINALOLS REGRESSION	(2) CONTROLS ONLY
Auction order	First cereal auctioned	-21.68**	-20.23**
0 (maize flour) = omitted	Second cereal auctioned	-10.71	-10.15
	Third cereal auctioned	-1.92	-4.34
	Fourth cereal auctioned	-	-
Enumerator	Enumerator 2 (Male)	96.42***	92.22***
Enumerator 1 (Male) = omitted	Enumerator 3 (Female)	47.80***	49.25***
	Enumerator 4 (Male)	-4.24	7.05
Market type	Main market / boma	17.72***	25.14***
Growing = omitted	Supermarket	12.60	24.65***
Interview conducted	Mid-morning	-5.24	-12.47*
Morning = omitted	Afternoon	3.70	-1.44
Constant	Constant	-12.01	-27.80***
		(16.387)	(10.406)
	Observations	1,685	1,690
	R-squared	0.576	0.519

Notes: Robust standard errors were used. *** p<0.01, ** p<0.05, * p<0.1.

Conclusions – market demand

- Traditional at-home porridges dominate current consumption, but there is interest in fortified, premixed porridges
- Caregivers state preference to substitute *likuni phala* for both maize porridge and family foods
  - Preferable that it only substitutes for the nutrient-poor starchy staple
- WTP is above considerably higher than supply cost for Lunda LP and Rab's Sunshine, suggesting unmet market demand
  - Anecdotally, these were not widely available in surveyed marketplaces

NUTRIENT CONTENT & MYCOTOXIN CONTAMINATION

Nutrient composition relative to MBS standards

Table 3. Proximate composition, iron and zinc content of pre-mixed cereal samples and compliance with MBS standards

		All	All	All	Infant	Fortified	Malawi	Foreign
Number of samples		94	94	94	78	90	37	57
Nutrient	**Required level**	**Med (IQR)**	**Mean ± SD**	**% of samples that met standard**				
Protein	14 g/100 g (min)	14.2 (1.9)	13.5 ± 2.8	**56**	56	58	78	42
Fat	8 g/100 g (max)	8.8 (5.7)	7.4 ± 2.9	**39**	38	38	**16**	54
Moisture	11% (max)	5.6 (2.8)	5.4 ± 2.1	98	97	98	100	96
Ash	5% (max)*	2.4 (0.8)	2.4 ± 0.7	100	100	100	100	100
Iron	4 mg/100 g*	16.0 (9.4)	**16.5 ± 9.7**	97	100	100	92	100
Zinc	5 mg/100 g*	4.1 (2.6)	4.6 ± 2.0	**35**	35	37	30	39

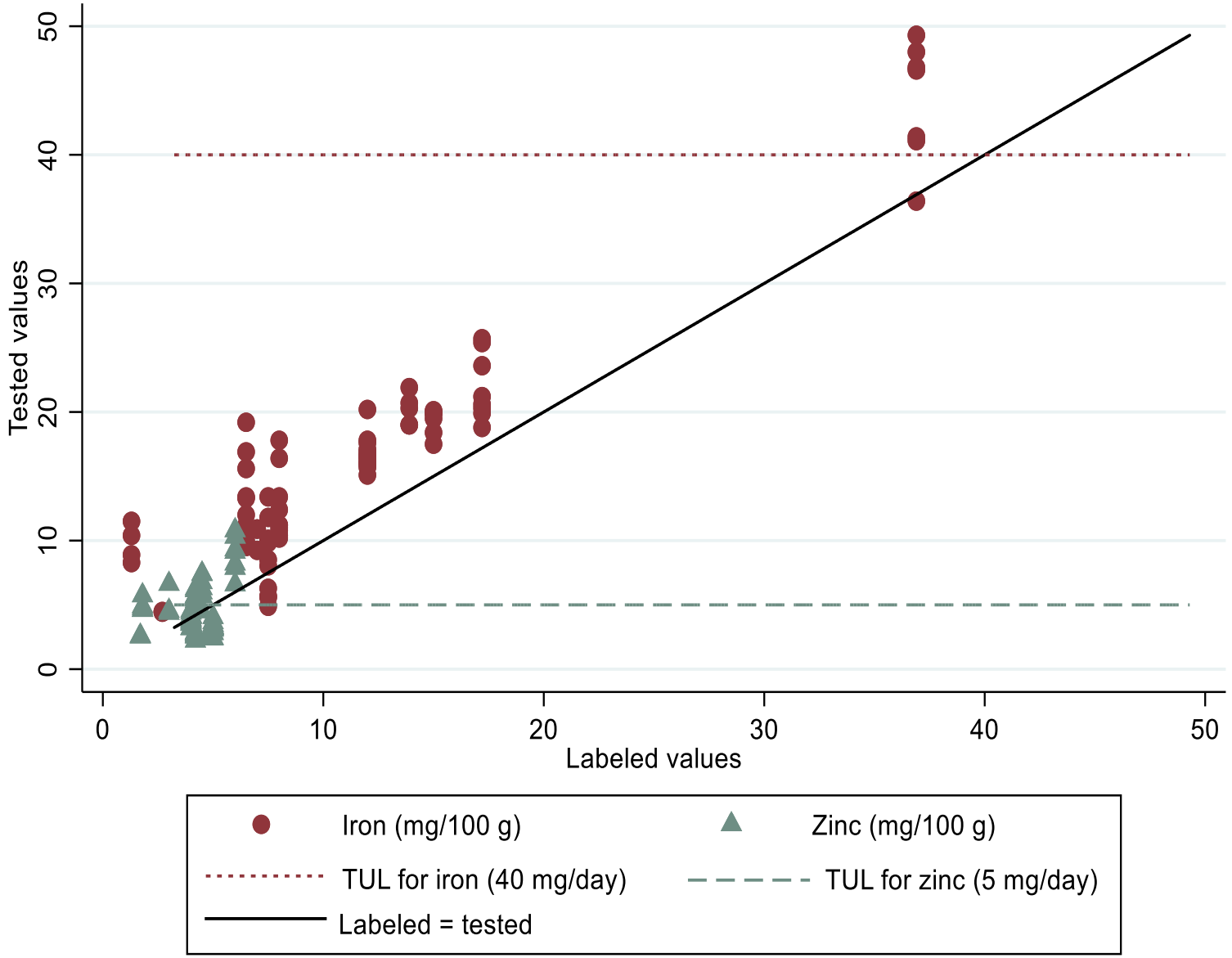
Notes: The MBS standards presented here are those included in MS90:1988 for high-protein infant cereals, and those which are starred (*) have been proposed in the draft Malawi Standard 90 (DMS90:2017) for high-protein cereal-based foods for infants and young children.

Macro and micronutrient issues

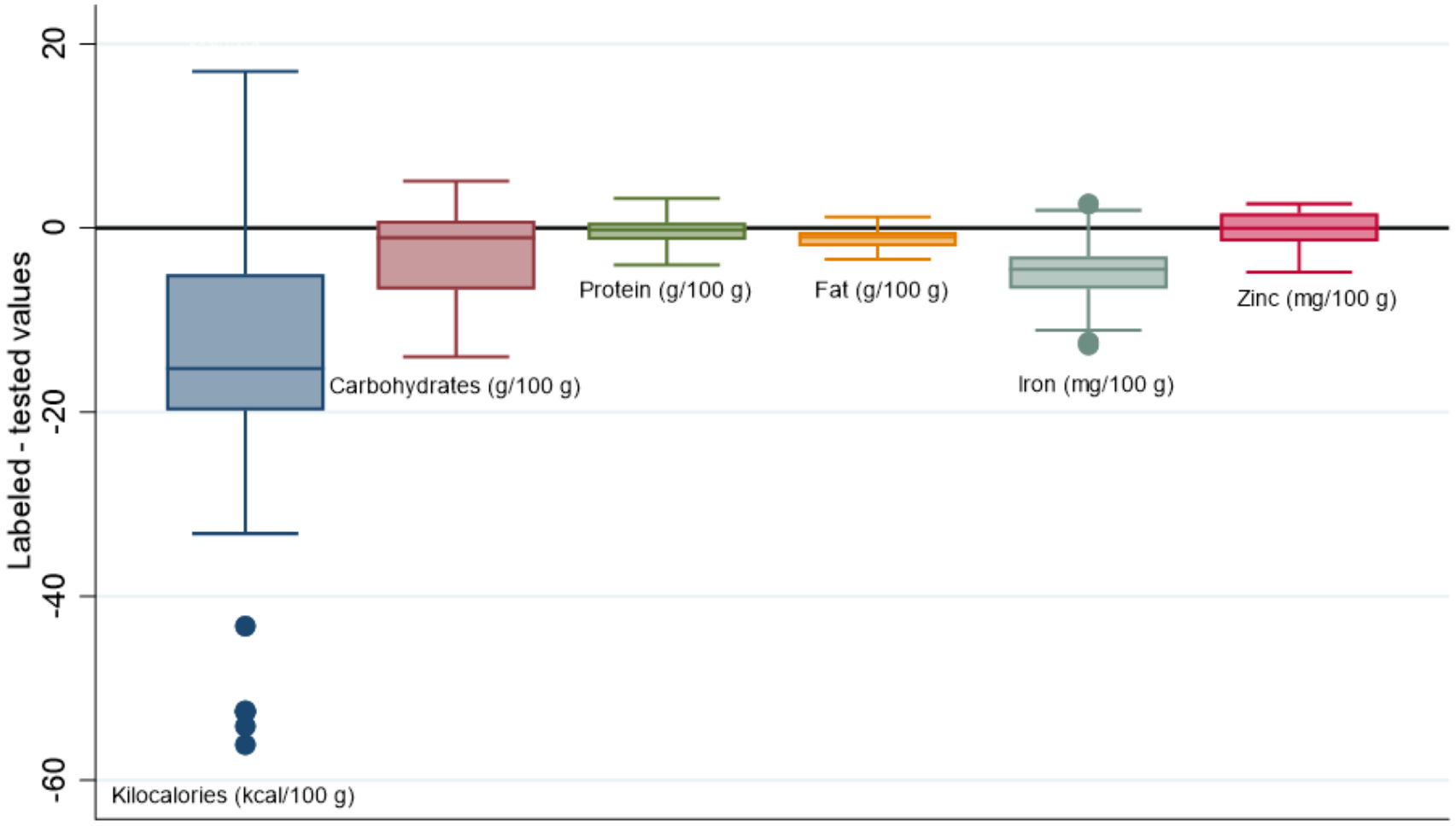
- Fat
  - MBS: maximum of 8 g while others recommend a minimum of 9 g (Lutter & Dewey 2003)
  - Should be 24% of energy as fat for infants 6-11 months, 28% for 11-23 months
- Protein
  - Imported cereals performing worse than locally-produced cereals
  - Some international standards suggest 16 g minimum
- Iron
  - Despite meeting minimum standards, high & highly variable iron content
- Zinc
  - Minimum zinc standards not met, in spite of fortification
  - Zinc standards is also the tolerable upper limit for zinc for 7-12-month-old children

Tolerable upper limits

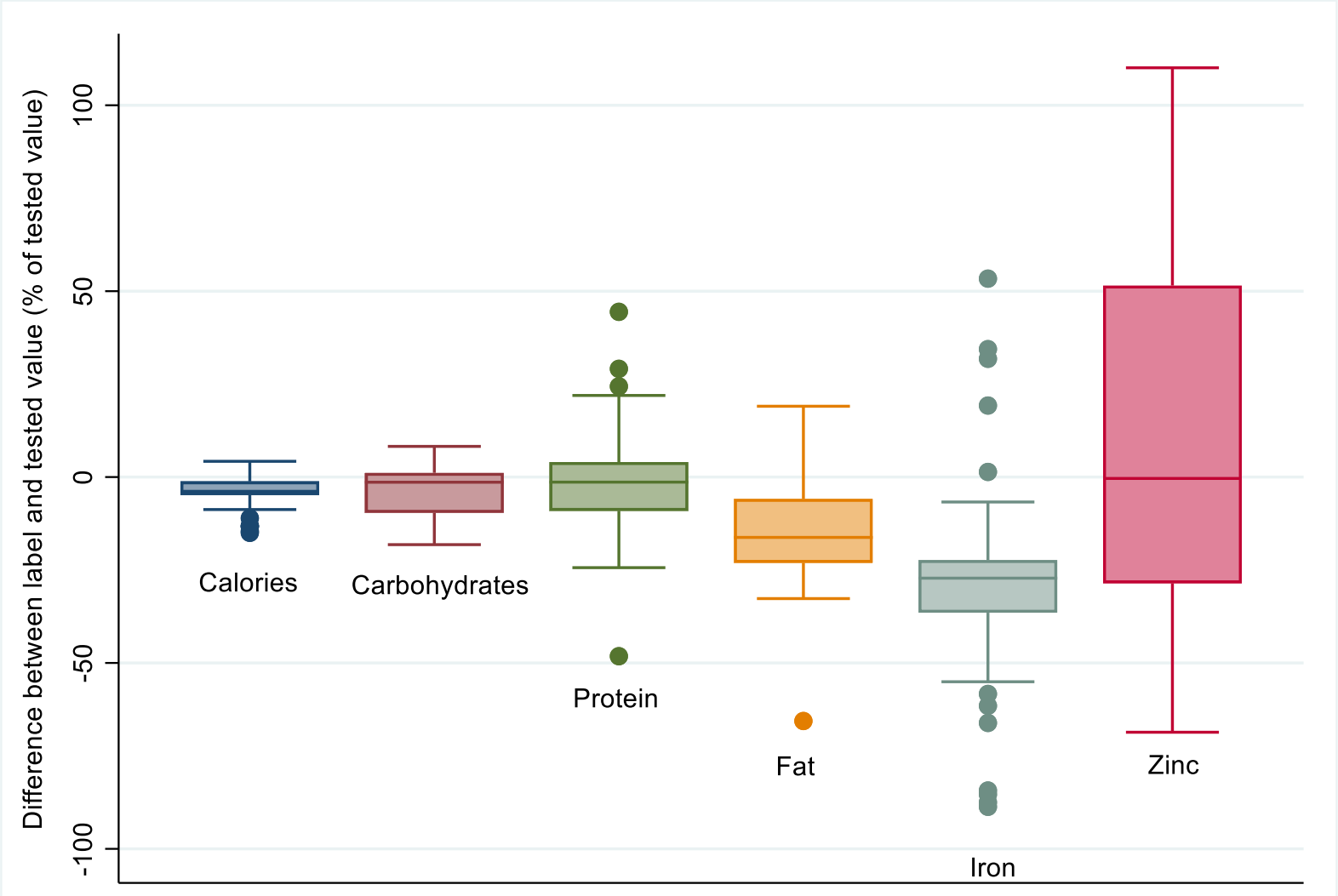
- Unsafe for children's health to exceed UL
- Bad feeding experience could alter preferences
- Poor use of expensive vitamin/mineral premix



Labeled versus tested values – absolute differences



Labeled versus tested values – relative differences



Aflatoxin and fumonisin contamination

Table 5. Mycotoxin levels in pre-mixed cereal samples and compliance with existing and proposed standards

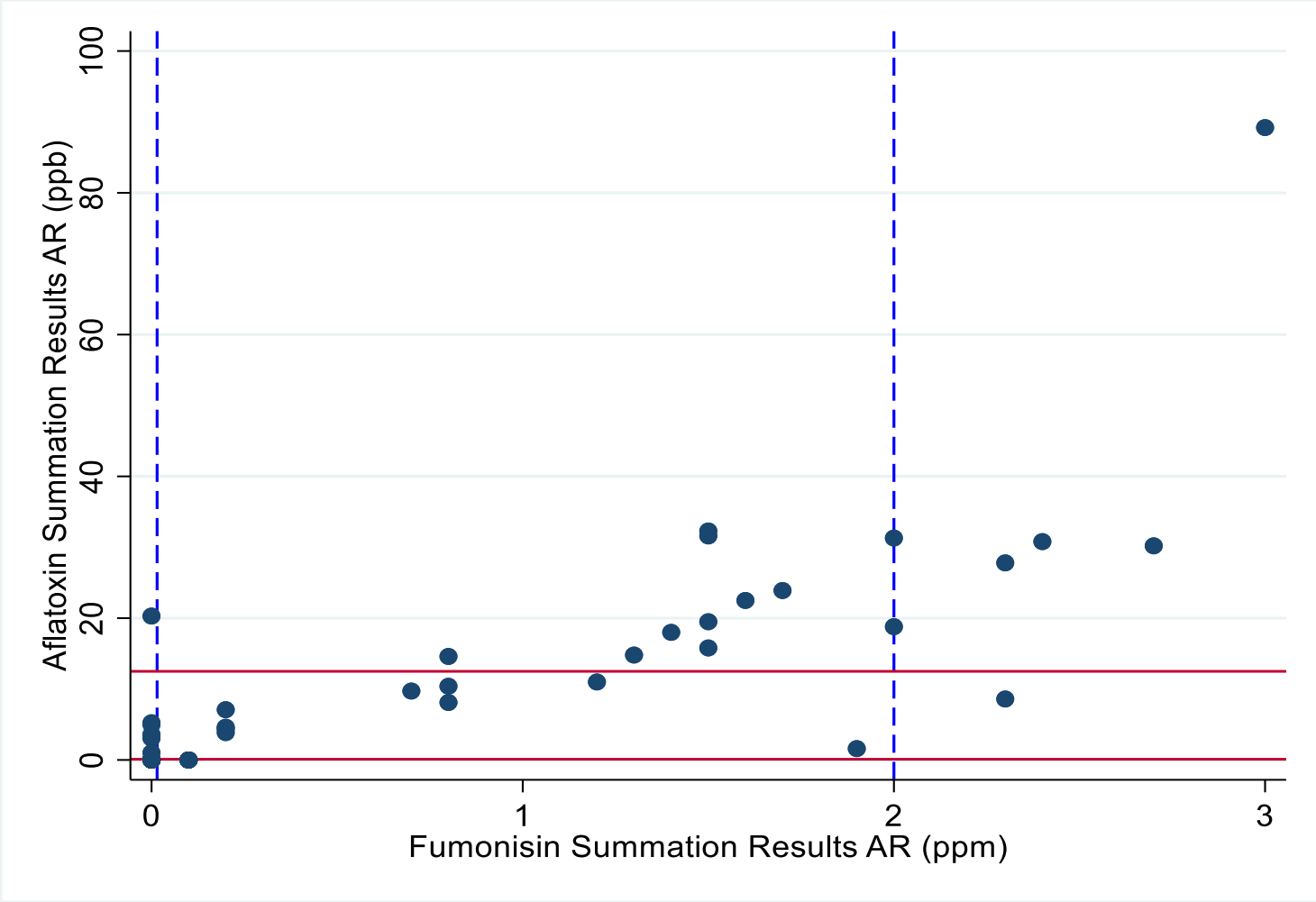
			All	All	All	Infant	Fortified	Malawi	Foreign
		N	94	94	94	78	90	37	57
Mycotoxin	**Standard**	**Limit [c]**	**Med (IQR)**	**Mean ± SD**		**% of samples that met standard**			
Aflatoxin	MS90:1988	12.5 ppb	0 (5.0)	5.7 ± 12.5	83	81	82	56	100
Aflatoxin	DMS90:2017	0.1 ppb	0 (5.0)	5.7 ± 12.5	66	69	66	**19**	96
Fumonisin [b]	JECFA	0.015 ppm	0 (0.2)	0.4 ± 0.7	66	73	66	**16**	97

Notes: The current aflatoxin standard is included in MS90:1988 for high-protein infant cereals, while the proposed aflatoxin standard is included in the draft Malawi Standard 90 (DMS90:2017) for high-protein cereal-based foods for infants and young children.[a] Fumonisin levels are not included in either MBS standard for infant foods. [b] Fumonisin level is set using health-based guidance values of 2 µg/kg body weight/day (JECFA 2016), assuming a median weight of 7.5 kg for a six-month-old child (Maleta 2003). [c] Non-detectable levels for aflatoxin and fumonisin were replaced with zeros for this analysis.

- Malawian cereals perform very poorly relative to imported products –
  - 44% of local cereals still don't meet MBS standard in place since 1988
  - Less than a fifth of all cereals meet standards that would protect infants' health

- 15% of samples had aflatoxin B1 concentrations two orders of magnitude higher than the EU standard for B1 in baby foods (0.1 ppb), and 34% percent of cereals did not meet that standard

Aflatoxin and fumonisin contamination



- 57% had no detectable levels of either mycotoxin
- Concerns about co-exposure
  - Possibly synergistic

Conclusions – quality

- Large and small foreign and local producers of infant cereals have trouble meeting quality standards and the macronutrient and micronutrient needs of infants – this is not limited to small, local producers.
  - General trend towards underreporting content on labels relative to actual values
- Locally-produced infant cereals are contaminated with mycotoxins at levels which are unsafe for babies
- Iron and zinc levels poorly managed for infants
  - Variable, exceed upper limits
  - Fortificants/premix not targeted at infants
- MBS fat standards should be revisited

Overall conclusions

- Locally-produced infant cereals have inconsistent quality and are contaminated with mycotoxins, but are likely still a better choice for mothers and caregivers than homemade porridges
  - Need to beware of substitution for nutrient-dense family foods; majority of children not meeting minimum dietary diversity

- There is unmet demand for locally-produced infant cereals in Central Malawi

Policy recommendations: Malawi Bureau of Standards

- Prioritize gazetting of Malawi Standard 90 ASAP
  - Reconsider fat content
  - Ensure that producers of these cereals are aware that this new standard exists
  - Explain to producers how it will be enforced and repercussions for failures
- Transparency
  - Standards should be freely available to the public, rather than for sale, and available online
  - Test results should be in the public domain
  - MBS should be incentivized to fairly and consistently enforce standards beyond certification stage
- MBS needs human and financial capital to increase market surveillance
  - Laboratory testing could be outsourced to labs which have demonstrated an ability to accurately test these types of products
  - Separate, independent lab for testing could also avoid potential influence over test results, and allow producers to challenge or verify results which seem inaccurate
  - Better coordination with other government entities involved in market surveillance (i.e. for fortification)

Policy recommendations

- Mycotoxin reduction in foods eaten by Malawians should be a priority
  - Emphasis on human health risks for Malawians in addition to export quality
- Sensitize people about food safety and quality, and how to identify and prepare safer foods.
  - At-home porridges dominate; their quality has the largest effect at this point in time
  - Evidence of graded-out groundnuts being added to at-home porridges
- Technical assistance clearly needed for producers to meet new, higher standards.
  - Need to train local food producers in best manufacturing practices and Hazard Analysis for Critical Control Points (HAACP)
  - Address possible issues with affecting micronutrient content i.e. quality and use of fortificants/premix
- Maize is the most likely entry point for aflatoxin and fumonisin in locally-produced cereals.
  - Help producers identify the safest possible sources of maize and soy, if these exist
  - If no safe source exists, help minimize continued contamination in their facilities (i.e. best practices for storage)

Other considerations

- Consider cooperative structure or find new financing mechanisms for smaller producers to facilitate investment in quality control measures:
  - Consistent access to expensive, imported vitamin/mineral premix
  - Bulk packaging
  - Greater demand for maize – could prioritize aflatoxin testing or if known supplier of higher quality maize
  - Machinery for extrusion – precooked cereals are ideal

- Consider private third-party certification of infant cereals for mycotoxin levels/quality.
  - Research needed on who consumers in Malawi trust
  - Research needed on how people understand food labels

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- Enumerators
- Key informants and survey participants for their time
- IFPRI Malawi office for their support – particularly in preparing DCE foods!

ADDITIONAL SLIDES
NOT FOR PRESENTATION

Marketplaces sampled

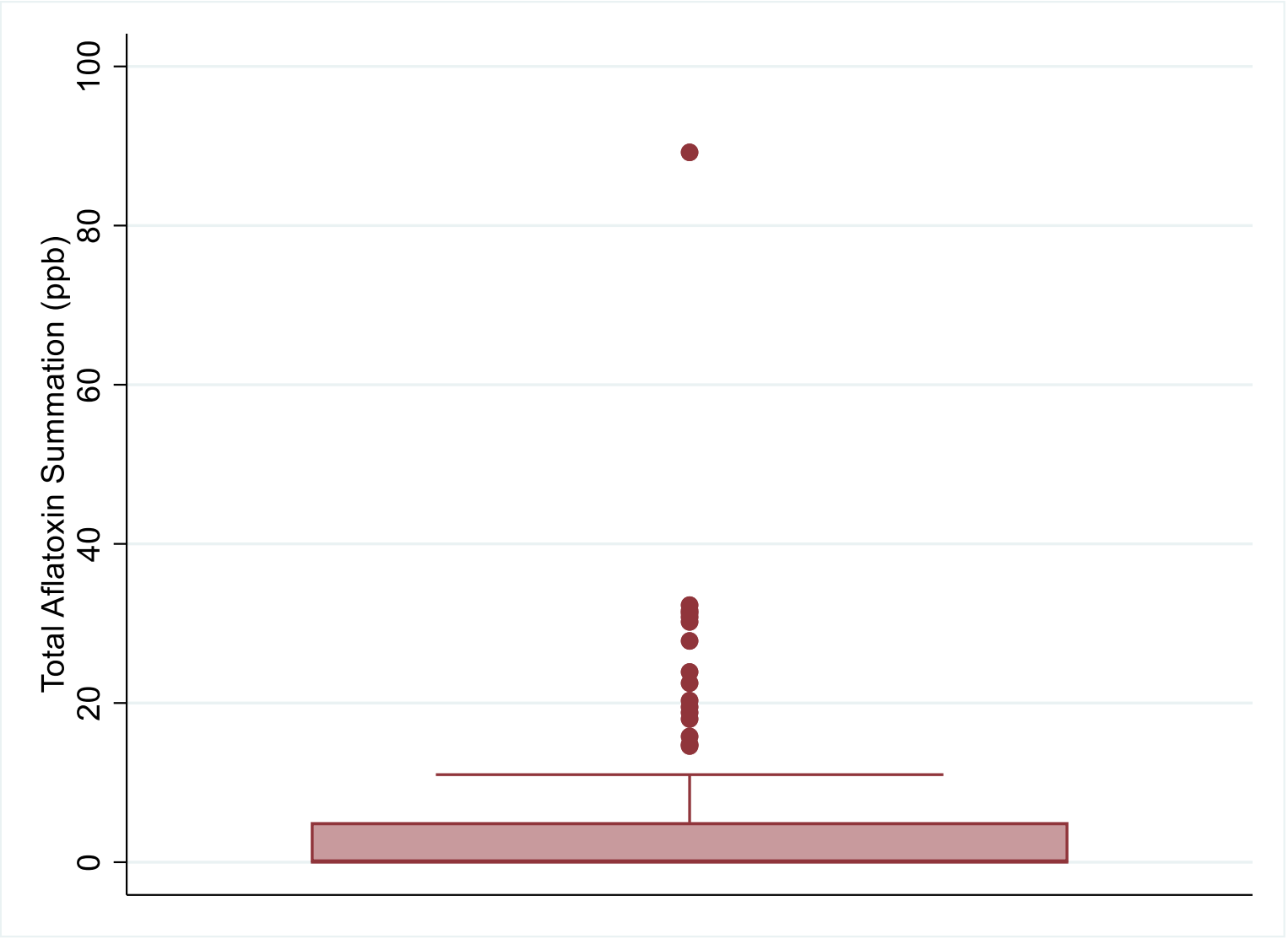
- Marketplace surveys were conducted at nine markets where the Malawi National Statistics Office (NSO) undertakes price monitoring, as well as seven supermarkets
- All in Central Region

Table 1. Sample location

Market type	District	Name of market
Main market*	Dedza	Dedza
	Ntcheu	Ntcheu
	Salima	Salima
	Kasungu	Kasungu
	Mchinji	Mchinji
Growing market*	Lilongwe	Mitundu
	Lilongwe	Nsalu
	Lilongwe	Mponela
Supermarket	Lilongwe	Chipiku (Kawale)
	Salima	Chipiku (Salima)
	Lilongwe	People's (Area 18)
	Lilongwe	Chipiku (Area 25)
	Lilongwe	Sana (Area 3)
	Salima	People's (Salima)

Notes: *as classified by the NSO

Total aflatoxin results – all cereals



Labeling discrepancies relative to infants' needs

Table 7. Differences in labeled and tested values as a percentage of estimated nutritional needs of infants.

	Difference (label-tested)		Desired intakes from CF [a]		Median diff as % of desired intake			
Nutrient (per 100 g DM)	**Median**	**Largest**	**6 mos.**	**24. mos.**	**6 mos.**	**24. mos.**	**Tested min.**	**Tested max.**
Calories (kcal)	-15.0	235.8	167.3	633.4	9.0	2.4	346.0	435.0
Carbohydrates (g)	-1.1	-14.0	NA	NA	NA	NA	61.9	82.8
Protein (g)	-0.2	-4.0	3.3	6.0	6.1	3.3	5.3	18.5
Fats (g)	-1.0	-3.4	0.0	17.5	NA	5.7	1.7	11.8
Iron (mg)	-4.5	-12.7	9.1	5.6	49.5	80.4	3.2	49.3
Zinc (mg)	0.0	-4.8	3.3	3.4	0.9	0.9	2.0	10.8

Source: [a] Taken from Table 3 of Masters, Nene and Bell (2017), capturing the desired intake from a complementary food for an infant of 6 or 24 months old based on estimated intakes from breastmilk.
Notes: DM= dry matter. Differences (diff.) were calculated as labeled values minus tested values, such that all negative differences indicate that the label understated the quantity of the nutrient in the product.

Food safety knowledge & moldy maize consumption

Table 4. Food safety knowledge and consumption of contaminated maize

% of respondents	Yes	No	Don't know/ No answer	N
If a person eats food with mold on it, does that person experience any health effects from the mold?	81.4	14.4	4.2	354
Does cooking a moldy food eliminate any potential health effects of the mold?	19.2	72.7	8.2	355
If animals are fed moldy food, do the animals experience any health effects from the mold?	41.4	45.4	13.2	355
If people eat eggs, milk, or meat from animals who were fed feed with mold, do the people experience any health effects from the mold?	34.9	50.4	14.7	355
In the last 12 months, did your household eat any maize that looked like this?	22.8	77.2	0.0	359