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Chronic Aflatoxin Exposure and Risk of Growth Impairment During the First 1000 Days: A Birth Cohort Study in Banke, Nepal

Photo Credit: LUANAR

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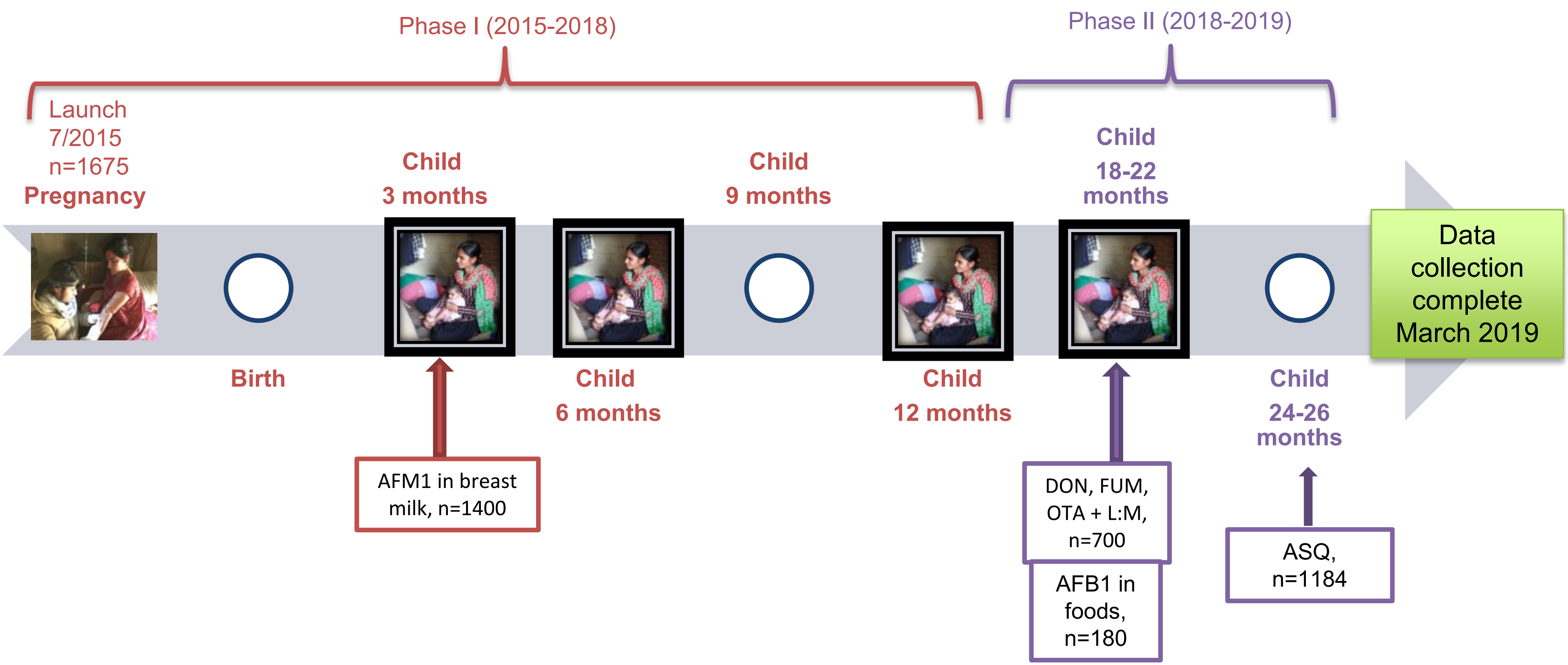
AflaCohort Study, Banke, Nepal (2015-2019)



Main objective: Understand the relationship of *in utero* and early life exposure to aflatoxin and linear growth in the first 24 months of life, controlling for other potential explanatory factors.

DATA COLLECTION & BIOMARKER ANALYSIS

Interview

MOTHER

1 blood sample

1 breast milk sample

- AFB1
- AFM1

INFANT

4 blood samples

- AFB1
- OTA (18-22 months only)

1 urine sample

- Gut barrier function (L:M test)
- DON
- FUM

SERUM AFLATOXIN CONCENTRATIONS

	n	Detectable Aflatoxin B1 (%)	Mean ± SD AFB1 * (pg/mg alb)	Min	Max
Pregnancy	1652	94.3	3.4 ± 8.5	0.4	147.3

High occurrence of aflatoxin exposure during pregnancy.

DIETARY DETERMINANTS OF AFB_1-LYSINE ADDUCTS IN PREGNANT WOMEN

Table 4. Multivariate ordinary least squares and quantile regression analysis of the association between weekly maize and groundnut consumption and maternal serum aflatoxin B_1-lysine adduct levels

	OLS	Q10	Q30	Q50	Q70	Q90
Maize consumption [b]	0.549	0.091	0.094 *	0.112 *	0.109 *	0.147
	(0.281)	(0.054)	(0.041)	(0.051)	(0.048)	(0.111)
Groundnut consumption [b]	0.730 ***	0.037	0.058 ***	0.085 **	0.133 ***	0.133 ***
	(0.121)	(0.027)	(0.016)	(0.026)	(0.026)	(0.030)
Milk consumption [c]	0.906	0.630 **	0.194	0.230 *	0.173	0.066
	(0.799)	(0.221)	(0.108)	(0.106)	(0.128)	(0.244)
Dietary diversity score	-0.229	0.064 *	0.004	0.008	-0.012	-0.057
	(0.149)	(0.029)	(0.020)	(0.018)	(0.026)	(0.053)
Winter season	2.339 ***	0.313 **	0.460 ***	0.552 ***	0.623 ***	1.101 ***
	(0.430)	(0.091)	(0.059)	(0.066)	(0.085)	(0.130)
Model Adjusted R^2	*0.0639*	*0.0539*	*0.0698*	*0.0801*	*0.1010*	*0.1367*

Standard errors in parentheses; n=1648; [a] OLS regression [b] number of times in past week [c] consumed in past year (yes/no). MUAC, mid-upper arm circumference; OLS, Ordinary Least Squares; Q, quantile; *p<0.05; **p<0.01; ***p<0.001. Models adjusted for age, education, MUAC, wealth index and VDC.

Diet-associated aflatoxin exposure in these women seems to be driven by groundnut and maize consumption.

Dietary diversity score showed no significant association with average maternal aflatoxin exposure.

Andrews-Trevino et al. (2019) "Dietary determinants of aflatoxin B1-lysine adducts in pregnant women consuming a rice-dominated diet in Nepal" - submitted to EJCN

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SOURCES OF AFLATOXIN-PRONE FOODS

Table 2. Bivariate associations of sources of maize, groundnuts and chilies and serum AFB_1 adduct level, AflaCohort Study, Banke, Nepal, 2015-2016

	n	%	AFB_1[a]	Unadjusted OLS		*P*	Adjusted OLS		*P*	R^2
MAIZE										0.17
Did not consume	280	17.0	3.2±7.4	-			-			
In-kind	568	34.6	2.4±5.4	ref			ref			
Home production	396	24.1	4.1±11.2	0.31	(0.072)	***	0.24	(0.075)	**	
Market	389	23.7	3.5±8.8	0.21	(0.072)	**	0.22	(0.076)	**	
Home production and market	11	0.7	3.3±4.9	0.08	(0.334)		0.10	(0.367)		
GROUNDNUTS										0.15
Did not consume	45	2.7	2.3±4.0	-			-			
In-kind	59	3.6	2.5±4.6	ref			ref			
Home production	25	1.5	1.6±3.3	-0.49	(0.264)		-0.35	(0.193)		
Market	1505	91.4	3.3±8.6	0.0006	(0.147)		0.03	(0.130)		
Home production and market	12	0.7	2.3±2.1	0.05	(0.350)		0.13	(0.311)		
CHILIES										0.15
Did not consume	4	0.2	0.7±0.3	-			-			
In-kind	23	1.4	6.9±16.3	ref			ref			
Home production	37	2.3	3.2±6.4	-0.37	(0.293)		-0.59	(0.316)		
Market	1524	92.6	3.1±7.3	-0.45	(0.232)		-0.50	(0.278)		
Home production and market	58	3.5	5.7±19.9	-0.24	(0.272)		-0.42	(0.316)		

Receiving in-kind food and a high reliance on market-purchased food limits consumers' information on the quality and safety of the food consumed.

Andrews-Trevino et al. (2019) "Aflatoxins in the blood of pregnant women, their food sources, and agricultural practices in rural Nepal" – manuscript in final edits

The Journal of Nutrition
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Relatively Low Maternal Aflatoxin Exposure Is Associated with Small-for-Gestational-Age but Not with Other Birth Outcomes in a Prospective Birth Cohort Study of Nepalese Infants

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SERUM AFLATOXIN CONCENTRATIONS

	n	Detectable Aflatoxin B1 (%)	Mean ± SD AFB1 (pg/mg alb)	Min	Max
Pregnancy	1652	94.3	3.4 ± 8.5	0.4	147.3
Child 3 mo	1363	80.5	1.0 ± 1.1	0.4	24.7
Child 6 mo	1294	75.3	1.2 ± 2.1	0.4	41.6
Child 12 mo	1329	81.1	2.0 ± 4.6	0.4	84.6

High occurrence of aflatoxin exposure in the first year of life in infants from this region of Nepal.

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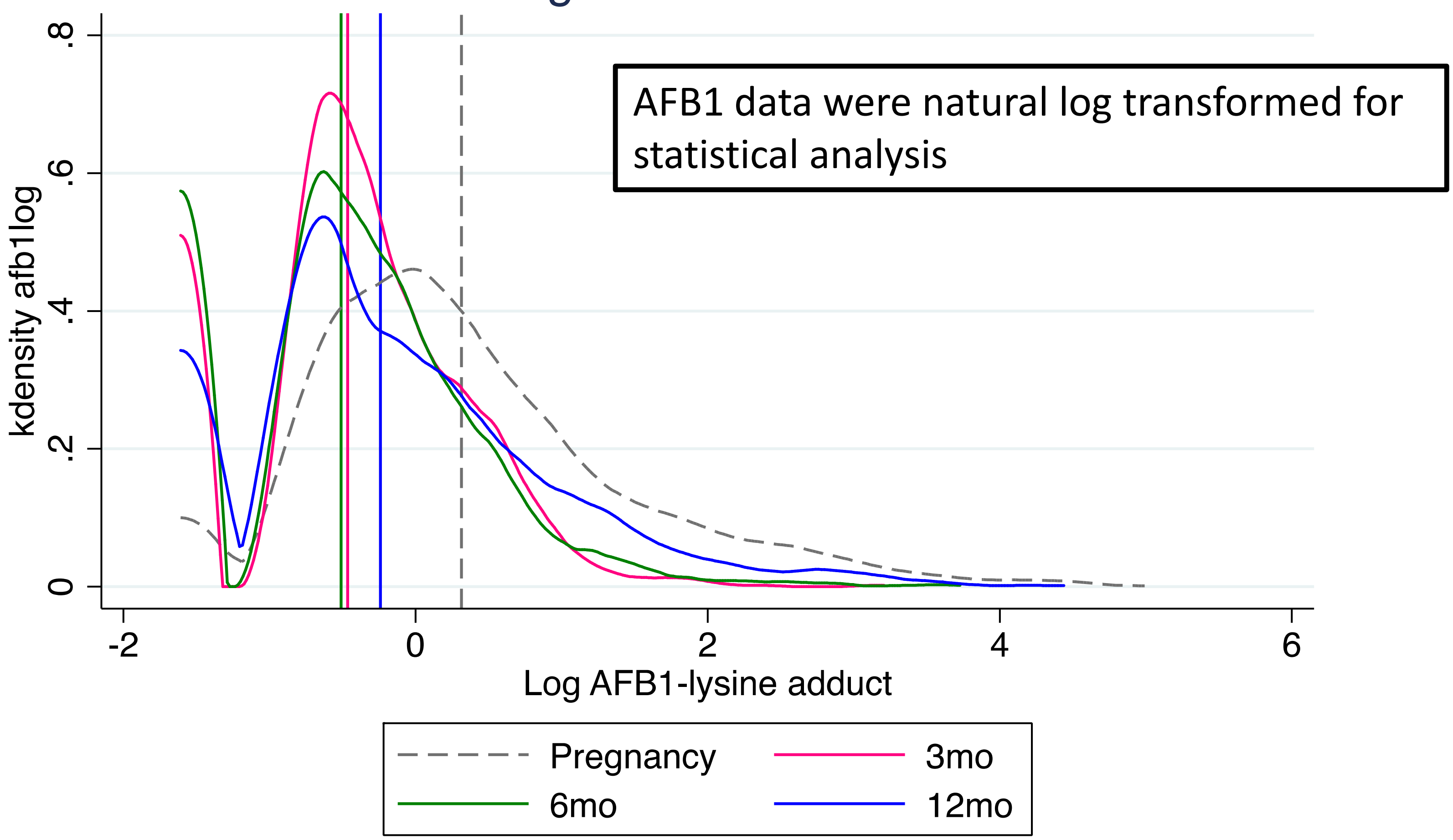
Log AFB1 over time



Source: Mycotoxin Birth Cohort Study / Banke, Nepal / 2015-2019

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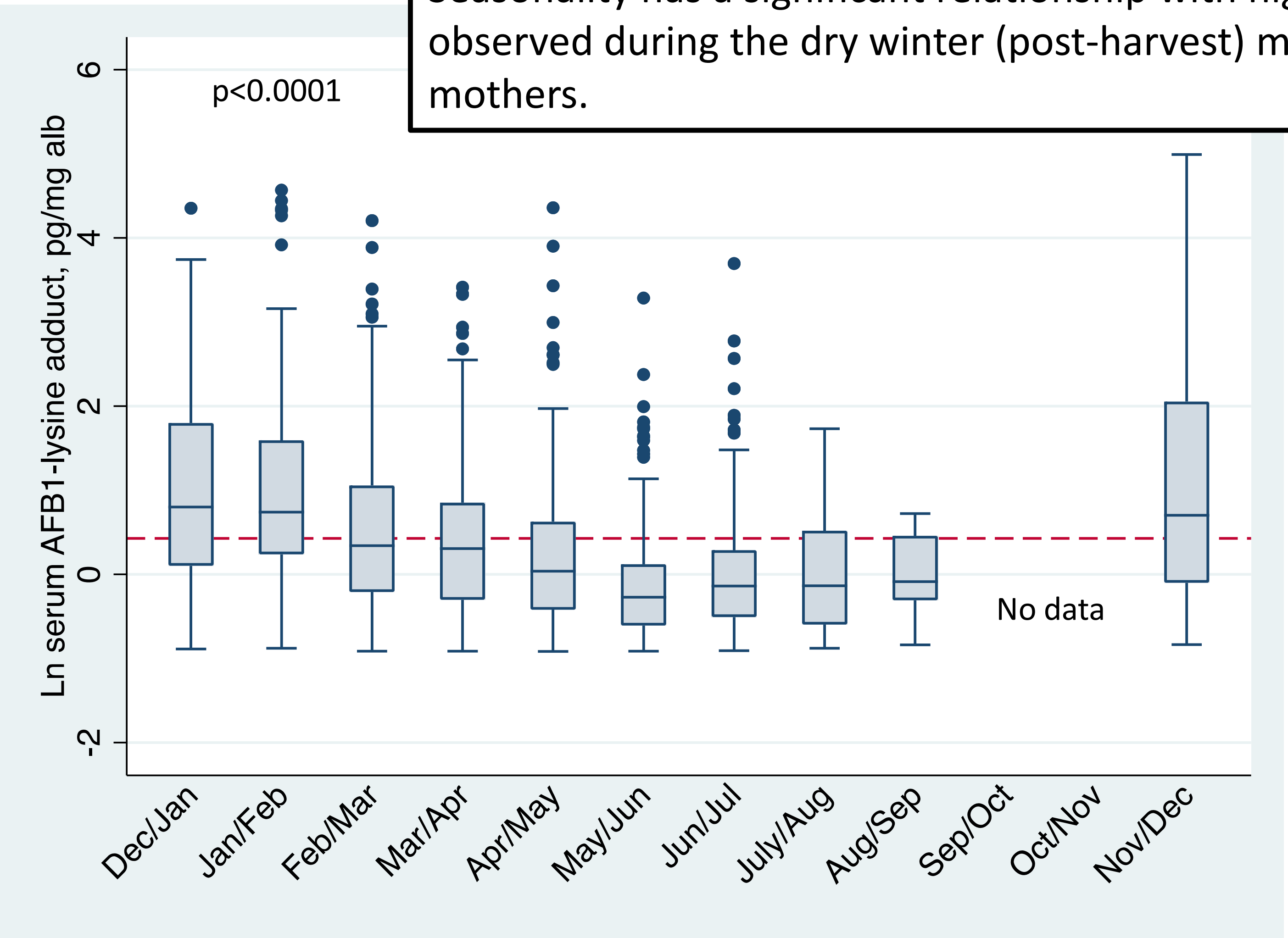
AFB1 VARIATION BY MONTH: PREGNANCY

Seasonality has a significant relationship with higher levels observed during the dry winter (post-harvest) months in mothers.



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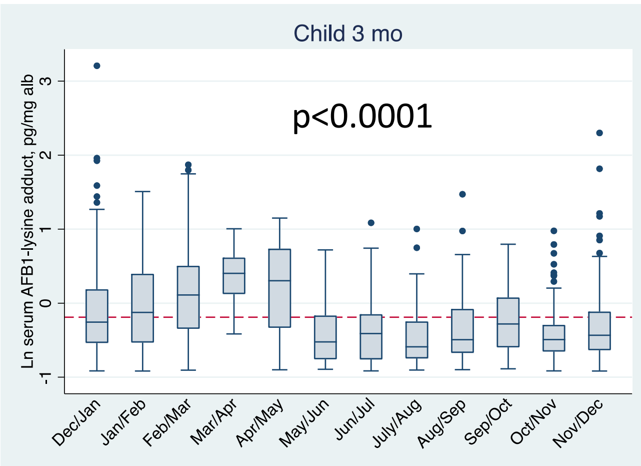
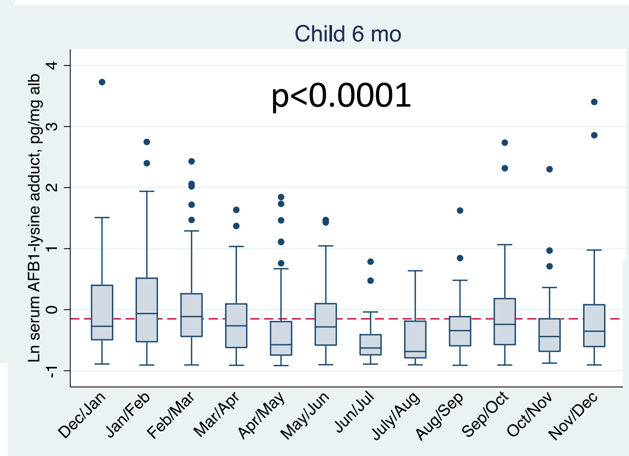
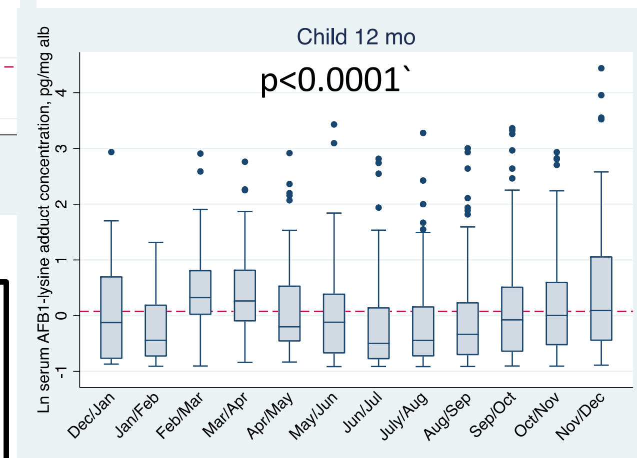
AFB1 BY MONTH: CHILD 3, 6 AND 12 MONTHS







Seasonality has a significant relationship with higher levels observed during the dry winter/spring (post-harvest) months in infants.

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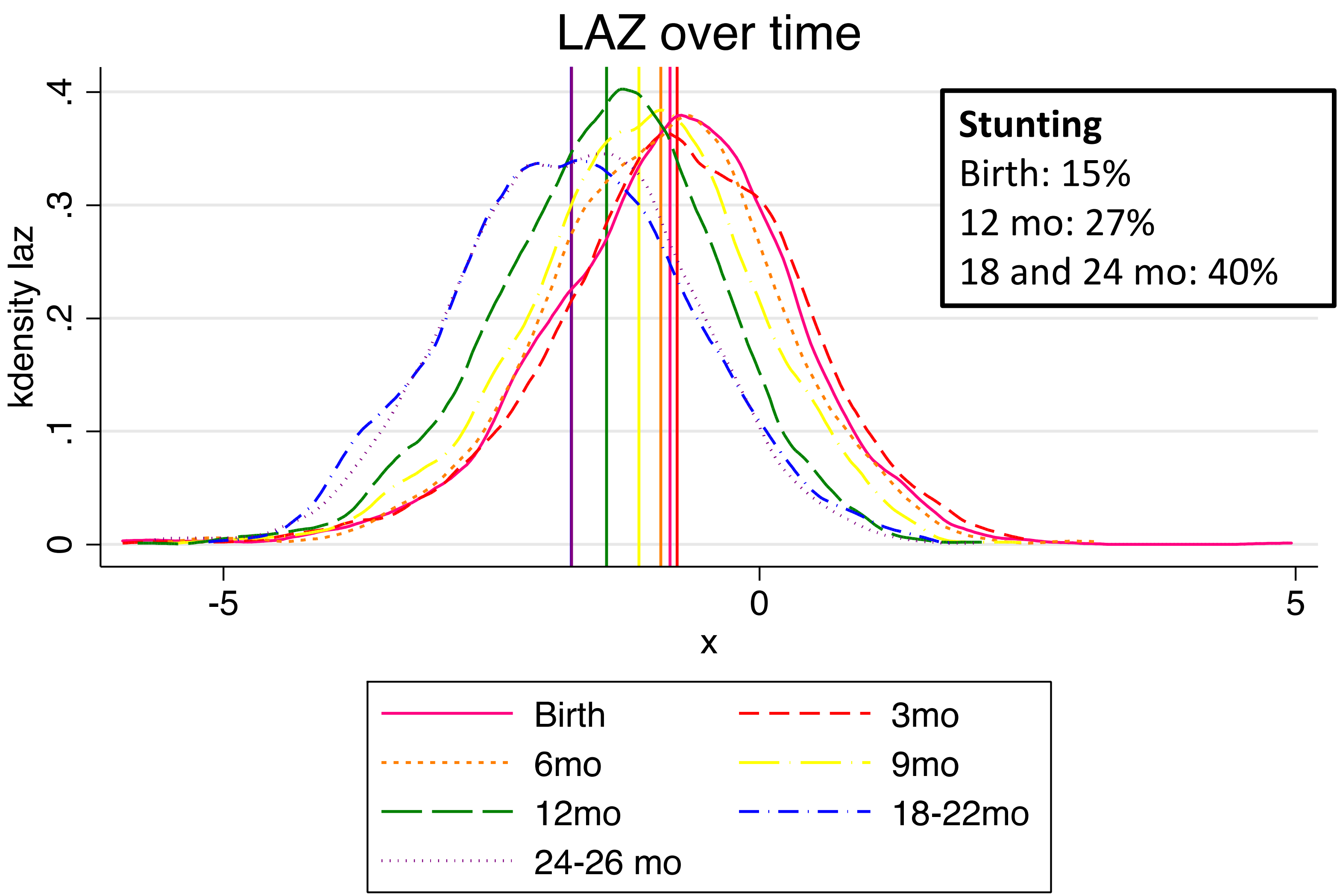
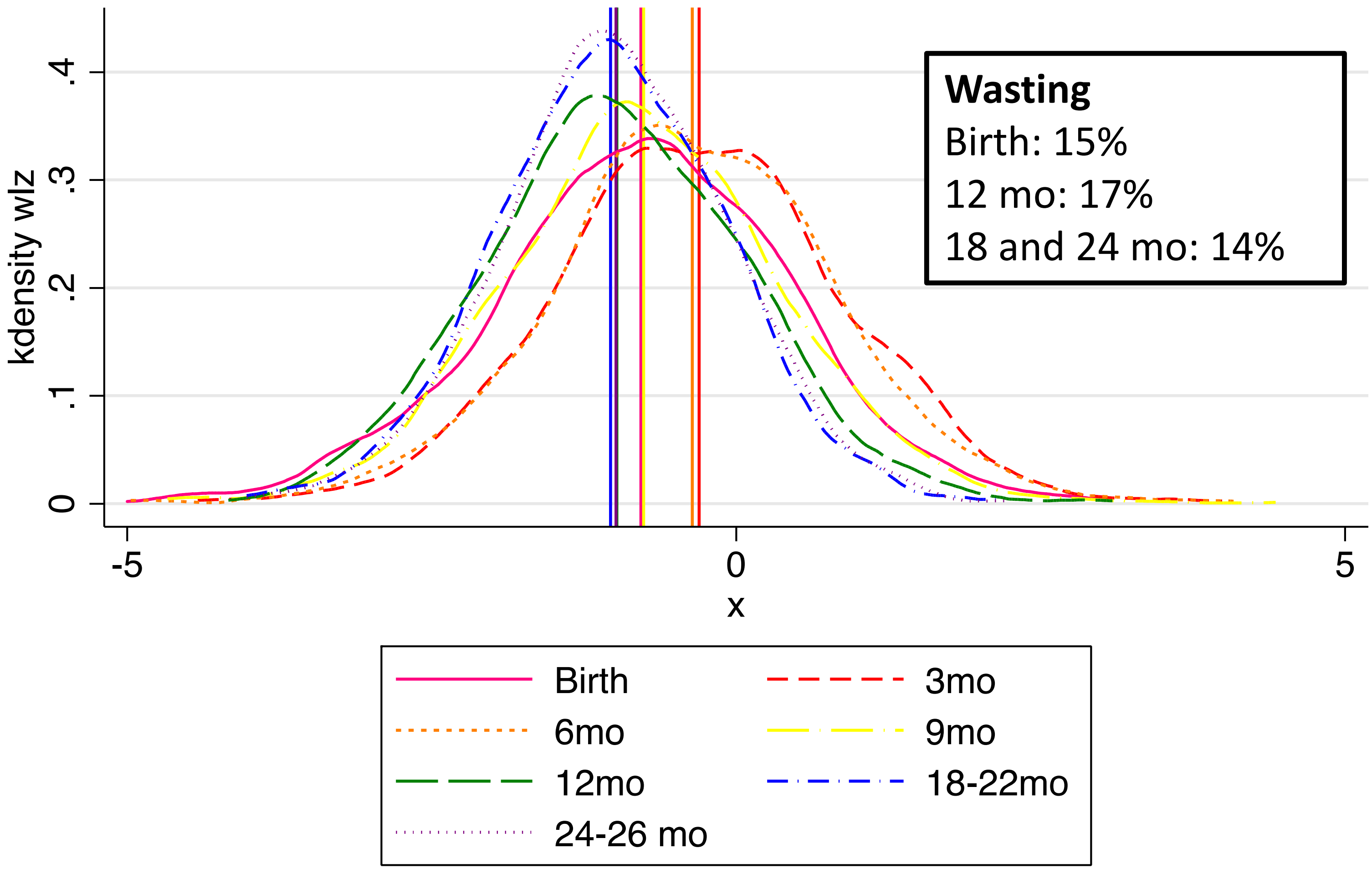


Source: Mycotoxin Birth Cohort Study / Banke, Nepal / 2015-2019

WLZ over time



Source: Mycotoxin Birth Cohort Study / Banke, Nepal / 2015-2019

AF AND LINEAR GROWTH – IN PROGRESS

	Unadjusted Model	*P*	**Adjusted Model**	*P*
Length (cm)[1]	-2.62 (-2.93, -2.31)	0.000	-0.09 (-0.14, -0.04)	0.000
LAZ[2]	-0.002 (-0.02, 0.02)	0.868	-0.01 (-0.03, 0.006)	0.169
Change in LAZ[3]	-0.03 (-0.07, -0.0005)	0.047	0.0008 (-0.03, 0.03)	0.996

Values are odds ratio (95% confidence interval); Adjusted fixed effect regression models controlled for age and WLZ.

[1] Adjusted model *n observations*=5275, *n groups*=1539

[2] Adjusted model *n observations*=5272, *n groups*=1538

[3] Adjusted model *n observations*=3779, *n groups*=1453

We did find statistical support for differential effects of aflatoxin exposure on child length.

We did not find statistical support for differential effects of aflatoxin exposure on LAZ or change in LAZ.

NEXT STEPS

- Incorporate 18-22 month aflatoxin results (September 2019)
- Correlations between food aflatoxin levels, serum aflatoxin concentrations and child growth collaboration with Feed the Future Innovation Lab for the Reduction of Post-Harvest Loss (PHLIL)).
- Explore the role of aflatoxins and other mycotoxins and EED.
- Consider the level of exposure and its relationship with health outcomes may be modulated by seasonality.

AFM1 CONCENTRATIONS IN BREAST MILK

	n	Detectable Aflatoxin M1 (%)	Mean ± SD AFM1 (ng/l) *	Min	Max
Child 3 mo	1439	94%	4.7 ± 19.3	0.04	315.99

* Detectable only

Statistically significant higher mean AFM1 level found in cool, dry winter (post-harvest) months.

Ongoing analysis by Ashish Pokharel et al.

CURRENT TAKEAWAYS

- Widespread exposure to aflatoxin in both pregnant women and young children.

- Undernutrition is persistent.

- As Nepal is faced with relatively high levels of malnutrition and food contamination, additional considerations should be given to regulatory reforms that concentrate on food safety rules.

- Emerging understanding of the complexity on exposure channels beyond the household. Awareness-creation is required to enhance consumers' ability to manage aflatoxin risks where off-farm food acquisition is common. However, individuals are exposed to dietary aflatoxin via multiple channels of food procurement, and that adoption of aflatoxin control practices at farm, market and consumer levels are all needed.

COLLABORATORS AND TEAM

- USAID Bureau of Food Security and USAID Nepal
- Child Health Division, Department of Health Services, MOHP
- Nepal Health Research Council (NHRC) and Tufts IRB
- Patan Academy of Health Sciences (PAHS)
- Helen Keller International (HKI) Nepal
- Purdue University
- University of Georgia, FTF Innovation Lab on Peanuts and Mycotoxins
- PHLIL
- Banke District Public Health Office
- Banke VDC and Ward Health Posts, FCHVs
- Nepalgunj Medical College
- AflaCohort Field team and participants

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