

# A Novel Sustainable Complementary Feeding Product for Infants and Young Children: Caterpillar Cereal

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# Inadequate Complementary Feeding

- Starch-based complementary feeding provides inadequate protein and micronutrients.
- Inadequate complementary feeding leads to stunting of linear growth and long term health consequences.
- WHO recommends animal-source foods for complementary feeding.

## The Problem in the DRC

- In Democratic Republic of Congo (DRC), complementary foods are starch-based.
- Prevalence of stunting at 18 months: 66%
- Meat is not accessible or affordable.

## The Need in the DRC

- An **animal-source** food for complementary feeding

# A Novel Substitute for Meat

- Insects are a staple in the diet in Central Africa.
- In Kinshasa, 70% of population consumes caterpillars.
- Caterpillars have a protein and micronutrient content similar to beef.
- Caterpillars available regionally and easily gathered.

# Objective

To prevent stunting among children at 18 months of age in rural DRC using caterpillars as an animal-source food for complementary feeding.

# Cereal Development



- Locally available ingredients: dried caterpillars, ground corn, palm oil, sugar and salt
- Quality control analyses performed on each batch at the University of Kinshasa, Department of Pharmacy
- Macro- and micronutrients measured
- Cereal was tested and acceptable to mothers and infants. *(Bauserman et al., Mat Child Nutr, 2013)*





## Methods: Efficacy Trial

- Design: Cluster randomized, controlled
- Study Site: Rural area of DRC
- Participants: Breastfed infants, 6 months
- Population: 227 mother/infants dyads
- Duration: 1 year (until 18 months of age)

# Intervention



- Intervention Group:  
Caterpillar cereal daily to supplement usual diet
  - » 6-12 months: 30-gram portion
  - » 12-18 months: 45-gram portion
- Control Group: Usual diet
- All participants received IYCF education messages weekly

# Data Collection

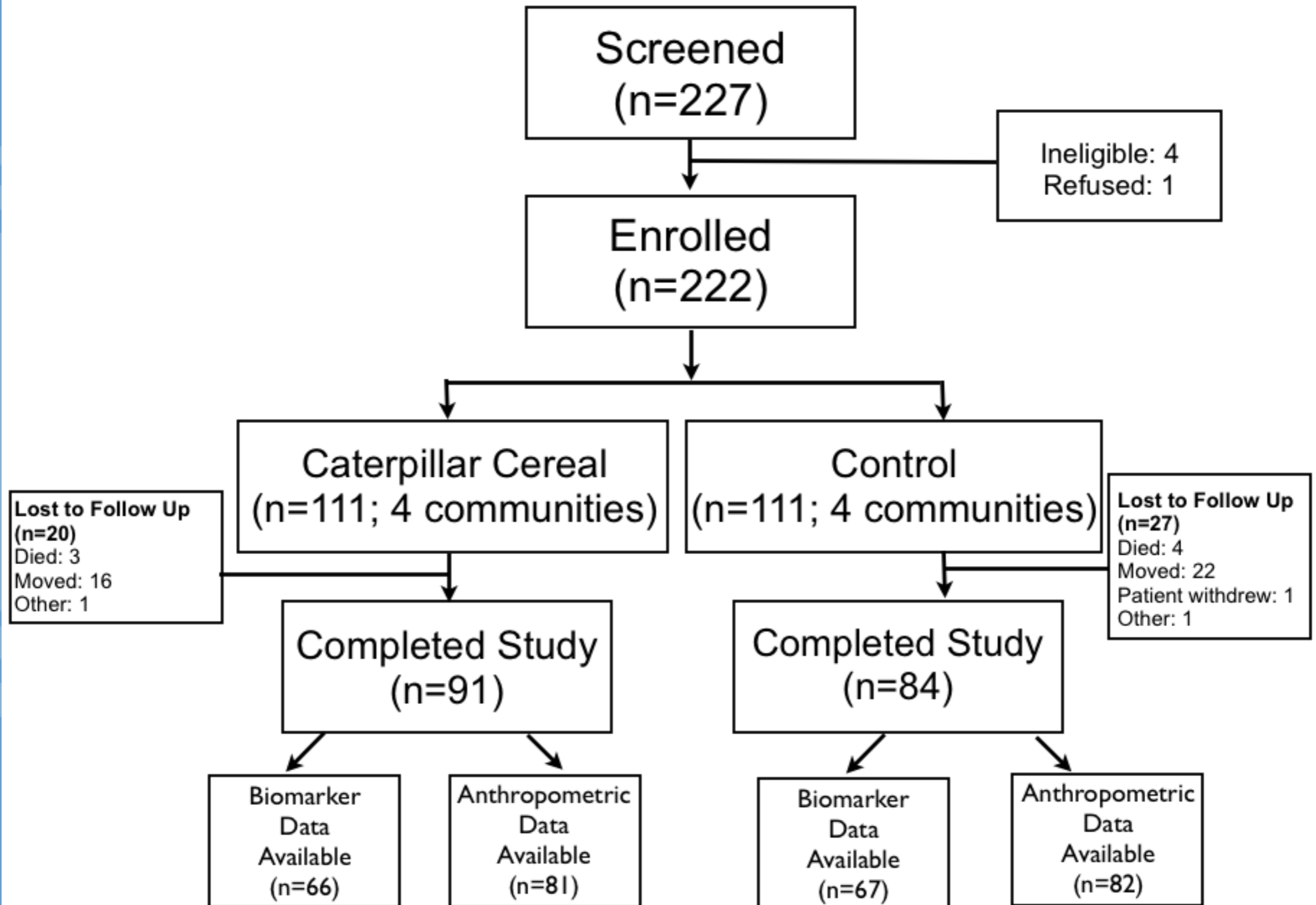


- Anthropometric Measures (6, 9, 12 and 18 months)
- Dietary Data
- Infectious Disease Morbidity (weekly)
- Biomarkers of Iron Deficiency (18 months)
  - » Measured on a subset

# Statistical Analyses

- Robust Poisson regression models for categorical measures
- Linear mixed models for continuous measures
- GEE extensions were used to account for cluster randomization
- $p < 0.05$  was considered to be significant

# Study Flow Diagram



# Baseline Characteristics

	<b>Statistic</b>	<b>Caterpillar Cereal Group (n=111)</b>	<b>Control Group (n=111)</b>	<b>P-Value</b>
<b>Maternal Characteristics</b>				
Maternal height (cm)	Mean (SD)	158 (7.0)	155 (8.4)	<b>0.01*</b>
Maternal weight (kg)	Mean (SD)	52.0 (7.4)	51.4 (8.7)	0.82
Maternal Body Mass Index (kg/m <sup>2</sup> )	Mean (SD)	21.0 (3.4)	21.4 (3.2)	0.72
Mother works for pay (yes)	n (%)	2 (1.8)	1 (0.9)	0.44
Highest level of formal education the mother has completed (y)	Mean (SD)	3.8 (3.2)	3.5 (3.2)	0.43
Highest level of formal education the father has completed (y)	Mean (SD)	8.2 (3.2)	7.1 (3.8)	<b>0.02*</b>
Number of pregnancies	Mean (SD)	3.7 (2.1)	4.1 (2.2)	0.15
Number of children	Mean (SD)	2.9 (1.7)	3.0 (1.6)	0.62



# Infant Characteristics

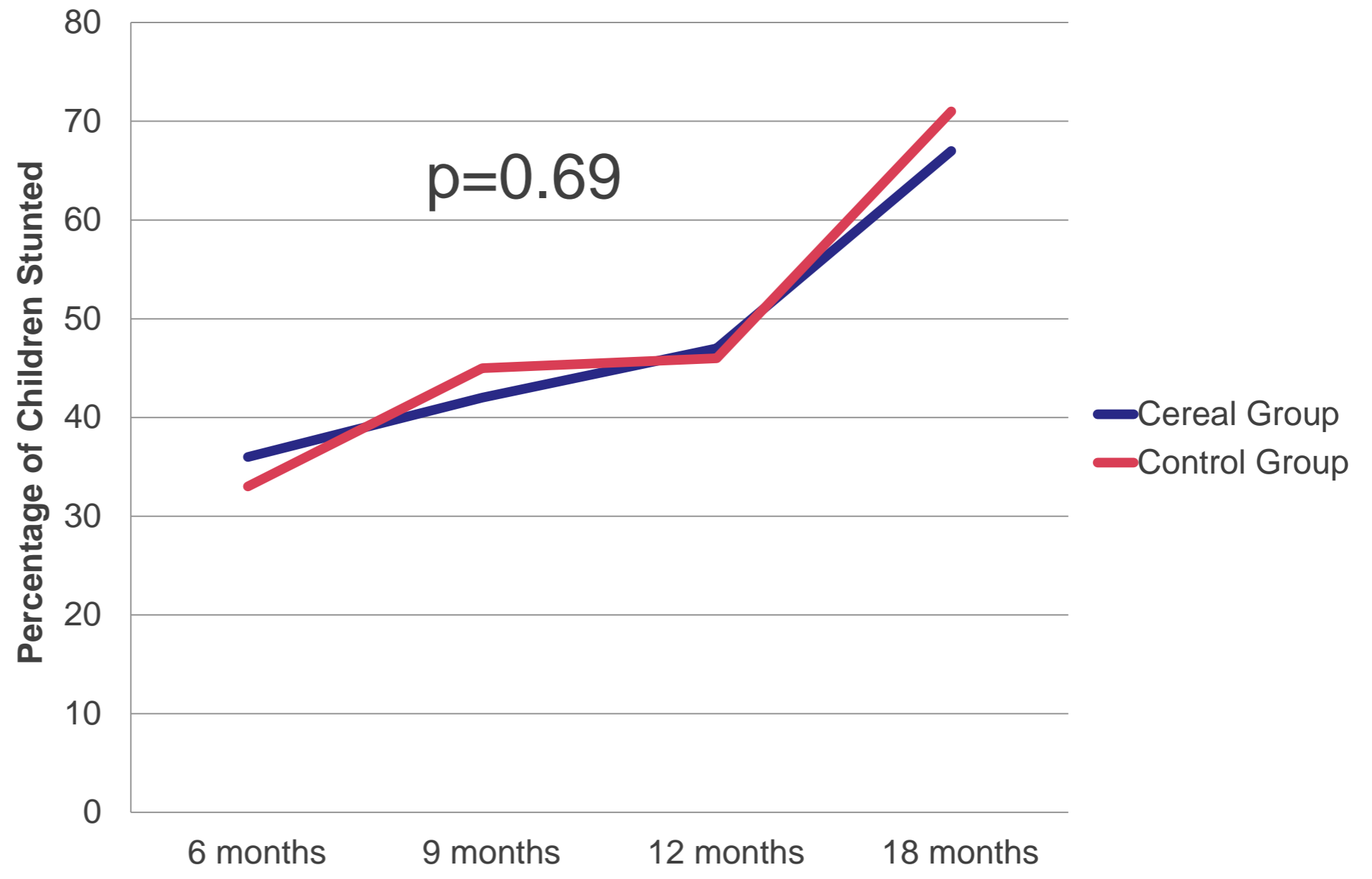
	<b>Statistic</b>	<b>Caterpillar Cereal Group (n=111)</b>	<b>Control Group (n=111)</b>	<b>P-Value</b>
<b>Infant Characteristics</b>				
Male	n (%)	56 (51)	57 (51)	0.89
Birth weight (g)	Mean (SD)	3175 (518)	3377 (529)	<b>0.005*</b>
Born Prematurely	n (%)	2 (1.8)	1 (0.9)	0.62
Exclusively breastfed at 6 months	n (%)	88 (79.3)	80 (72.1)	0.84

# Compliance and Feeding Practices

- 96 infants (90%) consumed >70% of the cereal
- 96% of women breastfed infants throughout the trial
- No difference between the two groups in ICFI scores at 6 and 18 months.



# Prevalence of Stunting



# Anthropometric Results

	n	Cereal Group Mean (SD) or n (%)	n	Control Group Mean (SD) or n (%)	P-Value
<b>Stunting Prevalence (LAZ &lt;-2)</b>					
6 months	111	40 (36)	111	37 (33)	0.71
9 months	97	41 (42)	103	46 (45)	0.90
12 months	93	44 (47)	99	45 (46)	0.82
18 months	81	54 (67)	82	58 (71)	0.69
<b>Length for Age Z Score (LAZ)</b>					
6 months	111	-1.5 (1.4)	111	-1.5 (1.4)	0.71
9 months	97	-1.7 (1.2)	103	-1.8 (1.5)	0.76
12 months	93	-1.9 (1.2)	99	-2.0 (1.5)	0.67
18 months	81	-2.5 (1.2)	82	-2.6 (1.7)	0.54
<b>Linear Growth Velocity (cm/mo)</b>	79	0.9 (0.3)	81	0.9 (0.2)	0.76

- A regression model, controlling for baseline covariate differences\* also showed no difference in the proportion of children who were stunted (p=0.38).

\*(paternal education, employment, number of pregnancies, maternal infectious morbidities, maternal anthropometry, prematurity, sex, exclusive breastfeeding, LAZ and ICFI at 6 months)



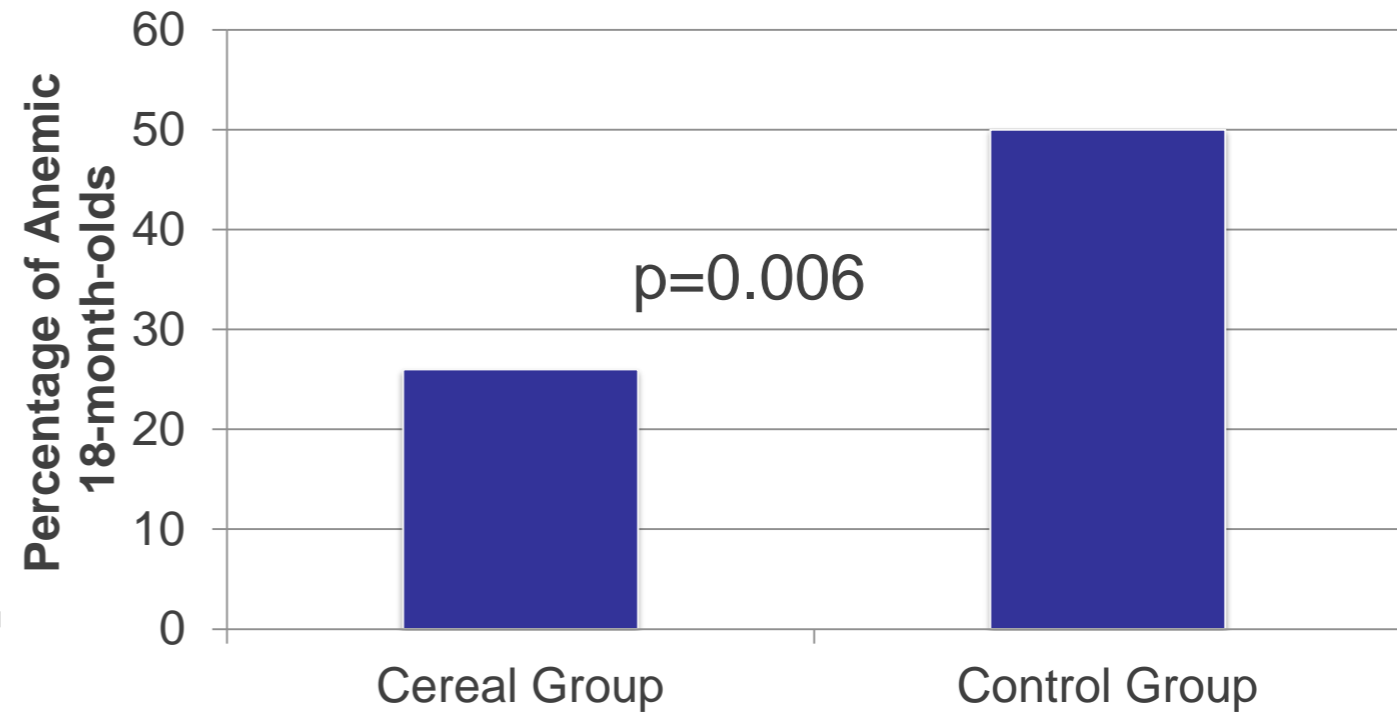
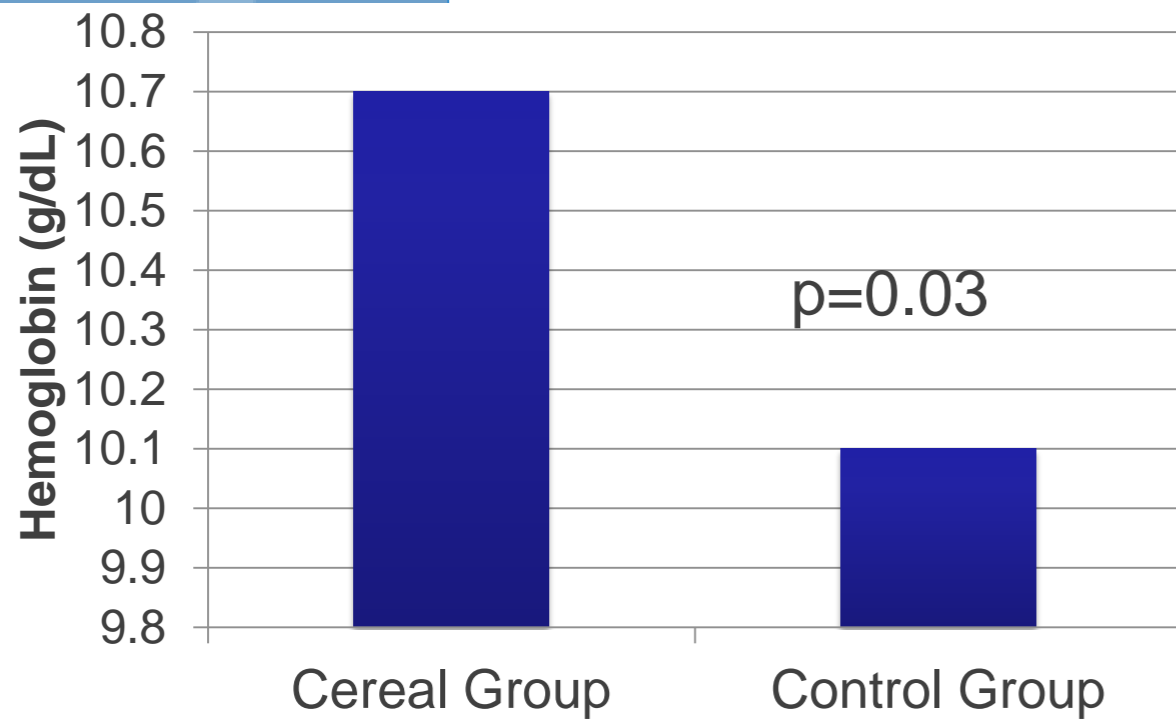
# Measurement of Iron Deficiency

- Ferritin
  - » Marker of iron storage
  - » Levels fall in iron deficiency
  - » Acute phase reactant that may be elevated in inflammatory states
- Accounting for inflammatory states can be performed by measuring other acute phase reactants (e.g. CRP)

# Results: Iron Deficiency

- Ferritin levels were lower in the cereal group (mean 145 vs 187 ng/dL,  $p=0.03$ )
- High burden of infection/inflammation
  - » Cereal Group: 44% (29/67) of infants with  $CRP > 5 \text{ mg/L}$
  - » Control Group: 52% (35/66) of infants with  $CRP > 5 \text{ mg/L}$

# Results: Anemia



# Results: Iron Deficiency Anemia

- Iron Deficiency Anemia, defined *a priori* as:  
Hgb  $\leq 10$  g/dL, Ferritin  $< 12$   $\mu\text{g/L}$ , excluding  
infants with CRP  $> 5$  mg/L
  - » Only 2 children met criteria for analysis

# Conclusions

- We observed a high prevalence of stunting at 6 months (36%).
- Supplementation with caterpillar cereal did not reduce the prevalence of stunting at 18 months of age.
- We observed a beneficial effect of consuming caterpillar cereal on the prevalence of anemia.
- Our sample size was too small to determine if there was a beneficial effect on iron deficiency.

# Speculations

- Adequate nutrient consumption alone will not significantly impact the problem of stunting in the rural areas of DRC.
- Early stunting (prior to 6 months) among breastfed infants might be caused by factors other than dietary deficiency (e.g., pre-natal factors or environmental enteropathy).



# Future Studies

- Evaluate the contribution of pre-gestational and gestational nutrition on early infant stunting (Women First Trial)
- Examine the etiology of stunting prior to 6 months of age, including environmental enteropathy
- Determine if dietary interventions, such as caterpillar cereal, will be efficacious if coupled with other interventions

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# Extra Slides

# Cereal Constituents

Macronutrients			Micronutrients		
	Caterpillar Cereal	Proposed* CF, 6-11 mo		Caterpillar Cereal	Proposed* CF, 6-11 mo
Energy, Kcal	132	176	Iron, mg	3.8	11
Protein, g	6.9	3-4.5	Zinc, mg	3.8	4-5
Fat, g	6.3	4.8	Magnesium, mg	9.4	40-60
Carbohydrate, g	12.0	n/a	Copper, mg	3.7	0.2-0.4

*\*Lutter and Dewey, J. Nutr, 2003*