

Effects of Animal Source Food Supplementation on Neurocognitive Outcomes of HIV-Affected Kenyan School- Aged Children: A Randomized, Double- Blind, Controlled Intervention Trial

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Background

- Mothers with HIV and their offspring, HIV-positive and HIV-negative, are susceptible to the effects of malnutrition and infection
- Many families live in impoverished areas of the world where food insecurity, poor dietary quality, opportunistic infections, lethargy and encephalopathy, and lack of medical care can impact caregiver & child health
 - Which impacts caregivers' abilities to cope and attend to the child's developmental care
- Infants and young children born to HIV-positive mothers in resource-poor settings have demonstrated greater neurodevelopmental delays
- Nutritional interventions addressing diet quality (with animal source foods or soy) may address gaps in the diet and affect cognitive function

(Abubakar, Van Baar et al. 2008; Antelman, Msamanga et al. 2000; Chase, Ware et al. 2000; Garvie, Zeldow et al. 2014; Le Doaré, Bland et al. 2012; Reddi, Powers et al. 2012; Weiser, Tsai et al. 2012)



Objective

- Assess the effects of animal source food (ASF) versus soy versus wheat biscuit supplementation on the neurocognitive performance of HIV-affected, nutritionally at-risk school-aged children in rural Kenya

Methods: Study Location

Three rural communities near Eldoret in western Kenya

- Turbo,
- Mautuma,
- Soi



Image source: <http://www.weather-forecast.com/locations/Eldoret>



Methods

- Study Participants:
 - Sample of 49 school-aged children (4-8 years old) of HIV-positive drug-naïve women who received care at the Academic Model Providing Access to Healthcare (AMPATH) partnership clinics in western Kenya
 - Some target children were found to be HIV-positive and receiving ART at baseline. The data from these children were excluded from the intervention effect analyses.
 - Participants enrolled over a two-year period (December 2008-December 2010).

Study Intervention

- Three-arm randomized, double-blind nutrition intervention trial
 - Isocaloric intervention biscuits made with either:
 - Dried powdered beef
 - Roasted soy flour
 - Wheat flour
- Biscuits consumed at home via direct observation treatment (DOT), 5 days/week over 18 months
 - Follow-up at 6 months post intervention

Cognitive Assessments

- Performed at home every 6 months starting from the time children enrolled in study
 - Digit span forward,
 - Digit span backward,
 - Digit span total,
 - Raven's Progressive Matrices (RPM), nonverbal test of cognitive performance, abstract reasoning and problem-solving (fluid intelligence),
 - Verbal meaning test,
 - Arithmetic test,
 - Embedded figure test,
 - Beery Test of Visual-Motor Integration (VMI), assesses integration of visual and motor abilities

(Beery and Beery 2010; Raven 1960; Sigman, Neumann et al. 1989; Weschler 1974)

Results: Baseline Characteristics

	SOY (n=18)	BEEF (n=20)	WHEAT (n=11)	All (n=49)	p-value
Location	n (%)				
Turbo	11 (61.1)	12 (60.0)	2 (18.2)	26 (51)	0.117
Soi	3 (16.7)	5 (25.0)	6 (54.6)	14 (29)	
Mautuma	4 (22.2)	3 (15.0)	3 (27.3)	10 (20)	
Baseline Characteristics	n (%)				
Males*	8 (47)	10 (50)	3 (27.3)	21 (43.8)	0.448
	mean (sd)				
Baseline age (months)	73.2 (17.3)	68.4 (17.84)	62.7 (15.6)	68.9 (17.3)	0.289
CD4 count (cells/mm3)*	1046.3 (540.1)	950.9 (406.0)	1199.2 (467.0)	1041.5 (469.2)	0.378
HGB (g/dl)*	12.86 (0.9)	12.02 (1.4)	12.35 (1.3)	12.39 (1.2)	0.129
Weight (kg)*	18.1 (3.0)	17.1 (3.6)	15.5 (2.4)	17.0 (3.2)	0.124
Height (cm)*	110.7 (8.5)	106.0 (10.9)	105.2 (6.4)	107.4 (9.3)	0.219
BMI (kg/m2)*	14.7 (1.3)	15.0 (1.2)	14.0 (1.1)	14.6 (1.3)	0.100
Head circumference (cm)*	49.9 (1.7)	51.0 (2.2)	49.1 (1.2)	50.1 (1.9)	0.117

*Missing data occurred in 2% of gender; in 4% of CD4 counts, and HGB; in 6% of weight, height and BMI measures; and in 53% of head circumference measures.

Baseline Cognitive Scores

	SOY (n=18)	BEEF (n=20)	WHEAT (n=11)	All (n=49)	p-value
Outcomes	n (%)				
Digital span Forward	3.44 (1.2)	3.05 (1.8)	2.63 (1.3)	3.10 (1.5)	0.366
Digital span Backward	1.33 (1.4)	0.85 (1.4)	0.45 (0.8)	0.94 (1.3)	0.212
Digital span total	4.78 (2.3)	3.90 (2.9)	3.09 (1.6)	4.04 (2.5)	0.196
Raven's progressive matrix (RPM) total	13.6 (2.9)	13.6 (3.4)	12.9 (5.4)	13.4 (3.7)	0.867
Verbal meaning total	26.2 (6.2)	25.1 (6.1)	19.9 (8.1)	23.3 (6.9)	0.046
Arithmetic total	4.67 (2.9)	4.20 (3.0)	2.63 (2.4)	4.02 (2.9)	0.174
Embedded figure test total	9.50 (1.9)	9.15 (2.4)	8.00 (3.3)	9.02 (2.5)	0.269
Beery VMI total	7.44 (3.5)	6.70 (2.6)	5.81 (2.7)	6.78 (3.0)	0.368

Intervention Results

- All 3 groups: significant increases in the outcomes' scores over time (as expected through developmental maturation).
- Significant differences in rates of increase over time among all three groups for Raven's Progressive Matrices (RPM) performance
 - For RPM total score, there were significant differences in rates of increase over time (F test $df=2$, $p<0.05$)
 - Scores of children in Soy group almost two times higher than those in Beef and Wheat groups ($p=0.012$)
 - No significant difference in RPM scores between Beef and Wheat groups ($p=0.849$)



Intervention Results, continued

- No significant difference between biscuit groups over time for:
 - Verbal meaning,
 - Digit Span Backward, Forward and Total,
 - Embedded figure test,
 - Arithmetic test
 - Beery Visual Motor Integration scores



Discussion & Conclusions

- Soy nutrients may enhance neurocognitive skills in HIV-affected school-aged children.
 - Evidence exists that flavonoids in soy may enhance human memory and neurocognitive performance by protecting and enhancing neuronal function and stimulating neurogenesis
- Cognitive effects may also be mediated by family members':
 - Nutritional status
 - Developmental stimulation and educational support
- In this randomized feeding trial school-aged children provided with soy protein supplementation showed greater improvement in non-verbal cognitive (fluid intelligence) performance compared to peers receiving isocaloric beef or wheat biscuits.

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