

Supplemental Material

Undernutrition and Antibody Response to Measles, Tetanus and *Haemophilus Influenzae* Type b (Hib) Vaccination in Pre-School South African Children: The VHEMBE Birth Cohort Study

Supplemental Table 1. Stunting and undernutrition indicators by sex at ages 1, 2, 3.5 and 5 years, VHEMBE, South Africa.

Supplemental Table 2. Stunting and any undernutrition indicator at 1, 2, or 3.5 years and protection to and antibody titers for measles, tetanus and Hib at 3.5 and 5 years of age in VHEMBE boys and girls. P-interaction indicates the difference in these relationships by sex.

Supplemental Table 1. Undernutrition indicators by sex at ages 1, 2, 3.5 and 5 years, VHEMBE, South Africa.

Indicator	1 year		2 years		3.5 years		5 years	
	Boys N (%)	Girls N (%)	Boys N (%)	Girls N (%)	Boys N (%)	Girls N (%)	Boys N (%)	Girls N (%)
Length/height-for-age^a	54 (17.3)*	34 (11.3)*	113 (35.9)*	73 (24.1)*	47 (15.0)#	30 (9.9)#	27 (8.9)#	16 (5.4)#
Weight-for-age^a	34 (10.9)#	20 (6.6)#	25 (7.9)*	10 (3.3)*	16 (5.1)#	7 (2.3)#	11 (3.6)	6 (2.0)
Weight-for-length/height^a	11 (3.5)	15 (5.0)	5 (1.6)	5 (1.7)	7 (2.2)	4 (1.3)	NA	NA
BMI for age^b	20 (6.4)	18 (6.0)	7 (2.2)	5 (1.7)	10 (3.2)	9 (3.0)	17 (5.6)#	8 (2.7)#
Any undernutrition indicator^c	73 (23.2)*	47 (15.6)*	117 (37.1)*	77 (25.4)*	55 (17.5)	39 (12.8)	41 (13.5)*	22 (7.4)*

Percent indicates the percent with that indicator.

^aIncludes participants moderately (z-score between -2 and -3) or severely (z-score<-3) for the given indicator of malnourishment.

^bIncludes participants considered underweight according to BMI (BMI for age < 5th percentile)

^cIncludes participants moderately (z-score between -2 and -3) or severely (z-score<-3) for length/height-for-age, weight-for-age, or weight-for-length/height, OR who were considered underweight according to BMI (BMI for age < 5th percentile).

*p<0.05; #p<0.1

Supplemental Table 2. Stunting and any undernutrition indicator at 1, 2, or 3.5 years and protection to and antibody titers for measles, tetanus and Hib at 3.5 and 5 years of age in VHEMBE boys and girls. P-interaction indicates the difference in these relationships by sex.

Infection	Exposure	Age of visit	Risk of being unprotected RR (95% CI)			Difference in antibody levels % (95% CI)		
			Boys	Girls	p interaction -value	Boys	Girls	p interaction -value
Measles	Stunting	1 year	1.22 (0.35, 2.83)	0.47 (0.00, 1.33)	0.26	-13.2% (-35.2, 17.0)	16.1% (-17.4, 57.9)	0.21
		2 years	1.23 (0.49, 2.71)	1.30 (0.53, 2.58)	0.91	-1.6% (-21.9, 24.2)	-14.9% (-37.1, 14.8)	0.44
		3.5 years	1.11 (0.23, 2.50)	1.04 (0.00, 2.78)	0.85	-20.1% (-42.5, 9.8)	-27.7% (-57.0, 14.8)	0.80
	Any undernutrition indicator	1 year	1.21 (0.43, 2.76)	0.83 (0.15, 1.83)	0.55	-9.6% (-31.3, 15.4)	4.0% (-24.5, 39.0)	0.44
		2 years	1.15 (0.46, 2.49)	1.27 (0.58, 2.45)	0.83	2.3% (-18.2, 29.2)	-14.7% (-35.9, 13.2)	0.31
		3.5 years	1.24 (0.31, 2.76)	1.24 (0.26, 2.71)	1.00	-19.9% (-42.6, 9.5)	-33.8% (-59.1, 3.7)#	0.50
Tetanus	Stunting	1 year	0.50 (0.22, 0.86)*	1.11 (0.64, 1.67)	0.03	16.7% (-20.7, 66.9)	-19.8% (-47.0, 19.7)	0.18
		2 years	0.86 (0.54, 1.26)	1.20 (0.81, 1.69)	0.23	11.4% (-15.8, 52.0)	-23.5% (-44.0, 3.2)#	0.09
		3.5 years	0.85 (0.33, 1.48)	1.53 (0.91, 2.21)#	0.11	2.7% (-31.3, 58.1)	-38.7% (-59.6, -8.0)*	0.10
	Any undernutrition indicator	1 year	0.62 (0.36, 0.98)*	1.01 (0.64, 1.52)	0.15	23.8% (-10.7, 71.9)	-13.6% (-39.0, 22.5)	0.15
		2 years	0.84 (0.54, 1.22)	1.24 (0.83, 1.75)	0.16	14.3% (-13.2, 53.3)	-24.9% (-45.0, -0.5)*	0.03
		3.5 years	0.79 (0.34, 1.33)	1.40 (0.88, 2.04)	0.11	0.5% (-32.7, 54.8)	-36.8% (-59.3, -7.0)*	0.13
Hib	Stunting	1 year	1.03 (0.70, 1.39)	1.18 (0.76, 1.77)	0.64	3.9% (-34.1, 57.5)	-17.5% (-53.8, 40.0)	0.51
		2 years	1.07 (0.78, 1.40)	1.08 (0.73, 1.50)	0.96	-3.2% (-34.6, 41.8)	-5.8% (-40.2, 52.5)	0.88
		3.5 years	0.79 (0.44, 1.17)	0.97 (0.45, 1.56)	0.62	36.1% (-15.0, 123.1)	-2.3% (-52.4, 110.3)	0.45
	Any undernutrition indicator	1 year	0.99 (0.70, 1.34)	0.98 (0.61, 1.41)	0.94	9.8% (-24.2, 62.2)	3.1% (-36.2, 63.4)	0.87
		2 years	1.03 (0.75, 1.36)	1.06 (0.73, 1.46)	0.88	1.8% (-29.5, 48.2)	-3.2% (-36.0, 51.6)	0.83
		3.5 years	0.89 (0.55, 1.21)	0.76 (0.33, 1.22)	0.62	26.6% (-15.5, 96.1)	10.6% (-39.0, 91.0)	0.71

*p<0.05; #p<0.1

^aControlling for maternal age, education, marital status, alcohol consumption, smoking, exposure to environmental tobacco smoke and HIV status during pregnancy; household poverty and wealth index; method of delivery and child sex. Models with measles and tetanus outcomes additionally controlled for whether the children received booster doses of the vaccine.