Child stuntedness

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Abstract

Abstract goes here.

1. Stunting

1.1. Definition

According to [1], “Growth stunting is defined by comparing measurements of children’s heights to the NCHS[1] growth reference population: children who fall below the fifth percentile of the reference population in height for age are defined as stunted, regardless of the reason for their shortness. As an indicator of nutritional status, comparison of children’s measurements with growth reference curves may be used differently for populations of children than for individual children. The fact that an individual child falls below the fifth percentile for height for age on a growth reference curve may reflect normal variation in growth within a population: the individual child may be short simply because both his parents were short and not because of inadequate nutrition. However, if substantially more than 5% of an identified child population have height for age that is less than the fifth percentile on the reference curve, then the population is said to have a higher-than-expected prevalence of stunting, and inadequate nutrition is generally the first cause considered.”

1.2. Causes

Inadequate nutrition is just one of several causes of growth stunting. Other contributors to stunting include chronic or recurrent infections, sometimes in combination with intestinal parasites. The prevalence of growth stunting, particularly among children under two years of age, can also reflect the prevalence of low birth weight in a population. Finally, in rare cases, growth stunting may reflect extreme psychosocial stress without nutritional deficiencies.

The contributions of each of these causes to the growth stunting prevalence rate are only partly understood. One study concluded that from 20% to 40% of the prevalence of growth stunting in the first two years of life can be attributed to low birth weight. However, inadequate nutrition may still be implicated because some low weight births may be due to maternal nutritional deficiencies during pregnancy.

Just as low birth weight and nutritional deficiencies are interrelated, so also are inadequate nutrition and the chronic or recurrent infections that are believed to contribute to growth stunting. There is evidence that even mild nutritional deficits can alter the immune response in children, before clinical signs of malnutrition occur, and that nutritional deficiencies during pregnancy can impair the infant’s immune response after birth. Thus, the reasons for any given child’s growth impairment may be complex. However, inadequate nutrition is a common theme that suggests a key focus for a policy response to the problem of growth stunting.

1.3. Consequences

Children who suffer from growth retardation as a result of poor diets or recurrent infections tend to be at greater risk for illness and death. Stunting is the result of long-term nutritional deprivation and often results in delayed mental development, poor school performance and reduced intellectual capacity. This in turn affects economic productivity at national level. Women of short stature are at greater risk for obstetric complications because of a smaller pelvis. Small women are at greater risk of delivering an infant with low birth weight, contributing to the intergenerational cycle of malnutrition, as infants of low birth weight or retarded intrauterine growth tend be smaller as adults.

1.4. Measuring stunting

Several important age-related differences and discontinuities in the reference growth curves are used to measure stunting. First, for children less than 24 months of age, growth is determined by measuring the length of a recumbent child. After 24 months, growth is determined by measuring the height of a standing child. Because length and height measurements are not equivalent, there is a natural

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[1]National Center for Health Statistics

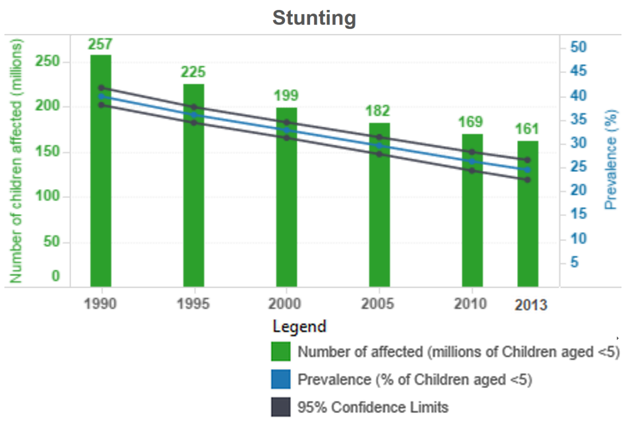


Figure 1. Child malnutriotion trend for stunting (According to [2]).

discontinuity between growth curves for children below and above 24 months of age.

The WHO[2] uses to classify stunting as height for age < -2 SD[3] of the WHO Child Growth Standards median (measurement charts of girls and boys are at the end of this document).

2. Problem statement

Using the statement described in [3], we have the goal to determine a combination of early measures that would be a good predictor for birth weight. In pursuit of this goal, we have collected time series data from ultrasounds on pregnant mothers. We would like you to use this data to predict a child's birth weight and birth date (days from pregnancy start).

For each fetus given sex, status, and multiple ultrasound measurements(columns 5-12) during the pregnancy (time being the variable t.ultsnd). The data from the repeated ultrasounds provides a small time series that can be used for predicting the birth weight and day.

For each prediction (b_i, w_i), the error from the true birth date and birth weight will be measured as the squared Mahalanobis distance,

$$e_i = (b_i - b_{0i}, w_i - w_{0i})^T S^{-1} (b_i - b_{0i}, w_i - w_{0i})' \quad (1)$$

where S^{-1} is the inverse of the sample covariance matrix calculated on the complete dataset.

$$S^{-1} = \begin{pmatrix} 3554.42 & -328.119 \\ -328.119 & 133.511 \end{pmatrix} \quad (2)$$

Scores will be calculated as a generalized R^2 measure of fit. This is calculated as follows. The total sum of errors for the submission will be calculated as $SSE = \sum(e_i)$.

[2] World Health Organization

[3] standard deviations

A baseline sum of squared error will be calculated by predicting the sample means for each fetus, that is the mean values of b and w for the current training set,

$$e_{0i} = (\bar{b} - b_{0i}, \bar{w} - w_{0i}) S^{-1} (\bar{b} - b_{0i}, \bar{w} - w_{0i})' \quad (3)$$

$$SSE_0 = \sum(e_{0i})$$

3. Development: numbers, results and dificulties

The dataset given in [3] is composed by 5651 rows, with 14 columns each row, as shown in 3.

There were lines referencing the measurement of only one child but in different times and different values that must be considered and some data entries did not have enough records to evaluate with the R script. In this case, we must to remove these spurious data.

After a clean, we divide the dataset in training, testing and validation in the proportion $80 : 16 : 4$ respectively, to be confident in the final results.

The answer is not only a variable, but a vector with components. These kind of problems are more complicated than problems involving only a variable response.

Some of the attributes are time series. We had to decide how to deal with it. Decide to stay with average and is an example; decide to work with the series implies having to think about how to include a number as an attribute, which is not trivial.

4. Further studies

There's a lot of ways to understand the problem of stunting in child populations. The website Topcoder[4] recently released another two problems regarding this issue [5].

Some ways of understand of how to deal this problem permeates the ethnic differences, for instance.

This work clearly does not contain all the possibilities and variations that may occur in relation to the subject of malnutrition and stunting. The possibilities of dealing with this subject are diverse, so we propose the extrapolation to this discipline and continue the development of intelligent algorithms that can be in support of medical decisions to inform pregnant women about the nutrition of their children.

For this problem, we are dealing with the issue of health information from children from the mother's womb. Thus, although the final result within a machine learning system is

[4] https://www.topcoder.com/

[5] http://community.topcoder.com/longcontest/?module=ViewProblemStatement&rd=16153&pm=13478 and https://www.topcoder.com/longcontest/?module=ViewProblemStatement&rd=16209&compid=45332

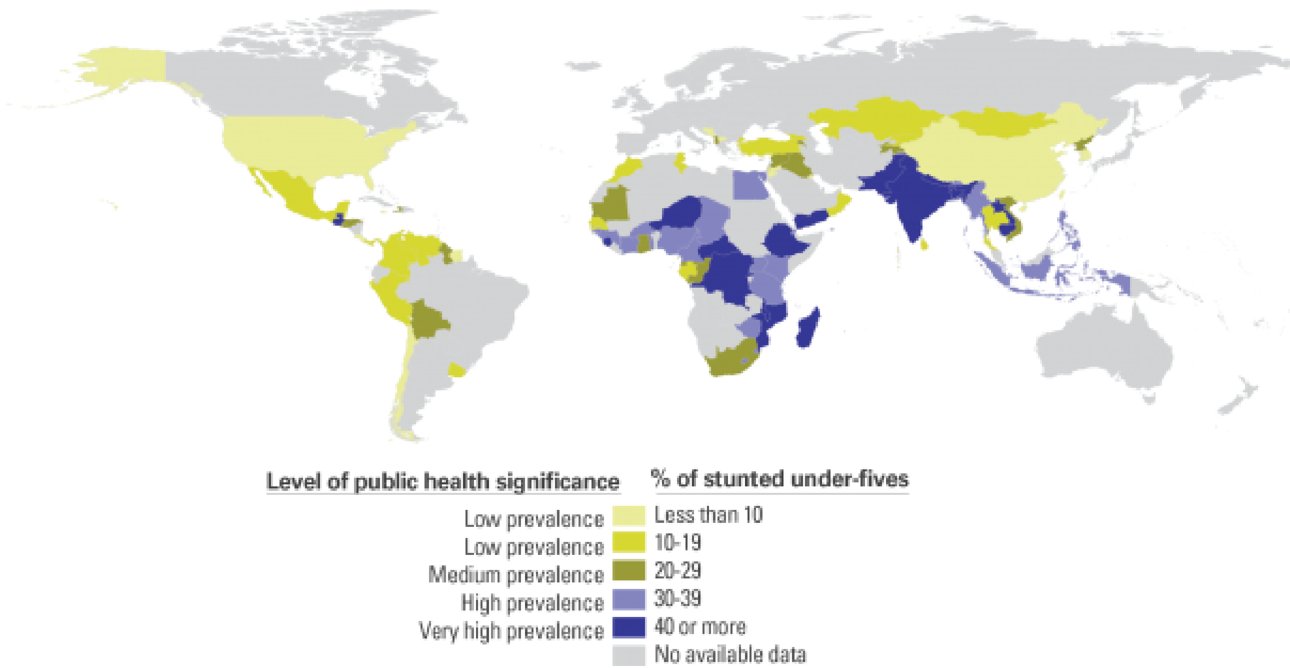


Figure 2. Undernutrition contributes to half of all deaths in children under 5 and is widespread in Asia and Africa Percentage of under-five children who are stunted, 2008 - 2013).

Column	Variable	Type	Label/Description
1	Id	int	Unique Fetus ID
2	t.ultsnd	float	Estimated fetus gestational age from last menstrual recall date
3	Sex	int	0 = Male, 1 = Female
4	Status	int	Maternal nutritional status (1 or 2)
5-12	Odv	float	Dependent variables: Ultrasound observed measurements
13	Birth Sz	float	Birth Weight (w)
14	Duration	float	Pregnancy Duration, or Birthday (b)

Table 1. Dataset definition (from [3])

a set of numbers from a practical way, it is actually helping doctors and / or families, analyzing the results and evaluating the need to take actions to revert the malnutrition.

Thus, the ultimate goal is eventually to create a model that can help make decisions about whether to take action to reverse a possible framework for future child malnutrition, to the extent that we are evaluating the child from the womb breast.

5. Charts and Tables

The charts below are from CDC[6] website and given the default curves of growth for girls and boys from the birth to 24 months.

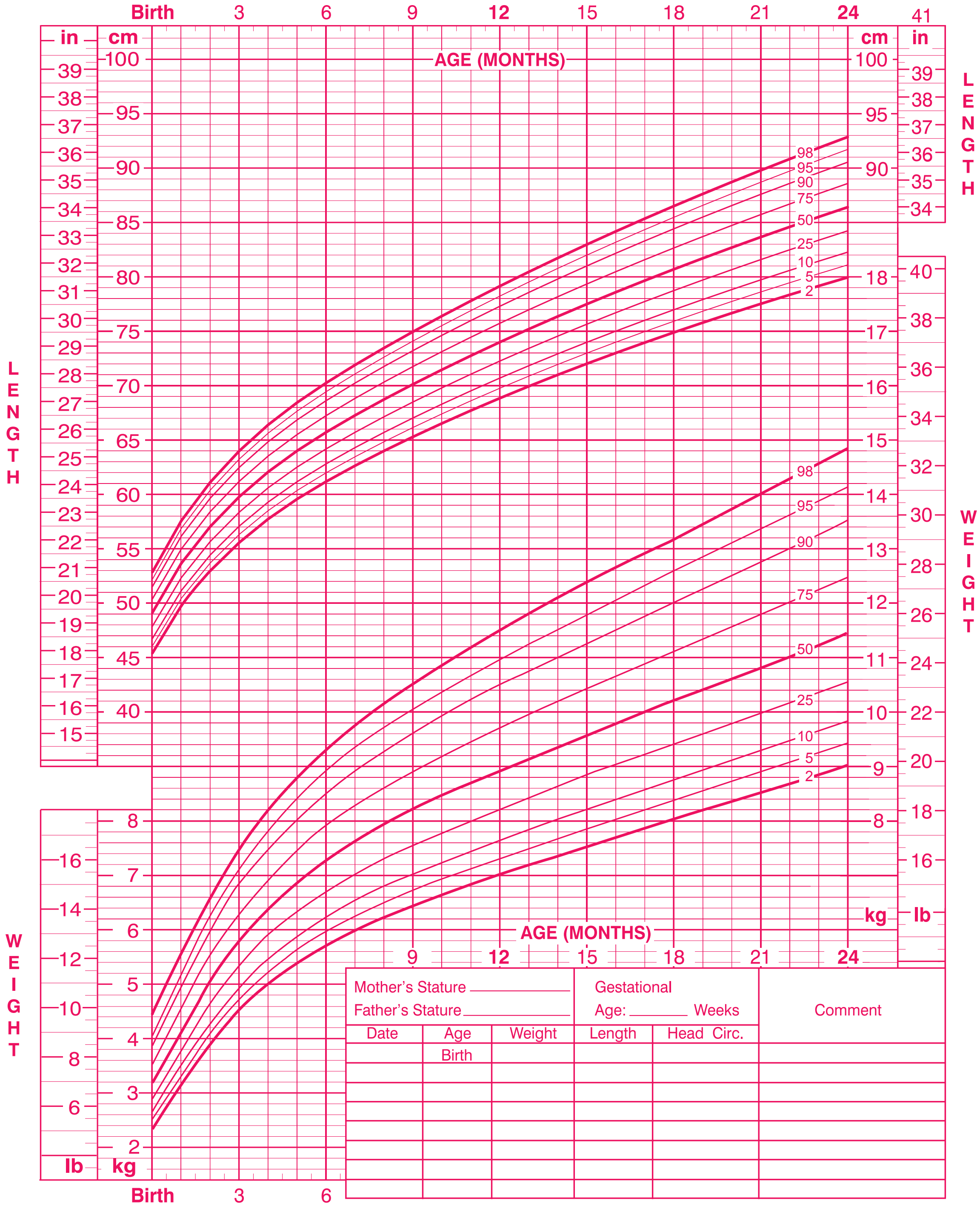
Note that

[6]Center for Disease Control and Prevention

Birth to 24 months: Girls
Length-for-age and Weight-for-age percentiles

NAME ______________________________

RECORD # ____________



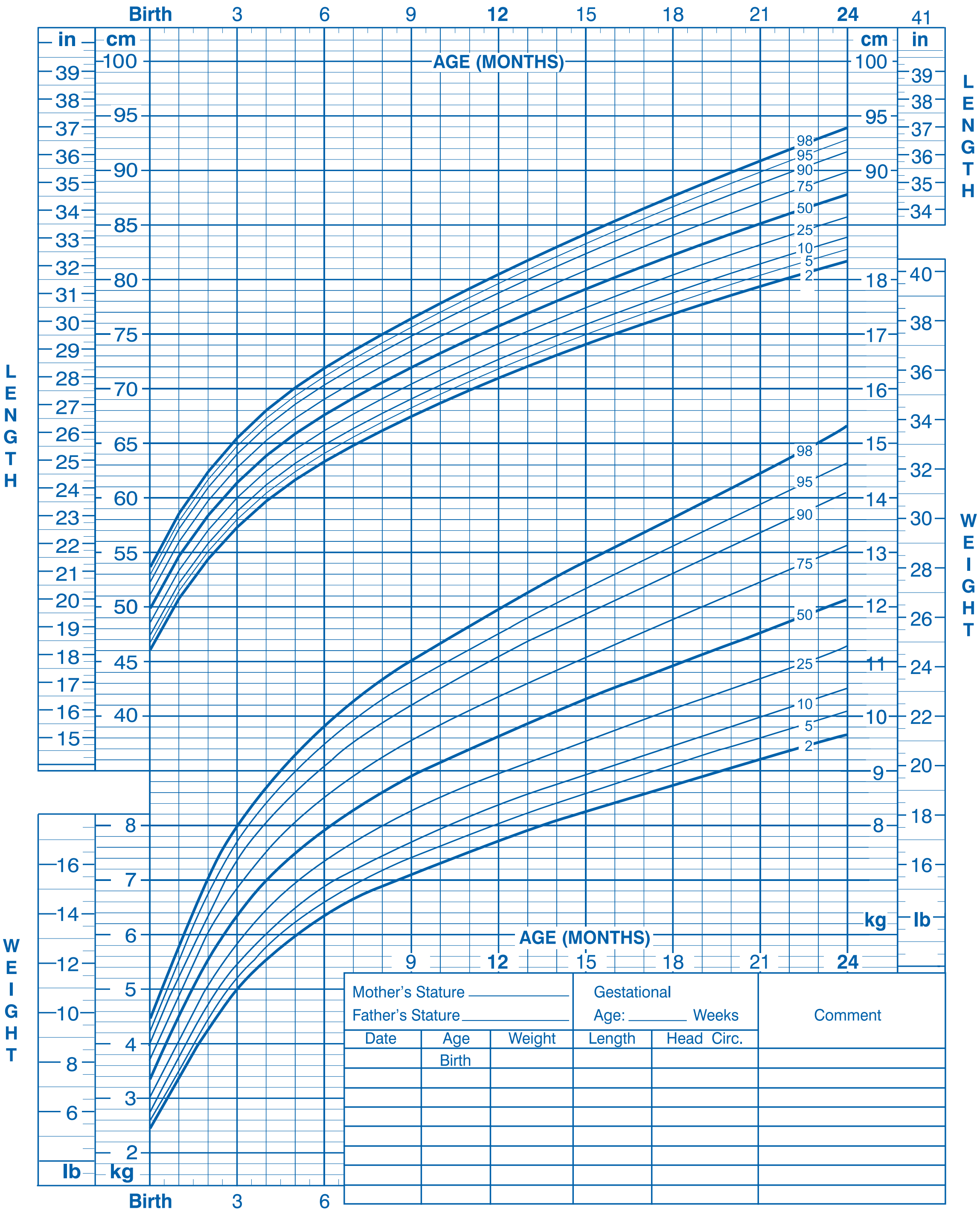
Mother's Stature ________ Father's Stature ________			Gestational Age: ______ Weeks		Comment
Date	Age	Weight	Length	Head Circ.	
	Birth				

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

Birth to 24 months: Boys
Length-for-age and Weight-for-age percentiles

NAME ______________________

RECORD # __________



Mother's Stature ________		Gestational Age: ______ Weeks		Comment
Father's Stature ________				

Date	Age	Weight	Length	Head Circ.	Comment
	Birth				

Published by the Centers for Disease Control and Prevention, November 1, 2009
SOURCE: WHO Child Growth Standards (http://www.who.int/childgrowth/en)

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Age (in months)	3rd Percentile Length (in centimeters)	5th Percentile Length (in centimeters)	10th Percentile Length (in centimeters
0	44.9251	45.56841	46.55429
0.5	47.97812	48.55809	49.4578
1.5	52.19859	52.72611	53.55365
2.5	55.26322	55.77345	56.57772
3.5	57.73049	58.23744	59.0383
4.5	59.82569	60.33647	61.1441
5.5	61.66384	62.18261	63.00296
6.5	63.31224	63.84166	64.67854
7.5	64.81395	65.35584	66.21181
8.5	66.19833	66.75398	67.63088
9.5	67.48635	68.05675	68.95591
10.5	68.6936	69.27949	70.20192
11.5	69.832	70.43397	71.38046
12.5	70.91088	71.52941	72.50055
13.5	71.9377	72.57318	73.56946
14.5	72.91853	73.5713	74.59309
15.5	73.85839	74.52871	75.57634
16.5	74.76147	75.44958	76.5233
17.5	75.63132	76.33742	77.43742
18.5	76.47096	77.19523	78.32168
19.5	77.283	78.0256	79.17863
20.5	78.06971	78.83077	80.01048
21.5	78.83308	79.61271	80.81919
22.5	79.57485	80.37315	81.60646
23.5	80.29656	81.11363	82.37381
24.5	80.99959	81.83552	83.12259
25.5	81.74464	82.58135	83.87245
26.5	82.47365	83.31105	84.60576
27.5	83.18812	84.02609	85.32399
28.5	83.88931	84.72769	86.02833
29.5	84.57826	85.41688	86.71978
30.5	85.25589	86.09452	87.39917
31.5	85.92294	86.76134	88.06723
32.5	86.58009	87.41799	88.72457
33.5	87.22791	88.06503	89.37177
34.5	87.86696	88.70301	90.00937
35.5	88.49774	89.33242	90.63786

Table 2. Males, Ages Birth - 36 Months

References

[1] Nancy Kerrebrock Eugene M. Lewit. Child indicators: Population-based growth stunting. http://futureofchildren.org/publications/journals/article/index.xml?journalid=53&articleid=293&sectionid=1935, 1997. 1

[2] UNICEF. Child nutrition interactive dashboard. http://data.unicef.org/resources/2013/webapps/nutrition#, 2014. [Online; accessed 15-November-2014]. 2

[3] TopCoder Team. Child Stuntedness. http://community.topcoder.com/longcontest/?module=ViewProblemStatement&rd=16065&pm=13367, 2014. [Online; accessed 11-October-2014]. 2, 3

[4] Sahilu Assegid Teshale Fikadu and Lamessa Dube. Factors associated with stunting among children of age 24 to 59 months in Meskan district, Gurage Zone, South Ethiopia: a case-control study. http://www.biomedcentral.com/1471-2458/14/800, 2014. [Online; accessed 29-November-2014].

[5] World Health Organization. Nutrition Landscape Information System (NLiS). http://apps.who.int/nutrition/landscape/help.aspx?menu=0&helpid=391&lang=EN, 2014. [Online; accessed 05-December-2014].

Age (in months)	3rd Percentile Length (in centimeters)	5th Percentile Length (in centimeters)	10th Percentile Length (in centimeters
0	45.09488	45.57561	46.33934
0.5	47.46916	47.96324	48.74248
1.5	50.95701	51.47996	52.29627
2.5	53.62925	54.17907	55.03144
3.5	55.8594	56.43335	57.31892
4.5	57.8047	58.40032	59.31633
5.5	59.54799	60.16323	61.10726
6.5	61.13893	61.77208	62.7421
7.5	62.60993	63.25958	64.25389
8.5	63.98348	64.64845	65.66559
9.5	65.2759	65.9552	66.99394
10.5	66.49948	67.19226	68.25154
11.5	67.66371	68.36925	69.44814
12.5	68.77613	69.4938	70.59149
13.5	69.8428	70.57207	71.68784
14.5	70.86874	71.60911	72.74233
15.5	71.85807	72.60914	73.75924
16.5	72.81433	73.57571	74.74217
17.5	73.74047	74.51184	75.6942
18.5	74.63908	75.42012	76.61797
19.5	75.51237	76.30282	77.51576
20.5	76.36229	77.16191	78.38958
21.5	77.19056	77.9991	79.2412
22.5	77.99868	78.81595	80.07216
23.5	78.78801	79.61381	80.88385
24.5	79.55974	80.39391	81.67752
25.5	80.33998	81.18804	82.49318
26.5	81.11332	81.97223	83.29459
27.5	81.87334	82.74084	84.07717
28.5	82.61506	83.48951	84.83741
29.5	83.33473	84.21496	85.57273
30.5	84.02972	84.91494	86.28139
31.5	84.69837	85.58809	86.96242
32.5	85.33987	86.23379	87.6155
33.5	85.95413	86.85208	88.24089
34.5	86.54167	87.44359	88.83932
35.5	87.10349	88.00937	89.41196

Table 3. Females, Ages Birth - 36 Months

[6] Center for Disease Control and Prevention. WHO Growth Standards Are Recommended for Use in the U.S. for Infants and Children 0 to 2 Years of Age . http://www.cdc.gov/growthcharts/who_charts.htm#TheWHOGrowthCharts, 2014. [Online; accessed 05-December-2014].

[7] Center for Disease Control and Prevention. Data Table of Infant Length-for-age Charts. http://www.cdc.gov/growthcharts/html_charts/lenageinf.htm, 2014. [Online; accessed 05-December-2014].