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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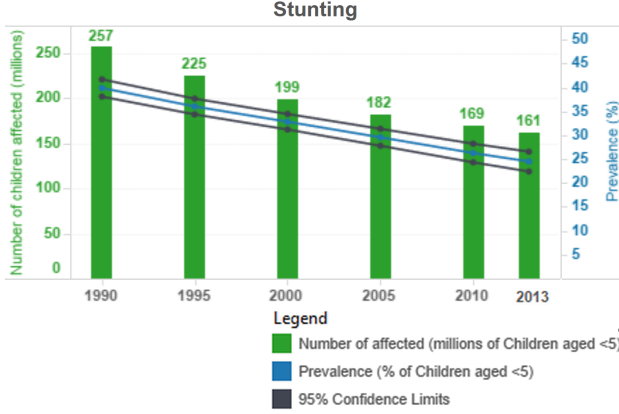[1]National Center for Health Statistics

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 $SSE = \sum(e_i)$.

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[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

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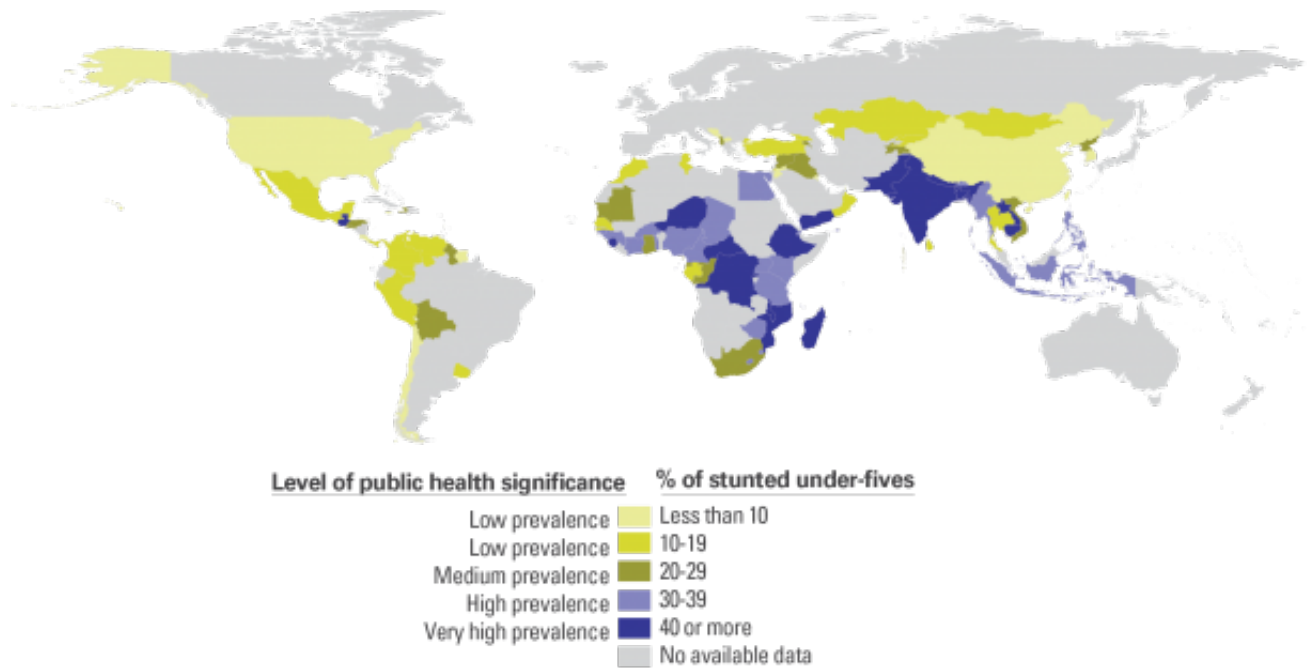ViewProblemStatement&rd=16209&compid=45332

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

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[6]Center for Disease Control and Prevention

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

NAME _____

RECORD # _____

AGE (MONTHS)

LENGTH

WEIGHT

Length percentiles: 98, 95, 90, 75, 50, 25, 10, 5, 2

Weight percentiles: 98, 95, 90, 75, 50, 25, 10, 5, 2

Mother's Stature _____		Gestational Age: _____ Weeks		Comment	
Father's Stature _____					
Date	Age	Weight	Length	Head Circ.	
	Birth				
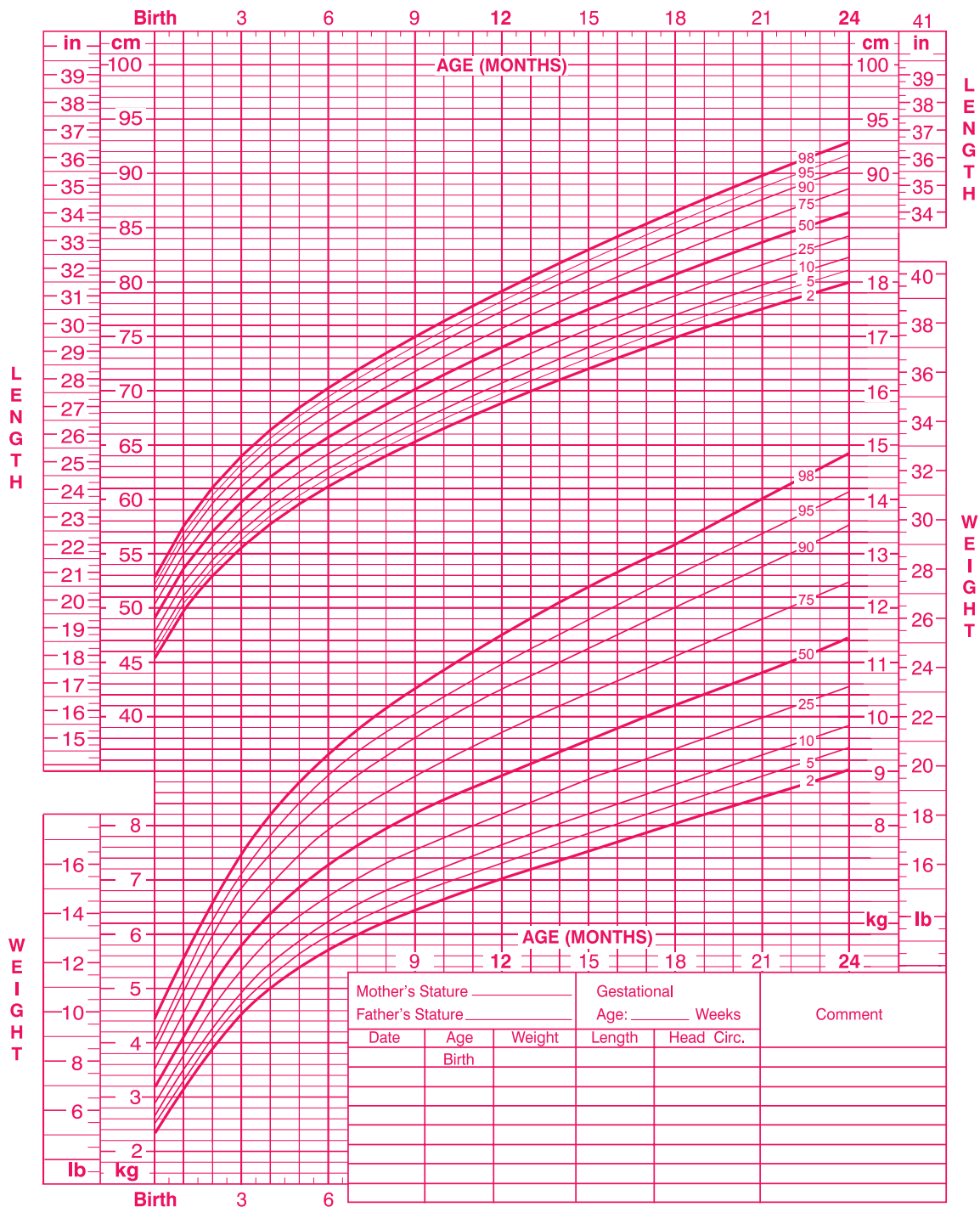
CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

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

NAME _____

RECORD # _____

AGE (MONTHS)

LENGTH

WEIGHT

Mother's Stature _____
Father's Stature _____

Gestational
Age: _____ Weeks

Comment

Date	Age	Weight	Length	Head Circ.	
Birth					

SAFER · HEALTHIER · PEOPLE™

CDC

Age (in months)	3rd Percentile (cm)	5th Percentile (cm)	10th Percentile (cm)	25th Percentile (cm)	50th Percentile (cm)	75th Percentile (cm)	90th Percentile (cm)	95th Percentile (cm)	97th Percentile (cm)
0	44.9251	45.56841	46.55429	48.18937	49.98888	51.77126	53.36153	54.30721	54.919
0.5	47.97812	48.55809	49.4578	50.97919	52.69598	54.44054	56.03444	56.99908	57.62984
1.5	52.19859	52.72611	53.55365	54.9791	56.62843	58.35059	59.9664	60.96465	61.62591
2.5	55.26322	55.77345	56.57772	57.9744	59.60895	61.33788	62.98158	64.00789	64.69241
3.5	57.73049	58.23744	59.0383	60.43433	62.077	63.82543	65.49858	66.54889	67.2519
4.5	59.82569	60.33647	61.1441	62.55409	64.21686	65.99131	67.69405	68.76538	69.48354
5.5	61.66384	62.18261	63.00296	64.43546	66.12531	67.92935	69.66122	70.75128	71.48218
6.5	63.31224	63.84166	64.67854	66.13896	67.86018	69.69579	71.45609	72.56307	73.30488
7.5	64.81395	65.35584	66.21181	67.70375	69.45908	71.32735	73.11525	74.23767	74.98899
8.5	66.19833	66.75398	67.63088	69.15682	70.94804	72.84947	74.6641	75.80074	76.56047
9.5	67.48635	68.05675	68.95591	70.51761	72.34586	74.2806	76.1211	77.27095	78.03819
10.5	68.6936	69.27949	70.20192	71.80065	73.66665	75.63462	77.50016	78.66234	79.43637
11.5	69.832	70.43397	71.38046	73.01712	74.9213	76.92224	78.81202	79.98578	80.76602
12.5	70.91088	71.52941	72.50055	74.17581	76.11838	78.15196	80.0652	81.2499	82.03585
13.5	71.9377	72.57318	73.56946	75.2838	77.2648	79.33061	81.2666	82.46167	83.25292
14.5	72.91853	73.5713	74.59309	76.34685	78.36622	80.4638	82.42185	83.6268	84.42302
15.5	73.85839	74.52871	75.57634	77.36973	79.42734	81.5562	83.53568	84.75006	85.55095
16.5	74.76147	75.44958	76.5233	78.35646	80.45209	82.61174	84.61204	85.83547	86.64078
17.5	75.63132	76.33742	77.43742	79.31042	81.44384	83.63377	85.65431	86.88645	87.69597
18.5	76.47096	77.19523	78.32168	80.23453	82.40544	84.62515	86.66541	87.90595	88.7195
19.5	77.283	78.0256	79.17863	81.13131	83.33938	85.58837	87.64786	88.89652	89.71393
20.5	78.06971	78.83077	80.01048	82.00292	84.24783	86.52562	88.60385	89.86038	90.68153
21.5	78.83308	79.61271	80.81919	82.85129	85.1327	87.43879	89.53533	90.79951	91.62428
22.5	79.57485	80.37315	81.60646	83.67811	85.99565	88.32957	90.44402	91.71563	92.54392
23.5	80.29656	81.11363	82.37381	84.48487	86.83818	89.19948	91.33143	92.61031	93.44203
24.5	80.99959	81.83552	83.12259	85.2729	87.66161	90.04985	92.19893	93.48491	94.31998
25.5	81.74464	82.58135	83.87245	86.03703	88.45247	90.8787	93.07143	94.38775	95.24419
26.5	82.47365	83.31105	84.60576	86.78329	89.22326	91.68468	93.91817	95.263	96.13962
27.5	83.18812	84.02609	85.32399	87.51317	89.97549	92.46929	94.74064	96.1121	97.00763
28.5	83.88931	84.72769	86.02833	88.22788	90.71041	93.23385	95.54016	96.93639	97.84957
29.5	84.57826	85.41688	86.71978	88.9284	91.42908	93.97951	96.318	97.73717	98.66677
30.5	85.25589	86.09452	87.39917	89.6156	92.13242	94.70732	97.07531	98.51569	99.46052
31.5	85.92294	86.76134	88.06723	90.2902	92.82127	95.41824	97.81324	99.27318	100.2321
32.5	86.58009	87.41799	88.72457	90.95287	93.49638	96.11319	98.53287	100.0109	100.9829
33.5	87.22791	88.06503	89.37177	91.60421	94.15847	96.79307	99.23531	100.73	101.7142
34.5	87.86696	88.70301	90.00937	92.24482	94.80823	97.45873	99.92162	101.4318	102.4274
35.5	88.49774	89.33242	90.63786	92.87525	95.44637	98.11108	100.5929	102.1174	103.1237

Table 2. Males, Ages Birth - 36 Months

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Age (in months)	3rd Percentile (cm)	5th Percentile (cm)	10th Percentile (cm)	25th Percentile (cm)	50th Percentile (cm)	75th l
0	45.09488	45.57561	46.33934	47.68345	49.2864	51.01
0.5	47.46916	47.96324	48.74248	50.09686	51.68358	53.36
1.5	50.95701	51.47996	52.29627	53.69078	55.28613	56.93
2.5	53.62925	54.17907	55.03144	56.47125	58.09382	59.74
3.5	55.8594	56.43335	57.31892	58.80346	60.45981	62.12
4.5	57.8047	58.40032	59.31633	60.84386	62.5367	64.22
5.5	59.54799	60.16323	61.10726	62.6759	64.40633	66.12
6.5	61.13893	61.77208	62.7421	64.35005	66.11842	67.86
7.5	62.60993	63.25958	64.25389	65.89952	67.70574	69.48
8.5	63.98348	64.64845	65.66559	67.34745	69.19124	71.01
9.5	65.2759	65.9552	66.99394	68.7107	70.59164	72.44
10.5	66.49948	67.19226	68.25154	70.00202	71.91962	73.80
11.5	67.66371	68.36925	69.44814	71.23128	73.18501	75.11
12.5	68.77613	69.4938	70.59149	72.40633	74.39564	76.35
13.5	69.8428	70.57207	71.68784	73.53349	75.55785	77.55
14.5	70.86874	71.60911	72.74233	74.61799	76.67686	78.71
15.5	71.85807	72.60914	73.75924	75.66416	77.75701	79.82
16.5	72.81433	73.57571	74.74217	76.67568	78.80198	80.90
17.5	73.74047	74.51184	75.6942	77.65565	79.81492	81.95
18.5	74.63908	75.42012	76.61797	78.60678	80.79852	82.97
19.5	75.51237	76.30282	77.51576	79.53138	81.75512	83.96
20.5	76.36229	77.16191	78.38958	80.4315	82.68679	84.92
21.5	77.19056	77.9991	79.2412	81.30893	83.59532	85.87
22.5	77.99868	78.81595	80.07216	82.16525	84.48233	86.79
23.5	78.78801	79.61381	80.88385	83.00187	85.34924	87.69
24.5	79.55974	80.39391	81.67752	83.82007	86.19732	88.57
25.5	80.33998	81.18804	82.49318	84.67209	87.09026	89.50
26.5	81.11332	81.97223	83.29459	85.5036	87.95714	90.40
27.5	81.87334	82.74084	84.07717	86.31151	88.79602	91.28
28.5	82.61506	83.48951	84.83741	87.09346	89.60551	92.12
29.5	83.33473	84.21496	85.57273	87.84783	90.38477	92.93
30.5	84.02972	84.91494	86.28139	88.57362	91.13342	93.70
31.5	84.69837	85.58809	86.96242	89.27042	91.85154	94.45
32.5	85.33987	86.23379	87.6155	89.93835	92.53964	95.16
33.5	85.95413	86.85208	88.24089	90.57795	93.19854	95.84
34.5	86.54167	87.44359	88.83932	91.1902	93.82945	96.49
35.5	87.10349	88.00937	89.41196	91.77639	94.43382	97.12

Table 3. Females, Ages Birth - 36 Months