

## ORIGINAL ARTICLE

# UPDATE OF GROWTH PERCENTILES FOR CHILDREN OF AN IRANIAN POPULATION

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**Background** – Growth assessment is an essential component of pediatric health surveillance because almost any problem within physiologic, interpersonal, and social domains can adversely affect growth. The growth chart is the most powerful tool in growth assessment. Standard growth charts are based on the data collected by the American National Center for Health Statistics (NCHS).

Growth percentiles require periodic revision because of the changes in the ethnic mix of the population as well as socioeconomic and environmental conditions. This paper describes the new reference percentile curves for weight, height, and head circumference in an Iranian population between birth and 6 years of age.

**Methods** – Fifteen-hundred and forty children (808 boys and 732 girls) were studied using cross-sectional method. Based on the primary data, 5 percentiles (5, 25, 50, 75, and 95) were determined for each sex and age group separately. The smoothed curves were then prepared. The smoothed curves of the 50<sup>th</sup> percentiles in our study compared to those of NCHS.

**Results** – Using Run test, there were no significant differences between the percentiles found in our study and those in NCHS except for three groups: the height of males at birth ( $p = 0.0268$ ), the weight of females at 18<sup>th</sup> month ( $p = 0.0456$ ), and the weight of males at 4 ½ years of age ( $p = 0.0109$ ). However, after 36<sup>th</sup> month, Iranian children were found to be generally lighter and smaller than the subjects in NCHS references.

**Conclusion** – The new reference smoothed curves are similar to NCHS curves. The means, NCHS/WHO standards are appropriate for growth assessment in our community in this range of age (0 – 6 years). Nevertheless, for determination of standard growth charts especially for weight and height, more extensive studies on other age groups and in different locations of Iran are recommended.

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**Keywords** • growth charts • head circumference • height • percentiles • weight

### Introduction

Knowledge of the normal growth pattern of children is essential for detecting and preventing pediatric diseases by recognizing overt deviations from normal patterns. Deviations in growth patterns are nonspecific yet important indicators of serious medical disorders. They often provide the first clue to learn that something is wrong, at times, even when the parents do not suspect a problem.<sup>1</sup>

The most important growth criteria are anthro-

pometric indices (weight, height, and head circumference) and the most powerful tool in growth assessment is the growth chart. Thus, an accurate measurement of height weight and head circumference should be obtained at every health supervision visit.<sup>2</sup>

The standard growth charts are based on the data collected, from 1963 to 1975, by the American National Center for Health Statistics (NCHS). New growth charts are scheduled to be released in 1999 based on a nationally representative sample collected from 1988 to 1994 as a part of the National Health and Nutrition Examination Survey (NHANES-III).

The NCHS charts have been accepted by

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## Update of Growth Percentiles for Children of an Iranian Population

**Table 1.** Percentiles for weight, length/ stature, and head circumference by age in males.

Percentiles	Age	5 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	95 <sup>th</sup>
Weight(kg)	Birth	2.425	2.900	3.210	3.450	4.167
	3 mon	5.050	5.950	6.300	6.790	7.530
	6 mon	6.585	7.392	8.150	8.625	9.700
	9 mon	6.930	7.800	8.600	9.540	10.825
	12 mon	8.050	9.050	9.500	10.400	11.700
	15 mon	7.850	9.762	10.050	10.787	11.800
	18 mon	8.890	9.862	10.575	11.950	13.767
	21 mon	8.845	10.662	11.575	12.150	13.202
	24 mon	10.162	11.225	12.075	12.737	13.837
	27 mon	10.640	11.925	12.350	13.325	14.580
	30 mon	10.780	12.450	13.400	14.200	16.420
	33 mon	10.850	12.250	13.200	14.250	16.370
	36 mon	10.890	12.850	14.000	14.800	17.420
	3.5 yr	13.080	14.000	15.000	16.200	17.840
	4 yr	13.220	14.975	15.650	17.000	17.820
	4.5 yr	14.235	16.000	17.000	18.125	20.970
	5 yr	13.510	15.500	17.000	18.200	20.600
	5.5 yr	15.100	17.200	18.000	19.200	21.000
6 yr	17.300	18.550	19.500	20.500	23.700	
Length/stature (cm)	Birth	47.625	50.000	50.500	51.875	54.350
	3 mon	55.800	60.000	61.200	63.000	65.600
	6 mon	63.230	67.000	68.000	70.000	75.000
	9 mon	67.050	71.000	72.300	74.000	75.850
	12 mon	69.00	73.000	75.500	76.500	81.500
	15 mon	71.850	77.250	79.000	80.000	84.500
	18 mon	75.805	78.875	81.600	82.875	86.650
	21 mon	74.650	80.000	83.500	86.000	90.000
	24 mon	82.000	84.675	87.250	88.450	98.375
	27 mon	80.350	86.000	88.000	91.000	95.500
	30 mon	84.000	87.200	90.000	94.000	97.400
	33 mon	83.400	88.500	91.000	94.000	100.200
	36 mon	85.800	91.000	93.000	96.000	100.100
	3.5 yr	93.100	95.000	99.500	102.000	108.000
	4 yr	93.550	98.000	103.000	104.000	109.800
	4.5 yr	97.000	105.000	107.000	108.000	117.300
	5 yr	97.800	106.000	107.000	111.000	116.200
	5.5 yr	97.500	110.000	113.000	115.500	119.000
6 yr	105.600	112.000	114.000	116.500	120.000	
Head circumference (cm)	Birth	32.325	33.500	34.100	35.525	37.675
	3 mon	38.250	39.875	40.600	41.350	43.175
	6 mon	42.090	43.075	43.750	44.850	46.000
	9 mon	40.900	44.600	45.200	46.050	48.050
	12 mon	43.900	45.800	47.000	48.000	49.000
	15 mon	45.525	46.550	47.650	48.175	49.000
	18 mon	46.415	47.725	48.500	49.225	50.845
	21 mon	45.325	47.000	48.250	49.425	51.280
	24 mon	46.450	48.125	49.100	50.300	51.000
	27 mon	46.910	48.650	49.200	50.000	50.530
	30 mon	47.175	48.975	49.750	50.525	51.275
	33 mon	47.550	48.900	49.800	50.500	51.440
	36 mon	48.140	49.500	50.000	50.750	52.360

yr = year; mon = month.

WHO as the international standard of growth for the first 5 years of life<sup>2</sup> but, over the last decade, these references have become more and more out of date due to secular trend in body size. Therefore, age-related reference ranges have received considerable attention in recent years.<sup>3-8</sup>

Growth varies from population to population, hence extrapolating growth patterns from one population to another may either over- or underestimate excessive or deficient growth.<sup>9</sup> The controversy over whether or not the growth standards for children developed in Europe and

North America are universally applicable, appears now to be settled in favor of those who maintain that they are. Thus, growth percentiles require periodic revision because of the changes in the ethnic mix of a population and socioeconomic factors. This paper presents growth percentiles for children of an Iranian population between birth and 6 years of age.

### Patients and Methods

Using descriptive cross-sectional method,

**Table 2.** Percentiles for weight, length/stature, and head circumference by age in females.

Percentiles	Age	5 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	95 <sup>th</sup>
Weight(kg)	Birth	2.270	2.730	2.950	3.200	3.780
	3 mon	4.455	5.550	6.200	6.662	7.132
	6 mon	6.500	6.912	7.375	8.137	8.527
	9 mon	6.442	7.702	8.450	9.275	10.370
	12 mon	7.515	8.200	9.100	9.650	11.015
	15 mon	8.360	8.975	10.000	10.950	11.870
	18 mon	9.185	9.900	10.500	11.725	13.400
	21 mon	9.600	10.650	11.150	12.250	12.790
	24 mon	9.555	10.712	11.550	12.137	13.100
	27 mon	10.230	10.912	12.100	13.275	15.580
	30 mon	10.100	11.100	12.100	13.000	15.800
	33 mon	10.932	12.287	13.275	14.325	17.480
	36 mon	11.275	12.575	13.500	14.125	15.162
	3.5 yr	12.600	13.575	14.500	15.587	17.150
	4 yr	13.305	14.000	14.900	15.625	16.970
	4.5 yr	13.150	14.650	16.000	16.400	18.690
	5 yr	12.950	15.050	16.000	17.000	20.180
	5.5 yr	14.945	15.850	17.550	18.650	20.550
6 yr	15.340	17.300	18.500	19.050	23.000	
Length/stature (cm)	Birth	46.000	48.500	49.500	50.500	52.300
	3 mon	55.050	59.000	62.000	63.000	66.370
	6 mon	63.700	65.000	67.000	68.500	71.200
	9 mon	66.000	69.000	70.750	72.500	74.000
	12 mon	68.975	72.525	74.500	78.000	83.000
	15 mon	71.740	76.250	77.800	78.750	81.490
	18 mon	77.650	78.750	80.500	83.000	86.700
	21 mon	78.200	81.500	84.000	85.500	87.420
	24 mon	79.275	83.500	85.250	87.625	90.900
	27 mon	81.000	82.875	87.000	89.625	96.150
	30 mon	82.000	87.000	88.000	90.000	95.000
	33 mon	86.650	90.000	92.000	94.375	99.750
	36 mon	85.500	90.750	93.000	96.250	102.000
	3.5 yr	93.000	95.500	100.000	102.000	104.750
	4 yr	93.300	96.000	99.000	100.250	103.850
	4.5 yr	97.300	101.000	104.000	106.250	111.400
	5 yr	97.600	103.000	106.000	110.000	114.000
	5.5 Yr	97.250	106.000	110.500	113.875	118.750
6 yr	102.200	109.000	113.000	115.000	118.650	
Head circumference (cm)	Birth	31.400	33.000	34.000	34.500	35.560
	3 mon	37.175	38.925	40.000	41.000	42.720
	6 mon	39.955	41.625	42.750	43.500	45.275
	9 mon	42.325	44.000	44.500	45.000	46.780
	12 mon	43.770	44.925	45.800	46.500	48.535
	15 mon	43.650	45.400	46.500	47.700	48.650
	18 mon	45.500	46.000	47.500	48.600	51.430
	21 mon	44.900	47.000	47.800	48.300	50.580
	24 mon	47.000	47.950	48.500	50.000	50.835
	27 mon	46.800	47.550	49.000	49.850	51.100
	30 mon	46.500	47.500	48.500	48.500	50.800
	33 mon	47.000	48.200	49.000	49.900	51.300
	36 mon	46.950	47.700	49.000	49.500	51.000

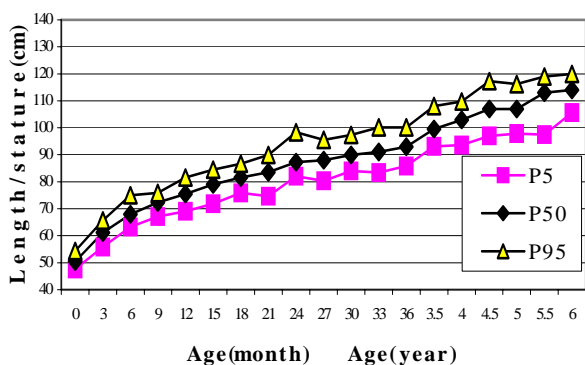
yr = year; mon = month.

parameters of growth (weight, length/stature, and head circumference) were determined in a 3-month period from birth to 36 months of age and a 6 month period between the ages of 3 and 6 years. For infants, two examiners measured their lengths with the infant supine on a measuring board, and for older children, the stature was measured with the child standing on a stadiometer. Head circumferences were determined only between birth and 3 years.

Fifteen-hundred and forty children (808 boys and 732 girls) without any previous medical

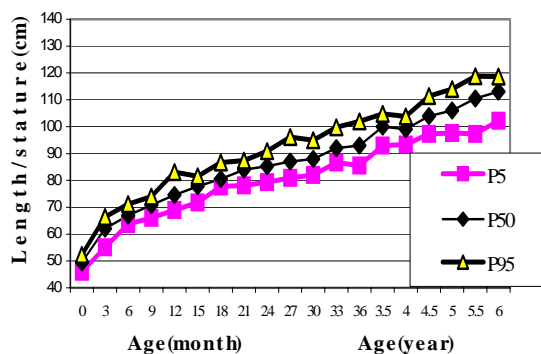
problems and no specific malformations were studied. The sampling method was random strata cluster. The age of the subjects were expressed as the number of months whose days were complete (complete months) and percentile values were derived accordingly, i.e. using the WHO convention that the age of each subject is recorded as the number of months whose days are complete; for example, 3 months and 29 days was recorded as 3 months. Five percentiles (5, 25, 50, 75, and 95) were separately determined for each criterion of both sexes.

## Update of Growth Percentiles for Children of an Iranian Population



**Figure 1.** Smoothed 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> percentiles for length/stature of males. P = percentage.

The growth curves were then drawn for each age and sex group. Using Run test, our study's percentiles were compared to those of NCHS; the probability value (*p* value) was calculated for

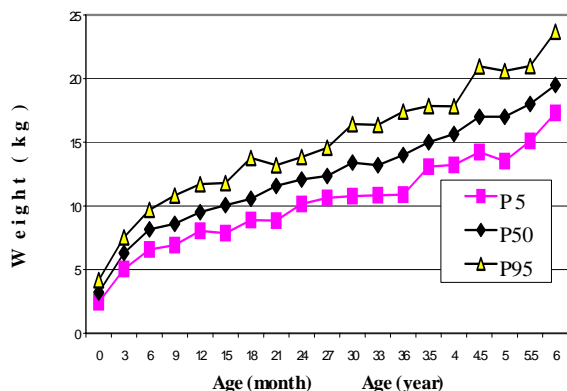


**Figure 2.** Smoothed 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> percentiles for length/stature of females. P = percentage.

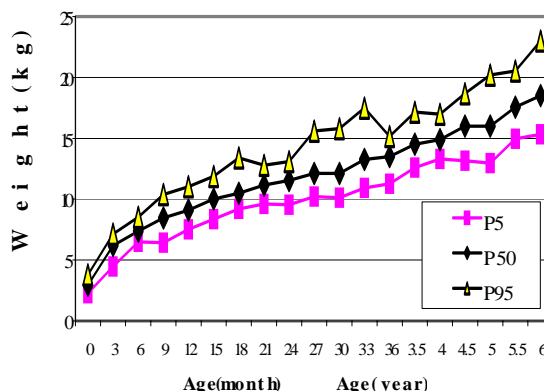
determination of significant differences.

### Results

There were 808 weight and length/stature

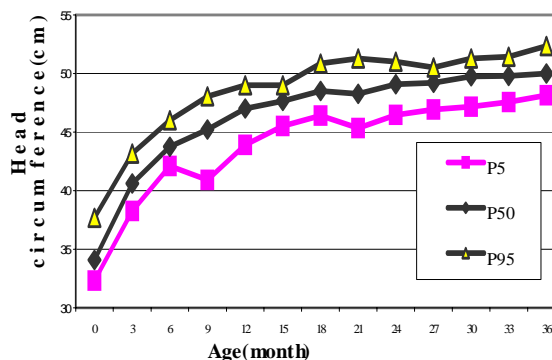


**Figure 3.** Smoothed 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> percentiles for weight of males. P = percentage.



**Figure 4.** Smoothed 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> percentiles for weight of females. P = percentage.

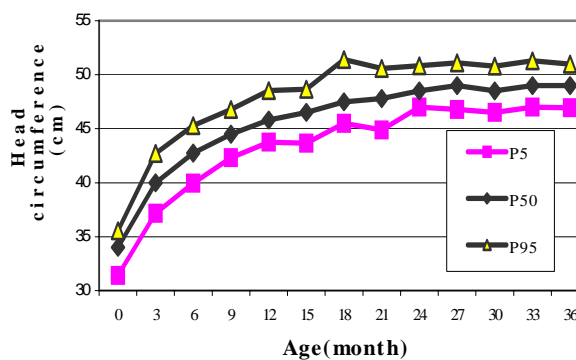
measurements for boys and 732 for girls between birth and 6 years of age. There were 423 head circumference measurements for boys and 393 for girls between birth and 3 years of age. The



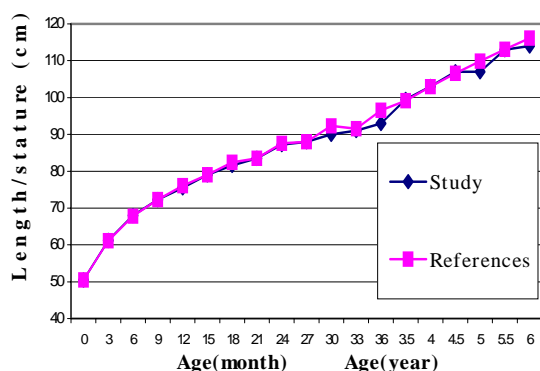
**Figure 5.** Smoothed 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles for head circumference of males. P = percentage.

percentiles are shown in Tables 1 and 2. According to the determined percentiles, the smoothed curves for the 5<sup>th</sup>, 50<sup>th</sup>, and 95<sup>th</sup> percentiles were drawn (Figures 1 to 6).

A comparison of the smoothed curve of the



**Figure 6.** Smoothed 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles for head circumference of females. P = percentage.



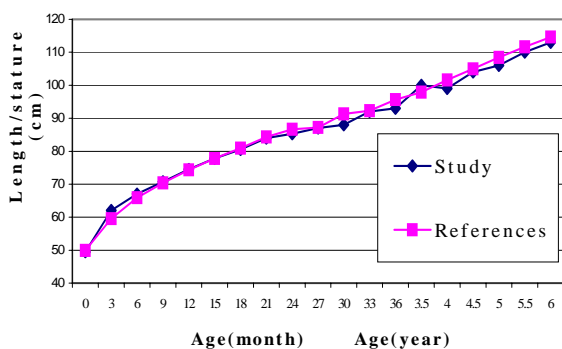
**Figure 7.** Comparison of smoothed 50<sup>th</sup> percentiles for length/stature of males in our study and that of NCHS.

50<sup>th</sup> percentiles for each parameter with that reported by NCHS are shown in Figures 7 to 12. There are no differences based on a visual comparison of the growth curves in the period between birth and 36 months during which only small deviations are seen. However, after 36 months of age, the curves of weight and length/stature of both sex groups drop slightly. When compared to NCHS/WHO reference, the heights and weights of Iranian children were lower in both sexes, but followed a similar pattern to that of weight and height for age in NCHS/WHO reference.

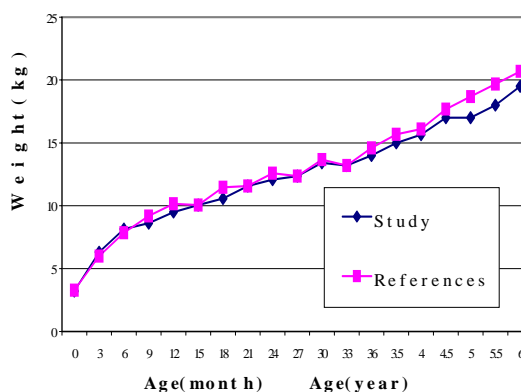
Using Run test, there were no significant statistical differences between the percentiles of our study and those of NCHS ( $p > 0.05$ ) except for three groups: the length of males at birth ( $p = 0.0268$ ), the weight of females at 18 months ( $p = 0.0456$ ), and the weight of males at 4 ½ years ( $p = 0.0109$ ).

### Discussion

Nowadays, the universal use of NCHS/WHO reference for all populations is controversial.



**Figure 8.** Comparison of smoothed 50<sup>th</sup> percentiles for length/stature of females in our study and that of NCHS.

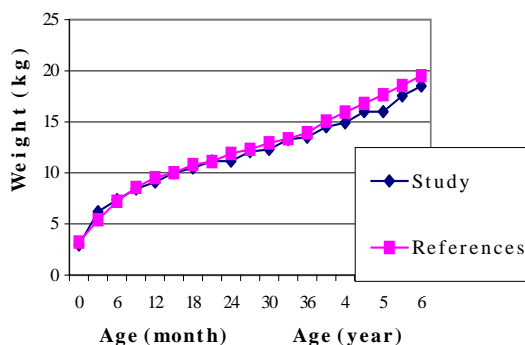


**Figure 9.** Comparison of smoothed 50<sup>th</sup> percentiles for weight of males in our study and that of NCHS.

Sullivan et al (1991) outlined the minimum criteria for the development of reference curves for specific populations. However, as well as recommending the NCHS/WHO international reference, they suggested that "in developing countries, the resources needed to produce a local growth reference might be more effectively used to meet other public health needs".<sup>10</sup> Goldstein and Tanner strongly argued that developing countries, in particular, should create their own standards for clinical use.<sup>11</sup> These beliefs explain the importance and necessity of our study.

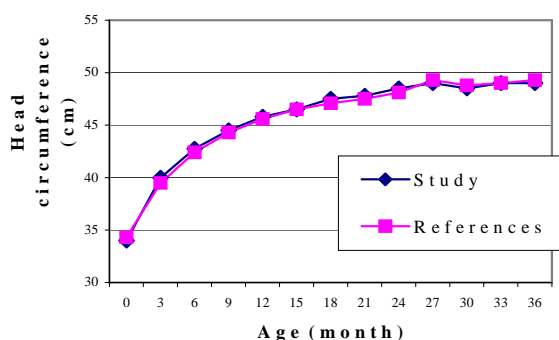
Our growth reference consists of the percentiles for the weight, length/stature, and head circumference of under 6-year-old children in a middle class Iranian population. As we expected, a comparison of the boys' and girls' percentiles revealed larger values for boys.

Comparing our percentiles with those of NCHS, we found no significant difference. Although, with these provisos, the reference sample is representative of a part of Iranian population and hence it is a growth reference and not a growth standard, but the NCHS standard is useful and appropriate for evaluation of growth



**Figure 10.** Comparison of smoothed 50<sup>th</sup> percentiles for weight of females in our study and that of NCHS.

## Update of Growth Percentiles for Children of an Iranian Population



**Figure 11.** Comparison of smoothed 50<sup>th</sup> percentiles for head circumference of males in our study and that of NCHS.

assessment in our community. Thus, more extensive studies are recommended in order to determine standard growth charts for Iranian children.

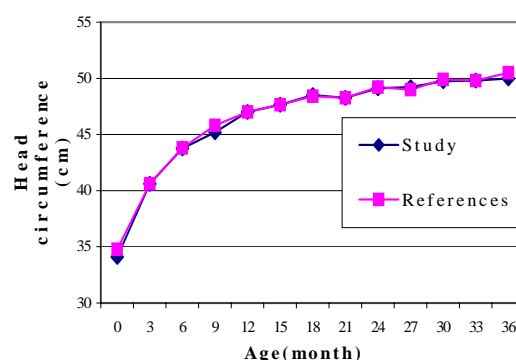
After an exhaustive review of growth studies worldwide, Eveleth et al declared that the growth patterns of healthy populations in different parts of the world are the same (at least up to 5 years of age) and concluded that they should be represented by a universal standard.<sup>12</sup>

Graitcer et al compared the growth indices of privileged groups of children in Haiti, Togo and Egypt with NCHS reference; they concluded that NCHS growth standards are appropriate for measuring child growth in developing countries;<sup>13</sup> this is in agreement with the results of our study. Guaran et al represented the growth percentiles for infants born in an Australian population during the 1980s and emphasized that birth-weight standards should be updated every 5 – 10 years.

British growth reference percentiles were determined by Cole et al in 1990 and turned out to be rather different from NCHS standards.<sup>14</sup>

Mohammadi et al (1997) compared the growth indices of a group of children in Tehran, Iran with those of NCHS and found that the head circumference percentiles of his subjects in the first year of life was similar to NCHS percentiles.<sup>15</sup> Talebian et al achieved similar results in Kashan, Iran in 1998.<sup>16</sup> Both of these studies demonstrated the same facts as our study.

In 1998, Sharif et al compared the 50<sup>th</sup> percentiles smoothed curves for the weight and length of breastfed infants (in the first year of life) in Kashan, Iran with those of NCHS and concluded that the curves they found were similar to NCHS curves up to 3 – 4 months of age, though they dropped gradually afterwards. Weight



**Figure 12.** Comparison of smoothed 50<sup>th</sup> percentiles for head circumference of females in our study and that of NCHS.

values dropped more prominently than length values.<sup>17</sup>

Hams P et al concluded that although there are no significant differences for head circumference percentiles in different areas, there is not a unique standard pattern for weight and height.<sup>18</sup> Therefore, according to our results and other studies in different areas of Iran, we can use the head circumference standard for Iranian children with confidence. However, due to the disagreement among the results of different studies, we recommend more extensive studies to determine standard growth charts in Iranian children.

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