

CLINICAL STUDY

Body mass index percentile curves for predominantly breastfed children aged 0–2 years from Ankara, Turkey

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Abstract: *Objective:* The percentiles of weight, height and body mass index (BMI) change markedly from one country to another and also from one city to another, particularly in childhood. The aim of the present study is to construct BMI percentile curves for predominantly breastfed Turkish children aged 0–2 years from Ankara, Turkey.

Methods: The study population consisted of healthy boys and girls aged 0–2 years from the middle–high socioeconomic status between 2002 and 2004 in well child clinic of Gazi University School of Medicine, Ankara, Turkey. The BMI values for boys and girls were calculated from the height and weight measurements, and BMI percentile values and curves were obtained separately for boys and girls by the LMS method.

Results: The current findings indicate that the BMI percentile values for boys are higher than those for girls in general. The estimated curves for BMI showed that there was a constant increase in BMI values towards 7th or 8th month and a slight decrease until 24th month in both boys and girls.

Conclusions: The current study presents percentile curves for BMI values in predominantly breastfed Turkish children aged 0 to 2 years living in Ankara, Turkey. To our knowledge, this is the first study considering BMI percentiles for predominantly breastfed Turkish children aged 0–2 years. However, WHO multicenter growth reference study curves can be used until constructing multicenter BMI reference curves representing Turkey (Fig. 2, Tab. 3, Ref. 19). Full Text in free PDF www.bmj.sk.

Key words: body mass index, children, growth, reference centile curves, LMS method.

The ages of 0–2 years are the ages when the families take their children to doctors very frequently due to child visits and vaccinations. In these visits, disorders of growth and development may be noticed as well as overfeeding problems, which result in obesity. Recent studies in the developed world have shown that patterns of growth during infancy may be associated with both childhood and adult obesity, suggesting the potential for intervention during infancy (1). Body mass index (BMI) is a useful method for diagnosis and monitoring a failure to thrive or obesity (2, 3). In order to make an early diagnosis of these growth disorders, growth must be monitored and BMI normal values must be known for early ages.

The Turkish growth standards for height and weight by age and gender have been commonly using in Turkey since 1978 (4). Recently, Bundak et al constructed the body mass index reference curves for Turkish children aged 6 to 18 years (5). To our knowledge, percentile curves for BMI have not been established for predominantly breastfed Turkish children aged 0–2 years liv-

ing in Ankara, Turkey yet. The aim of this study was to construct the BMI reference curves for predominantly breastfed Turkish children population aged 0–2 years from Ankara by LMS method.

Material and methods

This study was performed between 2002 and 2004 in well child clinic of Gazi University School of Medicine, Ankara, Turkey. The study population was usually from the medium–high socioeconomic status in Ankara. The study design was a prospective cohort. Ethical approval was granted by the Ethics Committee at Gazi University, Ankara, Turkey. Patient consent was informed. The subjects consisted of 466 children (239 boys and 227 girls). The singleton, term infants (38–42 weeks) with a birth weight of 2500–4000 gr, born in the year of 2002 and followed regularly for 2 years in this clinic were included in this study. Small for gestational age infants and infants with chronic diseases, and hospitalized infants were excluded. All infants have been seen by a pediatrician and a pediatric nurse on the 15th day of life and at the 2nd, 4th, 6th, 9th, 12th, 18th and 24th months. On these visits, their feeding histories, growth monitoring, and immunization schedule were noted in the standard forms prepared for this study. Also the standard forms included demographic characteristics of the children, and all information related to the children was recorded in the computer. Weight and

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height measurements were performed by the child clinic’s nurse. For the infants, recumbent length was measured with a portable infantometer; weight up to 18 kg was measured on a digital scale (Seca, Vogel & Halke, Hamburg, Germany). The mean number of measurements per boys and girls was 7.11±1.31 and 6.94±1.23, respectively.

BMI was calculated as:

$$\left(\frac{\text{weight}}{(\text{height})^2} \right)$$

BMI calculations are based on 1700 height and weight measurements for boys, and 1576 height and weight measurements for girls.

Statistical Analysis

BMI percentile curves were constructed by the LMS technique. LMS technique is one of the most commonly using methods for improving reference centile curves. Box-Cox power (ĕ), mean or median (ĕ) and coefficient of variation (ó), are the parameters of the LMS technique, respectively (6). A Box-Cox power transformation is applied to obtain the data closely approximated by a normal distribution (7). Three parameters of the method are estimated from the smoothed data curves (8). In this study, parameter estimation was organized at one-month age intervals, and was done separately for boys and girls. Specific centiles were formed by using determined L, M and S values for specific age points. The 3th, 10th, 25th, 50th, 75th, 85th, 90th, 95th, and 97th centiles were obtained by using estimated L, M and S values.

Results

The subjects consisted of 466 children (239 boys and 227 girls) and demographic characteristics of the children in this cohort are given in Table 1. Mean ages of mothers and fathers were 28.9±5.05 years and 33.1±5.24 years, respectively. In the first 4 months an exclusively breast feeding (EBF) rate was 53.7 %. None of the infants was fed with formula alone. Complementary food was started at the mean time of 4.4±2.8 months. The infants were still fed with breast milk in addition to complementary foods with a rate of 86 % at 6th month, 66 % at 12th month, and 22 % at 24th month. LMS parameters for BMI for each age (in months) in both genders are given in Table 2. Table 3 presents the smoothed percentile values of BMI for Turkish boys and girls aged 0–2 years. These percentile values of BMI include 3 %, 10 %, 25 %, 50 %, 75 %, 85 %, 90 %, 95 %, and 97 % for each gender. BMI percentile curves achieved from LMS parameters are shown in Figures 1 and 2. When the figures are examined for girls and boys, there is a general upward trend until 7 or 8 months of age, and then a slightly downward trend by 24 months of age appears. When BMI percentile values are considered in general, the BMI percentile values for boys are higher than those for girls.

Tab. 1. Demographic characteristics of the children.

Demographic characteristic	n	%
Gender		
Girl	227	49
Boy	239	51
Mother's education (years of schooling)		
<5 y	2	0.4
5-11 y	224	52.4
>11 y	220	47.2
Father's education (years of schooling)		
<5 y	-	-
5-11 y	214	46
>11 y	252	54
Mother's occupation		
Housewife	210	45.1
Civil servant (teacher, doctor etc.)	218	46.8
Business owner	16	3.4
Other	22	4.7
Father's occupation		
Civil servant (teacher, doctor etc.)	345	74
Workman	12	2.6
Business owner	81	17.4
Other	28	6

Tab. 2. The estimated LMS parameters for BMI by age and gender.

Age (months)	Boys			Girls		
	L	M	S	L	M	S
0	0.57	13.63	0.10	-0.54	13.31	0.09
1	0.44	14.68	0.10	-0.47	14.25	0.09
2	0.32	15.64	0.10	-0.39	15.12	0.10
3	0.22	16.38	0.10	-0.29	15.82	0.10
4	0.15	16.89	0.10	-0.18	16.33	0.10
5	0.09	17.18	0.10	-0.06	16.66	0.10
6	0.06	17.32	0.10	0.06	16.84	0.10
7	0.04	17.35	0.09	0.19	16.93	0.10
8	0.02	17.32	0.09	0.32	16.95	0.09
9	0.01	17.28	0.09	0.44	16.93	0.09
10	0.01	17.25	0.09	0.55	16.90	0.09
11	0.01	17.23	0.09	0.65	16.86	0.09
12	0.03	17.21	0.09	0.75	16.81	0.09
13	0.04	17.17	0.09	0.83	16.76	0.09
14	0.06	17.13	0.09	0.89	16.70	0.09
15	0.08	17.07	0.09	0.94	16.64	0.09
16	0.10	16.99	0.09	0.98	16.56	0.09
17	0.13	16.91	0.09	0.99	16.49	0.09
18	0.15	16.81	0.09	0.99	16.40	0.09
19	0.18	16.71	0.09	0.97	16.32	0.09
20	0.20	16.59	0.09	0.93	16.23	0.09
21	0.23	16.47	0.09	0.88	16.13	0.09
22	0.25	16.34	0.09	0.82	16.03	0.09
23	0.27	16.21	0.09	0.76	15.93	0.09
24	0.29	16.08	0.09	0.69	15.83	0.09

Discussion

Weight adjusted for height has been used to assess overweight and underweight status in children for many years (9). However,

Tab. 3. Predicted percentile values of BMI for Turkish children aged 0-2 years.

Age(month)	Boys									Girls								
	3	10	25	50	75	85	90	95	97	3	10	25	50	75	85	90	95	97
0	11.19	11.94	12.73	13.63	14.56	15.07	15.42	15.95	16.29	11.24	11.84	12.50	13.31	14.20	14.72	15.08	15.65	16.04
1	12.09	12.89	13.72	14.68	15.69	16.24	16.62	17.19	17.57	12.00	12.66	13.38	14.25	15.20	15.76	16.15	16.75	17.16
2	12.92	13.75	14.62	15.64	16.70	17.30	17.70	18.32	18.73	12.71	13.42	14.19	15.12	16.13	16.72	17.13	17.77	18.20
3	13.57	14.42	15.33	16.38	17.49	18.11	18.54	19.19	19.62	13.28	14.03	14.84	15.82	16.88	17.49	17.91	18.57	19.02
4	14.03	14.89	15.81	16.89	18.02	18.66	19.10	19.77	20.22	13.68	14.47	15.32	16.33	17.42	18.04	18.48	19.15	19.60
5	14.32	15.18	16.10	17.18	18.33	18.97	19.42	20.10	20.55	13.93	14.75	15.62	16.66	17.77	18.39	18.83	19.50	19.95
6	14.46	15.32	16.24	17.32	18.46	19.10	19.55	20.23	20.69	14.07	14.90	15.79	16.84	17.96	18.58	19.02	19.68	20.13
7	14.52	15.37	16.28	17.35	18.48	19.12	19.57	20.25	20.70	14.12	14.97	15.87	16.93	18.04	18.67	19.10	19.75	20.18
8	14.53	15.37	16.27	17.32	18.45	19.08	19.52	20.19	20.64	14.11	14.98	15.89	16.95	18.06	18.67	19.10	19.74	20.16
9	14.52	15.35	16.23	17.28	18.39	19.02	19.45	20.12	20.56	14.08	14.96	15.88	16.93	18.03	18.64	19.05	19.68	20.09
10	14.51	15.33	16.21	17.25	18.35	18.97	19.40	20.06	20.50	14.04	14.92	15.85	16.90	17.99	18.58	18.99	19.61	20.01
11	14.50	15.32	16.20	17.23	18.32	18.94	19.37	20.02	20.46	13.99	14.88	15.81	16.86	17.94	18.52	18.92	19.52	19.92
12	14.49	15.31	16.18	17.21	18.30	18.91	19.33	19.98	20.42	13.94	14.84	15.77	16.81	17.88	18.46	18.85	19.44	19.82
13	14.46	15.28	16.15	17.17	18.26	18.87	19.29	19.93	20.36	13.89	14.79	15.72	16.76	17.81	18.38	18.77	19.35	19.72
14	14.42	15.24	16.11	17.13	18.21	18.81	19.23	19.87	20.30	13.83	14.74	15.67	16.70	17.74	18.31	18.69	19.26	19.62
15	14.36	15.18	16.05	17.07	18.14	18.75	19.16	19.80	20.22	13.77	14.68	15.61	16.64	17.67	18.22	18.60	19.16	19.53
16	14.29	15.11	15.98	16.99	18.07	18.67	19.08	19.72	20.14	13.72	14.62	15.54	16.56	17.59	18.14	18.51	19.07	19.42
17	14.21	15.03	15.89	16.91	17.98	18.58	18.99	19.62	20.04	13.65	14.56	15.47	16.49	17.50	18.05	18.42	18.97	19.32
18	14.12	14.93	15.80	16.81	17.88	18.48	18.89	19.51	19.93	13.59	14.49	15.40	16.40	17.42	17.96	18.33	18.87	19.22
19	14.02	14.83	15.70	16.71	17.77	18.36	18.77	19.40	19.81	13.53	14.41	15.31	16.32	17.32	17.86	18.23	18.77	19.12
20	13.90	14.72	15.58	16.59	17.65	18.24	18.65	19.27	19.68	13.46	14.34	15.23	16.23	17.23	17.76	18.13	18.67	19.02
21	13.78	14.60	15.46	16.47	17.53	18.11	18.52	19.14	19.54	13.39	14.26	15.14	16.13	17.13	17.66	18.03	18.57	18.93
22	13.66	14.48	15.34	16.34	17.39	17.98	18.38	19.00	19.40	13.32	14.17	15.05	16.03	17.02	17.56	17.93	18.47	18.83
23	13.53	14.35	15.21	16.21	17.26	17.84	18.24	18.85	19.26	13.25	14.09	14.95	15.93	16.92	17.46	17.82	18.37	18.73
24	13.41	14.22	15.08	16.08	17.12	17.70	18.10	18.71	19.11	13.18	14.00	14.86	15.83	16.82	17.35	17.72	18.27	18.63

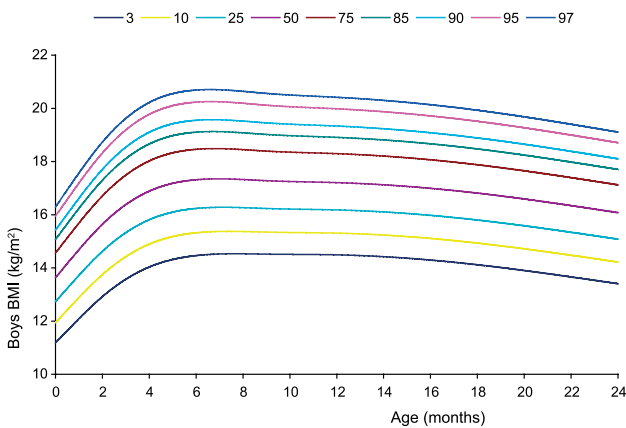


Fig. 1. BMI Percentile curves for boys.

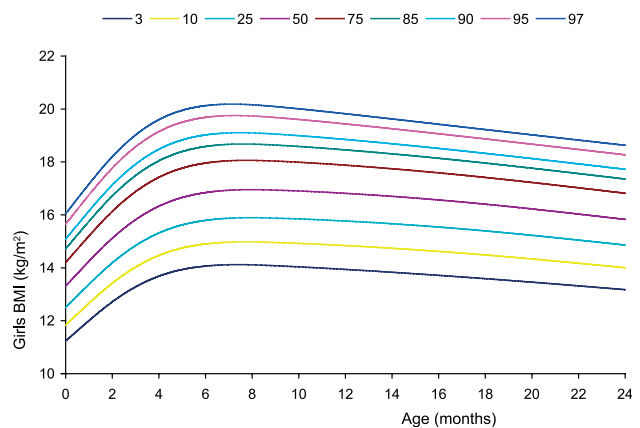


Fig. 2. BMI Percentile curves for girls.

recently age adjusted BMI values shown to be more useful for diagnosis and monitoring a failure to thrive or obesity (10, 11). Studies on BMI and fat mass in children indicated that factors such as age, sex, pubertal stage and race were important in predicting adiposity (12, 13). Universal criteria have not yet been established to define obesity childhood. For this reason, BMI reference curves may differ from one country to another and also from one city to another and need to be constructed regionally (5). Therefore, the percentile curves have to be revised and updated periodically according to feeding type, certain ages, different country or city and so forth. This is, to our knowledge, the first study, which presents the BMI values obtained from predominantly breastfed Turkish children aged 0–2 years from the middle–high socioeconomic status living in Ankara, Turkey.

In our study, a comparison of the median BMI values in different genders revealed that boys had higher BMI values in each month compared to girls. This finding is consistent with Fredrick et al who also report that BMI values of boys were higher compared to girls in the first year of life (11).

In boys, the inclination of the curve increased steadily between the ages of 1–7 months, and a steady decrease was seen between 8 and 24 months. In girls, the inclination of the curve increased steadily from 1st month to 8th month, and then a steady decrease appeared by 24 months of age. Fredrick et al reported a similar trend in their study and obtained the peaks between 6 and 12 months for each gender (11).

The other finding in our study was the fast increase of BMI in the first 6 months, which is the period with the fastest growth

in the infant's life (14). BMI increase was parallel to this growth. Although the median BMI values of our study were similar to the Fredriks' study between 0–24 months (11), the increase in the first 6 months was more prominent. This finding may be due to both the fact that exclusively breast feeding rate of the infants in our study was quite high and racial differences.

The limitation of this study is that the sample does not represent the whole country, but as in Bundak et al's study (5), the sample represents optimally fed and developed infants because the sample was taken from a birth cohort who was born into optimal conditions with high socio cultural level families. Additionally, as the sample is a birth cohort, weight and height values are prospective data obtained from the same infants and children.

Neyzi et al (17) created the updated reference standards for the growth of Turkish infants and children in relatively economically well off districts in İstanbul. In this study, all children were from well-to-do families and all were healthy. Their body mass index values for age indicated an increase starting in prepubertal age, indicating an increasing trend for obesity. More recently, Ozturk et al (18) conducted a cross-sectional study for determining reference body mass index curves using LMS method for Turkish children 6 to 18 years old in Kayseri, Turkey. Their study includes only children aged between 6 and 18 years. From the point of view, the BMI values change from one city to another, and the related values may differ. There are no other BMI normal values for Turkish infants from the middle–high socioeconomic status living in Ankara, with which we can compare our results, as BMI values might be influenced by age, gender, race and geography. Although there is no established cutoff point for childhood obesity, an expert committee has recommended guidelines for screening overweight children based on age and sex specific BMI percentiles as an alternative to absolute BMI values. According to this recommendation, children with BMI values above the 85th age and sex specific centile can be considered at risk for overweight in adulthood, while children with BMI values above the 95th centile can be considered obese (15, 16). Therefore our results might represent normal values for 0–2 years age group and we can consider obesity as BMI >95th centile.

In summary, the current study presents percentile curves for BMI values in predominantly breastfed Turkish children aged 0 to 2 years living in Ankara, Turkey. To our knowledge, this is the first study considering BMI percentiles for predominantly breastfed Turkish children aged 0–2 years living in Ankara. However, WHO multicenter growth reference study curves can be used until constructing multicenter BMI reference curves representing Turkey.

Note that the updated percentile values and curves of height and weight for the same cohort studied in this work were published in our previous study (19).

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