Original Article

Infants Body Mass Index Reference Curves for Iran

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ABSTRACT

Background: The body mass index, defined as weight/height^2, is often used to monitor childhood obesity. The BMI offers a reasonable measure of fatness in children. This study was designed to document the distribution of body mass index (BMI) in healthy south Iranian infants and present local BMI reference values.

Methods: A cohort of 317 healthy full term neonates (153 boys and 164 girls) were selected randomly from all maternity hospitals of Shiraz (southern Iran) and were followed for two years from their birth. BMI centiles based on the original height and weight data were derived using the HRY method.

Results: BMI rised in the first six months of infants life, followed by a mild fall up to the age of 21 months, then stayed almost stable. Age related cut off points were assigned to the 5th centile for thinness, 85th centile for overweight and 95th centile for obesity, which were appropriate for classifying the degree of fatness. Girls BMI centiles lie below boys.

Conclusions: Shiraz infants were relatively free of obesity. BMI centiles are suitable tools to monitor infantile obesity and serve as a baseline. However, they should be studied with other obesity indices such as weight-for-height and scaled weight by height.

Keywords: Body Mass Index, Obesity, Overweight, Percentile, Preschool Children, Developing Countries, Infants.

The body mass index (BMI), defined as weight/height^2, is often used to monitor childhood obesity[1-7]. The BMI offers a reasonable measure of fatness in children[8-13].

Data on infants obesity are very limited even in the developed world[1, 6, 12-13]; However, several studies have been carried out on preschool and school children, adolescents, and adults in Iran so far[14-28]. Most of these studies have compared their data with BMI cut-off points suggested by Garrow[7] as reference, which may be misleading for clinical work in Iran. A few of them have tried to provide local BMI reference data for school children and adolescents [14, 15, 22]. The value of dynamic BMI charts, which take age into account, is of crucial importance in clinical works as well as public health strategies.

At present time, no data are available on infants obesity in Iran. The purpose of this study is, therefore, to present BMI reference data for infants in Iran.

Materials and Methods

Nearly all pregnant women in Shiraz (97.5%) give birth in hospital. A cohort of 317 neonates (164 girls and 153 boys) were selected randomly, probably proportional based on their size scheme, among those born at the 14 maternity clinics of Shiraz during 2 random consecutive weeks from 7th of June to 20th of June 1996 with a random start (Sampling weights were considered and corrected for selection bias). Maternity clinics were scattered across the city and each one formed a stratum. The selected subjects were healthy singleton neonates whose mothers conceived them in Shiraz and their parents did not intend to migrate elsewhere during the study period. They were visited at home at target ages 1.5, 3, 4.5, 6, 8, 10, 12, 15, 18, 21, 24 months and their supine lengths and weights were measured by the trained auxologists. Five trained auxologists observed infants in the first year of study. In the second year 4 of them left the study

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and 4 newly trained auxologists were employed. All observers had a first university degree in the area of public health or nursing and midwifery with distinction. In addition, 4 community medicine experts monitored the subjects for 3 months from birth. Once it was needed, infants were referred to a consultant paediatrician for the whole study period. A subject was considered as missing if he/she was not in for any reasons when home visit performed at least 3 times at that occasion or his/her family migrated elsewhere for unseen reasons or decided to leave the study or the baby expired. The selected cohort was a 2.5% sample of neonates born in 1996 in Shiraz.

The lengths were measured in millimetres using portable length tables (infantometer) . The weights were measured to the last 10 grams on sophisticated balance scales calibrated at each home. The auxologists were instructed to weigh the infants naked. Once this was not possible due to baby circumstances, the type of clothes was recorded and in the analysis, weight data were adjusted for average baby cloth weight, giving the real infant weight.

Ages at each occasion were recorded exactly based on the difference between date of visit and date of birth in days and then converted to months. Infants' age was corrected for his/her gestational age (GA) if GA was < 38 weeks. In this case the infants age was calculated as:

Age (from EDD) = Age (from birth) – 40 + GA

where EDD stands for expected date of delivery which is 40 weeks. Observations were included only if Age from EDD was greater than or equal to zero.

Birth weights (BW) of 9 subjects (2.8%) were under 2500 grams (range from 2050 to 2450 grams). No failure to thrive subjects was observed. A total number of 34 subjects (10.7%) left the study by age of six months, another 14 subjects (4.4%) by age of one year and 22 subjects (6.9%) by the end of the study period, giving 70 dropouts (22.0%) totally. Migration of parents to other cities due to occupational reasons was the main factor for missing data. No significant differences were seen between dropouts and other subjects with respect to socio demographic as well as behavioural and anthropometric characteristics. Therefore, dropouts were not selective.

The charts were constructed using HRY nonparametric method[29]. This method was used to estimate age related smoothed centiles, which makes no assumption about the nature of the measurements. It first assumes that the 50th measurement centiles can be expressed as a polynomial of degree q (q=1, 2,...) in age represented by t. The smoothed value of the 50th measurement centile (y_{50}) might be: $y_{50} = a_1t + a_2t^2 + a_3t^3 + \ldots$. Second, at any given age the other measurement centiles may be expressed in polynomials of standard normal deviate, z, in relation to the 50th centile, i.e. $y_i = y_{50} + b_0 + b_1z + b_2z^2 + b_3z^3 + \ldots$ where y_i is the qth smoothed centile of the measurement and z is the corresponding normal equivalent deviate (NED). In the second equation we see that if the measurements were exactly normally distributed with standard deviation of SD(y), then $b_2 = b_3 = \ldots = 0$ and $b_1 = SD(y)$. A term in z^2 can account for skewness and in z^3 for kurtosis. The HRY method does not assume that the coefficients b_1, b_2, b_3, ... are fixed but allows them to vary with age (t), so that after collecting terms in t^0, t^1, t^2, etc togeher. from the two equations, the whole model may be written as:

$y_{it} = a_0 + b_{01}z + b_{02}z^2 + \ldots + (a_1 + b_{11}z + b_{12}z^2 + \ldots)t + (a_2 + b_{21}z + b_{22}z^2 + \ldots)t^2 + \ldots$

This method has been implemented for the World Health Organisation in the GROSTAT computer package. Goodness of fit was assessed both graphically and numerically. The Z-scores (SD scores) of the measurements were calculated upon fitting smoothed aged related centiles. Goodness of fit of data was evaluated both by z-score method and counting number of observations between the centiles using GROSTAT software.

BMI was calculated as weight/height^2, and expressed as kg/m^2. In total 3363 paired measurements (1598 on boys and 1765 on girls) for (height and weight) were made for the studied cohort at different occasions.

We adopted 5th, 85th and 95th centile as cut-off points for thin, overweight and obese infants respectively, as generally accepted for children and adults[3, 30-35].

Results

Figures 1 and 2 display BMI by age charts for boys and girls respectively. BMI increases up to the age of six month then decreases to the age of 21 months, which becomes almost steady to the age of 24 months. A comparison of boys and girls BMI for thin, overweight and obese infants is shown in figure 3. Girls centile lies below boys'. Table 1 presents smoothed percentiles of BMI values for thin, median, overweight, and obese infants at specified ages.

Discussion

The present study reports BMI percentiles and highlights thinness, overweight, and obesity of a cohort of infants aged 0 to 2 years living in Shiraz, the centre of Fars province of Iran. This city located in south is the most developed one of southern Iran and the symbol of ancient civilisation, known as the cultural capital of the country.

The BMI percentiles in the studied population follow the well-known trend of an increase with age to the age of six months and a moderate decrease later on and are higher in boys than girls.

Infantile obesity is an increasing public health problem and a predictor of adolescence and adulthood obesity. However, its importance has been undermined and a limited number of studies took this age range into consideration[1,6,12-13]. A comparison of our data to these studies indicate that: a) BMI of our subjects follow the same trend of rise and fall and b) our overweight infants (85% centile) lie below their median curve, suggesting that clinical work in Iran needs local reference data to study paediatric obesity as we provided here. The charts presented here can be used to identify children who are unusually fat or thin or overweighted for further clinical actions or interventions.

The aetiology of the paediatric obesity is not completely understood but certainly there is an important interaction between a genetic predisposition with regard to the energetic efficiency to store body fat and an environment that is permissive to the expression of that genetic tendency[36]. Further research to identify genetic and environmental risk factors for paediatric obesity is urgently needed as well as early preventive actions at the high-risk and at the population level[37].

Being the first study in Iran on infantile obesity and the data representativeness, the reference curves are likely to be used in urban paediatric clinics of Iran until further longitudinal studies are carried out periodically.

Acknowledgements

The author is grateful to Mr. S.T. Heidari for his computing assistance

Table 1. Smoothed percentiles of BMI for thinness (5th centile), median (50th centile), over weight (85th centile) and obese (95th centile) of infants, Shiraz, Iran.

	Girls				Boys			
Age	P5	P50	P85	P95	P5	P50	P85	P95
1	11.7	13.9	15.6	16.7	12.3	14.7	16.1	17.0
2	12.6	14.8	16.5	17.5	13.1	15.5	17.1	18.1
3	13.3	15.5	17.2	18.2	13.7	16.2	17.8	18.0
4	13.8	16.0	17.7	18.7	14.2	16.6	18.3	19.5
5	14.2	16.4	18.0	19.0	14.5	16.9	18.7	19.9
6	14.4	16.6	18.3	19.2	14.6	17.1	18.9	20.1
9	14.6	16.7	18.4	19.3	14.8	17.2	19.0	20.1
12	14.2	16.4	18.0	18.9	14.6	16.9	18.5	19.6
15	13.7	15.9	17.5	18.3	14.4	16.5	18.0	18.6
18	13.5	15.6	17.1	17.9	14.2	16.2	17.7	18.4
21	13.3	15.4	16.8	17.6	14.0	16.0	17.4	18.1
24	13.1	15.3	16.7	17.4	13.4	15.4	17.9	17.8

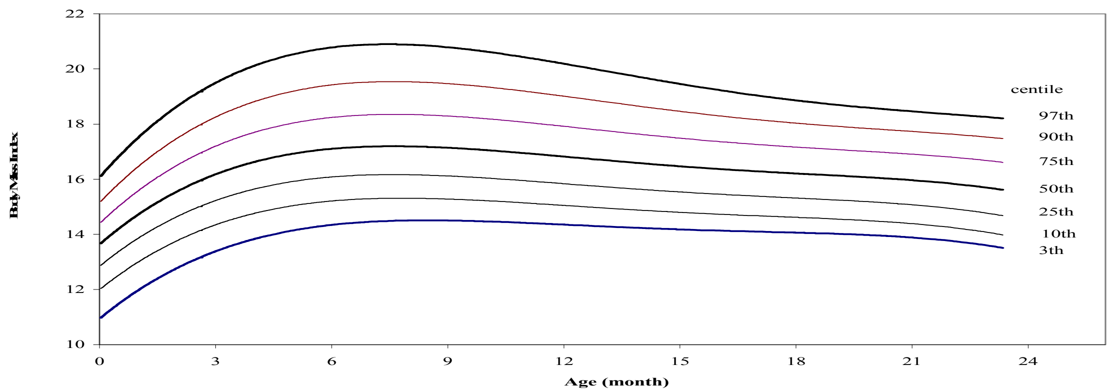

Figure 1 : Body Mass Index by Age charts for boys in Shiraz, Iran

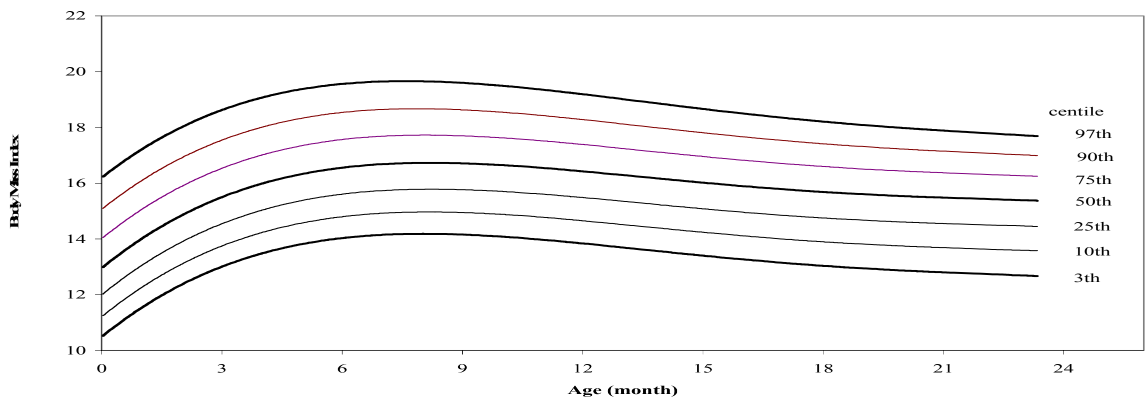

Figure 2 : Body Mass Index by Age charts for girls in Shiraz, Iran

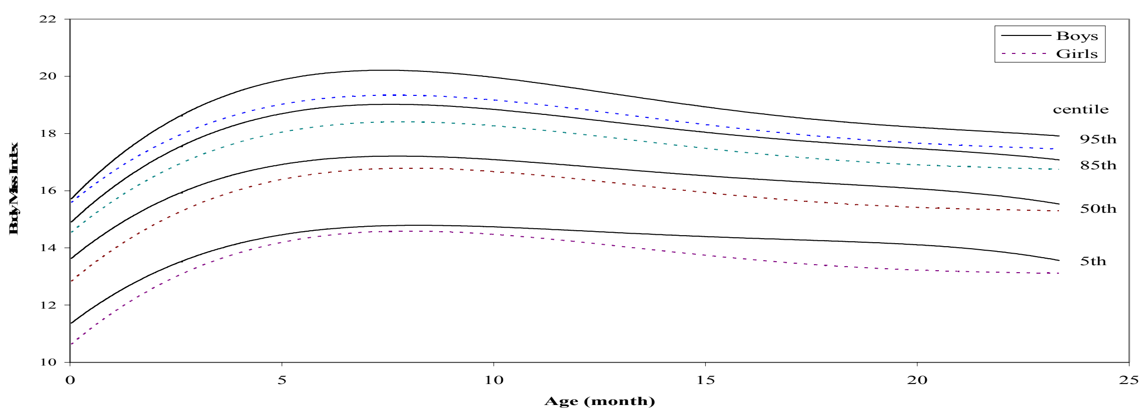

Figure 3. Copmarsion of Body Mass Index by Age charts of boys and girls in Shiraz, Iran for thinness(p5), median (p50), overweight (p85) and obese (p95)

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