Thinness and Overweight among Children belonging to the Bengalee Population Aged 3-10 Years

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ABSTRACT: The present cross-sectional study was conducted to assess the prevalence of thinness and obesity among 520 school children (boys: 287; girls: 233) aged between 3-10 years and residing in a rural area in the district of Darjeeling, West Bengal. Height and weight of the children were measured and the body mass index (BMI) was calculated. The new international BMI-based cut-off points proposed by Cole et al., (2007) for thinness and Cole et al., (2000) for overweight and obese were utilized to determine the respective prevalence. Boys have significantly higher height, weight and BMI than girls. Girls were more undernourished than boys. The clear rising of overweight and obesity along with the prevalence of undernutrition is alarming for the policy maker of the country.

INTRODUCTION
Undernutrition is a major public health concern in many of the developing countries (Khor, 2008). It has also been estimated that it is the largest contributor to the global burden of disease (Black et al., 2008). Approximately 200 million children are unable to attain their full development potential because of stunting and micronutrient deficiency (WHO, 2013). Malnourished children suffer from longer and more severe illnesses (Black et al., '84; Sepulveda et al., '98) and have a higher risk of mortality and morbidity (Schroeder and Brown, '94) as compared to well nourished ones. The evaluation of child growth also provides useful insights into the nutrition and health situation of entire population (Gorstein and Akre, '88). Healthy children are better able to learn, and healthy adults are better able to contribute socially and economically (WHO, 2013). It has been estimated this approximately 70.00% of the world’s malnourished children live in Asia, giving that region the highest concentration of worldwide childhood malnutrition (Khor, 2008). In India, given its large population size and widespread poverty, a majority of individuals remain undernourished and underprivileged (Ramachandran, 2007; Antony and Laxmaiah, 2008). Moreover, India shows the highest occurrence of childhood undernutrition in the world (Bamji, 2003) and it has been estimated that more than half of Indian children are undernourished (Measham and Chatterjee, '99). The problem is more acute in the rural areas (Dolla et al., 2005). The legacy of malnutrition among children is a major public health problem and an impending obstacle to national development (Bishno et al., 2004).

Anthropometry is the universally applicable, inexpensive and non-invasive technique available to researchers for the assessment of the size and proportion of the human body (WHO, '95) and is a very useful tool in the assessment of growth and nutrition (Gorstein et al., '94; Hamieda and Billot,
It is the single most universally applicable, easy to use, quick, non-invasive and inexpensive technique of choice to researchers to assess nutritional status of children (Bose et al., 2007; Mondal and Sen, 2010a; Sen et al., 2011). A variety of conventional anthropometric measures have been used to assess undernutrition on the basis of stunting (low height-for-age), wasting (low weight-for-height) and underweight (low weight-for-age) (WHO, '95; Nandy et al., 2005; Bose et al., 2007; Mondal and Sen, 2010a; WHO, 2007; Sen and Mondal, 2012). These conventional anthropometric measurements reflect certain distinct biological processes of human life and their usages are very important for determining appropriate nutritional interventions (WHO, '95, 2007). A number of studies have reported the prevalence of undernutrition among Indian children using these conventional anthropometric measures (Nandy et al., 2005; Som et al., 2006; Bose et al., 2007; Mondal and Sen, 2010a; Sen and Mondal, 2012).

Overweight and obesity are now considered to be two other very serious public health problems contributing to a number of preventable non-communicable diseases such as hypertension and diabetes mellitus. They substantially increase the risk of premature mortality and morbidity and are recognized as conditions where excess of body fat accumulates to such degrees that health of the individual remains negatively affected (Ulijaszek and Lofink, 2006). It has been observed that during the last few decades, obesity has been increasing at an alarming rate in both the developed and the developing countries (Popkin, 2001). In fact, some studies have reported that the prevalence of obesity had already reached epidemic proportions in the developed countries (Popkin and Doak, '98). Obesity is an environmental issue. Societies that are transitioning to westernized lifestyles are experiencing substantial increases in its prevalence. The primary environmental determinants of obesity are high calorie intake and low levels of activity. Socioeconomic status and place of residence are important contributors. These factors together comprise an ‘obesogenic’ or ‘toxic’ environment where the development of obesity is the expected course for humans leading lifestyles incompatible with their evolutionary development. A number of the developing countries typically portray high prevalence of undernutrition along with overweight and obesity. This is now being referred to as the “double burden of malnutrition”. India is no exception and recent trends have shown that the prevalence of overweight and obesity along with that of undernutrition are major public health concerns in both the rural and sub-urban regions of the country (Popkin, 2002; Mungreiphy and Kapoor, 2010; Sen et al., 2011).

The body mass index (BMI) is a surrogate and proxy anthropometric measure that has been extensively used to assess nutritional status in terms of thinness (low BMI-for-age) or chronic energy deficiency (WHO, 2007; Cole et al., 2007). It has also been suggested that BMI-for-age is a better indicator than weight for age to assess the risk of infections associated with undernutrition (WHO, 2007; Ramachandran and Gopalan, 2009). Recently, BMI in relation to age (BMI-for-age) has been recommended to be the best surrogate anthropometric measure of thinness among children and adolescents aged between 2-18 years (Cole et al., 2007). International age-sex specific reference cut-offs have also been proposed (Cole et al., 2007; WHO, 2007). These cut-off points were derived based on multicentre data from four developed countries (the United States, Great Britain, Hong Kong, the Netherlands) and one developing country (Brazil). It has been further opined that undernutrition could be better assessed in terms of thinness (low BMI-for-age) (Cole et al., 2007). Prior to this proposal of Cole et al. (2007), there was no suitable cut-off points for thinness that would have encouraged direct comparisons of worldwide trends in thinness among children and adolescents and provide a classification of thinness for public health purposes. Very recently, there has been some studies that have utilized these cut-offs to report the magnitude of thinness among Indian children (Biswas et al., 2009; Chakraborty and Bose, 2009; Mandal et al., 2009; Bisai et al., 2010; Bisai and Manna, 2010; Mondal and Sen, 2010b; Das and Bose, 2011; Mandal and Bose, 2014; Tigga et al., 2015).

Therefore, information on prevalence of thinness among children belonging to the developing countries such as India where vast segments of the populations
remain undernourished and underprivileged, are
needed to be generated for international and national
comparisons. Moreover, the information can play an
important role in formulating nutritional intervention
programmes for the concerned individuals. With this
issue in mind, the present study has been conducted
to determine prevalence of thinness among school
children aged between 3-10 years using the recently
proposed international cut-offs of Cole et al. (2007).
The present study also reports the prevalence of
overweight and obesity in present population using
BMI-for-age (Cole et al., 2000).

MATERIALS AND METHODS

The northern part of the state of West Bengal,
India, is popularly known as North Bengal and
comprises of six districts. The district of Darjeeling
is one of them, which comprises of Eastern Himalayan
hills and the foot hills, Terai. This northern-most
district of West Bengal shares borders with Nepal in
the west, state of Sikkim in the north, kingdom of
Bhutan in the north-east. The area is inhabited by a
number of indigenous, tribal and caste populations
such as the Rajbanshi, Lepcha, Toto and Bengali Caste
Hindu. Given the area’s general backwardness, the
communities of the region remain vulnerable to
undernutrition (Banik et al., 2007; Mondal and Sen,
2010a; Sen and Mondal, 2012; Sen et al., 2011;
Mondal and Sen, 2010b; Sen and Mondal 2013; Tigg a
et al., 2015).

The present community based cross-sectional
study was carried out among 520 school children
(boys: 287; girls: 233) aged between 3-10 years and
residing in a rural area in the district of Darjeeling,
West Bengal. The children covered in course of the
study belonged to the heterogeneous Bengalee caste
populations, nature of which has been described
elsewhere (Mondal and Sen, 2010a). All the study
participants were the students of 5 schools located in
Naxalbari block of the district. The study area is
located near the India-Nepal international border in
the Terai region of the district. The study was
conducted during the month of March, April and May
2014.

The children were selected using a multi-stage
stratified random sampling method. Initially 564
children (boys: 312; girls: 252) were approached to
take part in the study. Forty four of them (boys: 25;
girls: 19) were subsequently excluded from the
study as either their dates of birth were not available
in the school records or they did not belong to the
age-group selected. The final sample size consisted of
520 children (boys: 287; girls: 233). All the children
were free from any physical deformities, nutritional
deficiency symptoms, and were not suffering from
any diseases at the time of data collection. Permissions
for the study were taken from school authorities and
local Panchayats (a village level governing authority)
prior to data collection. An informed consent was
obtained from either parent of the children. Necessary
research approvals and clearances were obtained from
the University of North Bengal. The study was
conducted in accordance with the ethical guidelines
for human experiments as laid down in the Helsinki
Declaration of 2000 (Touitou et al., 2004).

ANTHROPOMETRIC MEASUREMENTS

Measurements of height and weight were
recorded following standard procedures (Weiner and
Lourie, '81). Height of the children was recorded
using an anthropometer rod to the nearest 0.10 cm.
Weight of the children wearing minimum clothing and
with bare feet was taken using a portable weighing
scale to the nearest 0.10 kg. Intra-observer and inter-
observer technical errors of the measurements (TEM)
were calculated using the standard procedure of
Ulijaszek and Kerr ('99). The TEM was calculated
using the following equation:

\[ TEM = \sqrt{(\bar{D})^2/N} \]

where \( \bar{D} \) is the difference between the
measurements, \( N \) is the number of individuals.

The co-efficient of reliability (R) was
subsequently calculated from TEM using the
following equation:

\[ R = 1 - (EM)^2/SD^2 \]

where \( SD \) is the standard deviation of
the measurements.

For calculating TEM, height and weight were
recorded from 50 children other than those selected
for the study by the author (BD) and another person
well versed in the techniques of anthropometry. Very
high values of R (>0.975) were obtained for TEM
and these values were observed to be within
acceptable limits (R=0.95) as proposed by Ulijaszek
and Kerr ('99). Hence, the measurements recorded

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where \( \bar{D} \) is the difference between the
measurements, \( N \) is the number of individuals.

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well versed in the techniques of anthropometry. Very
high values of R (>0.975) were obtained for TEM
and these values were observed to be within
acceptable limits (R=0.95) as proposed by Ulijaszek
and Kerr ('99). Hence, the measurements recorded
by BD were considered to be reliable and reproducible.

**ASSESSMENT OF NUTRITIONAL STATUS**

The BMI was calculated following the internationally accepted standard equation (WHO, '95) which is as follows:

$$\text{BMI} = \frac{\text{weight}}{\text{height}^2} \text{ kg/m}^2$$

The prevalence thinness (low BMI-for-age) has been assessed following the international BMI cut-off points as proposed by Cole et al. (2007). The BMI values were used to determine the definite grades of thinness (Grade-I: mild, Grade-II: moderate, Grade-III: severe). These grades are similar to the different chronic energy deficiency grades based on BMI among adults (WHO, 2007; Cole et al., 2007). Hence, a child observed to be below the thinness grades of I, II and III of the age and sex specific cut-offs has been classified as mild, moderate and severely thin respectively (Cole et al., 2007). Similarly overweight and obese were categorised using Cole et al., (2000). The classification are defined to pass through BMI values of 16.0, 17.0, and 18.5 kg/m² for thinness as in adult and 25.0 kg/m² for overweight and 30 kg/m² for obese, respectively, at age 18 years.

All statistical analyses were undertaken using the SPSS Statistical Package (version 17.0). One-way ANOVA (F-test) was performed to test for sex and age differences in means of weight, height and BMI. A p-value of <0.05 was considered to be statistically significant.

**RESULTS**

The overall mean and standard deviation of height, weight, BMI and age of the children are shown in Table 1. Boys have significantly (p < 0.05) higher height, weight and BMI than girls. There were significant mean difference between ages among boys in height (F = 97.61; p < 0.05), weight (F = 46.24; p < 0.05) and BMI (F = 10.91; p < 0.05). Similarly, among girls, significant difference were observe in height (F = 106.24; p < 0.05), weight (F = 33.95; p < 0.05) and BMI (F = 2.57; p < 0.05). Height and weight increases along the age- groups from lower to higher among both boys and girls except for the 4 years age-group boys. Age-group 3, 6 and 9 have higher BMI than the other age-group boys. Similarly age-group 3, 9 and 10 have higher BMI among girls.

**TABLE 1**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI (kg/m²)</th>
<th>n</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI (kg/m²)</th>
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<td>(3.86)</td>
<td>(1.98)</td>
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<td>(1.99)</td>
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<td>(1.85)</td>
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<td>(1.75)</td>
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<td>(4.87)</td>
<td>(2.54)</td>
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<td>(2.88)</td>
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<td>(8.58)</td>
<td>(6.52)</td>
<td>(2.45)</td>
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<td>128.47</td>
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<td>28.93</td>
<td>16.49</td>
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<td>(5.30)</td>
<td>(2.25)</td>
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<td>15.49</td>
<td>233</td>
<td>114.13</td>
<td>19.68</td>
<td>14.79</td>
</tr>
</tbody>
</table>

*Figures in parenthesis are percentages
Thinness and Overweight among Children belonging to Bengalee Population

Girls (44.21%) were more undernourished than boys (36.93%) in the present study are shown in Figure 1. Overall prevalence (sex combine) of thinness grade I, II and III were 21.92%, 11.73% and 6.54% respectively and prevalence of overweight were 4.42% and obese were 3.85% among the studied population as shown in the Table 2. Prevalence of thinness, overweight and obese for boys and girls are separately depicted in the Table 3 and 4. For the boys percentage prevalence of thinness grade I, II and III were 19.51%, 9.76% and 7.67% respectively and among girls thinness grade I, II and III were 24.89%, 14.16% and 5.15% respectively. Grade III thinness (boys: 13.92%; girls: 9.68%) and Grade II thinness (boys: 13.95%; girls: 16.13%) were highest for 4 year age-group of the present study. Grade I thinness (40%) separately depicted in the Table 3 and 4.

### TABLE 2

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
<th>Normal(%)</th>
<th>Gd I(%)</th>
<th>Gd II(%)</th>
<th>Gd III(%)</th>
<th>Overweight(%)</th>
<th>Obese(%)</th>
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</thead>
<tbody>
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<td>9 (10.88)</td>
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<td>3 (3.37)</td>
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<td>8</td>
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<tr>
<td>Total</td>
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<td>268 (51.54)</td>
<td>114 (21.92)</td>
<td>61 (11.73)</td>
<td>34 (6.54)</td>
<td>23 (4.42)</td>
<td>20 (3.85)</td>
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*Figures in parenthesis are percentages

### TABLE 3

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
<th>Normal(%)</th>
<th>Gd I(%)</th>
<th>Gd II(%)</th>
<th>Gd III(%)</th>
<th>Overweight(%)</th>
<th>Obese(%)</th>
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<td>56 (19.51)</td>
<td>28 (9.76)</td>
<td>22 (7.67)</td>
<td>14 (4.88)</td>
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*Figures in parenthesis are percentages
## TABLE 4

*Prevalence of overall thinness, overweight and obesity among the girls*

<table>
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<tr>
<th>Age (years)</th>
<th>n</th>
<th>Normal (%)</th>
<th>Gd I (%)</th>
<th>Gd II (%)</th>
<th>Gd III (%)</th>
<th>Overweight (%)</th>
<th>Obese (%)</th>
</tr>
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<td>31</td>
<td>17 (54.84)</td>
<td>5 (16.13)</td>
<td>5 (16.13)</td>
<td>3 (9.68)</td>
<td>1 (3.23)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>5</td>
<td>38</td>
<td>16 (42.11)</td>
<td>13 (34.21)</td>
<td>5 (13.16)</td>
<td>2 (5.26)</td>
<td>1 (2.63)</td>
<td>1 (2.63)</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
<td>19 (52.78)</td>
<td>9 (25.00)</td>
<td>4 (11.11)</td>
<td>2 (5.56)</td>
<td>0 (0.00)</td>
<td>2 (5.56)</td>
</tr>
<tr>
<td>7</td>
<td>42</td>
<td>21 (50.00)</td>
<td>11 (26.19)</td>
<td>7 (9.52)</td>
<td>2 (4.76)</td>
<td>2 (4.76)</td>
<td>2 (4.76)</td>
</tr>
<tr>
<td>8</td>
<td>33</td>
<td>12 (36.36)</td>
<td>9 (27.27)</td>
<td>7 (21.21)</td>
<td>2 (6.06)</td>
<td>2 (6.06)</td>
<td>1 (3.03)</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
<td>11 (57.89)</td>
<td>5 (26.32)</td>
<td>1 (5.26)</td>
<td>1 (5.26)</td>
<td>1 (5.26)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>13 (65.00)</td>
<td>5 (25.00)</td>
<td>1 (5.00)</td>
<td>0 (0.00)</td>
<td>1 (5.00)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td>114 (48.93)</td>
<td>58 (24.89)</td>
<td>33 (14.16)</td>
<td>12 (5.15)</td>
<td>9 (3.86)</td>
<td>7 (3.00)</td>
</tr>
</tbody>
</table>

*Figures in parenthesis are percentages*

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Figure 1: Percentage (%) prevalence of Thinness (Grade-III: severe, Grade-II: moderate, Grade-I: mild), Overweight and Obesity among the boys and girls of the present study.
Thinness and Overweight among Children belonging to Bengalee Population

were highest among the boys of 5 years age-group and 3 years age-group girls shows highest prevalence of grade I thinness (35.71%).

On the other hand prevalence of overweight were 4.88% and obese were 4.53% among boys and among girls overweight were 3.86% and obese were 3.00%. Overweight were found highest among 10 years age-group (12.20%), followed by 6 years age-group (10.87%) boys. It is highest among 3 years age-group (7.14 %) followed by 8 years (6.06 %), 9 years (5.26%) and 10 years (5.00%) age-group. On the other hand obese boys are highest among 10 years age-group (14.63%) followed by 9 years age-group (9.68%) boys and among girls is 3 years age-group (7.14%) followed by 6 years (5.46%).

DISCUSSION

Assessments of nutritional status play a key role in documenting the overall health of an individual and/or population, and also act as an indicator of the well-being of a region. Despite economic developments, prevalence of undernutrition among children especially those aged under-5 years pose a major public health problem in many of the developing countries including India (Nandy et al., 2005; Ahmed et al., 2012; Bose et al., 2007; Mondal and Sen, 2012).

Such prevalence is generally attributed to a large population size, illiteracy, poverty, poor infrastructure and inappropriate healthcare facilities (NFHS-3, 2005-2006; Antony and Laxmaiah, 2008; Bose et al., 2007; Sen and Mondal 2012; Measham and Chatterjee, ‘99; Som et al., 2006; Tigga et al., 2013). It also reflects inadequate nutrition during early childhood and is likely to be a consequence of well-known phenomenon of inadequate weaning food with lower energy-density as observed in India (NFHS-3, 2005 – 2006; Antony and Laxmaiah, 2008; Khor, 2008; Measham and Chatterjee, ’99). The importance of assessing nutritional status of these nutritionally
vulnerable children should be recognized, not only for the improvement of the overall health condition of the future generations, but also for overall developments of the concerned region. The results of the present study undoubtedly shall be useful for policy makers in their endeavor to formulate various developmental and healthcare programmes and appropriate nutritional interventions and proper monitoring of the ongoing intervention programmes. Priority interventions are necessary in terms of appropriate complementary feeding, supplementation with proper balance food, micronutrient, breast feeding promotion and acute undernutrition and related morbidity management.

This study is among the few Indian studies which utilizes BMI-for-age after Cole et al., (2007; 2000) for different grade of thinness (I, II, III), overweight and obese. The study has also claim that BMI-for-age is comparatively better at assessing undernutrition than wasting (low weight for height), which also enable world-wide comparison of the trend. This cross-sectional study traces the prevalence of overweight and obese beside thinness among the young Bengali children of Naksalbari, Darjeeling District of West Bengal, India. Total sample size was 520 of which 268 (51.54%) were normal but overweight and obese were 23 (4.42%) and 20 (3.85%). The prevalence of overweight (0.8%) among Kura-Mundi children of Paschim Medinipur District of West Bengal is much lower than the present study (Basai et al., 2010). However, study by Bose et al. (2007) reported overweight and obesity were 17.63% and 5.10%, respectively from their study of 431 children. Similar prevalence of overweight (17.62%) and a higher obesity (6.41%) were found by Ghosh (2014) among the children of Kolkata.

The overall prevalence of thinness of the present study 40.19% is higher than the 34.39% of Bisai et al. (2008) and 36.39% of Chaterjee and Saha (2008) reported from Paschim Midnapur and Kolkata respectively. However, other Bengali ethnic children of West Bengal have higher prevalence of undernutrition as reported 50.15% (Acharya et al., 2013), 62.21% (Chakraborty and Bose, 2009) and 85.18% (Mandal et al., 2009). The prevalence of stunting (46.6%) and thinness (42.4%) among adolescents of Darjeeling study by Mondal and Sen (2010) is also higher than the present study. The present study has lowest prevalence of undernutrition among the studies which uses Cole et al. (2007) BMI-for-age cut-offs to assess undernutrition in India as shown in the Figure 2 (Mishra and Mishra, 2007; Bose et al., 2008; Biswas et al., 2009, Bisai et al., 2010; Mondal and Sen, 2010). It is apparent from the above figure there is high prevalence of undernutrition in the region.

It is clear from the preceding paragraphs obesity is raising and undernutrition still is a major problem. The prevailing double burden of nutrition equally impairs the physical and cognitive development of children, which ultimately leads to higher morbidity and mortality in the population. Findings suggest that there is raising challenge for policy maker of the country. Further there is need for more such studies.

REFERENCE CITED


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— 2007. World Health Organization child growth standards: head circumference-for-age, arm circumference-for-age, triceps skin-fold-for-age and sub-scapular skin fold-for-age methods and development.
