BMI- An Indicator Of Growth In Comparison With Who Growth Charts-2006

ORIGINAL ARTICLE

Bmi- an indicator of growth in comparison with who growth charts-2006

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ABSTRACT:
BACKGROUND: WHO conducted ‘multi-center growth reference study’- community based multi-country project and published the new growth charts, 2006 for internationally applicable growth standards. The growth charts are age and gender specific. The children included in the study were raised in environments that minimized constraints to growth. They provide data on ‘how children should grow’ under optimal environmental condition. BMI charts are Reference charts. BMI is a screening tool to identify individuals who are overweight or overweight. BMI charts are also age and gender specific and provides indirect measure of body fat. They represent existing growth pattern – how children grew in particular place and time. In 2 to 5 years of age; WHO growth charts and 5 to 12 years BMI charts are used usually. This study compared one time growth on WHO Growth chart and BMI chart of children of 2 to 12 years of age.

MATERIALS AND METHODS: All patients admitted in pediatric unit from 1st November 2013 to 30th April 2014 (6 months) were enrolled in the study. Accurate measurement of each child’s weight and height obtained. Appropriate growth charts and BMI charts selected according to gender of the patient. Values plotted on charts and results were analyzed.

RESULTS: Out of 563 patients – 432 children were included in the study. 260 children (60%) were malnourished as per WHO growth charts and 189 (43%) were malnourished as per BMI charts (P value <0.001). In 2 to 5 years of age group, 139(66%) children were malnourished as per WHO growth chart and 80(38%) as per BMI charts (P value <0.001). In 5 to 12 years of age group, 121(54%) were malnourished as per WHO growth chart and 109(49%) as per BMI charts (P value = 0.31). In children 2 to 12 years of age, under nutrition was missed by 17% as per the BMI charts. In 2 to 5 years of age group, under nutrition was missed by 28% as per BMI charts. In the age group of 5 to 12 years, under nutrition was missed by 5% as per BMI charts.

CONCLUSION: To have proper inference regarding the nutritional status of children of age group 2 to 12 years, the present study suggests that in children 2 to 5 years of age group, WHO growth charts should preferably be used. In children 2 to 5 years of age group, under nutrition is likely to be missed if only BMI charts are used. After 5 years of age any of the growth charts- WHO growth charts or BMI charts can be used.

Key words: WHO growth chart, BMI chart, Under-nutrition

INTRODUCTION

Growth is a continuous process commencing at conception and progressing at a varying pace till its completion about two decades later.2 The process of Growth is accompanied with increase in body size and/or mass at varying rates. It is multifactorial and complex, still remarkably predictable. Boys and girls grow differently and each child has his or her distinct growth pattern.

Growth charts are used to measure growth. Any faltering in growth process may indicate disease. Therefore, frequent and accurate growth assessment is of primary importance. Growth charts show the growth of a reference population and are used for the assessment of individuals and groups of children. Serial measurements of the child’s growth plotted on a growth chart are used to identify and assess patterns of growth.

Development of growth charts

1. NCHS (1977)
The US National Centre for Health Statistics (NCHS) growth reference was used to monitor the growth of children in Australia from the late 1970’s to the early 2000’s.3
This reference was produced using cross-sectional data from the United States National Health Examination Survey (NHES II and NHES III. and National Health and Nutrition Examination Survey NHANES I, 1971-74). The major concerns about the NHCS growth charts were that the data was obtained from an unrepresentative group of infants who were mostly artificially fed, and that measurements were made infrequently.

2. CDC (2000)
In 2000, the Centers for Disease Control, Atlanta (CDC) produced a revised set of reference growth curves. These were based on more recent data than NCHS; solely collected from the USA National Health and Nutrition Survey (NHANES) program. Data collection took place between 1963 and 1994 in 5 cross sectional, nationally representative health examination surveys. Exclusions from the survey were made for very low birth weight infants (birth weight <1500g) as these infants are known to grow differently from normal birth weight babies, and data from NHANES III (1988-94) for children 6 years or older because their inclusion would have significantly increased the cut-offs for overweight.

In 2006 the World Health Organization (WHO) released a new set of growth standards and charts, based on data from the Multicentre Growth Reference Study (MGRS). The WHO recommends the application of these standards for all children worldwide, regardless of ethnicity, socioeconomic status and type of feeding. WHO describe these as a standard – how children should grow; they establish breastfeeding as the ‘norm’ and the breastfed infant as the standard for measuring healthy growth. In 2011 over 140 countries were at various stages of implementing the 2006 WHO Growth Standards.

The MGRS involved children from 6 countries representing different regions of the world: Brazil, Ghana, India, Norway, Oman and the United States. Site inclusion criteria included socioeconomic status that does not constrain growth, indicated by low infant mortality rates, and rates of stunting wasting and underweight lower than 5% at 12-23 months of age. Other characteristics of sites included altitude less than 1500 metres above sea level, low mobility of the population to allow follow-up, at least 20% of mothers willing to follow the feeding recommendations, and existence of breastfeeding support services.

Eligibility criteria included:
- No health, environmental, economic constraints on growth
- willingness of the mother to exclusive or predominant breastfeed for the first 4 months, starting complementary food by 6 months and continuing breastfeeding to at least 1 year
- single birth; gestational age >37 and <42 weeks
- exclusion of preterm and very low birth weight infants
- optimal health care including immunisations and good routine paediatric care
- absence of significant morbidity and
- absence of maternal smoking before and after delivery

A survey of 125 countries adopting the WHO standards indicated that the anthropometric indicators used for the assessment of growth varied. Weight-for-age was adopted almost universally, with a large number also adopting the length/height-for-age and weight-for-length/height. Less than half the countries surveyed reported adopting the BMI-for-age and head circumference-for-age. Further research is needed to validate the use of BMI-for-age to assess nutritional status in the first two years of life. In preschool children BMI-for-age and weight for length or height (WFLH) provide similar information hence there is no need to monitor both indicators.
Body Mass Index is an anthropometric index of weight and height that is defined as: body weight in kilograms divided by height in meters squared.\(^4\)

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\text{BMI} = \frac{\text{weight (kg)}}{\text{height (m})^2
\]

BMI is the commonly accepted index for classifying adiposity in adults and it is recommended for use with children and adolescent. BMI is a screening tool used to identify individuals who are underweight or overweight. BMI is NOT a diagnostic tool. Because BMI changes substantially as children get older, BMI-for-age is the measure used for children ages 2 to 20 years. BMI-for-age reached a minimum at 4 years of age and then increased with increasing age. BMI is not a direct measure of body fatness. However, BMI parallels changes obtained by direct measures of body fat such as underwater weighing and dual energy x-ray absorptiometry (DXA). BMI can be considered a proxy for measures of body fat. BMI-for-age compares well with both weight-for-stature measurements and measures of body fat.

A study completed by researchers at the CDC compared the performance of BMI-for-age and weight-for-stature with fatness measured by dual energy x-ray absorptiometry (DXA), a direct measure of adiposity. NHANES III data were used to test how well BMI-for-age predicts underweight (below the 15th percentile) and overweight (above the 85th percentile) relative to their traditional weight-for-stature in children 2 to 19 years old. Both BMI-for-age and weight-for-stature performed equally well in screening for underweight and overweight among children 3 to 5 years of age. For school-aged children (6 to 11 and 12 to 19 age groups), BMI-for-age was slightly better than weight-for-stature in predicting underweight and overweight. CDC recommends the use of BMI-for-age for children aged 2 years and older. However, weight-for-stature performed equally well in pre-school aged children and can be used in both.

**METHODS**

Permission for the study was obtained from institutional review board. It was a cross sectional study done over a period of 6 months from 1st November 2013 to 30th April 2014. All patients of 2 to 12 years admitted in paediatric unit were included. Children with chronic diseases, cerebral palsy-Mentally retardation and syndromic children were excluded from the study. Accurate measurement of child’s weight and height obtained. Each child weighed on electronic weighing scale measuring to a precision of 0.001kg. Appropriate growth chart and BMI chart were selected according to gender. Birth Date (confirmed as per the birth certificate) child’s name, age, weight, and height were recorded on chart. Weight of the child was plotted on standard WHO growth chart and BMI plotted on BMI chart and compared with reference to percentile values given on chart and analyzed\(^5\) \(^6\)Chi-square \((\chi^2)\) test and Student- \(t\) test were used to compare variables and tests were considered significant when P-Value < 0.05.

**RESULTS**

Total admitted patients were 563. Patients fulfilling inclusion criteria were 521. Out of 521 in 89(15%) patients we could not get Birth certificate-to know the exact age of the child - were excluded from the study, so the total number of patients included in the study were 432. Number of patients in 2 to 5 years were 210, number of patients in 5 to 12 years were 222.

**WHO Growth Charts:**

| Undernourished in 2 to 12 years: | 260 (60%) |
| Undernourished in 2 to 5 years: | 139 (66%) |
| Undernourished in 5 to 12 years: | 121 (54%) |

**BMI charts:**

| Undernourished in 2 to 12 years: | 189 (43%) |
| Undernourished in 2 to 5 years: | 80 (38%) |
| Undernourished in 5 to 12 years: | 109 (49%) |

Thus in children of 5 to 12 years, 121 children were undernourished as per WHO growth charts. Amongst them 55 were normal as per BMI charts. 109 children were undernourished as per BMI charts. Amongst
them 43 were normal as per WHO growth charts (p value insignificant).

**Table 1: 2 to 12 years undernourishment by Growth chart and BMI chart**

<table>
<thead>
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<th>BMI chart undernourished</th>
<th>BMI chart normal</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Growth chart</td>
<td>142</td>
<td>118</td>
<td>260</td>
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<tr>
<td>Undernourished</td>
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<tr>
<td>Growth chart</td>
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<td>125</td>
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<tr>
<td>Significant</td>
<td>Chi square value 38.7</td>
<td>P value &lt;0.001</td>
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</tbody>
</table>

Figure 1: 2 to 12 years undernourishment by Growth charts and BMI charts

DISCUSSION

In present study we aimed to study BMI an indicator of Growth in comparison to WHO growth charts in children 2 to 12 years of age. Out of 432 children under study 260 were undernourished as per WHO growth charts and 189 as per BMI charts, so 17% children with undernourishment could have been missed if only BMI charts were used. Statistically significant implying Growth charts and BMI charts cannot be used interchangeably for assessment of growth. Their results differ significantly.

In children 2 to 5 years of age group, out of 200 patients 138 were undernourished by Growth charts and 80 by BMI charts. So, 28% children with undernourishment could have been missed if only BMI charts were used. In children 5 to 12 years of age group, 121 were undernourished as per WHO growth charts and 109 as per BMI charts. Statistically insignificant p value <0.31 implying Growth charts and BMI charts give similar results.

Khadilkar’s study stating use of 2006 WHO growth charts are likely to over diagnose under nutrition and stunting particularly in developing countries like India. In a multicentre study done on 1493 affluent children mean values for height weight were below WHO growth standards. A concern regarding adoption of WHO growth charts, 2006 is also expressed from many parts of world as Indonesia, Malawi etc. as these charts are likely to over diagnose under nutrition. So, it is likely that present study could over diagnose under nutrition if only WHO Growth charts were used rather than missing under nutrition if only BMI charts were used.

Thus in children of 2 to 5 years, 139 children were undernourished as per WHO Growth charts. Amongst them 63 were normal as per BMI charts.

Figure 3: 5 to 12 years undernourishment by Growth chart and BMI chart
CONCLUSION
To have proper inference regarding the nutritional status of children of age group 2 to 12 years the present study suggests that in children 2 to 5 years of age group, WHO growth charts should preferably be used. In children 2 to 5 years of age group, under nutrition is likely to be missed if only BMI charts are used. After 5 years of age any of the growth charts- WHO growth charts or BMI charts can be used.

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