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Assessing Overweight in School Going Children: A Simplified Formula

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Abstract

Background: The International Obesity Task Force (IOTF) has developed new cut-offs for defining overweight and obesity in children. The cut-offs have been developed for children 2-18 years of age. Objective: To develop a simplified formula for rapid assessment of overweight in school going children. Methods: We used the extended IOTF standards used for assessment of overweight and obesity among school going children. We plotted the Body Mass Index (BMI) at level 25, developed by IOTF as the cut-off for defining overweight among children, against age in months. Scatter plots and simple linear regression was used to develop a simplified formula for the relationship between age in months and the IOTF BMI cut-off for overweight. Correlation coefficients and R2 values were used to choose an appropriate simplified formula. Results: Age in months and IOTF BMI cut-offs are linearly related from age six to 18 years. The trend is more linear in boys. Girls show a more or less ‘S’ shaped relationship compared to boys where the relationship is ‘J’ shaped. The simplified formula developed has a higher correlation coefficient for boys as compared to girls. Conclusion: The simplified formula can be easily used in field settings for rapid assessment of overweight among school children, in absence of IOTF cut-offs. Further studies are warranted to estimate the validity of these formulae under field settings.

Keywords: BMI, Children, Overweight

1 Introduction

Diseases like hypertension, diabetes mellitus, atherosclerosis, coronary artery disease are linked to excess body fat [1-3]. The ideal definition of overweight and obesity is based on body fat percentage but this is not used in surveys. One of the most commonly used

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indices of relative weight is the Body Mass Index (BMI), which is defined as body weight in kilogram divided by height, in meters squared. Even though BMI is less sensitive than skinfold thickness [4], there is general agreement on the appropriateness of BMI to define overweight and obesity and a cut-off point of 25 kg/m2 is recognized internationally as a definition of overweight among adults [5]. Body mass index in childhood changes substantially with age [6, 7]. At birth the median is as low as 13 kg/m2, increases to 17 kg/m2 at age 1, decreases to 15.5 kg/m2 at age 6, then increases to 21 kg/m2 at age 20. Researchers thus felt the need for a clear cut-off point related to age to define child overweight and obesity.

The International Obesity Task Force (IOTF) reference, used for children and adolescents 2–18 years old, was developed from a database of 97 876 boys and 94 851 girls from birth to 25 years from six countries (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the USA) [8]. Centile curves were constructed using the LMS method [9], and BMI values of 25 and 30 at 18 years of age for boys and girls were tracked back to define BMI values for overweight and obesity at younger ages. The IOTF recently updated the international child cut-offs - Extended International IOTF Body Mass Index Cut-Offs for Thinness, Overweight and Obesity in Children [10].

Overweight and obesity among children are a growing problem worldwide [11, 12]. The situation is no better in India. A study from Kerala suggests that the prevalence of overweight among school children is rising by 0.8% annually [13].

The present study aims to develop a simplified formula for rapid assessment of overweight in school going children. Such a formula will obviate the need for a reference chart and hence will help public health researchers, primary care physicians and policy makers to make rapid assessments of overweight among school children.

2 Material and Methods

The present study is based on extended international IOTF BMI cut-offs for overweight in children. Data was downloaded from the internet [12].

IOTF cut-offs for overweight among children was downloaded from IOTF website (www.iaso.org/resources/reports/newchildcutoffs/). An exploratory analysis was done to arrive at a simple yet feasible and valid formula for overweight cut-off. Scatterplots for age in months versus IOTF BMI cut-offs for overweight were constructed to study the nature of relationship between age, gender and cut-off values. Feasibility of linear relationships were then explored by means of eyeballing and a simple linear regression analysis. Simple linear regression equations were developed separately for boys and girls. Feasibility of a single simplified formula was explored by using scatterplots, comparing residuals, and by correlation coefficients and R2 values. Microsoft Office Excel 2007 was used for data entry and graphical presentation. SPSS version 20.0 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Amronk, NY:IBM Corp.) was used for producing correlation coefficients and simple linear regression analysis.

3 Main Results

The scatterplot of IOTF cut-off values of BMI (Kg/m2) for overweight among boys and girls versus age in months is shown in figure 1. Eyeballing of the scatterplot revealed that there is a possible linear relationship between the cut-off values and age in months from age six years to 18 years. It was thus decided to further explore the relationship between the cut-off values and age in months for the age group six years to 18 years.

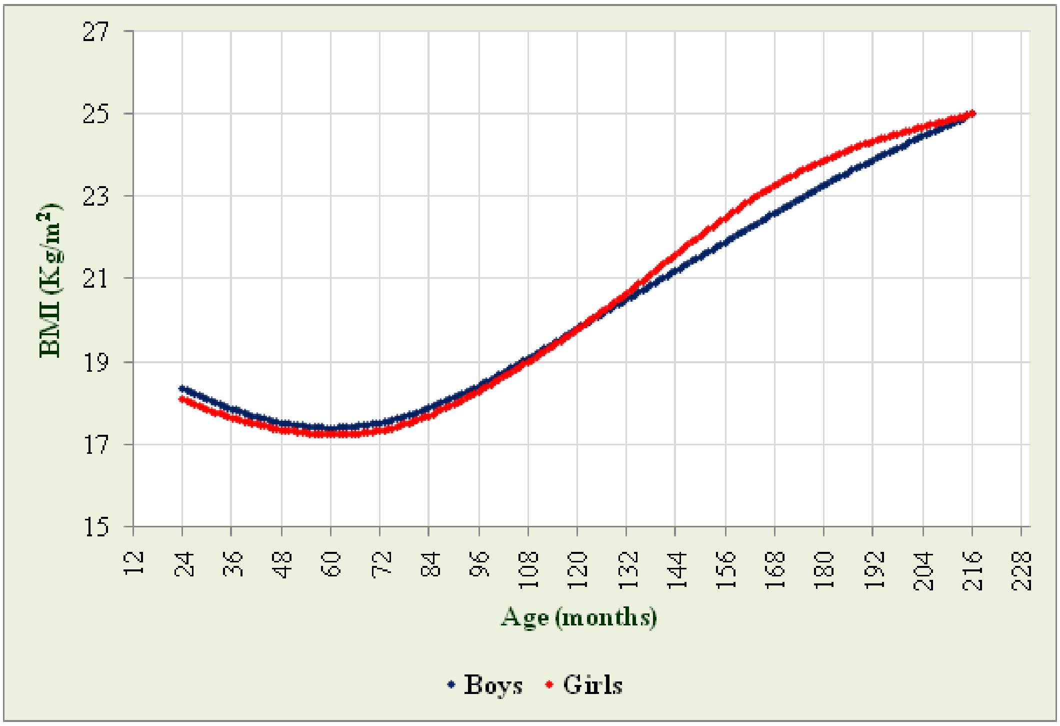

Figure 1: Age (months) versus Body Mass Index (Kg/m2) for boys and girls 2-18 years

Next, a linear regression line was fit separately for the scatterplots of IOTF BMI cut-off values versus age in months (restricted to age six years to 18 years) in boys and in girls (Figure 2 and 3). The regression line was a good fit for boys (R^2=0.9984) as well as for girls (R^2=0.9877). The regression coefficients are shown in figures 2 and 3.

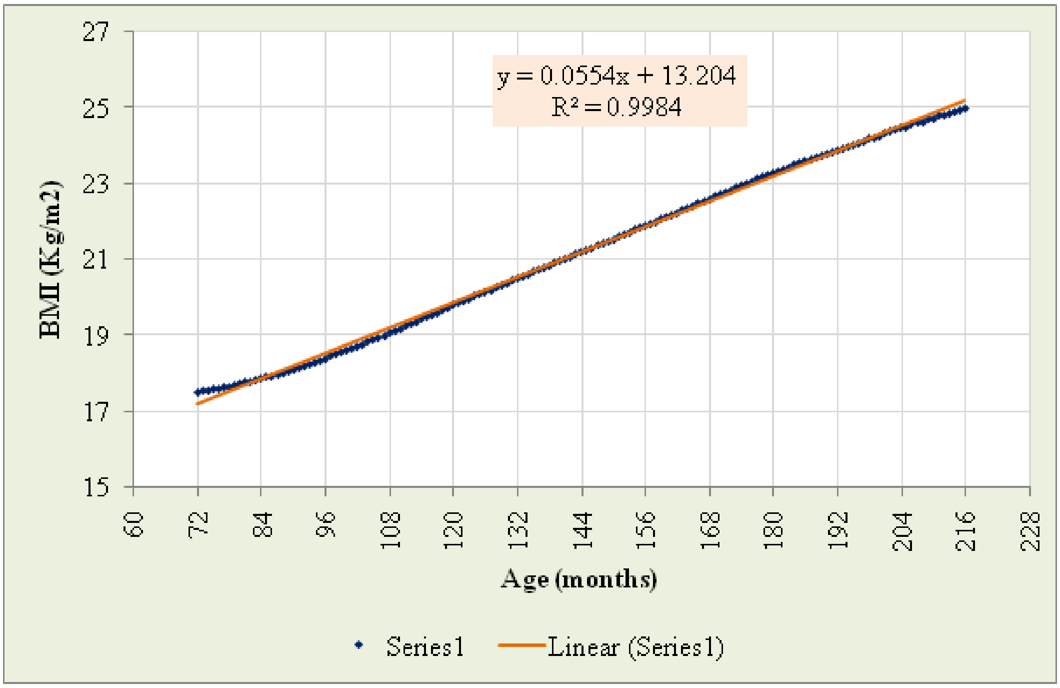

Figure 2: Scatter plot with linear trendline-Age(months) versus BMI (Kg/m2) Boys 6-18 years

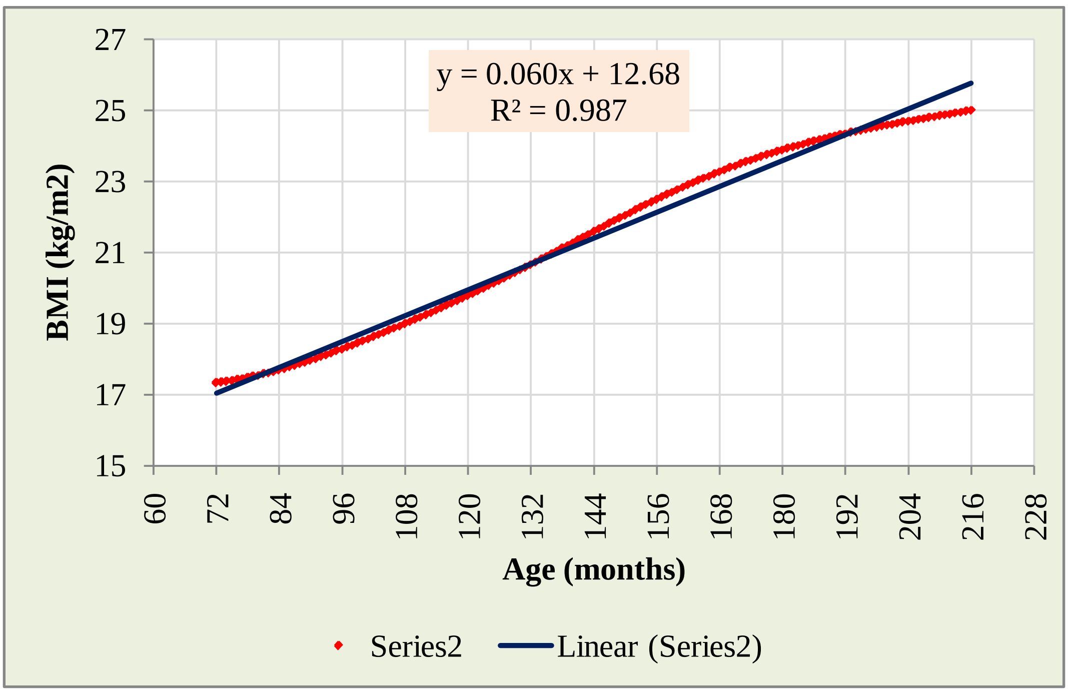

Figure 3: Scatter plot with linear trendline-Age(months) versus BMI (Kg/m2) Girls 6-18 years

A formula that is simple, a good fit in both boys and girls and can be used for both sexes was arrived at by averaging the regression coefficients and constants obtained in figure 2 and 3 above. The formula thus obtained was "Cut-off BMI (Kg/m^2)=0.058 x Age(months) + 12.9". This simplified formula was tested for fitness to original data by a simple correlation analysis (figure 4). There was a very high degree of correlation between the simplified formula and IOTF cut-off for boys (r=0.9992) and girls (r=0.9939).

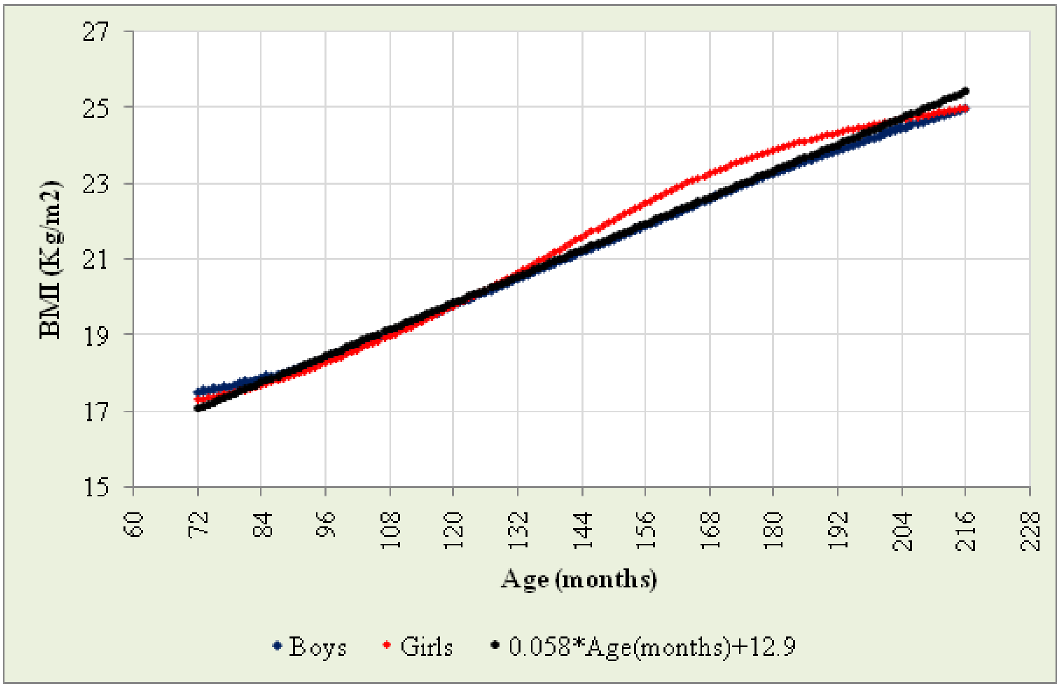

Figure 4: The simplified formula versus IOTF cut off values for boys and girls-an eyeball comparison

The fitness of the simplified formula to IOTF was also tested by comparing the unstandardized and standardized residuals separately for boys (figures 5 and 6) and girls (figures 7 and 8).

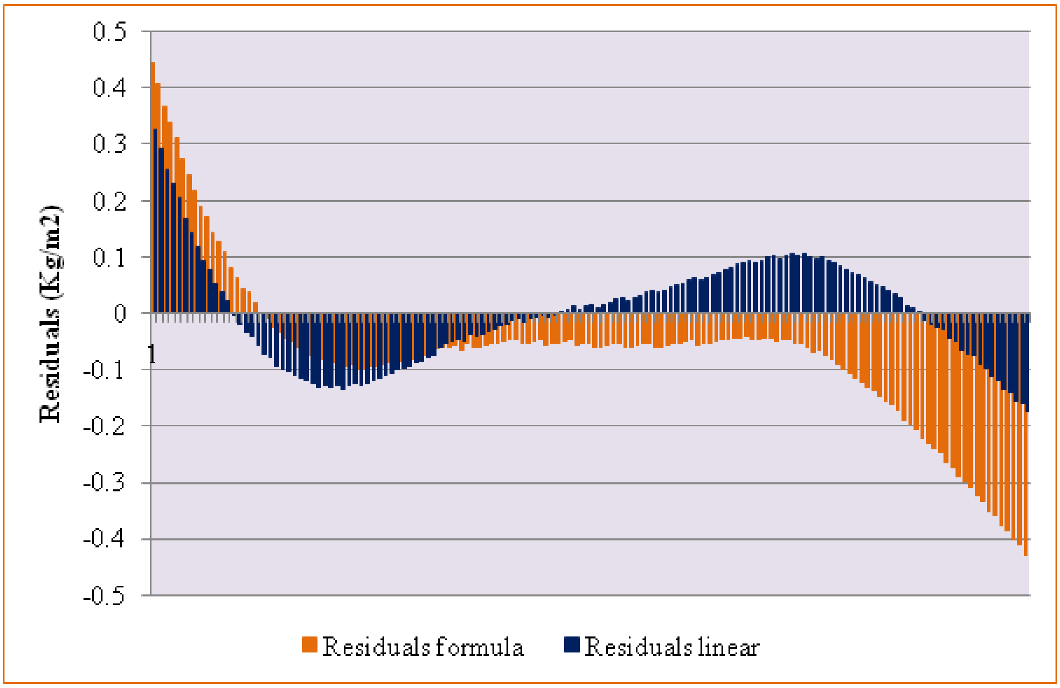

Figure 5: Comparison of residuals-Simplified formula versus linear trendline-Boys 6-18 years

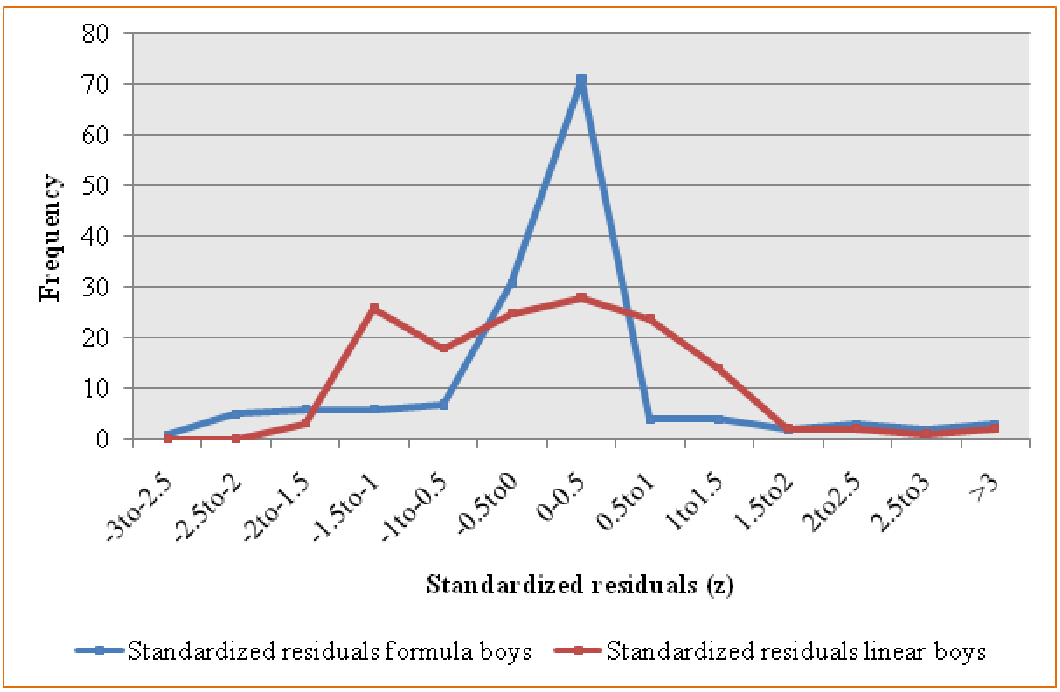

Figure 6: Comparison of standardized residuals-Simplified formula versus linear trendline-Boys 6-18 years

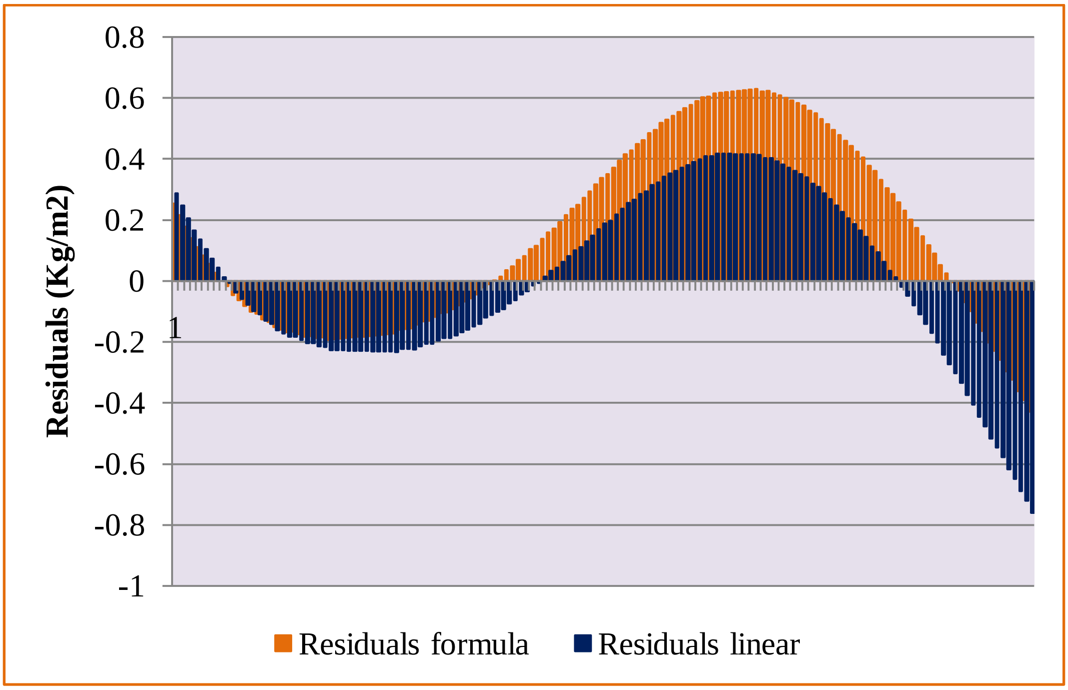

Figure 7: Comparison of residuals-Simplified formula versus linear trendline-Girls 6-18 years

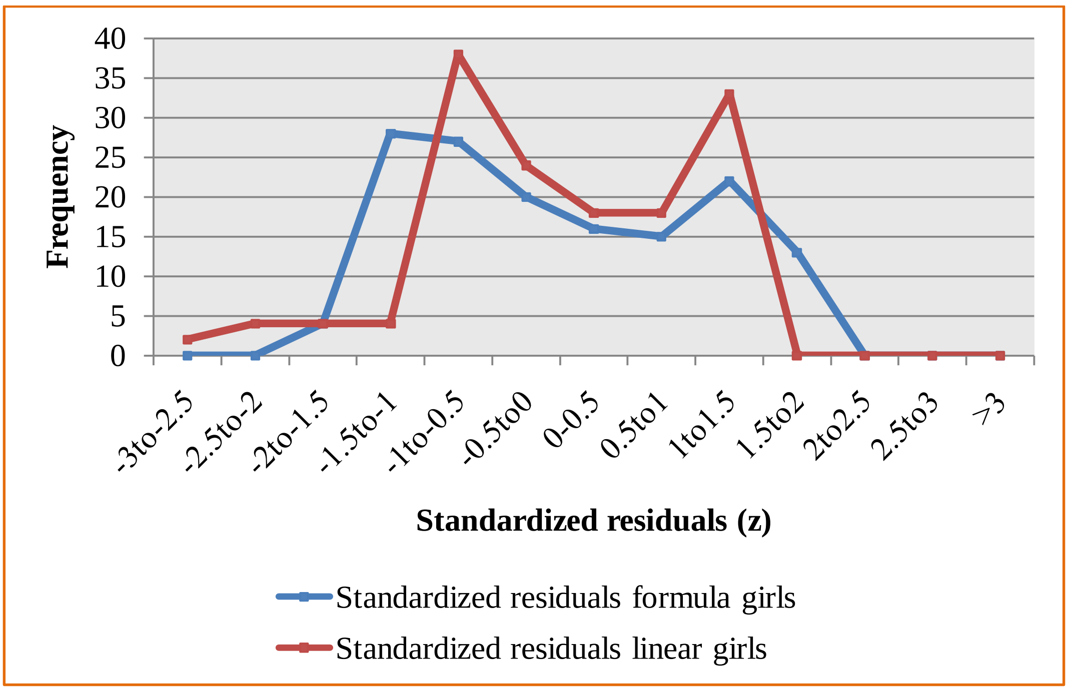

Figure 8: Comparison of standardized residuals-Simplified formula versus linear trendline-Girls 6-18 years

4 Discussion

The IOTF cut-off value of BMI to define overweight is linearly related to age for children 6-18 years of age so a simplified formula based on a linear trendline is possible. The trendline has higher R2 value for boys (0.9984) as compared to girls (0.9877) confirming that the relationship of BMI with age is more linear for boys. The simplified formula developed in this paper is strongly correlated to the IOTF values, more so for boys (r=0.9992) compared to girls (r=0.9939). The residuals for the simplified formula have higher values towards extremes of age for boys (figure 5) and towards higher age groups for girls (figure 7).

The simplified formula developed is easy to use in field settings for a rapid assessment. Such a formula can also be of use to primary care physicians assessing the status of overweight among children, just like the Weech's formula is for assessment of undernutrition [14, 15]. The formula however cannot be used as a replacement to the extended IOTF cut-offs, when they are available. Further studies are needed to evaluate the feasibility and validity of the formula under field settings.

5 Conclusion

The simplified formula derived in this article will be useful for clinicians to assess overweight among children 6-18 years of age. The validity of the formula however needs to be tested in actual outpatient or field settings. Further studies in this regard need to be undertaken.

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