Body fat percentage of school age children (10-15 years) using the bioelectric impedance analysis technique in a rural area of Bengaluru, South India

Madhusudan M[1], Ramesh N R Masthi[2], Yannick P Puthussery[3], Sanjay T V[2], Arun Gopi[1]

[1]Department of Community Medicine, DM Wayanad Institute of Medical Sciences, Meppadi, Kerala, India, [2]Department of Community Medicine, Kempegowda Institute of Medical Sciences, Bengaluru, Karnataka, India, [3]Medical Officer, PHC Kaipamangalam, Thrissur, Kerala, India

Correspondence to: Madhusudan M, E-mail: madhusudan_kims12@rediffmail.com

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ABSTRACT

Background: The prevalence of pediatric obesity is increasing rapidly, worldwide and emerging as a major risk factor for several chronic diseases. Body mass index (BMI) does not distinguish between increased mass in the form of fat, lean tissue or bone. Since the pathology and morbidity associated with obesity is driven by excess fat mass, the ideal monitoring tool should directly assess adiposity. Assessment of body fat percentage (BFP) is one of the methods to assess adiposity. **Objectives:** To assess the BFP of school age children and to compare the same across different ages and sexes. **Materials and Methods:** This was a cross-sectional study conducted in the rural field practice area of a medical college in Bengaluru from June 2013 to November 2014. All schools in the rural field practice area of the medical college were included and children in the age group of 10-15 years were the study subjects. BFP of children was assessed by bioelectric impedance analysis technique. **Results:** 48.4% had normal BFP, 32.1% low, 13.6% slightly high and 5.9% very high BFP. Mean BFP among males and females were 17.13 and 19.32, respectively. There was a strong positive correlation between BMI and BFP (r = +0.822). **Conclusions:** Majority of the children fell into normal BFP category, females had a higher mean BFP when compared to males, and there was a strong positive correlation between BMI and BFP. BFP assessment may be used as a screening tool to detect the obese/overweight children and also children who are at risk for the same.

KEY WORDS: School Age Children; Body Fat Percentage; Bioelectric Impedance Analysis, Bengaluru

INTRODUCTION

The prevalence of pediatric obesity is increasing rapidly, worldwide and emerging as a major risk factor for several chronic diseases of public health significance. Although body mass index (BMI) is a simple tool to assess obesity, it has numerous disadvantages such as it does not distinguish between increased mass in the form of fat, lean tissue or bone which can lead to a significant level of misclassification in large-framed, and/or muscular children who are rated as overweight or obese by BMI. Since the pathology and morbidity associated with obesity is driven by excess fat mass, the ideal monitoring tool should directly assess adiposity. The assessment of body fat percentage (BFP) is one of the methods of assessing adiposity.

Of the various methods available to assess BFP, bioelectrical impedance analysis (BIA) technique is practical, inexpensive,

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relatively easy to use in large field studies and reliable for evaluating body fatness in children.[1] Tissues containing much water such as muscles, blood vessels, and bones are highly conductive to electricity, but fat tissues are not. Therefore, by using this principle, it is possible to determine the ratio of fat tissue compared to other tissues in the body by measuring the electric resistance of the body tissues, using extremely weak electric current applications to the body.[2] There are no studies done in this part of the country to assess the BFP of school age children and adolescents. Hence, in this context, this study was undertaken to assess the BFP of school age children and compare the same across different ages and sexes.

MATERIALS AND METHODS

It was a cross-sectional study conducted in the field practice area of Rural Health Training Centre (RHTC), Hosabyrohalli of a medical college in Bengaluru from June 2013 to November 2014. All schools (government, aided, and private) in the field practice area of RHTC were included in the study. Informed consent was obtained from the heads of the institution, and data obtained were kept confidential. All children in the age group of 10-15 years present on the day of examination and willing to participate were included as study subjects. The BFP of children was assessed by bioelectrical impedance method using the body fat monitor (Omron-HBF-306). The subjects were made to stand straight with feet slightly apart and hold the body fat monitor in such a way that the middle finger rests in the groove of the handle, palm is in contact with electrodes, thumbs up and resting on the top of the unit and arms held straight out and making 90° with the body.[2] Height and weight of the subjects were recorded in the metric system using standardized techniques recommended by WHO.[3] The height, weight, date of birth, and date of visit of the subjects were then entered in the WHO Anthroplus software to obtain the BMI and BMI for age *Z*-score.

The data were entered in Microsoft Excel-10 and analyzed using SPSS v.21.0. *Z* test was used to test the difference in BFP categories between sexes, and two-way ANOVA to test the difference in BFP between age and sex. The correlation was tested between (a) BMI and BFP and (b) age and BFP.

RESULTS

Of the 1570 children tested, the majority (48.3%) fell into normal BFP category. The prevalence of low BFP was highest among 10 years, slightly high BFP among 14 years, very high BFP among 13 years (Table 1). It was found that the prevalence of low BFP was higher among females (54.8%) compared to males (11.2%), normal, slightly high, and very high BFP higher among males (59%, 20.1%, and 9.7%, respectively) compared to females (36.7%, 6.6%, and 1.9%, respectively). The difference of BFP categories between sexes was found to be statistically significant by *Z*-test for all categories ($P < 0.01$).

Table 1: BFP categories - comparison between ages

Age (years)	BFP category				Total
	Low	Normal	Slightly high	Very high	
10	**112 (46.3)**	85 (35.0)	30 (12.4)	16 (6.6)	243 (100)
11	112 (43.9)	98 (38.4)	29 (11.4)	16 (6.3)	255 (100)
12	107 (40.7)	112 (42.6)	31 (11.8)	13 (4.9)	263 (100)
13	72 (27.2)	131 (49.4)	40 (15.1)	**22 (8.3)**	265 (100)
14	54 (19.9)	**162 (59.6)**	**43 (15.9)**	13 (4.8)	272 (100)
15	47 (17.2)	172 (63)	41 (15)	13 (4.8)	273 (100)
Total	**504 (32.1)**	**760 (48.4)**	**214 (13.6)**	**93 (5.9)**	**1571 (100)**

Low: <10 for males, <20 for females; Normal: 10-19.9 for males, 20-29.9 for females; Slightly high: 20-24.9 for males, 30-39.9 for females; very high >25 for males, >40 for females[2]

Table 2: Comparison of mean BFP between ages and sex

Ages	Males		Females	
	Number	Mean BFP	Number	Mean BFP
10	133	17.06±6.32	110	**14.40±6.36**
11	136	17.60±6.14	119	15.17±6.65
12	126	16.98±5.88	137	17.75±6.20
13	144	**17.95±5.50**	121	20.62±7.10
14	126	17.05±5.40	146	23.16±6.43
15	152	**16.21±5.24**	121	**23.72±5.81**
Total	**817**	**17.13±5.76**	**754**	**19.32±7.35**

BFP values are normally distributed (mean>SD) hence parametric test has been used, BFP: Body fat percentage, SD: Standard deviation

Females had a higher mean BFP compared to males. Among males, 13 years children had the highest mean BFP and 15 years the least. Among females, 15 years children had the highest mean BFP and 10 years the least (Table 2). The difference of BFP between ages and sex was found to be statistically significant by two-way ANOVA (F = 24.959, P = 0.001 for age and F = 41.860, P = 0.001 for sex). The variability of BFP between ages (10 and 13, 14, 15; 11 and 13, 14, 15; 12 and 13, 14, 15; 13 and 10, 11, 12; 14 and 10, 11, 12; 15 and 10, 11, 12) was statistically significant by *post-hoc* tests (Bonferroni) ($P < 0.01$). There was no much net change in mean BFP with age between 10 and 15 years for males. Whereas for females, there was an increase in mean BFP with age especially between 11 and 14 years where there was a sharp rise (Figure 1).

There was a strong positive correlation between BMI for age *Z* scores (BAZ) and BFP ($r = +0.827$) (Figure 2) (mean BAZ = −1.24, Mean BFP = 18.18) and it was found to be statistically significant ($P = 0.001$). Coefficient of

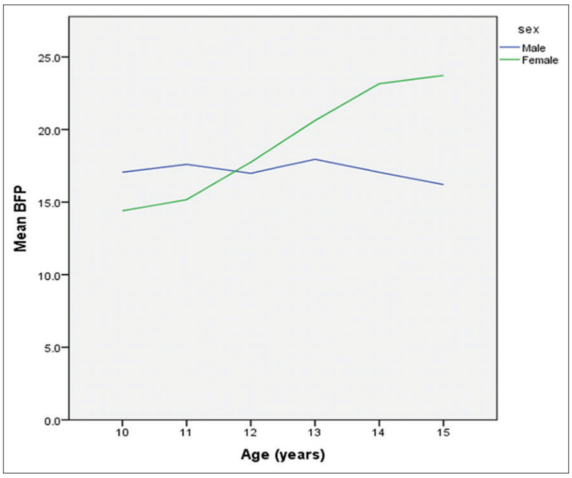

Figure 1: Trend of body fat percentage with age

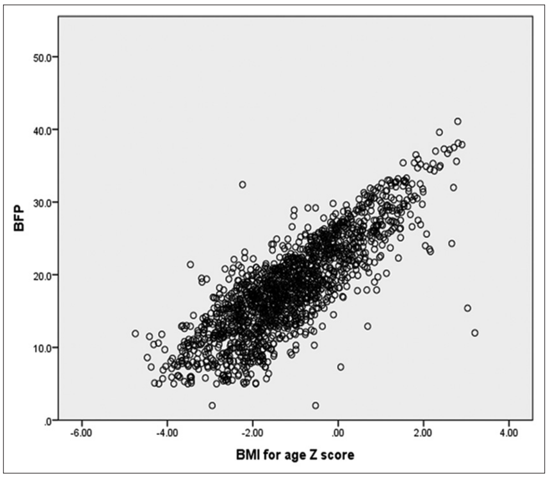

Figure 2: Correlation of body fat percentage with body mass index for age *Z*-score

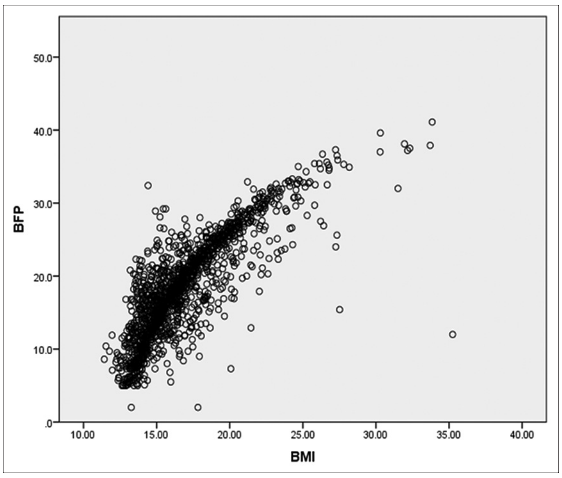

Figure 3: Correlation between body mass index and body fat percentage

determination (r^2) was 0.684 which implies 68.4% change in BAZ can be attributed to BFP. Age had a moderate positive correlation with BMI (r = +0.400) and weak positive correlation with BFP (r = +0.231), and these correlations were found to be statistically significant (P = 0.001). Coefficient of determination (r^2) values were 0.160 and 0.053 which imply 16% and 5.3% change in BMI and BFP, respectively, can be attributed to age. There was a strong positive correlation between BMI and BFP (r = +0.822) (mean BMI = 16.62) and it was found to be statistically significant (P = 0.001) (Figure 3). Coefficient of determination (r^2) was 0.676 which implies 67.6% change in BMI can be attributed to BFP.

DISCUSSION

The mean BFP of males in this study was 17.13 ± 5.76 which is similar to other studies.[4-6] In contrast, few other studies have reported it as 23, 23.6, 25.08 ± 10.12.[1,7] The probable reasons for this difference could be the difference in the age groups of the study subjects (the subjects were in the age group of 6-8 years at Pune centre and 7-9 years at Mysore centre in the study by Kehoe et al., and 8-10 years in the study by Nasreddine et al.) and also differences in ethnicities as in the study by Nasreddine et al. The mean BFP of females in this study was 19.32 ± 7.35 which is similar to other studies.[1,4,8] In contrast, few other studies have reported it as 26.3, 33.6, 27, 26.6 ± 5.7.[5-7] The probable reasons for this difference could be the difference in the age groups of the study subjects (subjects were between 9-18 years and 10-18 years, respectively, in the studies by Jeddi et al. and Vidal et al.), difference in ethnicities (as in the studies by Jeddi et al. and Vidal et al.), and also different method used for assessing BFP (dual energy X-ray absorptiometry in the study by Jeddi et al.).

Jeddi et al. found that among boys, 10 years children had the highest mean BFP and 15 years children the least and among girls 14 years children the highest and 10 years the least.[5] Vidal et al. found that 10 and 15; 10 and 14 years children had the highest and the lowest mean BFP for boys and girls, respectively.[6] Goon et al. observed that 10, 12, and 13 years children had the highest mean BFP among boys and 11 years the least, 13 years the highest and 9 years the least among girls.[4] Whereas in our study highest and least mean BFP among boys and girls were found among 13 and 15; 15 and 10 years children, respectively. The differences could be attributed to differences in the age groups as well as ethnicities of the subjects.

In this study, males had a net decrease of 5% in the mean BFP between the ages 10-15 years and females a net increase of 64.7% which is similar to the study by Jeddi et al., where boys had a net decrease of 23.1% and girls a net increase of 16.6%.[5] In contrast, Vidal et al. observed that both boys and girls had a net decrease which was 37.9% and 12.5%, respectively.[6] Goon et al. observed that both boys and girls had a net increase which was 4.7% and 20.5%, respectively.

Jeddi et al. and Vidal et al. found that there was a moderate positive correlation between BMI and BFP and Khadgawat et al., strong positive correlation similar to our study.[5,6,9]

Vidal et al. also found that there was a negative correlation of age with BFP and BMI unlike our study where there was a positive correlation.[6]

This study is cross-sectional in nature; hence, it is difficult to make causal inference of the observations. The BIA is attractive in terms of cost, equipment portability, and minimal need for personnel training but considered as doubly indirect method in the measurement of BFP.[10] Furthermore, the Instrument failed to compute the BFP values of a few students as the measurements were out of range.

CONCLUSION

To conclude the majority of the children fell into normal BFP category, females had a higher mean BFP when compared to males, and there was a strong positive correlation between BMI and BFP. BFP assessment may be used as a screening tool to detect obese/overweight children and also children who are at risk for the same.

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