Assessment of Body Fat and its Relation to Growth Score for Iraqi Children

Sura A. Abdulsattar

College of Science, Department of Chemistry, Al-Mustansyria University ,Iraq
*E-mail: sura742003@yahoo.com

Abstract
Percentage body fat is the only factor reflects the relative body composition. This search aimed to study the growth score of Iraqi children and its relation to percentage body fat. A total of 107 healthy children (53 girls and 54 boys), aged 2-12 y, were included in the present study. There were no significant differences between girls and boys in body mass index (p >0.05) while a significant differences (p<0.05) were observed in protein, bone mineral content, body water, and free fat mass (p<0.001). The growth score ranged (0-98) with mean (45.54 ±24.96) for girls, and (1-94) with mean (55.61 ±25.37) for boys. Percentage body fat was significantly and positively correlated with body mass index and inversely with growth score in each sex group .While a non significant correlation was found between body mass index and growth score. We conclude that percentage body fat is a stronger tool than body mass index to follow the growth score and subsequently the health of children.
Keywords: Body fat, Body mass index, Overweight, Growth, Children.

1. Introduction

Normal growth indicates the state of health and good nutrition for children, which represents changes in height, weight, and head circumference[1]. There are a set of graphs which they can assess the growth of children and the early detection of deviations pathological (eggs, poor weight gain due to a metabolic disorder, short stature due to illness inflammation of the intestine) and can prevent unnecessary evaluation of children with normal variations in acceptable growth[2,3]. Body composition is one of the growth measurements that defined as the quantity of fat, muscle, and bone in the body. It is generally expressed as either a percentage of fat or as a percentage of lean mass[4].Those with a higher proportion of fat-free mass to a lower proportion of body fat have a healthy body composition[5]. Body fat includes essential body fat and storage body fat where essential body fat is necessary to maintain life and reproductive functions [6], while storage body fat is part of which protects internal organs in the chest and abdomen [7]. Since the body fat percentage (%BF) is a measure of fitness level, it is the only body measurement which directly calculates a person's relative body composition without regard to height or weight[7]. Body Mass Index (BMI) is widely used as an index of body fatness; however it is a measure of weight relative to height rather than of adiposity [8,9]. BMI in childhood changes extraordinarily with age, where at birth the median is as low as 13 kg/m^2, increases to 17 kg/m^2 at age 1, and decreases to 15.5 kg/m^2 at age 6, then increases to 21 kg/m^2 at age 20[10,11]. The overweight in children differs from that in adults because they are in a state of growth and usually there is a difference between boys and girls in the rate of growth .The growth charts use a child's BMI, age, and sex to produce a BMI percentile [12].The aim of this study is to assess the association between body fat and the level growth in children of Iraqi population aged (2,12) year

2. Subject and Methods

The study included 107 subjects,53 girls and 54 boys with an age range from 2 to 12 years. Subjects were healthy at the time of investigation and had no chronic or acute illnesses. Information on total body composition was available for these subjects by body composition analysis (In Body230 Kr/Biospace) .Height was measured to the nearest mm with a wall-mounted stadiometer, and weight was measured on electronic scales to the nearest 0.1 kg with subjects wearing light clothing and no shoes.BMI is be calculated directly as weight (in kilograms)/[height (in meters)]^2, compared to reference data, and made the basis for important decisions regarding the child's health[13]. Overweight and obese group was identified as BMI ≥85th percentile and normal group was indicated between 5th and 85th percentile for age and sex [14]. The equations proposed by Slaughter et al. for children were used to calculate the percentage of body fat (%BF)[15]. Based on these data, fat mass was calculated by %BF×weight. The fat-free mass was calculated by subtracting the fat mass from the weight. Basal metabolic rate(BMR) was estimated using the Schofield Equation[17], and the growth score was determined using growth chart depended on BMI of child and age, sex[17]. Total body water (TBW) was estimated using Mellits-Cheek equation for children [18] as following: Boys TBW= -1.927+0.465x weight + 0.045x height (height<132.7cm)

Boys TBW = -21.993+0.406x weight+ 0.209x height (height>132.7cm)
Girls TBW= 0.076+0.507x weight + 0.013x height (height<110.8cm)
Girls TBW = -10.313+0.252x weight+ 0.154 height (height>110.8cm)
Body protein was calculated using bioelectrical impedance analysis (BIA) equation[19]

SM mass (kg)=[(Ht^2/R×0.401)+(gender×3.825)+(age×-0.071)]+5.102
Where Ht is height in centimetres; R is BIA resistance in ohms; for gender, boy = 1 and girl = 0; and age is in years.
Bone mineral content (BMC) was calculated by subtracting the total water and protein values from the fat free mass.

3. Statistical Analysis

The statistical analyses were performed using SPSS version 15.0 software (SPSS, Chicago, IL, USA). The results are expressed as mean ± standard deviation (SD) . Pearson's correlation coefficient was used to verify correlations between the growth and other parameters of body composition. The results were considered statistically significant at $p<0.05$.

4. Results

The characteristics of the study population are presented in Table1. The boys tended to be slightly, but not significantly, taller ($p >0.05$) and heavier ($p >0.05$) than were the girls and tended to have slightly, but not significantly, less body percentage fat (%) ($p >0.05$) than did the girls. There were no significant differences between girls and boys in BMI($p >0.05$) while a significant differences ($p<0.05$) were observed in protein, bone mineral content and body water.

Table 1. Descriptive Statistics of Body composition for the Study Population by Gender .

Variable	Girls (*n* = 53)	Boys (*n* = 54)	P Value
Age (year)	5.61 ± 2.37	6.2 ± 2.72	>0.05
Height (cm)	102.47 ± 18.37	108.27 ± 20.67	>0.05
Weight (kg)	19.05 ± 8.44	22.37 ± 11.18	>0.05
Body Mass Index (kg/m^2)	17.30 ± 2.54	17.39 ± 4.79	>0.05
Percentage Body Fat (%)	31.13 ± 7.53	29.37± 7.88	>0.05
Protein(kg)	2.56 ± 0.97	3.01 ± 1.28	<0.05
Bone Mineral Content (kg)	0.93 ± 0.38	1.19 ± .818	<0.05
Total body water (kg)	9.74 ± 3.67	11.53 ± 4.67	<0.05
Basal Metabolic Rate (kcal)	656.09 ± 108.09	705.05 ± 137.92	<0.05

The fat mass and free fat mass of the both groups are presented in Figure1. The girls tended to be slightly, but not significantly, more fat mass ($p >0.05$) than were the boys. While a highly significant increase in free fat mass($p<0.001$) was observed in boys than the girls.
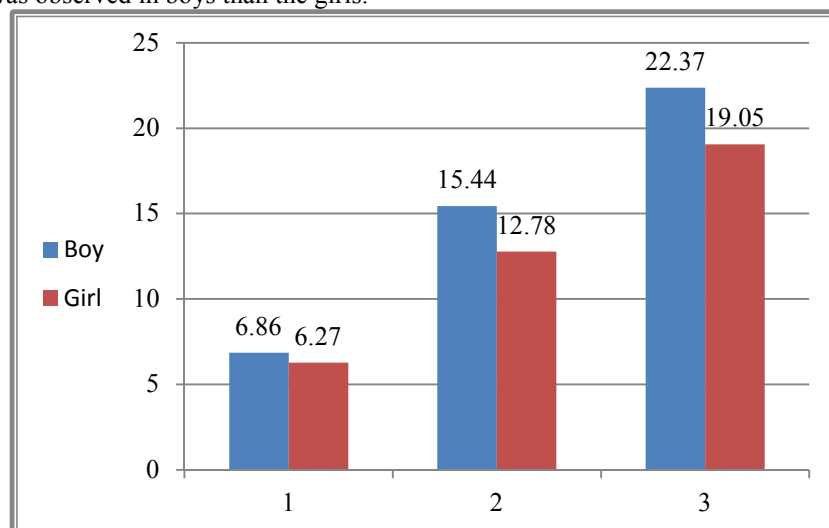

Figure 1.The study analysis of Fat mass (1),Free fat mass(2),and Weight(3) for boys and girls.

The obesity degree of the study population by gender are presented in Figure 2.The results indicated that 29% of the girls and 23% of the boys tended to have obesity. While 27% of the girls and 17% of the boys have under the normal range.
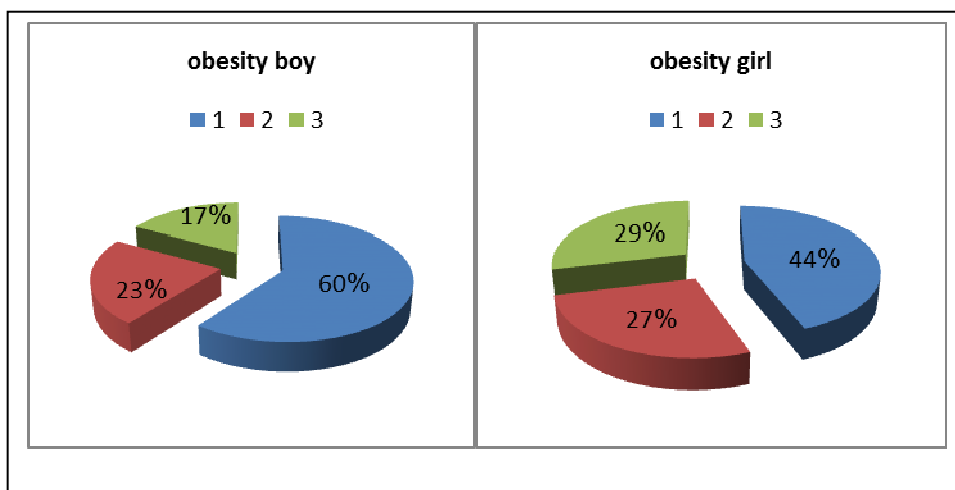
Figure 2.The Obesity Degree Of The Population Study By Gender

The growth score of the study population by gender are presented in Figure 3. The results indicated that the growth score ranged (0-98)with mean (45.54 ±24.96) for girls, and (1-94)with mean (55.61 ±25.37) for boys.

The correlations of BF% and BMI with age, growth score and body composition variables by gender are presented in Table2. BF% was significantly and positively correlated with BMI and inversely with growth score in each sex group . BMI was significantly and positively correlated with all of the variables in boy group except height , bone mineral content, and growth score ,while in girl group BMI was significantly and positively correlated with all of the variables except height , age ,and growth score .
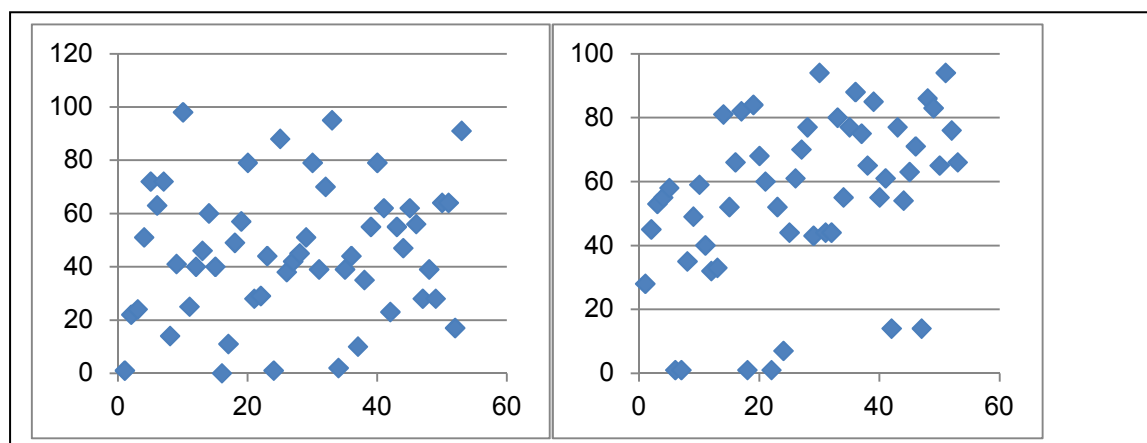

Figure3.The Growth Score Of The Study Population By Gender

Table2.The correlations of BF% and BMI with age, growth score and body composition variables by gender.

Sex	Girl				Boy			
	BF%		BMI		BF%		BMI	
Variable	r	p	r	p	r	p	r	p
Age (year)	-0.031	0.826	0.176	0.209	-0.134	0.334	0.310	0.022
Height (cm)	0.109	0.437	0.270	0.051	-0.161	0.244	0.199	0.150
Weight (kg)	0.261	0.059	0.576	0.000	0.332	0.014	0.743	0.000
Body Mass Index (kg/m^2)	0.792	0.000	1		0.622	0.000	1	
Percentage Body Fat (%)	1		0.792	0.000	1		0.622	0.000
Protein(kg)	0.049	0.726	0.513	0.000	-0.024	0.864	0.513	0.000
Bone Mineral Content (kg)	0.058	0.681	0.430	0.001	0.018	0.896	0.201	0.145
Total body water (kg)	0.072	0.608	0.473	0.000	0.001	0.992	0.518	0.000
Basal Metabolic Rate (kcal)	0.069	0.624	0.469	0.000	-.006	0.963	0.508	0.000
Growth score	-0.326	0.017	-0.034	0.808	-0.636	0.000	-0.327	0.016

5. Discussion

Growth score are the most important components of the children because normal growth patterns are the gold standard by which clinicians assess the health and well-being of children [17]. It was found from this present study that growth score of both boys and girls were low which may be due to poor socioeconomic. Body composition is one of the growth measurement .The results of these composition for the group as a whole, indicated that the growth score correlation inversely with BF% not with BMI. BMI has probably become the most common indicator used to assess overweight and obesity in a wide variety of settings, including clinical, public health, and community-based programs [20]. Obesity is an increasing problem not only in adults but also in children [21,22]. Obesity is define according to the American Academy of Pediatrics and Centers for Disease Control and Prevention as a body mass index (BMI) ≥ 95th percentile based on age and sex, and overweight as a BMI ≥ 85th to 94th percentiles in patients 2 to 20 years of age [23]. The obesity degree of the girls in the present study was more than the boys, and this in agreement with the results obtained by Bingham ,et al who found that the prevalence of obesity was greater in girls than in boys[24]. Although the prevalence of childhood obesity, as determined by BMI has tripled over the last 3 decades, this index is a measure of excess weight rather than excess body fatness [25]. Few studies have examined the relationship between BMI and the fat-free component of body weight in healthy children [26-28]. While other studies have emphasized the relationship of BMI to fat mass or %BF [29-31]. Highly significant correlation was found in the present study between BMI and %BF .This result was agreement with previous studies were high correlations have been reported between BMI and both total body fat and percentage of body fat (%BF) during childhood [32,33]. Fat free mass can be further broken down into three components comprised of body water, protein, and mineral. The ratios of these components are considered to be constant. The present study indicated a significant differences between boys and girls in protein, BMC, and TBW .Also It were observed a significant positive correlation of %BF with protein in girls ,while a significant inversely correlation of %BF with protein in boys.

Basal metabolic rate varies from person to person and increases with the amount of muscle tissue. Age, gender, weight, and physical activity directly effect on basal metabolic rate. A non significant correlation of %BF with BMR of the girls group was observed while a significant inversely correlation was observed in boys group. This results somewhat agreement with previous study which included that BMR increases from infancy to adulthood and then decreases with old age possibly due to changes in the thyroid hormone concentration or fat free mass [34].

6. Conclusion

It conclude from this research that the decline in the growth rate for both sexes of the children is the result of the high level of fat and this shows that diet approach is unhealthy and wrong and this requires awareness of cultural on how correct that lead to reduce fat and increase growth, such as eating fruits and exercise.

References

1-   WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards: *Growth velocity based on weight, length and head circumference:* Methods and development. World Health Organization, Geneva, 2009.

2-   Connolly M.V. , Nutrition in Pediatrics.4th ed. Hamilton, Ontario, Canada: BC Decker Inc; 2008.

3-   Lifshitz F, Cervantes CD. Short stature. *In: Pediatric Endocrinology,* Lifshitz F (Ed), Marcel Dekker, New York 1996. p.3.

4-   Veldhuis JD, Roemmich JN, Richmond EJ, Rogol AD, Lovejoy JC, Sheffield-Moore M, Mauras N. *Endocrine Control of Body Composition in Infancy, Childhood, and Puberty. Endocrine Reviews* February 1, 2005 vol. 26 no. 1 :114-146.

5-   Halton JM, Atkinson SA, Barr RD. *Growth and body composition in response to chemotherapy in children with acute lymphoblastic leukemia.* Int J Cancer Suppl. 1998;11:81.

6-   ACE (2009) *What are the guidelines for percentage of body fat loss?* American Council on Exercise (ACE). Ask the Expert Blog. December 2, 2009.

7-   Jackson, AS; Stanforth, PR; Gagnon, J; Rankinen, T; Leon, AS; Rao, DC; Skinner, JS; Bouchard, C et al. *The effect of sex, age and race on estimating percentage body fat from body mass index: The Heritage Family Study. "True".* International Journal of Obesity (2002). 26 (6): 789–96 .

8-   *Prentice AM, Jebb SA. Beyond body mass index.* Obes Rev.2001;2 *(3):*141– *147.*

9-   *Demerath EW, Schubert CM, Maynard LM, et al. Do changes in body mass index percentile reflect changes in body composition in children? Data from the Fels Longitudinal Study.* Pediatrics.2006;117 *(3).*

10-   Rolland-Cachera M. F., Deheeger M., Bellisle , et al .*Adiposity indices in children. Am J Clin Nutr* July 1982 vol. 36 no. 1 178-184.

11-   Power C, Lake JK, Cole TJ. *Measurement and long-term health risks of child and adolescent fatness. Int J Obesity 1997; 21: 507–526.*

12- National institutes of health. *Calculate Body Mass Index* .www.nhlbi.nih.gov/.../healthy-weight.../body-mass-index.htm.

13- Lohman TG, Roche AF, Martorell R. *Antropometric Standardization Reference Manual. Champaign, IL*: Human Kinetics Books;1988.

14- Krebs NF, Himes JH ,Jacobson D, & et.al. *Assessment of Child and Adolescent Overweight and Obesity. Pediatrics* Vol. 120 No. Supplement 4 December 1, 2007.

15- Slaughter MH, Lohman TG, Boileau RA, Horswill CA, Stillman RJ, Van Loan MD, Bemben DA. *Skinfold equations for estimation of body fatness in children and youth.* Hum Biol. 1988 Oct;60(5):709-23.

16- Schofield WN . *Predicting basal metabolic rate, new standards and review of previous work.* Hum Nutr Clin Nutr. 1985; 39 Suppl 1: 5–41.

17- Sarah M Phillips SM., Shulman RJ, Motil kJ,& Hoppin AG. *Measurement of growth in children.* Wolters Kluwer Health. Literature review current through: Sep 2013.

18- 18- MELLITS, ED, CHEEK, DB: *The assessment of body water and fatness from infancy to adulthood.* Monographs Soc Res Child Dev 1970 35:12–26.

19- Janssen I, . Heymsfield SB, Baumgartner RN, and Ross R. *Estimation of skeletal muscle mass by bioelectrical impedance analysis. Journal of Applied Physiology August 1, 2000 vol. 89 no. 2 465-471*

20- John H. Himes, *Challenges of Accurately Measuring and Using BMI and Other Indicators of Obesity in Children. Pediatrics* 2009
Vol. 124 No., pp. S3 -S22

21- Wenig CM. *The impact of BMI on direct costs in children and adolescents: empirical findings for the German Healthcare System based on the KiGGS-study.* Eur J Health Econ. 2012 Feb;13(1):39-50.

22- Parvaneh Reza Soltani, Atefeh Ghanbari, Afagh Hasanzadeh Rad. Parvaneh Reza Soltani, Atefeh Ghanbari, & Afagh Hasanzadeh Rad.Iran J Nurs Midwifery Res. 2013 May-Jun; 18(3): 175–179.

23- Gish EC, Harrison D, Johnson PN. *Dosing Evaluation of Continuous Intravenous Fentanyl Infusions in Overweight Children: A Pilot Study.* J Pediatr Pharmacol Ther.2011;16(1):39-46.

24- Bingham DD, Varela-Silva MI, Ferrão MM, Augusta G, Mourão MI, Nogueira H, Marques VR, Padez C. *Socio-demographic and behavioral risk factors associated with the high prevalence of overweight and obesity in portuguese children.* Am J Hum Biol. 2013 Sep 3. doi: 10.1002/ajhb.22440

25- Freedman DS.& Sherry B. *The Validity of BMI as an Indicator of Body Fatness and Risk Among Children. Pediatrics 2009* Vol. 124 No.1 ,pp. S23 -S34.

26- Maynard LM, Wisemandle W, Roche AF, Chumlea WC, Guo SS, Siervogel RM. *Childhood body composition in relation to body mass index.* Pediatrics.2001;107 :344– 350.

27- *Wells JCK, Coward WA, Cole TJ, Davies PSW. The contribution of fat and fat-free tissue to body mass index in contemporary children and the reference child.* Int J Obes Relat Metab Disord.2002*;*26 *:*1323*– 1328.*

28- Freedman DS, Wang J, Maynard LM, et al. *Relation of BMI to fat and fat-free mass among children and adolescents.* Int J Obes Relat Metab Disord.2005;29 :1– 8

29- Mei ZG, Grummer-Strawn LM, Pietrobelli A, Goulding A, Goran MI, Dietz WH. *Validity of body mass index compared with other body composition screening indexes for the assessment of body fatness in children and adolescents. Pediatrics* Vol. 124 No. Supplement 1 September 1, 2009 pp. S23 -S34 .

30- Taylor R, Jones I, Williams S, Goulding A. *Body fat percentages measured by dual-energy x-ray absorptiometry corresponding to recently recommended body mass index cutoffs for overweight and obesity in children and adolescents aged 3–18 y.* Am J Clin Nutr.2002;76 :1416– 1421.

31- Lindsay RS, Hanson RL, Roumain J, Ravussin E, Knowler WC, Tataranni PA. *Body mass index as a measure of adiposity in children and adolescents: relationship to adiposity by dual energy X-ray absorptiometry and to cardiovascular risk factors.* J Clin Endocrinol Metab.2001*;*86 *:*4061*– 4067.*

32- Field A, Laird N, Steinberg E, Fallon E, Semega-Janneh M, Yanovski J. *Which metric of relative weight best captures body fatness in children?* Obes Res.2003;11 :1345– 1352

33- *Pietrobelli A, Faith MS, Allison DB, Gallagher D, Chiumello G, Heymsfield SB. Body mass index as a measure of adiposity among children and adolescents: a validation study.* J Pediatr.1998*;*132 *:*204*– 210.*

34- Gayya, Gemma p. Yuchingtat, Celeste c. Tanchoco and Mitchie p. *Basal metabolic rate (bmr) determination using the 5ᵗʰ national nutrition survey data Cynthia.* www.fnri.dost.gov.ph/.../abstracts31st/basal(2007).