VALIDITY OF CONVENIENT INDICATORS OF OBESITY

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Abstract: Study objective is to evaluate validity of body mass index (BMI) and fat mass index (FMI) as indicators of obesity in 272 boys and 242 girls aged 3–5 years. Bioelectrical impedance analysis (BIA) was used to calculate percentage fat mass (%BF) and FMI (fat mass/stature^2). Boys and girls were considered obese when %BF ≥25 and ≥30, respectively. Highest prevalence of obesity detected by using different cutoffs BMI or FMI was found at 90th percentile for both sexes. BMI and FMI had high specificities and lower but variable sensitivities. FMI is associated with a level of sensitivity that is somewhat higher than that of BMI. BMI should be used with caution as an indicator of childhood obesity. Further investigations are required to define the best cutoff point of obesity for Egyptian children.

Keywords: obesity; BMI; body mass index; FMI; fat mass index; SN; sensitivity; SP; specificity; children.

INTRODUCTION

Excessive amount of adipose tissue in children, and simple obesity in particular, constitute a growing health problem throughout the world. Adverse health effects of obesity of children justify the need to look for adequate and simple tool for diagnosis (Weker et al., 2006).

Obesity is defined as an excess of body fat mass (FM). However, FM is extremely difficult to measure in young children, because accurate techniques require a high degree of the subject compliance. Therefore, the majority of large-scale studies of increasing FM in children used a body mass index (BMI, kg m^{-2}) as an index of body fatness (Troiano et al., 1995; Reilly and Dorosty, 1999). However, BMI is a measure of excess weight rather than excess body fatness, its ability to predict the percentage body fat (%BF) reliably is doubtful (Freedman et al., 2005a). So, it is important to understand the ability to identify children who truly have excess adiposity. Therefore, validity of BMI as a diagnostic tool of obesity is questioned (Wickramasinghe et al., 2005).

The %BF is influenced by the relative amount of fat free mass (FFM); and like BMI; is not an independent index of body fatness. The importance of this issue is demonstrated by the fact that, even in the general population, variability between subjects in relative FFM size is two-thirds of the variability in fatness (Wells, 2000). Obesity results in additional FFM as well as additional FM (Griffiths et al., 1990), and the expression of body fatness in obese children as %BF will underestimate the absolute amount of FM gained, and conceal the variability in

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FFM. To resolve this issue, both FFM and FM can be normalised for stature.

These two indices, known as the fat-free mass index (FFMI, kg m^{-2}) and fat mass index (FMI, kg m^{-2}), are both discrete and adjusted for body size (Van Itallie et al, 1990). Just as BMI is useful in evaluating the body mass of individuals of different statures, so is the FMI potentially useful in helping clinicians interpret FM data from obese individuals who differ in stature. Furthermore, the BMI has limitations; it tends to have high specificity (SP) as well as variable sensitivity (SN) in children (Himes and Bouchard, 1989; Marshall et al., 1991). The purpose of the current study is to evaluate the SN and SP of BMI and FMI in detecting excess adiposity in groups of Egyptian children aged 3–5 years.

SUBJECTS AND METHODS

The study included 514 children (272 boys and 242 girls), aged 3–5 years. They were gathered from two private kindergartens situated in Greater Cairo area. The nature and purpose of the study were fully explained to each subject's parents before the study, and they provided informed consent before the testing began.

All subjects were recruited after a routine medical examination to exclude organic and genetic disorders that might interfere with normal growth. A simple questionnaire was also directed to their parents, including personal, socioeconomic data (parental education and occupation, crowding index), the presence or absence of consanguinity, the medical history of the child with special emphasis on any chronic condition or long-term systemic treatment. The socioeconomic status of the child was characterised by scoring the parental education and occupation and crowding index to low with score = 3–11, medium = 12–16 and high ≥17. The majority of the study sample was from the medium socioeconomic level. So, the children related to the other socioeconomic classes were excluded from the analysis due to their small numbers, and only the medium levelled children were enrolled in the study. Anthropometrical assessment (body weight, stature, skin fold thickness at triceps and sub-scapular areas) was performed on the same day, using standardised equipments, and following the recommendations of the International Biological Programme (Hiernaux and Tanner, 1969). Three consecutive measurements were taken, and when the differences between the readings were acceptable the mean was recorded. The body weight was measured using Seca scale Balance, approximated to the nearest 0.01 kg with minimal clothes and without shoes for which no correction was made. It was followed by measurement of stature to the minimum of 0.1 cm via Holtain portable anthropometer. BMI [body weight (kg)/stature^2 (m)] was calculated for all subjects. The skin fold thickness was determined to the minimum of 0.2 mm using a Harpenden skin fold caliper. Measurements were taken at the left triceps and sub-scapular. The body composition was measured by the Holtain Body Composition Analyser (bioelectrical impedance analysis (BIA)) to measure his/her %BF and FFM using his/her age, weight and height approximated to the nearest unit. All BIA measurements were performed in 2–3 hr after the last meal. The whole-body resistance (R) was measured with four surface electrodes placed on the right wrist and ankle, as previously described by Lukaski (1986). Briefly, the principle was based on the application of an electrical current of 50 kHz and 0.5 mA produced by a generator (TP-95K, Toyo Physical, Fukuoka, Japan) and applied to the skin using adhesive electrodes (Red Dot-2330, 3M Health Care, USA) with the subject lying supine (Houtkooper, 1996).

The skin was cleaned with alcohol. Before each testing session, the calibration of the unit was checked using a 400-W precision resistor. The FFM equation used here for children is based on total body water (TBW) and stature^2/resistance, as reported by Goran et al. (1993). FM is then calculated as the difference between the body weight and FFM. Both FFM and FM were divided by stature^2 to give FFMI and FMI, respectively, as described previously (Van Itallie et al., 1990).

The used BIA apparatus recorded that the target %BF was 15 for boys and 20 for girls, so cutoffs at specific levels of %BF were used to determine obesity. According to Lohman (1992), obesity was defined as %BF $\geq$25 for boys, and $\geq$30 for girls. However, BMI are also often used in many countries although the cutoff points vary between 85 and 97 percentile (Guillaume, 1999). In this study, different cutoff points of BMI: at or above the 90th, 95th and 97th percentile of age- and sex-specific data, to determine the most sensitive and specific point to define obesity. The percentile cutoffs for FMI were the same as for BMI using the same sample.

STATISTICAL ANALYSIS

The physical characteristics and body composition of all children under study are expressed as mean ± SD, and summarised in Table 1. Data for boys and girls were analysed separately. Gender and group differences in physical characteristics and body composition were examined by unpaired *t*-test.

The validity of using BMI or FMI to diagnose obesity was determined. The interrelations among stature, body weight, triceps, sub-scapular, FFM, FM, BMI, %BF, FMI and FFMI were examined using partial correlation to exclude the effect of age. The relationships between BMI and stature or %BF, and between FMI and stature or %BF, were also assessed using regression analysis.

Because, the %BF is now used widely to measure obesity (as it measure directly the fat content of the body), both BMI and FMI at the studied percentiles were compared with the %BF to define it. Prevalence of obesity was determined according to each indicator. The SN and SP were calculated using the equations of Himes and Bouchard (1989). The statistical package of social science 'SPSS/PC' software version 9.05 program was used for statistical analysis. Differences with p values less than 0.05 were considered significant.

RESULTS

Age, anthropometry and body composition of the children show only significant sex difference as regarding the age and sub-scapular skin fold thickness ($p < 0.01$), where girls are older than boys and have higher values of sub-scapular skin fold thickness (Table 1).

The inter-correlations of body weight, stature, skin folds, FM, FFM, BMI, %BF, FMI and FFMI are investigated using partial correlations to exclude the effect of age. The %BF is weakly correlated with weight and skin fold thickness (r = 0.21 – 0.40 in boys and 0.27 – 0.31 in girls; p = 0.001), and moderately correlated with BMI (r = 0.63 in boys and 0.62 in girls; p = 0.001). It is strongly correlated with FM and FMI (r = 0.95, 0.98 in boys and 0.95, 0.97 in girls; p = 0.001). BMI and FMI show moderate correlation with weight (r = 0.70, 0.49 in boys and 0.64, 0.41 in girls: $p < 0.001$) and strong correlation with each other (0.75 for boys and 0.77 in girls). However, %BF, BMI and FMI have insignificant correlation with stature in boys, and weak negative correlation in girls (Table 2).

Table 1 Age, anthropometry and body composition of the children

	Boys (n = 272)				Girls (n = 242)					
	Mean	±SD	Range		Mean	±SD	Range		t-value	p
Age	4.46	0.78	3.0	5.0	4.62	0.66	3.0	5.0	−2.562	0.011
Weight	19.90	3.91	13.0	33.0	19.81	3.60	11.0	33.5	0.274	0.784
Stature	106.9	8.42	86.5	132.0	106.7	7.92	86.0	125.5	0.281	0.779
Skin fold thickness (mm)										
Triceps	9.3	2.32	4.2	18.0	9.52	2.07	4.40	17.0	−0.864	0.388
Sub-scapular	6.2	1.68	1.8	12.8	6.63	1.78	3.0	12.8	−2.667	0.008
Fat mass (kg)	3.69	2.30	0.23	11.98	3.73	2.26	0.20	12.80	−0.205	0.837
Fat-free mass (kg)	16.21	3.14	10.56	25.08	16.10	2.97	10.04	24.34	0.403	0.687
Body mass index (kg m^{-2})	17.3	1.82	13.42	26.76	17.30	2.05	14.05	24.73	0.020	0.984
%Body fat	18.02	9.07	1.21	45.21	18.31	9.25	1.33	44.96	−0.357	0.721
Fat mass index (kg m^{-2})	3.22	1.89	0.18	10.03	3.28	2.01	0.19	10.80	−0.333	0.739
Fat-free mass index (kg m^{-2})	14.08	1.31	10.7	17.26	14.03	1.38	10.99	19.40	0.442	0.659

Table 2 Intercorrelation of anthropometry and body composition (partial)

		Wt	L	TRI	Sub-scapular	FM	FFM	BMI	%Fat	FMI	FFMI
Wt	*r*	–	0.659	0.326	0.345	0.549	0.706	0.644	0.303	0.407	0.364
	p		0.000	0	0	0	0	0	0	0	0
L	*r*	0.781	–	0.011	0.026	−0.008	0.779	−0.137	−0.208	−0.21	0.1
	p	0		0.863	0.688	0.9	0	0.036	0.001	0.001	0.125
TRI	*r*	0.365	0.1	–	0.654	0.367	0.072	0.369	0.307	0.325	0.076
	p	0	0.104		0	0	0.274	0	0	0	0.234
Sub-scapular	*r*	0.331	−0.005	0.644	–	0.327	0.128	0.409	0.266	0.312	0.153
	p	0	0.937	0		0	0.051	0	0	0	0.019
FM	*r*	0.636	0.236	0.295	0.425	–	−0.204	0.731	0.948	0.969	−0.319
	p	0	0	0	0		0.002	0	0	0	0
FFM	*r*	0.748	0.809	0.22	0.064	−0.036	–	0.136	−0.448	−0.344	0.697
	p	0	0	0	0.3	0.561		0.138	0	0	0
BMI	*r*	0.696	0.014	0.45	0.517	0.743	0.263	–	0.624	0.765	0.372
	p	0	0.084	0	0	0	0		0	0	0
%Fat	*r*	0.4	0.013	0.211	0.374	0.947	−0.296	0.629	–	0.972	−0.482
	p	0	0.832	0.001	0	0	0	0		0	0

(*continued*)

Table 2 Intercorrelation of anthropometry and body composition (partial) (continued)

FMI	*r*	0.489	0.035	0.275	0.437	0.971	−0.202	0.75	0.98	–	−0.313
	p	0	0.569	0	0	0	0.001	0	0		0
FFMI	*r*	0.265	0.097	0.229	0.092	−0.363	0.655	0.312	−0.533	−0.394	–
	p	0	0.114	0	0.135	0	0	0.000	0	0	

Note: Upper, girls (*n* = 242); lower, boys (*n* = 272).
**Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Plots of stature and %BF against BMI and FMI are given in Figure 1. There were insignificant correlations between BMI and stature or between FMI and stature (R^2 = 0.00 for boys and 0.01, 0.02 for girls, respectively). On the other hand, the correlations were significantly moderate between BMI and %BF (R^2 = 0.40 for boys and girls), and strong between FMI and %BF (R^2 = 0.96 for boys and 0.95 for girls). FMI and BMI were significantly correlated with %BF in boys and girls with nearly similar regression slopes. The same results were obtained previously by the partial correlations.

The entire study sample was classified into two groups; normal and obese; according to %BF (Lohman, 1992) and different cutoffs of BMI and FMI: 90th, 95th and 97th percentiles. Table 3 demonstrates the validity of using multiple cutoff points of BMI or FMI as indicators of obesity compared to %BF. When the percentiles of BMI and FMI were used to define obesity, the prevalence with using different percentiles of them was lower compared with using the %BF criterion. The prevalence of obesity was higher by using FMI than by BMI at the different cutoffs for both sexes. The highest prevalence of obesity by using different cutoffs BMI and FMI was found at 90th percentile for both sexes. Although the SP of both indices (proportion diagnosed lean by them if lean by %BF) was high in the populations, the definitions of obesity based on BMI and FMI were found to be somewhat of moderate sensitive to obesity as determined by BIA. The sensitivities of the FMI (proportion diagnosed obese by FMI if obese by %BF) were 46.7% at 90th, 23.3% at 95th and 16.7% at 97th percentiles in boys and 70.0% at 90th, 33.3% at 95th and 26.7% at 97th percentiles in girls for %BF. BMI indicated obesity in less than half of the boys (36.7% at 90th, 16.7% at 95th and 13.3% at 97th percentiles) and girls (33.3% at 90th, 20.0% at 95th and 20.0% at 97th percentiles) who were defined as obese by the %BF criterion. Although, the false positive rates of BMI criterion as an obesity definition (proportion misdiagnosed as obese by BMI if lean by %BF, it forms 100% with SP) were 2.8% at 90th, 0.9% at 95th and 0.09% at 97th percentiles in boys and 6.7% at 90th, 2.9% at 95th and 1.9% at 97th percentiles in girls, the false negative rates for this definition (proportion misdiagnosed as lean by BMI if obese by %BF, it forms 100% with SN) were 63.3% at 90th, 83.3% at 95th and 86.7% at 97th percentiles in boys and 66.6% at 90th, 80.0% at both 95th and 97th percentiles in girls, respectively. In contrast, the false negative rates of the FMI criterion were lower than those of the BMI, ranging from 53.3% at 90th, 76.6% at 95th and 83.3% at 97th percentiles in boys to 30.1% at 90th, 66.7% at 95th percentiles and 73.3% at 97th percentile in girls for the obesity with %BF as the criterion. The false positive rates of the FMI criterion were also lower than those of the BMI, ranging from 0.0 for boys to 0.1 for girls at the different

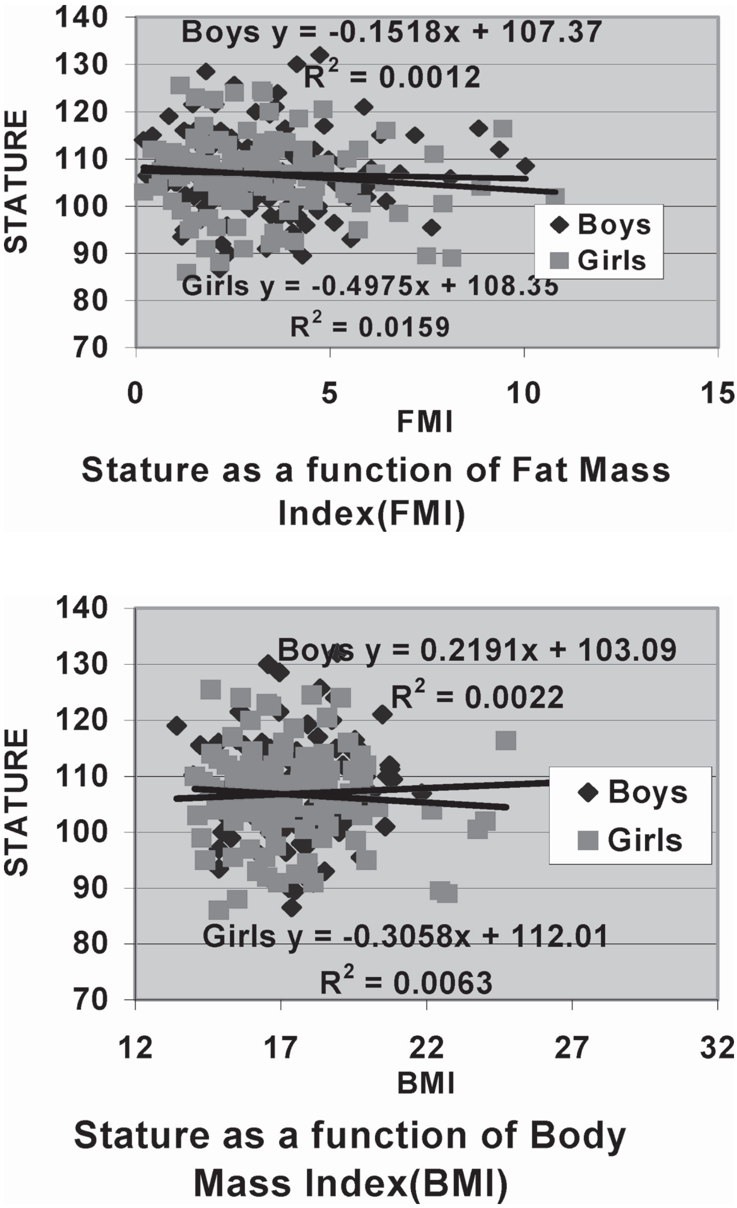

Figure 1 Stature and %BF as functions of BMI and FMI (see online version for colours)

Figure 1 Stature and %BF as functions of BMI and FMI (see online version for colours) (continued)

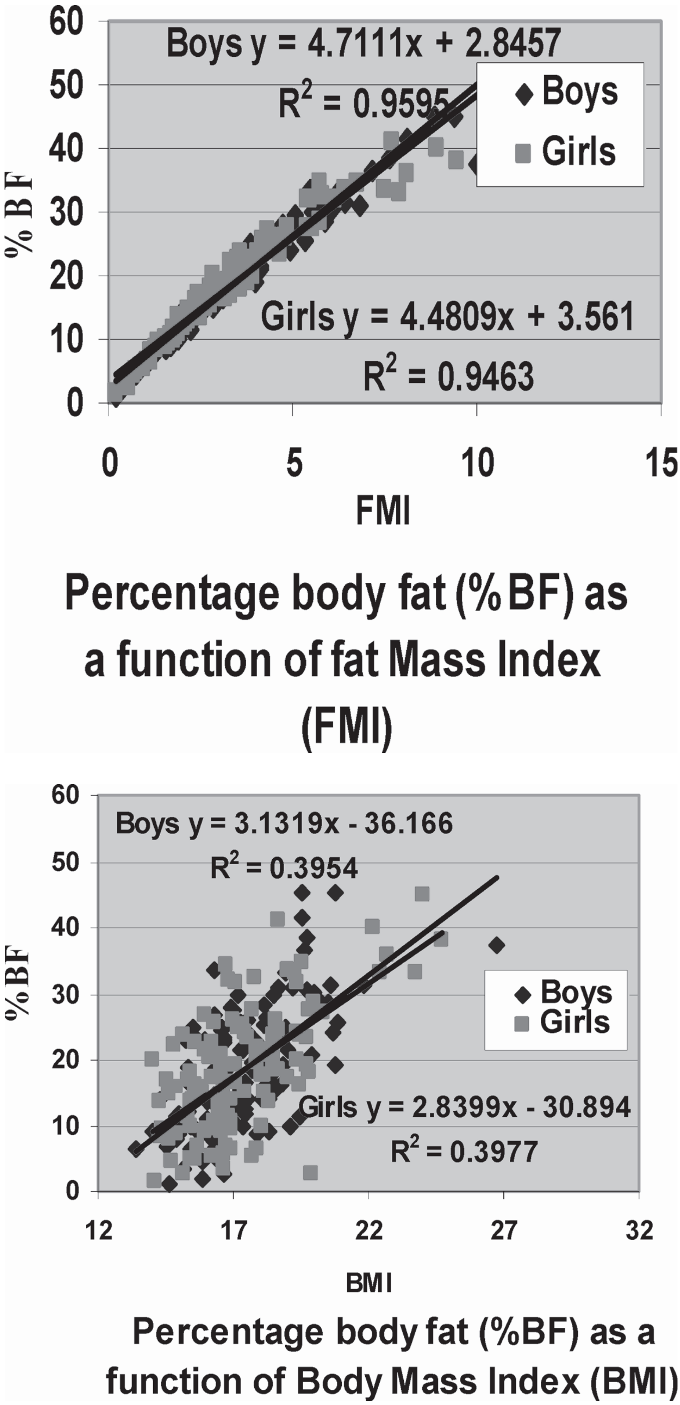

Table 3 Validity of BMI and FMI as indicators of obesity, at different cutoff points, compared to percentage body fat

		Prevalence (%)	Sensitivity (%)	Specificity (%)	False negative	False positive
Boys						
BMI						
	At 90%	8.1	36.7	97.2	63.3	2.8
	At 95%	3.7	16.7	99.1	83.3	0.9
	At 97%	2.9	13.3	99.1	86.7	0.9
FMI						
	At 90%	10.3	46.7	100	53.3	0.0
	At 95%	5.1	23.3	100	76.6	0.0
	At 97%	3.7	16.7	100	83.3	0.0
Girls						
BMI						
	At 90%	4.8	33.3	93.3	66.7	6.7
	At 95%	2.9	20.0	97.1	80.0	2.9
	At 97%	2.9	20.0	98.1	80.0	1.9
FMI						
	At 90%	10.1	70.0	99.0	30.1	1.0
	At 95%	4.8	33.3	99.0	66.7	1.0
	At 97%	3.8	26.7	99.0	73.3	1.0

Note: Prevalence of obesity based on %BF, boys = 22.1; girls = 12.4.
SN, proportion diagnosed obese by the BMI if obese by the %FM.
SP, proportion diagnosed lean by the BMI if lean by the %FM.
False negative, 100% – SN; False positive, 100% – SP.

cutoff points. It was obvious that the highest prevalence of obesity according to BMI and FMI, the highest SN and the least false negative rates were found at the 90th percentile cutoff point. FMI have higher prevalence of obesity, SN and SP, and less false negative and positive rates than BMI in both sexes.

The descriptive statistics on the obese boys and girls according to %BF, BMI and FMI at 90th percentile are presented in Table 4. The unpaired *t*-test was used to evaluate the group differences for %BF vs. BMI and FMI. When the 90th percentile of BMI was used to define obesity, BMI, FMI and %BF for both boys and girls were significantly higher compared with using the %BF criterion ($p < 0.01$). When the 90th percentile of FMI was used to define obesity, FMI and BMI in boys were significantly higher compared with using the %BF criterion, but the differences were statistically insignificant in girls.

DISCUSSION

Selected anthropometric measurements including stature, body mass and skin folds are globally accepted sensitive indicators of growth patterns and health status of a child (Chatterjee et al., 2006). The body mass (wt) comprises both the fat-free mass (FFM) and FM, and both of these components can vary among individuals. BMI represents an index of body mass that has been normalised for stature. Once the body mass has been normalised in this way, it can be divided into FFM/stature^2 and FM/stature^2. These two indices have been termed FFMI and FMI, respectively (Van Itallie et al., 1990).

Recently, published standards for BMI based on population studies of height and weight in healthy Egyptian children (Ghalli et al., in press) allows an easy but indirect assessment of adiposity in healthy children. Due to the fact that obesity is defined as excess of FM, so the purpose of this study was to test the hypothesis that whether the BMI and FMI can be used as a valid measure for the detection of the obesity in preschool children. Then, to evaluate the SN and SP of BMI and FMI as indicators of obesity in a sample of Egyptian children aged 3–5 years.

In the current study, there were significant moderate to strong correlations between BMI, FMI and %BF with nearly similar regression slopes for both sexes. However, there were insignificant correlations between BMI, FMI and stature in boys and weak negative correlations in girls. Therefore, BMI and FMI in this study are useful indices to assess obesity and are reasonable indicators of fatness. This coincides with the study of Eto et al. (2004). Rolland-Cachera et al. (1982) have also demonstrated that the coefficient of the correlation between BMI and stature are weak and sometimes negative from 1 to 6 years.

Higher prevalence of obesity by using FMI than by BMI at the different cutoffs for both sexes was also revealed. The highest prevalence of obesity by using different cutoffs BMI and FMI, the highest SN and the least false negative rates were found at 90th percentile for both sexes. This was proved previously by Reilly et al. (2000) in UK. They studied the ability of BMI to successfully screen for children with high body fatness using the ROC analysis. The ROC analysis showed that lower cutoffs applied to the BMI improved SN with no marked loss of SP: the optimum combination of SN (92%) and SP (92%) was at a BMI cutoff equivalent to the 92nd percentile. They concluded that screening for childhood obesity using the BMI is specific, and can have moderately high SN if an appropriate cutoff is chosen.

Table 4 Means and standard deviation of stature, body weight, %fat, BMI, and FMI in obese children by each obesity indicator at cutoff points 90%

	Boys								Girls							
	%Fat (n=60)		BMI (n=22)			FMI (n=28)			%Fat (n=30)		BMI (n=10)			FMI (n=21)		
	Mean	**±SD**	**Mean**	**±SD**	**P^1**	**Mean**	**±SD**	**p^1**	**Mean**	**±SD**	**Mean**	**±SD**	**p^1**	**Mean**	**±SD**	**p^1**
Age	4.40	0.76	4.45	0.80	NS	4.50	0.75	NS	4.73	0.45	4.60	0.52	NS	4.89	0.32	NS
Weight	22.27	4.67	24.500	3.823	0.48	24.214	3.639	NS	21.91	4.21	23.900	5.815	NS	22.876	4.435	NS
Stature	107.60	9.25	107.954	6.595	NS	108.642	6.612	NS	103.83	7.95	101.280	9.288	NS	105.276	8.019	NS
%Body fat	30.99	5.65	34.141	5.916	0.03	35.010	5.629	0.003	35.39	3.87	37.364	4.356	NS	36.504	4.134	NS
Body mass index (kg m^{-2})	19.06	2.05	20.933	1.992	0	20.445	1.944	0.003	20.29	2.72	22.964	1.906	0.007	20.559	2.474	NS
Fat mass index (kg m^{-2})	5.96	1.52	7.154	1.467	0.002	7.166	1.385	0.001	7.23	1.56	8.612	1.461	0.019	7.564	1.615	NS

In general, anthropometrical indicators of obesity are characterised by low sensitivities and high specificities (Himes and Bouchard, 1989). In this study, the specificities of BMI relative to %BF were high, but the sensitivities were low, ranging from 36.7% to 46.7% for obese boys and girls, respectively, at the 90th percentile, with %BF as the criterion. While, the sensitivities of the FMI relating to %BF were somewhat high, ranging from 46.7% in boys to 70.0% in girls. Accordingly, the majority of truly obese children are not correctly identified using the BMI or FMI, but almost all children who are not obese are correctly identified. The BMI and FMI were less sensitive predictors of obesity compared with %BF, but FMI was better predictor for obesity than BMI for this age group (3–5 years).

These results came in agree with other studies as in Japan (Eto et al., 2004) which revealed that FMI approach for defining childhood obesity is associated with a level of SN higher than that of the BMI approach in children aged 3–5 years. In UK, Warner et al. (1997) found that BMI under-predicts the prevalence of excess adiposity using dual energy X-ray absorptiometry (DXA) in children with disease states but surprisingly to no greater degree than that seen in healthy subjects. In USA (Freedman et al., 2005b), DXA was used to measure fat and FFM among 1,196 subjects. They concluded that BMI levels among children should be interpreted with caution. Although a high BMI-for-age is a good indicator of excess fat mass, BMI differences among thinner children can be largely due to FFM. Sweeting (2007) concluded that, while it is a relatively simple measure and a valuable tool, BMI has several disadvantages, which are described. These include a lack of consensus on which values should be used to define 'overweight' or 'obese', with the result that the literature contains a confusing multiplicity of child and adolescent obesity rates. On the other hand, Sarria et al. (2001) in Spain concluded that BMI predicted total fat content well in male children and adolescents. In Austria, Widhalm et al. (2001) concluded that BMI might be a useful parameter for epidemiological studies: however, in the individual paediatric patient, especially from 10 years onwards, it gives only a limited insight to the degree of obesity based on the definition. Also, Pecoraro et al. (2003) in Italy concluded that FM measurement using total skin fold thickness (TST) and BIA is comparable in different BMI ranges.

Unfortunately, on recording the values of the different percentiles of BMI, FMI and %BF, it was noticed that the sex difference in %BF was not so large. In the current study, the 90th percentile for %BF corresponded to 30.32 for boys and 32.5 for girls, at 95th it was 33.47 for boys and 34.56 for girls and at 97th it was 38.36 for boys and 38.20 for girls. These are in contrast with what is mentioned in the literature (Owen, 1988; Lohman, 1992), that the cutoff point of obesity in boys is lower than girls by 5%. This may explain why the prevalence of obesity in boys was double the prevalence in girls as determined by the %BF. Therefore, the prevalence of obesity based on BMI or FMI was lower than that based on %BF. It also explains the low SN of BMI and FMI in determining the obese children. So, on comparing the physical characteristics of the obese boys and girls according to %BF, BMI and FMI at 90th percentile, significant differences were recorded. Children diagnosed obese by the %BF had lower values than those diagnosed by either BMI or FMI, except the obese girls diagnosed by the FMI where the differences were insignificant. So, the FMI for girls recorded the highest SN (70%) in this study. These indicate that the used cutoff values for obesity based on %BF in this study (>25%BF in boys; >30%BF in girls) were low or, conversely, the cutoff values for obesity based on the BMI (i.e. >90th percentile in boys and girls) were too high such that the criteria did not appropriately reflect a safe amount of total body fatness for the Egyptian preschool children. These %BF were higher than those used by Owen (i.e. >20%BF in boys; >30%BF in girls) (Owen, 1988).

Surprisingly, FMI has not yet found a wide application, probably because appropriate reference standards have yet to be defined. One advantage of FMI, as compared to the BMI concept, is that it amplifies the relative effect of growth on FM. The expression of a change in FM in absolute value fails to allow an appropriate comparison among subjects of different body size. Considering that BMI is the sum of FFMI and FMI, an increase in BMI could be accounted for by a rise in one component or the other or in both components. Note that, for a given BMI, if FMI increases then FFMI should decrease, since, at a constant BMI, there is an inverse mathematical relationship between the two. Therefore, the advantage of the combined use of these indices is that one can judge whether the excess of body mass is selectively due to a change in FM vs. FFM or both combined. However, up to now, FMI cutoff points for obesity have not been clearly defined, at least not in a large group of Egyptian children.

In summary, while the SN of FMI in the current study was somewhat high, the definition of childhood obesity based on BMI had a lower SN at the different cutoff points. The highest level of SN of either BMI or FMI was detected at the 90th percentile of age- and sex-specific data in this study. However, in screening for obese children, the SP may be more important than the SN. Maximising SP minimises the proportion of children who will be incorrectly considered obese by the screen. In the current study, the 90th percentile cutoff points for BMI and FMI had very high SPs and SNs. However, the partitioning of BMI into FFMI and FMI is obviously not possible without the associated measurements of body composition. So, BMI alone should be used with caution as an indicator of childhood obesity.

Future investigations including body composition measurements will help to elucidate the relationship between the magnitude of FMI and potential risk factors. The current study assessed the validity of BMI and FMI as indicators of obesity in children, but it definitely warrants complementary investigations in a large group of Egyptian children. This paper is a preliminary attempt to promote future research in the area of childhood obesity. Furthermore, the concept of FMI could also be developed for obese children although less information on body composition is available for young children. Further investigations also are required to define the best cutoff point of obesity for Egyptian children.

BIOGRAPHY

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