Relationship between body mass index and adiposity in prepubertal children: ethnic and geographic comparisons between New York City and Jinan City (China)

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1Obesity Research Center, St. Luke’s-Roosevelt Hospital; 2Nutrition and Food Science in Urban Public Health Program, Hunter College of the City University of New York; and 3Institute of Human Nutrition, Columbia University, New York, New York; 4Jinan Maternity and Childcare Hospital, Jinan, People’s Republic of China; and 5Mednet Research Center, Beijing, People’s Republic of China

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Navder KP, He Q, Zhang X, He S, Gong L, Sun Y, Deckelbaum RJ, Thornton J, Gallagher D. Relationship between body mass index and adiposity in prepubertal children: ethnic and geographic comparisons between New York City and Jinan City (China). J Appl Physiol 107: 488–493, 2009. First published June 18, 2009; doi:10.1152/japplphysiol.00086.2009.—Body mass index (BMI) is often used as a surrogate estimate of percent body fat in epidemiological studies. This study tested the hypothesis that BMI is representative of body fatness independent of age, sex, ethnicity, and geographic location in prepubertal children. The study sample included a total of 605 prepubertal children (275 girls and 330 boys) of which 247 were Chinese from Jinan, Shandong, Mainland China, and 358 children were from various ethnic backgrounds in New York City (NYC): 121 Caucasians, 94 African Americans, and 143 Asians (Chinese and Korean). In this cross-sectional study, dual energy X-ray absorptiometry was used to quantify total body fat (TBF) and percent body fat (PBF). Prepubertal status was assessed by the criteria of Tanner. Multiple regression models were developed with TBF and PBF as the dependent variables and BMI, age, sex, and ethnicity as independent variables. Multiple regression analysis showed that BMI alone explained 85% and 69% of between-subject variance for TBF and PBF, respectively. Sex was a significant contributor to the models (P < 0.001) with girls having higher TBF and PBF than boys. Ethnicity and geographic location were significant contributors to the model (P < 0.0001) with Asians (Jinan and NYC Asians) having higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001) with Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. Among prepubertal children, for the same BMI, Asians have significantly higher PBF than all non-Asian groups (P < 0.0001), and Jinan Asians having higher TBF and PBF than NYC-Asians. 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Over the past 30 years, BMI, which is body weight (kg) divided by height squared (m²), has been used to diagnose obesity in adults and children in a myriad of epidemiological studies because of its simplicity and low cost (26). This measurement was first described by Adolphus Quetelet in the mid-19th century based on the observation that body weight or mass was proportional to height or stature squared in adults with normal body frames (26). This simple, inexpensive index has been widely recommended for individual use in clinical practice to guide recommendations for weight loss and weight control. A major assumption in adults, however, is that BMI represents adiposity independent of age, sex, and ethnicity.

It has been suggested that racial and ethnic differences affect the relationship between BMI and body fatness. An increasing number of studies have proposed the need to redefine the BMI overweight and obesity cutoff points for Asian populations (4, 9, 29, 42). The rationale is based on findings that Asian populations have different associations between BMI, percent body fat (PBF), and health risks than do European populations (9, 11, 17, 23, 28, 37, 40).

Based on the different relationships between BMI and body fat percent in adults from different ethnic groups, it is questionable whether the uniform cut-off points recommended for BMI by the International Obesity Taskforce in children are appropriate (4). Limited data exist on the relationship between BMI and body fat in prepubertal children from different ethnic backgrounds. This time period, just before puberty (adiposity rebound), is hypothesized to be one of the three critical periods of obesity development in children and is probably the least understood (12). To our knowledge no previous study has looked at the relationship between body fat and BMI across this wide prepubertal age range (3–12 yr).

The primary aim of this study was to establish whether BMI is an appropriate surrogate measure of body fat in prepubertal children. A secondary aim was to determine whether sex and ethnicity differences exist in the body fat-BMI relationship in this prepubertal period. A third aim was to compare the body fat-BMI relationship between Asian children from urban settings on two separate continents—Asian (Chinese) children raised in Jinan City, Mainland China, and Asian (Chinese and Korean) children raised in New York City (NYC). With respect to the latter, this study aimed to compare populations of similar genetic background from distinctly different environ-
ments. Overall, this study was undertaken to test the hypothesis that BMI is representative of body fatness independent of age, sex, ethnicity, and environment in prepubertal children.

**METHODS**

**Protocol**

All body composition evaluations were carried out on the same day at least 1 h after a light meal, with the subject clothed in a hospital gown and wearing foam slippers. The studies were approved by the Institutional Review Board of St. Luke’s-Roosevelt Hospital (SLRHC) and by the Institutional Review Board of Jinan Maternity and Childcare Hospital (JMCH).

**Subjects**

Included in the study were a total of 605 prepubertal children (275 girls and 330 boys) of whom 247 were Asians from Jinan, Shandong, Mainland China (Jinan Asians), and 358 children were from various ethnic backgrounds in New York City (NYC)–121 Caucasians, 94 African Americans, and 143 Asians. The Asian volunteers from Jinan were Chinese and those from NYC were of Chinese and Korean background. The children ranged in age from 3 to 12 yr. The Jinan Asians were recruited (2003–2004) through local schools or were children of hospital employees. The NYC children were recruited (1995–2000) through local newspaper notices, announcements at schools and after-school centers, and word of mouth. Consistent with ethnic backgrounds in New York City–121 Caucasians, 94 African Americans, and 143 Asians. The Asian volunteers from Jinan were Chinese and those from NYC were of Chinese and Korean background of both parents and all four grandparents by questionnaire established ethnicity in the NYC group.

After physical examination, only prepubertal children were included in the study. Prepubertal status (breast stage 1 and pubic hair stage 1 for female subjects; and genital stage 1 and pubic hair stage 1 for male subjects) was established according to the criteria of Tanner (38) by a pediatric endocrinologist or nurse. There were no body weight or height limitations to enrollment, and inclusion criteria required that participants be healthy and free from any diagnosed medical condition that could potentially affect the variables under investigation. Consent was obtained from each volunteer’s parent or guardian, and assent was obtained from each volunteer as well.

**Anthropometrics**

A physical examination was performed including body weight, height, and pubertal staging. All measurements were standardized between SLRHC and JMCH; a pediatrician from JMCH received training in the Body Composition Unit of SLRHC in the methods used for data collection before initiation of the study. Body weight was measured to the nearest 0.1 kg (SLRHC: Weight Tronix, New York, NY; JMCH: Wuxi Weigher Factory, Wuxi City, China) and height to the nearest 0.5 cm using a stadiometer (SLRHC: Holtain, Crosswell, UK; JMCH: Shanghai Drawing Stationery Factory, Shanghai, China).

**Dual-Energy X-Ray Absorptiometry**

Total body fat (TBF) was measured with a whole body dual-energy X-ray absorptiometry (DXA) scanner (SLRHC: DPX, Lunar, Madison, WI, using pediatric software version 3.8G; JMCH: Prodigy, GE Lunar, Madison, WI, using pediatric software version 4.0).

**DXA Quality Control**

A standard soft-tissue calibration method for DXA developed in NYC and used daily since 1987 was employed in both the JMCH and SLRHC laboratories and has been previously described (25). During the study setup phase, ethanol and water bottles (8-liter volume, Fischer Scientific, Pittsburgh, PA), simulating fat and fat-free soft tissues, respectively, were scanned as soft-tissue quality control markers three times per day for 7 consecutive days in JMCH. These data were sent to the Body Composition Unit in NYC for quality control verification. The purpose of this calibration procedure was twofold: 1) to monitor the stability of a DXA machine over time, and 2) to allow for the pooling of DXA soft-tissue data (i.e., PBF) collected on different machines. The latter is essential when data collected at different locations on similar machines from the same manufacturer are compared, because machines do not read the same exact soft-tissue values. During the course of the data collection phase, the soft-tissue quality control was performed weekly (when no subject was studied) and each day that a subject was studied. Reproducibility of DXA in children has been reported (15); however, because of concerns surrounding unnecessary radiation exposure in healthy children, scan reproducibility in children was not performed in this study. All DXA data were sent to NYC and analyzed by a single technician in the Body Composition Unit.

**PBF Conversion Equation**

To answer the question of whether, for a similar BMI, Asian children from JMCH have a greater PBF compared with NYC Caucasians, African Americans, and Asians, the PBF readings (derived from the ratio of the attenuation at 2 energy peaks) from the methanol and water bottles were used to generate a regression equation where PBF for the JMCH sample was converted to NYC values. The conversion equation was: PBF Jinan Asian = 0.964218 × JMCH + 3.536583.

**Statistical Analysis**

ANOVA was used to test the effects of sex, race, and sex-by-race interaction on the demographic variables age, body mass, stature, BMI, TBF, and PBF. To test the main hypothesis, multiple linear regression analysis was used to investigate the possible influence of age, sex, and ethnicity on the relation between TBF and BMI and PBF. Interaction on the demographic variables age, body mass, stature, BMI, TBF, and PBF was used as the dependent variables, and BMI, sex, age, ethnicity, and their interaction terms were used as independent variables. Gender and ethnic groups were

<table>
<thead>
<tr>
<th>Table 1. Descriptive characteristics of subjects</th>
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</thead>
<tbody>
<tr>
<td><strong>Jinan Asian</strong></td>
</tr>
<tr>
<td>Boys (n = 148)</td>
</tr>
<tr>
<td>Age, yr</td>
</tr>
<tr>
<td>Weight, kg</td>
</tr>
<tr>
<td>Height, cm</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
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<tr>
<td>TBF, kg</td>
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</tbody>
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All values are given as means ± SD (unadjusted); n = 330 boys and 275 girls. NYC, New York City; BMI, body mass index; DXA, dual-energy X-ray absorptiometry; TBF, total body fat; PBF, percent body fat.
Table 2. Pearson correlation matrix between main variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>PBF</th>
<th>THF</th>
<th>Height</th>
<th>Weight</th>
<th>BMI</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBF</td>
<td>1.0000</td>
<td>0.9011</td>
<td>0.3367</td>
<td>0.7094</td>
<td>0.8303</td>
<td>0.1790</td>
</tr>
<tr>
<td>THF</td>
<td>0.9011</td>
<td>1.0000</td>
<td>0.5643</td>
<td>0.9140</td>
<td>0.9287</td>
<td>0.4129</td>
</tr>
<tr>
<td>Height</td>
<td>0.3367</td>
<td>0.5643</td>
<td>1.0000</td>
<td>0.8070</td>
<td>0.4353</td>
<td>0.8746</td>
</tr>
<tr>
<td>Weight</td>
<td>0.7094</td>
<td>0.9140</td>
<td>0.8070</td>
<td>1.0000</td>
<td>0.8701</td>
<td>0.6528</td>
</tr>
<tr>
<td>BMI</td>
<td>0.8303</td>
<td>0.9287</td>
<td>0.4353</td>
<td>0.8701</td>
<td>1.0000</td>
<td>0.2966</td>
</tr>
<tr>
<td>Age</td>
<td>0.1790</td>
<td>0.4129</td>
<td>0.8746</td>
<td>0.6528</td>
<td>0.2966</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

All correlations are significantly different from zero (P < 0.0001).

coded as dummy variables (sex: 1 = male, 0 = female; ethnicity: c = 1 if Caucasian, 0 otherwise; b = 1 if African American, 0 otherwise; a = 1 if Asian, 0 otherwise, making the Jinan group the reference group). Two-sided P values were considered significant at P < 0.05. Pooled subject data are expressed as the mean with SD. Data were analyzed using the SAS statistical program version 9.1 (35).

RESULTS

Group Characteristics

Characteristics for the 605 prepubertal subjects are presented in Table 1. The Jinan Asian children were younger (P < 0.001), shorter (P < 0.001), and had higher TBF and PBF (P < 0.001). Across groups, girls in general weighed less (P < 0.001), were shorter (P < 0.001), and had a lower BMI (P < 0.001) compared with boys. A correlation matrix describing the relationships between the main variables is presented in Table 2.

Fatness-BMI Regression Models

TBF vs. BMI. Multiple regression analysis was performed for all subjects with TBF as the dependent variable and BMI, age, sex, ethnicity, and their interactions as independent variables (Table 3). TBF was first regressed onto BMI alone. Results indicated that BMI was significantly associated with TBF (R² = 0.85; P < 0.0001). Age was next added to the model as a covariate, and the variance increased to 87% (P < 0.0001). To test whether the association between BMI and TBF was consistent across the age range, the BMI × age interaction was included. The interaction was significant (P < 0.0001) but increased the explained variance by only 1%, suggesting that the association between BMI and TBF is generally consistent across the age range in these prepubertal children. When sex was added as a covariate, the variance increased modestly to 89% (P < 0.0001), with girls having significantly higher TBF (adjusted) than boys. With the addition of ethnicity to the model, the explained variance increased to 94% (P < 0.0001). Jinan Asians had significantly higher TBF (adjusted) than all NYC groups (P < 0.0001). When groups within NYC were compared, African Americans had lower TBF (adjusted) than Caucasians (P < 0.01) and Asians (P < 0.0002), while no difference was seen between Caucasians and Asians.

PB vs. BMI. The overall regression models with PBF as a dependent variable are shown in Table 4. PBF was first regressed onto BMI alone. Results indicate that BMI was significantly associated with PBF (R² = 0.69; P < 0.0001). Age was next added to the multiple regression model as a covariate, and even though it was significant, it did not add to the model (R² = 0.69). To test whether the association was consistent across the entire age range, the BMI × age interaction was tested, which was not statistically significant (not shown in Table 4). The addition of sex significantly added to the model (R² = 0.72), with girls having higher PBF than boys (P < 0.0001). Finally when ethnicity was added to the model, it resulted in a marked significant increase in the explained variance (R² = 0.86). Significant differences were seen between PBF in all four ethnic groups: African American had the lowest PBF (adjusted), followed by NYC Caucasians, NYC Asians, and Jinan Asians (P < 0.001). The PBF (adjusted for age and sex) in Asians was significantly higher than the NYC Caucasians and African Americans (Fig. 1). The positive age coefficient in the final model indicates that after controlling for BMI, sex, and ethnicity, TBF increases with age.

Other analytical approaches. When TBF was used as the dependent variable with body weight and height (as opposed to BMI) used as separate independent variables in the model, results were similar to those obtained when BMI was used as the independent variable. The influence of sex and ethnicity was highly significant (P < 0.001). The variance explained in TBF was higher when body weight and height were used as separate independent variables (R² = 0.91) compared with the model in which BMI was an independent variable (R² = 0.85). The explained variance for PBF as the dependent variable was, however, lower when body weight and height were used as separate independent variables (R² = 0.66) compared with the model in which BMI was an independent variable (R² = 0.69).

Table 3. Multiple regression analysis of TBF vs. BMI, age, sex, and ethnicity for the total study population

| Coefficient ± SE |  
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| BMI               | Age              | BMI × age         | Sex‡             | NYC Caucasian§   | NYC African American§ | NYC Asian§        | Intercept         | SEE               | R²               |
| 1.599±0.027†      | 0.440±0.052†     | 0.571±0.101†      | 0.559±0.100†     | 0.675±0.076†     | -20.612±0.496†      | 2.470±0.85        | 1.531±0.027†      | -22.664±0.528†    | 2.336±0.87        |
| 5.261±0.122†      | -1.729±0.226†    | -1.780±0.224†     | 0.125±0.012†     | 0.030±0.009†     | -5.809±1.787*       | 2.17±0.88         | 0.571±0.101†      | -5.261±1.767*     | 2.140±0.89        |
| 2.693±0.103†      | -1.110±0.172†    | -1.071±0.136†     | -2.967±0.190†    | -3.568±0.203†    | -2.693±0.180†       | -7.439±1.342†     | 0.675±0.076†      | -5.918±1.342†     | 1.620±0.94        |

R² is the explained variance of the model; SE is standard error; SEE is standard error of estimate. †P < 0.001, †P < 0.0001. §1 = male, 0 = female. §Reference group: Jinan Asian.
performed better than weight and height for predicting PBF. BMI as an independent variable was significantly associated with predicting TBF, whereas BMI as an independent variable explained 85% and 69% of the between-individual differences in fatness. Specifically, in the pooled sample BMI alone explained 85% and 69% of the between-individual differences in TBF and PBF, respectively. The finding that BMI is closely related to TBF and PBF derived from DXA is compatible with several previous investigations in children over a wide age range and in adults (7, 13, 14, 16, 22, 24, 30, 32, 36). Results were similar although quantitatively different when PBF was compared with the model with Asians (Jinan and NYC Asians) having higher PBF than all non-Asian groups, and Jinan Asians having higher TBF and PBF than NYC Asians. The latter are important and novel findings of this study.

BMI as a Measure of Body Fatness

The results of this study carried out in four different groups over a wide prepubertal age range with an established body composition reference method indicate that BMI accounts for a large proportion of the between-individual differences in fatness. Specifically, in the pooled sample BMI alone explained 85% and 69% of the between-individual differences in TBF and PBF, respectively. The finding that BMI is closely related to TBF and PBF derived from DXA is compatible with several previous investigations in children over a wide age range and in adults (7, 13, 14, 16, 22, 24, 30, 32, 36). Results were similar although quantitatively different when PBF was examined as the dependent variable rather than TBF. The stronger association observed between BMI and TBF than between BMI and PBF is consistent with several previous investigations (7, 21, 32). For the present data, weight and height as independent variables performed better than BMI for predicting TBF, whereas BMI as an independent variable performed better than weight and height for predicting PBF.

BMI-Ethnicity Relations

The International Obesity Taskforce (IOTF) recommends BMI as an index of fatness in children and has developed international cutoff points for BMI for obesity by sex between 2 and 18 yr, defined to pass through BMI of 30 at age 18, and were obtained by averaging data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States (4). These cutoff points were used to calculate the cutoffs for normal, overweight, and obese children in the present study. Even though the mean BMI among the ethnic groups was not significantly different within each subgroup, the PBF (adjusted for age and sex) in Asians was significantly higher than the NYC Caucasians and African Americans (Fig. 1). This extends earlier findings in which a different relationship between BMI and PBF has been reported in Indonesians (23), Koreans (3), and in Singaporean Chinese (10, 11). Differences have also been observed across Black populations living on different continents (18) and between Caucasians and African Americans (6) and between Caucasians and Polynesians (37). The present study confirms that the relationship between BMI and PBF in Asians is different from that in Caucasians and African Americans. The elevated TBF and PBF at low levels of BMI suggest that the BMI cutoff values recommended by IOTF are too high for Asian prepubertal children and may need to be lowered. With the lowered values, the overweight and obesity rates will be much higher in Asian children, and this could have important implications on public health policy.

BMI-Environmental Relations

This study also offered a unique opportunity to compare populations of similar genetic background from distinctly different environments or geographic locations. A comparison of Asian children from urban settings on two separate continents showed the Jinan Asians have significantly higher PBF compared with the NYC Asians ($P < 0.001$). Urbanization has been suggested as an important obesity risk factor in developing nations undergoing fast economic transition (33). It has been reported that many urban Chinese residents have high family incomes, easier access to energy-dense fast food, and are also adopting more sedentary lifestyles (41). With one-child per family in China, there is also an increased chance of overnutrition (2). All of these could contribute to the greater PBF in Jinan Asians compared with NYC Asians.

BMI-Age Relations

An important consideration in this study was whether age contributed to fatness predictions in prepubertal children after controlling for BMI. After adjusting for BMI, increasing age was associated with a significantly greater TBF but lower PBF.
Although these fat-related observations may seem contradictory, they are nonetheless consistent with each other. If a young and an older subject has an equivalent BMI and PBF, the older and thus heavier and taller subject would have a greater TBF. Children in this study, after controlling for BMI, had greater TBF with greater age. Evidently, the relative increase in fat-free body mass with increasing age was greater than that for TBF, and therefore the proportion of body mass as fat (i.e., PBF) decreased. These observations highlight the differing nature of TBF and PBF as measures of fatness. Similar findings were reported in healthy Italian children between 5 and 19 yr of age (32).

BMI-Sex Relations

While it is known that sex differences are consistently present in adolescents (5, 8, 31), greater subcutaneous fat (5, 20, 34) and greater TBF (39) have been reported in girls than in boys before puberty. The results of the present study using DXA confirm significantly greater amounts of TBF and PBF in prepubertal girls compared with boys for an equivalent BMI. The difference in PBF between boys and girls of similar BMI were maintained throughout the prepubertal age range of 3–12 yr (P < 0.05) and is consistent with previous reports in prepubertal children (1, 7, 19).

Study Limitations

Although this study was based on a large population of children, as with all convenience samples, the results should be considered sample specific. This study was also cross-sectional; there is a clear need to explore the observed relations between BMI, fatness, age, sex, and ethnicity in longitudinally evaluated cohorts. Last, the purpose of this study was to evaluate the relationship between BMI and body fat measurements and not to establish reference values for prepubertal children from various ethnicities.

Conclusion

While the results of this study support the recommendation that BMI be used as a screening tool for pediatric obesity in Asian and non-Asian prepubertal children, we conclude that for comparisons of fatness/obesity across ethnic groups, universal BMI cutoff points would be misleading. For the same BMI, Asian prepubertal children both in the United States and China have higher PBF than Caucasians and African Americans, which puts them at a higher risk of developing chronic diseases.

GRANTS

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REFERENCES


