Paternal body fat is a longitudinal predictor of changes in body fat in premenarcheal girls[1–3]

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ABSTRACT

Background: Longitudinal studies in infants and children suggest that low total energy expenditure (EE) (TEE) and parental body composition are important predisposing factors to obesity.
Objective: The aim of this study was to examine potential predictors of changes in total or percentage body fat over 2.7 y in premenarcheal girls.
Design: We studied 47 normal-weight prepubertal girls aged 4.8–8.9 y in 3 visits. The girls' age, total and percentage body fat at baseline, sleep EE (SEE) and activity-related EE (AEE) adjusted for fat-free mass (FFM) and total body fat, mothers' and fathers' total and percentage body fat and FFM at baseline, and time to follow-up visits were measured; 24-h EE and SEE were measured by whole-room indirect calorimetry. AEE was calculated as TEE minus (SEE + 0.1 TEE), with the assumption that the thermic effect of food was 10% of TEE. The girls' body composition was measured at each visit and that of the parents was measured at the time of the girls' enrollment by using dual-energy X-ray absorptiometry.
Results: From baseline to the first ($\overline{x}$: 1.6 y) and the second ($\overline{x}$: 2.7 y) follow-up visits, the girls' mean ($\pm$SD) change in total fat adjusted for FFM was 1.2 ± 2.7 and 3.3 ± 4.0 kg, respectively, and the mean change in percentage body fat was $-2.0 \pm 5.0\%$ and $-0.8 \pm 5.9\%$, respectively. Fathers' total and percentage body fat were the main predictors of changes in the girls' total and percentage body fat. For the first follow-up visit, SEE, girls' age at baseline, and AEE were significant predictors of percentage body fat.
Conclusion: Fathers' total and percentage body fat were predictors of changes in body fat of premenarcheal girls during a 2.7-y period.   *Am J Clin Nutr* 2000;71:829–34.

KEY WORDS   Premenarcheal girls, body fat, fat-free mass, body composition, total energy expenditure, sleep energy expenditure, activity-related energy expenditure, obesity predictors, parents

INTRODUCTION

Longitudinal studies in infants (1) and children (2) suggested that low total energy expenditure (EE) (TEE) and parental body composition are important predisposing factors to the development of obesity. However, cross-sectional studies in children (3, 4) and adolescents (5), as well as a meta-analysis in adults (6), indicated that TEE and resting EE (REE) are similar in obese and lean persons after adjustment for differences in body composition. Further-more, a recent longitudinal study examined whether reduced EE in children [TEE, REE, and activity-related EE (AEE)] was predictive of changes in fatness (7). That study showed that baseline EE (TEE measured by doubly labeled water and REE measured by indirect calorimetry) did not predict changes in body fatness over a 4-y period in 75 white children aged 4–7 y at study entry.

Whole-room indirect calorimetry is an accurate and reliable method for measuring 24-h EE, especially sleep EE (SEE), under well-controlled conditions (8). Measured components include REE (which comprises SEE and the energy cost of arousal), the thermic effect of food, and AEE. The 24-h whole-room indirect calorimeter imposes an artificial restriction on activity and living conditions compared with free-living conditions, and this reduces TEE. The objectives of this study were to use whole-room indirect calorimetry to examine potential predictors of changes in total and percentage body fat during a 2.7-y period and to develop prediction equations for individual estimation of total and percentage body fat in premenarcheal girls. The values measured were girls' age, total and percentage body fat at baseline, SEE and AEE adjusted for fat-free mass (FFM) and body fat, mothers' and fathers' total and percentage body fat and FFM at baseline, and time to follow-up visits.

SUBJECTS AND METHODS

Subjects

We studied 47 healthy, normal-weight girls [between the 10th and the 85th percentile for body mass index (BMI; in kg/m^2) (9)] at Tanner stage 1 and aged 4.8–8.9 y (**Table 1**). A pediatrician performed a complete physical examination, including Tanner staging (breast and pubic hair development) at baseline and at

TABLE 1
Age, body composition, and energy expenditure (EE) of premenarcheal girls at the 3 visits and their parents' body composition at the baseline visit[1]

	Baseline (n = 47 girls, 39 mothers, 36 fathers)	First follow-up (n = 39)	Second follow-up (n = 36)
Time from baseline (y)		1.6 ± 0.4	2.7 ± 0.6
Girls			
Age (y)	7.5 ± 1.1	9.1 ± 1.2	10.2 ± 1.3
FFM (kg)	18.8 ± 2.6	23.4 ± 3.5	27.4 ± 5.4
Total body fat (kg)	7.1 ± 2.6	8.2 ± 4.6	10.2 ± 6.0
Percentage body fat (%)	26.8 ± 5.8	24.4 ± 8.9	25.5 ± 9.7
Total EE in chamber			
(kJ/d)	6046 ± 745	6694 ± 862	6987 ± 1100
(kcal/d)	1445 ± 178	1600 ± 206	1670 ± 263
Sleep EE			
(kJ/d)	4134 ± 607	4439 ± 594	4862 ± 715
(kcal/d)	988 ± 145	1061 ± 142	1162 ± 171
Activity-related EE			
(kJ/d)	1498 ± 607	1812 ± 548	1640 ± 582
(kcal/d)	358 ± 145	433 ± 131	392 ± 139
Mothers			
FFM (kg)	46.2 ± 7.8		
Total body fat (kg)	35.8 ± 19.6		
Percentage body fat (%)	40.8 ± 10.9		
Fathers			
FFM (kg)	65.7 ± 8.9		
Total body fat (kg)	20.8 ± 7.9		
Percentage body fat (%)	23.4 ± 6.6		

[1] $\bar{x}$ ± SD. FFM, fat-free mass.

each visit. We chose to study girls who were prepubertal at baseline because prepubertal growth is relatively stable and is not confounded by differences in hormone concentrations or by dramatic shifts in body composition. In addition, this growth period is a susceptible period for obesity development (10). The girls were recruited from schools in the Birmingham area. The girls were not consuming special diets or taking any medications. Before enrollment, each girl was familiarized with the procedures and equipment to be used in the study during a demonstrative interview. The purpose of the study was explained to the girls and their parents before informed written consent was obtained. The Institutional Review Board of the University of Alabama at Birmingham approved the study.

Clinical research center

The girls were admitted to a clinical research center for a 3-d hospitalization (during the baseline visit) and a 2-d hospitalization (during follow-up visits 1 and 2) followed by 24 h in a whole-room indirect calorimeter. On each admission to the clinical research center, the girls consumed a self-selected diet and performed ad libitum physical activity. Energy intake was measured by weighing all foods before and after each meal and snack. No attempt to change the girls' diet or activity behaviors between visits was made.

Whole-room indirect calorimetry

The indirect calorimetric chamber was described previously (8). Briefly, the chamber has a total volume of 18 400 L (3.38 × 2.11 × 2.58 m). When furniture is in the chamber, the net volume is 16 300 L. This relatively small chamber is comfortable and is an appropriate size for studies in children. The chamber is equipped with a chair–foldout bed, desk, chair, lamp, refrigera-

tor, toilet, sink, television, videocassette recorder, intercom system, and telephone. The girls were allowed to occupy their time as they wished without any restrictions on activity, which included reading, writing, drawing, watching television or movies, playing video games, napping, and other sedentary EE activities. There was a living area located outside the chamber where the parents or a researcher could stay and interact freely with the girls through a window by using an intercom system. An airlock window (78.1 × 33.7 cm) allowed the passage of food and materials to the girls while they were inside the chamber. Two windows (116.2 × 77.1 cm) provided a view of a large room, and a third window (54.6 × 49.5 cm) on the door (2.07 × 0.908 m) provided a view of the equipment operations room. The door had an air gasket that was inflated to form a seal against a smooth aluminum surface secured to the door frame.

Temperature was controlled by an air conditioning and heating system in which air was passed from the air conditioner and 2 heaters continuously through a mixing chamber that allowed a constant temperature of air circulating in the room. A temperature controller (model CN9000A; Omega Engineering, Inc, Stamford, CT) was used to maintain a constant temperature of 24.0 ± 0.5 °C during the 24-h test. A barometer (model PX961–16A5V; Omega), powered by a 4-channel flow meter (model HFM-200 FAST; Teledyne Electronic Technologies, Hasting Instruments, Hampton, VA), measured the barometric pressure. Humidity and temperature were also measured (model HX12, Omega). The wire connections for these instruments were connected to the equipment operations room through a water-filled trap between the whole-room calorimeter and the equipment operations room.

Data acquisition involved analogue outputs of the analyzers, flow meter, temperature, humidity, and barometric probes to be processed by a computer (Gateway 2000 4DX-66; Gateway, Sioux

TABLE 2
Pearson's correlation matrix of all variables for premenarcheal girls at baseline[1]

	Total body fat	Percentage body fat	Activity-related EE	Sleep EE	FFM	Age	Mothers' total body fat	Mothers' percentage body fat	Fathers' total body fat	Fathers' percentage body fat
Total body fat	1.0000	0.9232[2]	0.1213	0.5900[2]	0.5309[2]	0.4685[2]	0.0575	−0.0159	0.1957	0.0835
Percentage body fat		1.0000	0.0544	0.4121[2]	0.1988	0.2601	0.1034	0.0386	0.3492[3]	0.2859
Activity-related EE			1.0000	−0.3206	0.2888[3]	0.2534	0.1123	0.1684	−0.2654	−0.2563
Sleep EE				1.0000	0.5663[2]	0.4499[2]	−0.0879	−0.1648	0.2109	0.0989
FFM					1.0000	0.6905[2]	−0.2044	−0.2549	−0.1784	−0.3111
Age						1.0000	−0.1271	−0.1389	−0.1044	−0.1325
Mothers' total body fat							1.0000	0.9123[2]	0.0274	−0.0752
Mothers' percentage body fat								1.0000	−0.0661	−0.1270
Fathers' total body fat									1.0000	0.9402[2]
Fathers' percentage body fat										1.0000

[1] EE, energy expenditure; FFM, fat-free mass.
[2,3] Significant correlation between variables: [2] $P < 0.0001$, [3] $P < 0.05$.

Falls, SD) via an analogue-to-digital converter (AT-Mid-16X; National Instruments, Austin, TX), by using a computer acquisition program (LABVIEW for WINDOWS, National Instruments). Under this system, oxygen consumption, carbon dioxide production, and respiratory quotient are reported every 15 min.

The whole-room calorimeter was calibrated before each girl's entry into the chamber. The girls entered the room at ≈0800 and spent 23 h in the chamber. Girls exited the room at ≈0700, allowing time for calibration and sanitation of the chamber before the next girl entered. TEE (in kJ/d) was extrapolated over 24 h by using mean EE during the awake state only. SEE was measured by averaging EE from the time each girl went to sleep until the time she was awakened, both times by direct observation by the researcher. AEE was calculated as TEE minus (SEE + 0.1 TEE), with the assumption that the thermic effect of food is 10% of TEE. Reported previously, the Pearson's correlation coefficient (*r*), *P* value, and total CV for the 61 intraindividual measurements between 2 baseline visits, 6 wk apart, were $r = 0.76$, $P < 0.0001$, and CV = 5.3% for TEE and $r = 0.63$, $P < 0.0001$, and CV = 5.6% for SEE (8).

Body composition

Dual-energy X-ray absorptiometry (DXA) (DPX-L; LUNAR Radiation Corp, Madison, WI) was used to assess total body composition of the girls at each visit. DXA involves minimal ionizing radiation (<1 mSv). The girls were scanned by using the pediatric medium mode. The scans were analyzed by using pediatric DPX-L software (version 1.5e; LUNAR Radiation Corp) for body-composition analyses (11). The parents were scanned by using the adult slow mode. The scans were analyzed by using adult DPX-L software (version 3.6z; LUNAR Radiation Corp) for body-composition analyses (11). DXA allows for determination of total and regional body composition (fat, soft lean tissue, and bone mineral content). FFM is defined as soft lean mass plus bone mineral content. The scanning arm moves from head to foot and counts photon attenuation rates from the X-ray source within the surface area of the table. During the scan, each girl lay quietly on the table for 20 min. All scans were performed and analyzed by the same laboratory technician. Reported previously, the Pearson's correlation coefficient, *P* value, and total CV for the 61 intraindividual measurements by DXA between 2 baseline visits, 6 wk apart, were $r = 0.96$, $P < 0.03$, and CV = 6.55% for

total body fat; $r = 0.91$, $P < 0.03$, and CV = 5.69% for percentage body fat; and $r = 0.96$, $P < 0.001$, and CV = 2.3% for FFM (12).

Statistical analyses

The descriptive data were reported as means ± SDs. Statistical analyses were performed by using SAS 6.12 for WINDOWS (SAS Institute, Cary, NC) and S-PLUS 4.5 for WINDOWS (MathSoft Inc, Seattle). The relation between changes in girls' total and percentage body fat and potential predictors (age, total and percentage body fat at baseline, SEE and AEE adjusted for FFM and body fat, mothers' and fathers' total and percentage body fat and FFM at baseline, and time to follow-up visits) was assessed by multiple regression analysis. The stepwise elimination procedure was used to establish the optimal model. Regression equations are presented with R^2 values, and any variable with a *P* value <0.05 for the last determinant added are presented. Correlations between variables were determined by using Pearson's correlation coefficient. The correlation matrix of all variables at baseline (**Table 2**) showed that FFM was correlated with age, total body fat, SEE, and AEE. Thus, to remove the confounding effect in this model, we considered age, SEE, and AEE adjusted for FFM and body fat. In general, the adjustment procedure was made according to Ravussin and Bogardus (13) by using the following equation:

$$y_{adjusted} = y_{measured} - \beta \, (x_{measured} - x_{average}) \qquad (1)$$

where β is the estimate of the regression coefficient of *Y* regressed on *X*. Intuitively, the adjustment procedure is aimed at removing the effect of a regressor, say *X*, from the response variable, say *Y*. Next, we modeled the response adjusted for one variable in terms of the other variables.

Some participants in the study were siblings, potentially complicating the analyses. The analyses could not be carried out by assuming a general structure for the covariance matrix because there were not enough observations to allow all the variance components to be estimated. Thus, we assumed that correlation of variables within a sibling group was the same as that between sibling groups. This meant that we had only one variable (ie, one common correlation) to estimate. This approach can be viewed as an approximation to incorporate the correlation structure into the modeling process. As a result, we observed that correlations within sibling groups were <0.1, which is negligible. Thus, the

TABLE 3
Multiple linear regression equations for predicting change in total body fat (BF) adjusted for fat-free mass (FFM) of premenarcheal girls[1]

Equations		R^2	P
First follow-up[2]			
Change in BF	−8580.67 + 9.40 sleep EE	0.34	0.001
First follow-up[3]			
Change in BF	−1693.58 + 0.12 fathers' BF	0.21	0.01
Change in BF	−6971.47 + 0.10 fathers' BF + 5.54 sleep EE	0.32	0.05
Change in BF	−2532.37 + 0.15 fathers' BF − 0.09 fathers' FFM + 5.75 sleep EE	0.44	0.03
Change in BF	−1998.73 + 0.26 girls' BF at baseline + 0.15 fathers' BF − 0.12 fathers' FFM + 6.03 sleep EE	0.53	0.02
Second follow-up[4]			
Change in BF	−2227.74 + 0.23 fathers' BF	0.33	0.001

[1] Predictors under consideration are age, BF at baseline, mothers' BF, mothers' FFM, fathers' BF, fathers' FFM, sleep energy expenditure (EE), activity-related EE (AEE; adjusted for FFM and BF), time from baseline to first and second follow-up visits, total BF interaction with time from baseline to first and second follow-up visits, sleep EE (adjusted for FFM and BF) interaction with time from baseline to first and second follow-up visits, and AEE (adjusted for FFM and BF) interaction with time from baseline to first and second follow-up visits.

[2] EE adjusted for FFM.

[3] EE adjusted for BF.

[4] EE adjusted for FFM and BF.

assumption of independence is adequate and the results provided are still valid. SAS/PROC MIXED (SAS Institute) was used to accomplish this task.

RESULTS

The racial distribution of the 47 girls was 42 white, 4 African American, and 1 Asian American. The cohort had 13 siblings (10 siblings from 5 families and 3 siblings from 1 family); the remaining 34 girls were unrelated. The body compositions of the girls' mothers ($n = 39$) and fathers ($n = 36$) were measured by DXA. The mean ($\pm$SD) of the girls' body composition and EE at the 3 visits and their parents' body composition at the girls' enrollment are shown in Table 1. The mean time between the baseline visit and the first follow-up visit was 1.6 ± 0.4 y and from the baseline visit to the second follow-up visit was 2.7 ± 0.6 y (Table 1). The sample size for which data are reported was 39 at the first follow-up visit and 36 at the second follow-up visit.

All the girls were offered an identical menu and were allowed to make their own food selections. The energy compositions of the lunches and evening meals were similar for all the girls. When the girls' energy intake was compared with their total body fat by DXA, no significant differences were observed. We believe that it is unlikely that the evening meal had a significant effect on SEE because the last main meal was consumed between 1700 and 1800. The girls went to bed no earlier than 2100, usually at $\approx$2200, and SEE was based on a period of $\approx$8–9 h, beginning 3–5 h after the meal. Therefore, the postprandial period occurred before the girls went to sleep.

From the baseline visit to the first follow-up visit, the girls' mean change in total body fat adjusted for FFM was 1.2 ± 2.7 kg and the mean change in percentage body fat was $-2.0 \pm 5.0\%$. From the baseline visit to the second follow-up visit, the girls' mean change in total body fat adjusted for FFM was 3.3 ± 4.0 kg and the mean change in percentage body fat was $-0.8 \pm 5.9\%$. The change in total body fat between the baseline visit and the first follow-up visit was regressed on all study variables, including interaction of total body fat with time to first follow-up visit, SEE adjusted for FFM and body fat interaction with time from baseline to first follow-up visit, and AEE adjusted for FFM and

body fat interaction with time from baseline to first follow-up visit. Total body fat and FFM were highly correlated at baseline (Table 2). Thus, the change in total body fat was adjusted for FFM. The change in EE was adjusted for FFM and body fat. As shown in **Table 3**, for the change in total body fat between the baseline visit and the first follow-up visit, SEE and fathers' total body fat were significant predictors of body fat in the girls. Note that the girls' SEE was positively predictive of their body fat gain (ie, a higher rather than a lower SEE tended to predict body fat gain). As more time elapsed (ie, between baseline and the second follow-up visit), fathers' total body fat was the only significant predictor of changes in the girls' body fat. The relation between fathers' percentage body fat and SEE adjusted for body fat and their daughters' changes in percentage body fat between baseline and the first follow-up visit is shown in **Table 4**. Girls' age at baseline and AEE adjusted for FFM were significant predictors of percentage body fat between baseline and the first follow-up visit. The only significant variable for change in percentage body fat between baseline and the second follow-up visit was the fathers' percentage body fat.

The multiple correlation (R^2) was more appropriate than the Pearson correlation coefficient for the multiple regression models (Tables 3 and 4). Also, note that the direction of correlation could be deduced directly from the sign of the variable estimates.

DISCUSSION

The main predictors of changes in total and percentage body fat in this cohort of premenarcheal girls were fathers' total and percentage body fat. Girls' SEE was also a predictor for the first follow-up visit. Girls' age at baseline and AEE were also significant predictors of percentage body fat between baseline and the first follow-up visit. One needs to be cautious in interpreting these results. Because of large variability in the data, R^2, which is a measure of goodness of fit, was relatively low. Thus, these equations do not serve as good predicting equations. However, we believe that if we were to increase the sample size, the elapsed time to follow-up, or both, this problem might be rectified and a clearer pattern of association might emerge.

TABLE 4
Multiple linear regression equations for predicting change in percentage total body fat (BF) in premenarcheal girls[1]

	Equations	R^2	P
First follow-up[2]			
Change in percentage BF	$-10.25 + 0.32$ fathers' %BF	0.21	0.01
Change in percentage BF	$-20.54 + 0.004$ girls' age at baseline $+ 0.32$ fathers' %BF	0.32	0.01
Change in percentage BF	$-17.35 + 0.004$ girls' age at baseline $+ 0.29$ fathers' %BF $- 0.01$ AEE	0.43	0.04
First follow-up[3]			
Change in percentage BF	$-21.51 + 0.02$ sleep EE	0.25	0.007
Change in percentage BF	$-26.76 + 0.29$ fathers' %BF $+ 0.02$ sleep EE	0.42	0.006
Change in percentage BF	$-34.12 + 0.003$ girls' age at baseline $+ 0.29$ fathers' %BF $- 0.01$ sleep EE	0.50	0.008
Second follow-up[4]			
Change in percentage BF	$-10.70 + 0.39$ fathers' %BF	0.22	0.01

[1] Predictors under consideration are age, BF at baseline, mothers' BF, mothers' fat-free mass (FFM), fathers' BF, fathers' FFM, sleep energy expenditure (EE), activity-related EE (AEE; adjusted for FFM and BF), time from baseline to first and second follow-up visits, BF interaction with time from baseline to first and second follow-up visits, sleep EE (adjusted for FFM and BF) interaction with time from baseline to first and second follow-up visits, and AEE (adjusted for FFM and BF) interaction with time from baseline to first and second follow-up visits.
[2] EE adjusted for FFM.
[3] EE adjusted for BF.
[4] EE adjusted for FFM and BF.

Reduced TEE was shown to be an important factor in the excessive weight gain of infants and children born to obese parents (1, 2). One study examined the relation between infant TEE and parental BMI in 124 infants at 12 wk of age (14). That study showed that no aspect of infant EE was related to parental BMI. Moreover, there was no significant difference between TEE of 2 subsets of infants born to parents with high (>30) and low (<20) BMI. In contrast, our study showed that there was a relation between the fathers' body fat and their daughters' SEE, AEE, and body fat.

In a retrospective study, the probability of obesity in young adulthood was examined in relation to the presence or absence of obesity at various times throughout childhood and the presence or absence of obesity in the child's parents (15). That study showed that obese children aged <3 y and without obese parents were at low risk of obesity in adulthood but that, among older children, obesity was an increasingly important predictor of adult obesity, regardless of whether the parents were obese. The effect of parental obesity on the risk of obesity in adulthood was most pronounced among obese and nonobese children aged <10 y. The risk of adult obesity was significantly greater if either parent was obese. Our cohort of normal-weight girls aged 4.8–8.9 y at the initiation of the study showed a relation between the fathers', but not the mothers', body fat and subsequent changes in the daughters' body fat.

Three cross-sectional studies in children and adolescents compared EE in obese and lean subjects (3–5). One study examined whether EE components (TEE, REE, and AEE) in 73 children aged 4–7 y were related to the children's body fatness or to the fatness of their parents (3). TEE was measured over 14 d by using doubly labeled water and AEE was derived by subtracting postprandial REE from TEE. Fat and FFM were measured in the children and their parents by using bioelectrical impedance analysis. The study showed no significant correlations between TEE, REE, and AEE in the children (after adjustment for FFM) and body fat in the children or body fat in their mothers or fathers (3). In another study the relation between EE and obesity was examined in 46 prepubertal children aged 10–11 y (4). The children were grouped into levels of obesity based on tertiles of

subscapular plus triceps skinfold thicknesses. TEE was measured over 8 d by using doubly labeled water and REE was measured by using indirect calorimetry. The study showed no significant differences in TEE, REE, or AEE among the 3 obesity levels after adjustment for FFM. The heaviest children had the same AEE and TEE as the leanest children while weighing 14 kg more, indicating that obese children had a lower activity level than did nonobese children.

In another study, REE and TEE were measured in 28 nonobese and 35 obese adolescents aged 12–18 y by using indirect calorimetry and doubly labeled water (5). The investigators found that absolute values for REE and TEE were significantly greater in the obese adolescents. The ratio of TEE to REE was similar in the 2 groups, indicating that the proportion of TEE allocated between resting and nonresting states did not significantly differ between the obese and the nonobese adolescents. The investigators concluded that lower EE could not be responsible for the maintenance of obesity in adolescents.

Cross-sectional studies showed associations between various metabolic factors and obesity, but these relations cannot be interpreted as causal. In longitudinal studies, such relations come a step closer to showing causality, although the factors studied are still predictors and not necessarily causes. A recent longitudinal study examined whether childhood EE components or parental body composition were related to the rate of change of body fat over 4 y in prepubertal children of obese and nonobese parents (7). The researchers studied 75 white children, aged 4–7 y at study entry, over a 4-y period by taking annual measurements of body composition (by anthropometry and bioelectrical impedance analysis), REE (by indirect calorimetry), and TEE and AEE (by doubly labeled water). The major determinants of change in fat mass adjusted for FFM were sex (fat gain was greater in girls), fatness at baseline, and parental fatness. None of the components of EE was inversely related to change in fat mass. The researchers concluded that the main predictors of change in fat mass relative to FFM were sex, fatness at baseline, and parental fatness, but not reduced EE (7). However, the body fat percentages encountered in the study were as high as 39.2%, suggesting that several of the children were already overweight when the

study began. The development of obesity may eliminate preexisting differences in EE (16).

The results of our study in prepubertal and premenarcheal girls, as well as studies in infants (1) and children (2), suggest that potential mechanisms for body fat gain, which are known to have a familial component, include low TEE, REE, and AEE and increased energy intake. In addition, our study showed that fathers' total or percentage body fat was predictive of long-term changes in total and percentage body fat in this cohort of premenarcheal girls. Collection of further longitudinal data is warranted to establish whether these results persist throughout puberty. ❧

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