Relations of Parental Obesity Status to Physical Activity and Fitness of Prepubertal Girls

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ABSTRACT. ***Objective.*** **To determine whether physical activity and fitness differ among normal-weight-for-height, multiethnic, prepubertal girls whose parents are lean, obese, or both.**

Setting. **Conducted in Houston, Texas.**

Study Participants. **Normal-weight white, black, and Hispanic prepubertal girls (mean age ± standard deviation: 8.5 ± .4 years) participated in this study. Girls were recruited according to parental leanness or obesity defined as follows: girls with 2 lean parents (LN group; n = 30); girls with 2 obese parents (OB group; n = 27); and girls with 1 lean and 1 obese parent (LNOB group; n = 44).**

Intervention. **Each child wore a heart rate monitor for two 24-hour periods, underwent a treadmill exercise test, answered an activity questionnaire, and completed energy expenditure measurements by basal calorimetry and doubly labeled water.**

Outcome Measures. **The amount of time spent above 125% and 150% of basal heart rate (BHR) was calculated during each 24-hour period (n = 84). Fitness (n = 97), habitual physical activity (n = 101), and physical activity level (PAL = total energy expenditure/basal metabolic rate; n = 101) were also measured.**

Results. **The times spent above 125% and 150% of BHR were similar among LN, LNOB, and OB groups. Black girls spent less time than did white girls on the weekend above 125% BHR and above 150% BHR. No significant familial or ethnic differences in peak oxygen consumption or habitual physical activity were observed. PALs were as follows: LN = 1.6 ± .21; LNOB = 1.64 ± .27; OB = 1.58 ± .20; white = 1.63 ± .23; black = 1.58 ± .24; and Hispanic = 1.65 ± .25. PAL was related to time spent above 125% BHR and 150% BHR (r = .31,.39).**

Conclusions. **Physical activity and fitness of normal-weight prepubertal girls predisposed to obesity did not differ from girls without a family history of obesity.** ***Pediatrics*** **2000;106(4). URL: http://www.pediatrics.org/cgi/content/full/106/4/e49;** ***obesity, children, energy metabolism, exercise, heart rate monitoring.***

ABBREVIATIONS. $\dot{V}O_2$peak, peak oxygen consumption; TEE, total energy expenditure; PAL, physical activity level; CNRC, Children's Nutrition Research Center; BMI, body mass index; DXA, dual-energy radiograph absorptiometry; LN group, girls with 2 lean parents; OB group, girls with 2 obese parents; LNOB group, girls with 1 lean and 1 obese parent; FM, fat mass; FFM, fat-free mass; BHR, basal heart rate; BMR, basal metabolic rate; RQ, respiratory quotient; SD, standard deviation.

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Obesity is an increasingly prevalent health problem in children and adolescents[1] and has been shown to be heritable.[2–4] A recent study reported that parental obesity more than doubled the risk of adult obesity among children <10 years of age.[5] Obesity results from an imbalance between energy intake and energy expenditure. Physical activity is quite variable in children, and low levels of activity may contribute to obesity development.[6] Physical activity habits have also been shown to be heritable; in the Framingham study children with active parents were 5.8 times more likely to be active themselves.[7] Whether activity differs in children with parents of varying adiposity levels remains to be determined.

Both genetics and ethnicity have been shown to be associated with fitness. Twin studies have shown the heritability of peak oxygen consumption ($\dot{V}O_2$peak; L/kg/minute) to be 40%, whereas that of endurance performance is much higher (70%).[8] Several investigators have found that black children have lower levels of fitness than do white children[9–11] and little is known about fitness in Hispanic children.

Physical fitness includes muscular, motor, and cardiorespiratory fitness, as well as body composition and metabolic components.[12] Physical activity includes any body movement produced by the skeletal muscles and resulting in a substantial increase over resting energy expenditure.[12] These 2 parameters have different measurement methods. Fitness can be assessed with an exercise treadmill test to exhaustion. However, it is not clear how best to measure physical activity. Questionnaires are easy to administer. Doubly labeled water for determination of total energy expenditure (TEE) and physical activity level (PAL) is an accurate, expensive method. Twenty-four-hour heart rate monitoring for minute-by-minute physical activity is an unobtrusive, inexpensive method. We used all these methods to assess physical activity and fitness in a sample of young girls. The aim of this study was to determine whether physical activity and fitness differ among normal-weight-for-height, multiethnic prepubertal girls with lean or obese parents. Our overall hypothesis was that activity and fitness would be lower in normal-weight-for-height, multiethnic, prepubertal girls with a familial predisposition to obesity.

METHODS

Subjects

Healthy prepubertal girls (n = 101) were recruited from the Houston area to participate in the study. All children were in the age range of 8 to 9 years. Recruitment and screening procedures were conducted to balance the sample sizes in the 3 categories of primary analytical interest, eg, girls with lean, lean and obese, or obese parents. Recruitment continued over a 3-year period throughout the Houston metropolitan area. Children were recruited using local advertisements, flyers, and the Children's Nutrition Research Center (CNRC) recruitment files. Body mass index (BMI) was used as an initial screening criterion over the phone. Dual-energy radiograph absorptiometry (DXA) was measured at the first visit. All children were allowed into the study over the 3 years, except for those who did not meet the body fat criteria. The girls were screened and had to be below the 90th percentile of their weight-for-height[13] and within 12% and 30% body fat to be included in the study. Children with cardiovascular disease, anemia, diabetes, significant renal or hepatic disease, hypothyroidism, and musculoskeletal problems were excluded. For the parents, documented diabetes (n = 3), cardiovascular disease (n = 1), hypertension (n = 4), and hypothyroidism (n = 4) were reported. All children and their parents provided written informed consent to participate in this study, which was approved by the Institutional Review Board for Human Subject Research for Baylor College of Medicine and Affiliated Hospitals.

Study Protocol

All procedures were completed at the US Department of Agriculture/Agricultural Research Service CNRC. Body composition of the children was measured by DXA, and their body weight and height were measured on the first visit. Height and weight of both parents were measured to place the children in the appropriate groups. Girls were recruited according to parental characteristics of leanness or obesity, as follows: girls with 2 lean parents (LN group; n = 30); girls with 2 obese parents (OB group; n = 27); girls with 1 lean and 1 obese parent (LNOB group; n = 44). BMI, calculated as weight (kg)/height² (m), was used to define lean (<25 kg/m²) or obese (>28 kg/m²).[13] Parents were asked to respond to a questionnaire concerning the child's activities over the previous year. The children were admitted on a later date to the Metabolic Research Unit at 8 AM, after a 12-hour overnight fast. The girls completed a $\dot{V}O_2$peak test, had breakfast, and spent the next 24 hours in a room calorimeter. The following day, each girl was given an oral dose of doubly labeled water and sent home with a heart rate monitor. The monitor was worn for two 24-hour periods within the subsequent 2 weeks.

Body Composition

Body weight was measured to the nearest .1 kg using a digital balance (Scale-Tronix, Dallas, TX), and height was measured to the nearest 1 cm using a stadiometer (Holtain Ltd, Crymmych, Pembs, UK). Body composition was assessed by DXA (Hologic QDR 2000, Madison, WI). DXA allows for the determination of lean tissue mass, fat mass (FM), and bone mineral content. Fat-free mass (FFM) was defined as the sum of lean tissue mass and bone mineral content.

Heart Rate Monitoring

Heart rate was stored with either a POLAR Vantage XL Heart Rate Monitor (Model 61204, Helsinki, Finland) or a Mini-mitter unit (Mini-mitter 2000, Sun River, OR) while the child was at home for 2 days. The watch was placed on the subject's wrist and the transmitter was placed on the child's chest by the investigator to demonstrate how it functioned before leaving the CNRC. The parents were also given instructions on how to start and stop the watch when using the POLAR monitor. The Mini-mitter was programmed for the 2 days that the child agreed to wear the monitor. Heart rate was recorded every minute for two 24-hour periods (1 weekday and 1 weekend day).

The basal heart rate (BHR) of all children was measured while they were in the calorimeter undergoing a basal metabolic rate (BMR) measurement. BHR was defined as the average heart rate while lying supine for 30 to 40 minutes with minimal activity level. For an index of free-living activity patterns, we calculated the percentage of total minutes recorded for which the heart rate was >125% of BHR and >150% of BHR, as cutoff points used previously.[14] A minimum of 1000 minutes of data from each 24-hour period was needed to be used in the analysis.

Fitness

To assess fitness, $\dot{V}O_2$peak was measured by collecting expired gases with a metabolic measurement cart (Model 2900, SensorMedics Corp, Yorba Linda, CA) during an exercise test on a treadmill (Model Q55, Quinton Instrument Co, Seattle, WA). The treadmill protocol involved a constant speed of 2.5 mph at an initial 0% grade for the first 4 minutes. The average of minutes 3 and 4 constituted the steady state. The grade was then increased to 10%. Every 2 minutes thereafter, the grade increased by 2.5% to a maximum grade of 22.5%, when speed was increased by .6 mph. $\dot{V}O_2$peak was determined using standard criteria, specifically a heart rate >195 bpm or respiratory quotient (RQ) >1.0 at maximum.[15] Four children failed to meet these criteria and are excluded from the analyses.

Physical Activity Questionnaire

The parents were given a questionnaire to evaluate their child's physical activity over the previous year. Exercise participation was assessed using the Physical Activity Interview for Children[16] with several modifications. Instead of recording an activity only if it occurred >10 times in the previous year, all activities that took place in the previous year were recorded, regardless of the frequency. Activities also were grouped by intensity.[17] Activities in the moderate category included: bicycling (on a trail), dancing, gymnastics, hiking, ice skating, martial arts, rollerblading, snow skiing, soccer, softball/baseball, swimming (recreational), tennis, and walking. Activities grouped in the strenuous category included: aerobics, basketball, bicycling (in the street), running for exercise, swimming laps, and volleyball. This questionnaire was also modified to include the breakdown of activities by the school year (September through May) and the summer (June through August). The number of months, the number of times per month, and the length of time spent on each activity (in hours) were recorded. From this, the overall sum of the hours spent in moderate and strenuous activities was calculated in terms of total hours per year.

PAL

TEE was determined using doubly labeled water and BMR using room respiration calorimetry. PAL is defined as the TEE/BMR. The BMR was measured for 40 minutes after a 12-hour overnight fast from the oxygen consumption per unit time ($\dot{V}O_2$) and carbon dioxide output, according to the method of Livesey and Elia.[18] The child was monitored both visually and by the activity sensor and was required to lie still for the entire measurement period. To be considered a valid BMR measurement, average activity counts during the period had to be <50. TEE over a 14-day period was calculated from the fractional turnover rates of ^2H and ^{18}O after oral ingestion of 100 mg/kg ^2H_2O and 125 mg/kg^{18}O as water.[19] Isotope dilution spaces were used to compute total body water. Baseline urine samples were collected from each subject in the calorimeter. After each subject left the calorimeter, she was given the oral dose of doubly labeled water. Subsequently, 1 daily urine sample was collected by each subject at home for the next 13 days. The ^2H and ^{18}O abundances of the urine samples were measured by gas-isotope-ratio mass spectrometry as previously described.[20] TEE was calculated using the Weir equation.[21] Data for the doubly labeled water and BMR measurements also have been reported previously elsewhere.[20]

Statistical Analysis

Data are presented as means ± standard deviation (SD). Microsoft Access for Windows 95, Version 7.0 (Microsoft, Redmond, WA) was used for database management. Statistical analyses were performed using Minitab for Windows, Version 12.2 (Minitab, State College, PA) with significance set at $P < .05$. To test whether girls in the LNOB group differed according to maternal (n = 23) or paternal (n = 21) obesity status, Student's t tests were completed on all variables. No significant differences were observed for any of the variables; therefore, the girls were combined into 1 group (LNOB). Initially, χ^2 analysis was completed to determine balance among the groups for ethnicity. All variables were then tested for effects of familial obesity (LN, LNOB, and OB) and ethnicity (white, black, and Hispanic) groups using analysis of variance. The model included the grouping factors for familial obesity and ethnicity and the interaction between the 2. For heart rate, RQ, and $\dot{V}O_2$, analysis of covariance was used. The covariates included weight or FFM and FM. Multiple comparisons were performed using the Tukey method.

RESULTS

Subject Characteristics

The sample size included 101 children classified as LN ($n = 30$), LNOB ($n = 44$), and OB ($n = 27$). A total of 52 white, 30 black, and 19 Hispanic girls were enrolled in the study. Mean (± SD) age (8.5 ± .4 years) did not differ among the familial groups. Ethnic distribution did not differ among the LN, LNOB, and OB familial groups.

Weight, height, FFM, FM, and percent fat were not significantly different among the familial groups (Table 1). However, the girls in the LN group had significantly lower BMI than did girls in the OB group ($P < .05$). Black girls had significantly greater weight and FFM than did white girls, and significantly greater height and FFM than did Hispanic girls ($P < .05$).

Physical Activity by Heart Rate Monitoring

A heart rate profile for a 24-hour period in 1 child is illustrated in Fig 1. Data from the heart rate monitoring (Table 2) were complete in 84 girls. This constitutes missing data from 8.3%, 8.4%, and 8.2% from the LN, LNOB, and OB groups, respectively. There were no differences among LN, LNOB, and OB groups or among ethnic groups in the heart rates calculated as 125% and 150% of BHR. The mean daily 24-hour heart rates were similar during the week (93 ± 10 bpm) and on the weekend (92 ± 10 bpm) for the entire sample. The duration of the study days during the week or weekend was similar among the familial or ethnic groups.

The amount of time (minutes), heart rate, and the percentage of the day spent >125% and >150% of BHR on the weekday and weekend day were similar among the familial groups (Fig 2A). There was a general trend on the weekday and weekend day at 125% and 150% of BHR for the girls in the LN group to be the most active, and the girls in the OB group the least active.

TABLE 1. Body Composition in Prepubertal Girls in the LN, LNOB, and OB Groups

	LN (n = 30)	LNOB (n = 44)	OB (n = 27)
Weight (kg)	27.2 ± 3.6	28.0 ± 4.6	29.6 ± 4.6
Height (cm)	130.4 ± 5.3	130.0 ± 5.6	130.9 ± 5.6
BMI (kg/m^2)	15.9 ± 1.5	16.5 ± 1.8	17.2 ± 1.4*
FFM (kg)	21.0 ± 2.5	21.2 ± 2.6	22.0 ± 3.1
FM (kg)	5.5 ± 1.5	6.1 ± 2.3	6.9 ± 1.8
Percent fat (%)	20.6 ± 3.8	21.7 ± 5.4	23.6 ± 3.9
Ethnicity white/black/Hispanic	20/8/2	20/12/12	12/10/5

Values are expressed as mean ± SD.
* Significantly different between the LN and OB groups ($P < .05$).

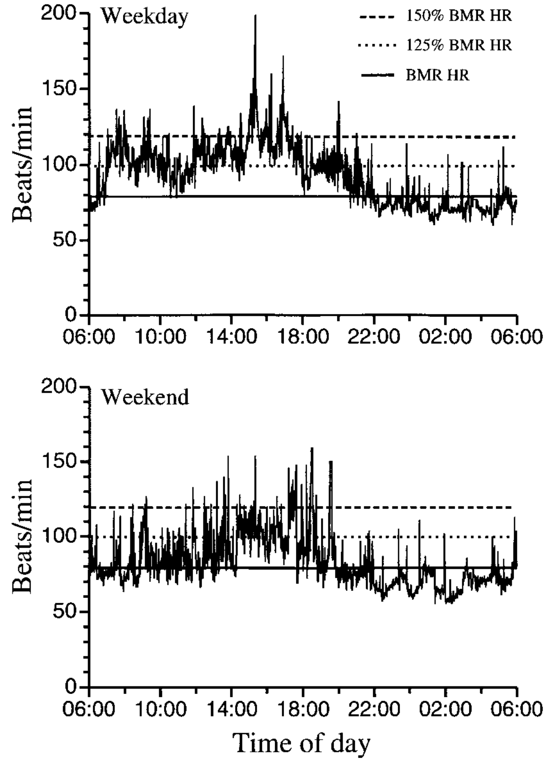

Fig 1. Profile of 2 separate 24-hour periods of heart rate monitoring for 1 child on a weekday (top) and weekend (bottom), with the 125% and 150% of BHR cutoffs shown.

No significant differences for the amount of time (minutes), heart rate, or the percentage of the day spent >125% and >150% BHR during the week were evident among the ethnic groups. However, the black girls spent less time (actual minutes) than the white girls >125% BHR (159 ± 126 minutes vs 268 ± 192 minutes; $P = .05$) and >150% BHR (38 ± 47 minutes vs 59 ± 52 minutes; $P = .03$) on the weekend. The mean heart rates during the active periods were not different among ethnic groups. This translates into a lower percentage of the day spent >125% BHR (21% ± 15% vs 33% ± 23%; $P = .08$) and >150% BHR (5% ± 5% vs 8% ± 6%; $P = .04$) on the weekend for black girls than for white girls (Fig 2B). There were no differences in these parameters with the Hispanic girls.

Activity Measured by Questionnaire

Activity data determined by the questionnaire (Table 3) were not different among the girls in the LN, LNOB, and OB groups. The black girls reported more time spent watching TV during the summer than did white girls (3.2 ± 1.8 hours/day vs 2.3 ± 1.4 hours/day; $P = .05$) and less time spent playing (2.2 ± 1.0 hours/day vs 2.8 ± 1.8 hours/day; $P = .05$). Black girls spent less time in sleep than did white girls ($P < .0001$). Hispanic girls were not different from the other ethnic groups.

PAL

PAL, TEE, and activity energy expenditure were not significantly different among familial groups. For

TABLE 2. Activity Measured by Heart Rate Monitoring in Prepubertal Girls in the LN, LNOB, and OB Groups

	LN (n = 25)	LNOB (n = 37)	OB (n = 22)	Familial P Value	Ethnic P Value
HR at 125% BHR (bpm)	112 ± 18	108 ± 11	112 ± 13	NS	NS
HR at 150% BHR (bpm)	133 ± 22	129 ± 13	134 ± 15	NS	NS
Weekday duration (min/d)	1347 ± 170	1276 ± 245	1264 ± 195	NS	NS
Weekend duration (min/d)	1266 ± 240	1335 ± 192	1343 ± 131	NS	NS
Weekday >125% BHR					
Active (min)	289 ± 193	233 ± 145	172 ± 138	NS	NS
Active heart rate (bpm)	127 ± 18	121 ± 11	123 ± 12	NS	NS
% d active	34.1 ± 23.1	29.0 ± 18.1	22.1 ± 19.0	NS	NS
(Range)	(1.5–75.9)	(2.9–70.0)	(1.0–58.6)		
Weekday >150% BHR					
Active (min)	65 ± 56	53 ± 55	28 ± 29	NS	NS
Active heart rate (bpm)	145 ± 20	141 ± 12	13.4 ± 34	NS	NS
% d active	7.7 ± 6.5	6.6 ± 6.6	3.8 ± 4.0	NS	NS
(Range)	(0–20.7)	(0–21.1)	(0–14.8)		
Weekend >125% BHR					
Active (min)	271 ± 217	226 ± 150	170 ± 147	NS	P = .05*
Active heart rate (bpm)	124 ± 17	121 ± 10	122 ± 11	NS	NS
% d active	35.1 ± 24.4	29.1 ± 17.8	21.4 ± 17.2	NS	P = .08*
(Range)	(0–83.4)	(1.0–73.3)	(1.1–63.0)		
Weekend >150% BHR					
Active (min)	80 ± 95	54 ± 66	37 ± 48	NS	P = .03*
Active heart rate (bpm)	141 ± 18	140 ± 12	144 ± 13	NS	NS
% d active	10.0 ± 11.1	6.5 ± 7.4	4.6 ± 5.8	NS	P = .04*
(Range)	(0–41.0)	(0–27.6)	(0–20.3)		

Values are expressed as mean ± SD. Active was defined as the period during which the child's HR was either >125% of BHR or >150% of BHR. Active (minutes) was compared using duration (minutes) as a covariate.
HR indicates heart rate; NS, not significant.
* Significantly lower values in black girls than in white girls.

the entire group, PAL was 1.62 ± .26 with a range from 1.10 to 2.15 (n = 92). PALs did not differ significantly among the familial or ethnic groups. Mean PALs (range) were as follows: LN = 1.60 ± .21 (1.30–2.04); LNOB = 1.64 ± .27 (1.10–2.15); OB = 1.58 ± .20 (1.33–2.01); white = 1.63 ± .23 (1.26–2.15); black = 1.58 ± .24 (1.10–2.01); and Hispanic = 1.65 ± .25 (1.33–2.10). The means ± standard error for TEE were 7138 ± 1159, 7376 ± 1280, and 7519 ± 1310 kJ/day in the LN, LNOB, and OB groups, respectively. In these same groups, the means ± standard error for activity energy expenditure were 1933 ± 866, 2105 ± 1121, 2130 ± 875 kJ/day. Free-living TEE was lower in black girls than in white girls ($P < .05$).

Fitness

Results from the treadmill exercise test are presented in Table 4. Steady-state values for heart rate, ventilation, $\dot{V}O_2$, and RQ were similar among the girls in the LN, LNOB, and OB groups. At the peak exercise level, heart rate, ventilation, $\dot{V}O_2$, RQ, and time to exhaustion were not significantly different; however, the girls in the LN group were able to exercise to a higher stage (intensity) than were the girls in the OB group (P = .02).

No statistically significant differences in steady-state or peak values for ventilation, heart rate, $\dot{V}O_2$, RQ, treadmill time to exhaustion, and stage were seen among the ethnic groups. At the peak exercise level, black girls had a lower (but nonsignificant) $\dot{V}O_2$peak than did white girls (P = .12) and Hispanic girls (P = .06) after adjustment for FFM (Fig 3).

Relationships Among Heart Rate Monitoring With the Questionnaire and Fitness

The relationships among heart rate monitoring with the questionnaire and fitness were evaluated in the entire sample of girls. The only 2 items from the questionnaire that were significantly related to the heart rate monitoring were time spent in team sports and the number of hours in strenuous activities. Time spent in team sports over the past year (r = .21; P = .06) and past week (r = .26; P = .02) were related to the percent weekday active >125% BHR. The number of hours in strenuous activities was related to percent weekday active >125% BHR (r = .39; P = .001), percent weekend active >125% BHR (r = .30; P = .006), and percent weekend active >150% BHR (r = .33; P = .002).

Steady-state or maximal heart rate, $\dot{V}O_2$, ventilation, or RQ were not related to the heart rate indexes. Only time on the treadmill and stage of the protocol were related to the heart rate indexes. The time on the treadmill was significantly related to percent weekend active >125% and >150% BHR (both r = .23; P = .04). The final stage reached on the treadmill was significantly related to percent weekday active >125% and >150% BHR (r = .22–.23; P = .04–.05) and percent weekend active >125% and >150% BHR (r = .25–.29; P = .01–.03).

Only a few relationships between the questionnaire and fitness were found. The time spent playing was related to $\dot{V}O_2$peak (r = .21; P = .04). The time spent watching TV/video games during the summer was negatively related to the time on the treadmill (r = −.21; P = .04) and to final stage on the treadmill

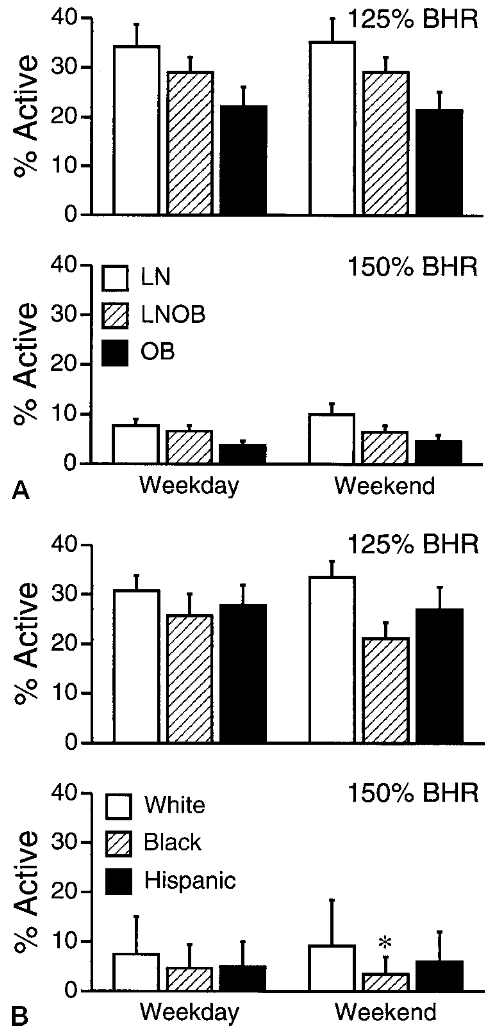

Fig 2. A, Percentage of active time spent (% active) above 125% BHR and 150% BHR during the week and weekend in prepubertal girls with either 2 lean parents (LN group), 1 lean and 1 obese parent (LNOB group), or 2 obese parents (OB group). There were no significant differences among the groups. B, Percentage of active time spent (% active) above 125% resting heart rate (BHR) and 150% BHR during the week and weekend in prepubertal white, black, and Hispanic girls. Values shown are means ± SE. *Significantly lower values in the black girls compared with the white girls.

($r = -.20$; $P = .05$). Moderate activities over the past year were also related to treadmill time ($r = .26$; $P = .011$) and stage ($r = .20$; $P = .06$).

Relationships Among Doubly Labeled Water and Heart Rate Monitoring, Questionnaire, and Fitness

The relationships between PAL and activity and fitness were examined for the entire group. PAL was significantly related to percent weekday active >125% BHR ($r = .31$; $P = .007$) and >150% BHR ($r = .39$; $P = .001$). PAL was related to time in sports teams over the past year, past week, and number of sports teams ($r = .21$–$.23$; $P = .03$–$.04$). PAL was not related to $\dot{V}O_2$peak or any exercise test variable.

DISCUSSION

In this study, we sought to determine whether physical activity and fitness differ among normal-weight-for-height, multiethnic girls predisposed to obesity by virtue of having 1 or 2 obese parents. We found that activity and fitness were similar among normal-weight prepubertal girls with either lean or obese parents. In these same children, we also reported similar 24-hour energy expenditure, BMR, sleeping metabolic rate, and activity counts while in a room respiration calorimeter.[20]

The lack of significant differences in activity and fitness in prepubertal normal-weight girls with a familial predisposition to obesity is an unexpected finding. There are several possible explanations for this finding. Perhaps at this age, these predisposed children are able to maintain their normal weights through adequate levels of physical activity and fitness. One other explanation for the lack of activity differences is that the obese parents may deliberately involve their children in physical activity to prevent obesity. We may also be studying a time frame (prepuberty) where activity is enjoyable, accessible, and rewarding, and it is not clear whether adolescence may be a time period when these things change. As health professionals, we would hope that these young children might maintain active lifestyles and not become obese.

Children living in low socioeconomic households may have limited access for recreation and sports participation. In this study, a range of socioeconomic status in the families was examined. Because fewer families in the lowest income range (<\$20 000/year) compared with those in the highest (>\$40 000/year) were enrolled, it may be possible that children living in low socioeconomic households would have lower activity levels. However, grouping in this study was based on BMI of the parents and the LN, LNOB, and OB groups contained families of all incomes. In addition, several families were single-parent homes; however, the other parent (usually the father) was required to come to the CNRC to undergo body composition measurements. Possible differences in nutrition and dietary habits of these children may also contribute to obesity development. The role of energy intake in the development of obesity is clearly an important factor.

The heart rate monitoring method has been validated previously in children against the doubly labeled water method[22] and is a valuable index of physical activity. We decided to examine 2 levels (>125% BHR and >150% BHR), so that we could examine differences among familial groups and ethnic groups in terms of physical activity intensity. We also requested that the children wear the heart rate monitor 1 day during the week and another day on the weekend, so that we could determine whether differences existed in the pattern of physical activity. The patterns or intensity of physical activity did not seem to be affected by predisposition to obesity in these normal-weight girls. We did observe significant differences at the higher intensity (>150% BHR) on the weekend between black and white girls. We did not find any differences between the Hispanic girls and the other ethnic groups, perhaps this was attributable to the lower sample size of the Hispanics. The intensity and time spent in physical activity in black girls might be important factors to modify in

TABLE 3. Activity Measured by Questionnaire in Prepubertal Girls in the LN, LNOB, and OB Groups

	LN (n = 30)	LNOB (n = 44)	OB (n = 27)	Familial P Value	Ethnic P Value
Number of team sports in past y	1.0 ± 1.2	.8 ± 1.1	.8 ± .9	NS	NS
Time in sports in past y (h/wk)	2.1 ± 3.1	1.8 ± 3.4	2.4 ± 3.1	NS	NS
Time in sports in past wk (h/wk)	1.8 ± 3.2	1.8 ± 3.6	1.8 ± 3.4	NS	NS
Time in PE (h/wk)	1.9 ± 1.0	1.5 ± 1.3	2.0 ± 1.2	(P = .07)*	NS
Time in sleep (h/d)	9.2 ± .9	9.2 ± 1.0	9.2 ± .9	NS	(P = .00)** (P = .06)‡
Time playing (h/d)	2.5 ± 1.0	2.6 ± 1.4	3.0 ± 1.8	NS	(P = .05)**
Time watching TV during school y (h/d)	1.4 ± .7	1.5 ± 1.1	1.5 ± 1.2	NS	NS
Time watching TV during summer (h/d)	2.4 ± 1.3	2.4 ± 1.7	2.8 ± 1.8	NS	(P = .05)†
Activity level during school y	2.6 ± .7	2.9 ± .8	2.7 ± .9	NS	NS
Activity level during summer	3.0 ± .6	3.2 ± .8	2.9 ± .9	NS	NS
Physical activities—moderate level (h/y)	282 ± 216	311 ± 246	374 ± 702	NS	NS
Physical activities—strenuous level (h/y)	120 ± 161	135 ± 132	110 ± 136	NS	NS

NS, not significant.
Values are expressed as mean ± SD.
* Comparison between the LN and LNOB groups with greater values in the LN group.
** Comparison between black and white girls with higher values in the black group.
† Comparison between black and white girls with lower values in the black group.
‡ Comparison between black and Hispanic girls with lower values in the black group.

TABLE 4. Physical Fitness ($\dot{V}O_2$peak) in Prepubertal Girls in the LN, LNOB, and OB Groups

	LN (n = 30)	LNOB (n = 42)	OB (n = 25)	Familial P Value	Ethnic P Value
Steady-state					
HR (bpm)	118 ± 10	117 ± 11	120 ± 14	NS	(P = .04)‡
Ventilation (b/min)	13 ± 3	13 ± 3	13 ± 3	NS	NS
$\dot{V}O_2$ (L/min)	.46 ± .10	.44 ± .07	.48 ± .08	NS	NS
RQ	.83 ± .04	.85 ± .05	.83 ± .05	NS	NS
Peak					
HR (bpm)	199 ± 9	199 ± 8	199 ± 9	NS	NS
Ventilation (b/min)	42 ± 7	41 ± 7	40 ± 7	NS	NS
$\dot{V}O_2$ (L/min)	1.18 ± .14	1.18 ± .16	1.19 ± .20	NS	(P = .12)† (P = .06)‡
$\dot{V}O_2$ (mL/kg/min)	43.5 ± 4.0	42.3 ± 5.3	40.8 ± 4.8	NS	(P = .02)† (P = .17)‡
RQ	1.06 ± .06	1.05 ± .06	1.03 ± .04	NS	NS
Treadmill time (min)	16.2 ± 1.3	16.1 ± 1.3	15.4 ± 1.7	NS	NS
Stage of protocol	7.6 ± .7	7.5 ± .7	7.1 ± .9	(P = .02)*	NS

NS indicates not significant; HR, heart rate.
Values are expressed as mean ± SD.
Steady-state is defined as the average of minutes 3 and 4 of the treadmill test. Stage of protocol refers to the grade and speed of the treadmill (eg, stage 7 = 22.5% grade, 2.5 mph).
* Comparison between the LN and OB groups and also when covaried for FFM.
† Comparison between black and white girls. Comparisons for $\dot{V}O_2$ (L/min) were adjusted for FFM, and FM and FFM.
‡ Comparison between black and Hispanic girls. Comparisons for $\dot{V}O_2$ (L/min) were adjusted for FFM, and FM and FFM.

these children, because high rates of obesity are seen in adult black women.

Inactivity, such as the sedentary experience of passively watching television, has been shown to be positively related to body fatness.[23,24] High levels of sedentary behavior, such as watching television, and low levels of physical activity have been related to body fatness in black girls.[25] Data from the Third National Health and Nutrition Examination Survey revealed that watching 4 or more hours/day of TV was associated with greater body fat and BMI than watching <2 hours/day.[26] Non-Hispanic black children had the highest rates of watching 4 or more hours of TV per day.[26] The black girls in this study reported watching ~3.2 hours of TV per day, which was significantly higher than the 2.3 hours per day reported by white girls. Decreasing the time spent in these sedentary activities has been shown to be effective in reducing adiposity in children.[27,28] Again, the higher levels of inactivity observed in these children may be an important modifiable factor to prevent the potential development of obesity in this high-risk population.

Ethnicity seems to be an important variable when comparing fitness in children and adolescents. A lower $\dot{V}O_2$peak has been reported in black children[9,10] and adolescents,[11] compared with white children. We did not find a significantly lower fitness in our black girls; however, the black girls tended to have a lower $\dot{V}O_2$peak after adjustment for body composition than both the white and Hispanic girls (Fig 3). Whether a lower fitness level leads to obesity is unknown and warrants further investigation.

The significant relationships between the heart rate monitoring technique and PAL indicate that the heart rate monitoring technique is a promising method to assess free-living activity. Interestingly, the amount of the day spent above the chosen heart rates was also related to the time spent in team sports, strenuous activities, and time on the treadmill. Thus, this technique has widespread applicability. Further studies would be needed to assess

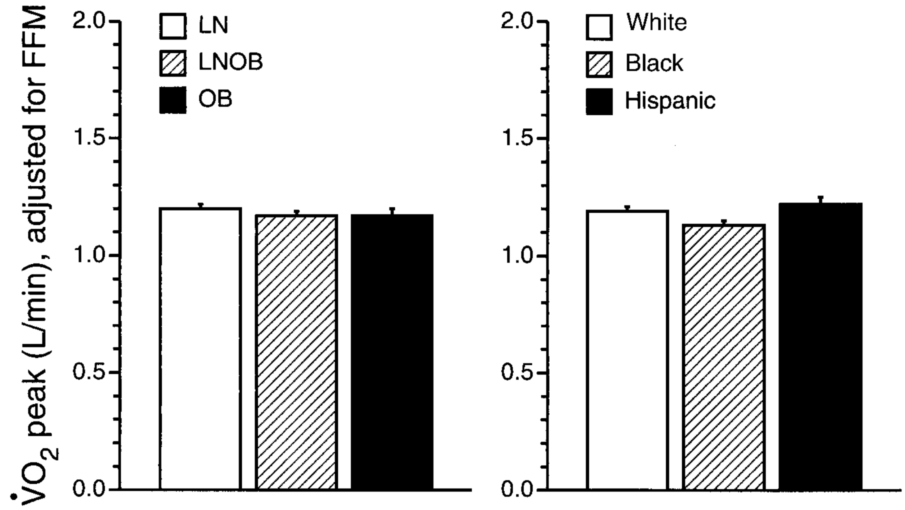

Fig 3. Adjusted for FFM, $\dot{V}o_2$peak in prepubertal girls with 2 lean parents (LN group), 1 lean and 1 obese parent (LNOB group), and 2 obese parents (OB group), or in white, black, and Hispanic girls.

whether different intensity levels (eg, >150% BHR) or more days of monitoring would improve the relationships.

Physical activity and fitness of normal-weight prepubertal girls predisposed to obesity did not differ from those of girls without a history of familial obesity; however, there was a wide range of PALs in all the groups. This study enrolled only children who were of normal-weight-for-height and between 12% and 30% body fat. It is highly possible that those children who are already obese at this age, and who were, therefore, omitted from this study, may have been very inactive. Given that children of obese parents are more likely to be obese themselves, and these obese children were omitted from the study, the comparison of our groups may be biased. Such that with respect to activity, the children of obese parents used in this study may not be representative of children of obese parents in general. The girls in this study are part of a longitudinal study examining the predictors of weight and fat gain; therefore, we could not enroll obese children. These girls will be followed for 2 years to determine whether low levels of physical activity and fitness, in combination with a predisposition to familial obesity, pose heightened risk for the development of later obesity. The results of the longitudinal aspect of the study must be awaited before any judgment can be made about the potential role of activity as a pathway through which parents transmit predisposition to obesity in their children.

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