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Youth and Young Adult Physical Activity and Body Composition of Young Adult Women: Findings From the Dietary Intervention Study in Children

Melissa Hodge,

Drexel University

Mary Hovinga,

Drexel University

Kelley Gabriel,

University of Texas

Linda Snetselaar,

University of Iowa

John Shepherd,

University of California San Francisco

Linda Van Horn,

Northwestern University

Victor Stevens,

Kaiser Permanente Center for Health Research

Brian Egleston,

Fox Chase Cancer Center

Alan Robson,

Children's Hospital, New Orleans

Seungyoun Jung,

University of Maryland

Joanne Dorgan

University of Maryland

Abstract

This study prospectively investigates associations between youth moderate-to-vigorous-intensity physical activity (MVPA) and body composition in young adult women using data from the Dietary Intervention Study in Children (DISC) and the DISC06 Follow-Up Study. MVPA was assessed by questionnaire on 5 occasions between the ages 8 and 18 years and at age 25–29 years in 215 DISC female participants. Using whole body dual-energy x-ray absorptiometry (DXA), overall adiposity and body fat distribution were assessed at age 25–29 years by percent body fat (%fat) and android-to-gynoid (A:G) fat ratio, respectively. Linear mixed effects models and generalized linear latent and mixed models were used to assess associations of youth MVPA with both outcomes. Young adult MVPA, adjusted for other young adult characteristics, was

significantly inversely associated with young adult %fat (%fat decreased from 37.4% in the lowest MVPA quartile to 32.8% in the highest (p-trend = 0.02)). Adjusted for youth and young adult characteristics including young adult MVPA, youth MVPA also was significantly inversely associated with young adult %fat ($\beta = -0.40$ per 10 MET-hrs/wk, $p = .02$). No significant associations between MVPA and A:G fat ratio were observed. Results suggest that youth and young adult MVPA are important independent predictors of adiposity in young women.

Keywords

adolescent; adiposity; female; body fat distribution

Hodge and Hovinga are with the Dept. of Epidemiology and Biostatistics, Drexel University, Philadelphia, PA. Shepherd is with the Dept. of Radiology and Biomedical Imaging, University of California, San Francisco, CA. Egleston is with the Fox Chase Cancer Center, Philadelphia, PA. Gabriel is with the Health Science Center, University of Texas, San Antonio, TX. Van Horn is with the Feinberg School of Medicine, North-western University, Chicago, IL. Robson is with the Dept. of Nephrology, Children's Hospital, New Orleans, New Orleans, LA. Snetselaar is with the Dept. of Epidemiology, University of Iowa, Iowa City, IA. Stevens is with the Kaiser Permanente Center for Health Research, Portland, OR. Jung and Dorgan are with the Dept. of Epidemiology and Public Health, University of Maryland, Baltimore, MD.

The increasing prevalence of obesity in the United States has been associated with sedentary lifestyles. Physical activity alters body composition in youth and adults (21,27,32,33). For instance, LeMura and colleagues reported that young women who participated in an aerobic training program for 16 weeks decreased their percent body fat by 13.2% while percent body fat of sedentary women remained stable (21). Similarly, Ruiz and colleagues reported that children between the ages of 9 and 10 years who participated in more vigorous intensity activity had less body fat (33). However, little is known about the long-term effects of youth physical activity on adult body composition.

To begin to address this gap in knowledge, data from the Dietary Intervention Study in Children (DISC) and the DISC06 Follow-Up Study were used to evaluate associations between usual moderate-to vigorous-intensity physical activity (MVPA) during youth and young adulthood with total adiposity and body fat distribution in young adult women.

Methods

Analyses were conducted utilizing data collected in the Dietary Intervention Study in Children (DISC). Detailed methodology and design parameters have been previously reported (8,9,28,42). Briefly, DISC was a multicenter, randomized, controlled trial designed to assess the efficacy of a dietary intervention in children to reduce low-density lipoprotein cholesterol (LDL-C) levels and the safety of the intervention to promote growth and development. The study included 362 boys and 301 girls who were 8–10 years old and had elevated LDL-C levels when they were recruited between 1988 and 1990. Participants were randomly assigned to a behavioral intervention that aimed to decrease total and saturated fat

and increase dietary fiber intake or to a usual care control group and continued on the trial for a median of 7 years. No specific intervention on physical activity was provided. In 2006–2008 when participants were 25–29 years old, the DISC06 Follow-Up Study was conducted to evaluate the longer-term effects of the intervention on biomarkers associated with breast cancer risk in female participants (10,11). The current analysis includes data from both the DISC trial and follow-up study on DISC female participants. The original DISC protocol was approved by an independent data and safety monitoring committee and by institutional review boards at all DISC clinical centers and the data coordinating center. The DISC06 protocol was approved by institutional review boards at the Fox Chase Cancer Center, all DISC clinical centers and the data coordinating center.

Participants

The DISC eligibility criteria for girls included: age between 7.8 and 10.1 years, serum LDL-C in 80th to 98th percentiles (22), no major illness, no medication that may affect blood lipids or growth, height greater than or equal to the 5th percentile and weight for height between the 5th to 90th percentile, prepubescent (Tanner stage I for breast and pubic hair development) (37), and normal cognitive and psychosocial function. Girls were excluded if they had family members who were prescribed a low-fat diet, had a parent with a history of early heart disease, had a family that was planning on moving within 3 years, or if they had known behavioral problems. The children were recruited through schools, pediatric medical practices, and health maintenance organizations and were in the trial for a median of 7 years.

All female DISC participants were invited to participate in the DISC06 Follow-up Study and 260 (86.4% of those randomized) accepted. Of the 230 participants who were not pregnant or breast feeding at or within 12 weeks before the visit, 215 had a whole body dual-energy x-ray absorptiometry (DXA) scan for assessment of body composition and were included in the current analysis.

As children all DISC participants assented to participate in the trial and informed consent was obtained from their parents or legal guardians. Informed consent was obtained from participants before the DISC06 follow-up visit.

Data Collection

Data were collected at baseline and annually thereafter in the DISC trial by trained staff who were blinded to the participants' treatment assignments. Information was obtained on demographics, medical history, use of medications, and smoking history. Height and weight were measured and BMI (body mass index = $\text{wt}(\text{kg})/\text{ht}(\text{m}^2)$) was calculated. Diet and physical activity were assessed during the DISC trial at baseline, year-1, year-3, year-5, and last visits that occurred approximately 7 years after randomization. Diet was assessed by 3 nonconsecutive 24-hr dietary recalls that were collected over a 2-week period. Nutrient analyses were performed by the Nutrition Coordinating Center at the University of Minnesota using version 20 of their database. Nutrient intake estimated from the 3 recalls was averaged to estimate mean intake at each visit. Physical activity was assessed using a questionnaire that asked participants or their parents to report the number of hours the participant usually spent during the past month on weekdays and weekend days sleeping, in

sedentary or seated activities, light or casual activities, moderate intensity or start/stop activities and vigorous intensity or sustained activities. Numbers of hours per week at each activity level were calculated by weighting weekday hours by 5 and weekend hours by 2 and summing. To estimate energy expended in MVPA in metabolic equivalent per hour per week (MET-hrs/wk), hours spent in moderate and vigorous intensity categories were weighted by an estimate of the average METs for moderate- (4 METs) and vigorous- (8 METs) intensity activity and summed.

At the DISC06 follow-up visit, participants completed a questionnaire that ascertained information on demographic characteristics, medical history, reproductive and menstrual histories, prescription and nonprescription drug use including past and current hormone use, smoking, alcohol use, family history of breast cancer and other chronic diseases, physical activity, and diet. Diet and MVPA were assessed using the same procedures described for the DISC trial except nutrient intake was estimated using the University of Minnesota's PC-based Nutrition Data System for Research. Height, weight and waist circumference were measured and whole body DXA was performed to measure body composition as described previously (10). Total adiposity was the primary outcome and was assessed as percent fat mass (%fat) estimated as $(\text{fat mass}/\text{total mass}) \times 100$. Body fat distribution was a secondary outcome and was assessed as the android:gynoid (A:G) fat ratio estimated as android fat mass/gynoid fat mass (Figure 1).

Statistical Analysis

Summary statistics such as means and standard deviations were used initially to describe the sample. Each of the outcome variables of interest (%fat and A:G fat ratio) were approximately normally distributed.

Initially, the univariate association of %fat with MVPA (MET-hrs/wk) at DISC06 follow-up visits was assessed by the Spearman correlation coefficient. Univariate associations of continuous covariates with %fat and MVPA were also assessed using Spearman correlation coefficients, while means of %fat and MVPA were compared across levels of categorical covariates using *t* tests. Covariates that were associated with %fat and MVPA at $p < .20$ in univariate analyses were considered potential confounders. Subsequently, linear mixed effects models were used to evaluate the multivariable adjusted association of MVPA with %fat including DISC clinic as a random effect and MVPA and all other variables as fixed effects. Variables included in final adjusted models are total energy intake, percent calories from carbohydrates, percent calories from fat, total dietary fiber, number of cigarettes smoked/day and number of full term pregnancies. Adjusted means were calculated by including quartiles of MVPA in the model, whereas the test for trend was conducted using the continuous MVPA variable. Multicollinearity was evaluated by calculating variance inflation factors (VIF) from simple linear regression models (4). The analysis was repeated for our secondary outcome (A:G fat ratio). Age (years), duration of hormone use (years), education (high school/ some college, bachelor's degree, and graduate degree), and DXA scanner type (Hologic, Lunar) were included as fixed effects in the multivariable adjusted model for A:G fat ratio.

Linear mixed effects models and generalized linear latent and mixed effects models (GLLAMM) (30,35) were used to evaluate associations of MVPA during youth with %fat and A:G fat ratio during young adulthood. Initially, analysis proceeded as described above to evaluate the association of MVPA at baseline, Year 1, Year 3, Year 5, and last DISC trial visits with %fat at the follow-up visit. Associations were evaluated separately for each visit using linear mixed effects models. Final models were adjusted for young adult characteristics including MVPA (MET-hrs/wk in quartiles), total energy intake (kcal), percent calories from carbohydrates, percent calories from fat, total dietary fiber (g/1000kcal), number of cigarettes/day, number of full-term pregnancies, and youth characteristics including total energy intake (kcal), percent calories from carbohydrates, total dietary fiber (g/1000kcal), and BMI expressed as a z-score relative to CDC 2000 Growth Charts (20). GLLAMM models were then used to combine the data across DISC visits to assess the association of average youth MVPA with %fat in young adulthood. These models allow for incorporation of covariates at both DISC visits during youth and at the follow-up visit. Young adult characteristics included as covariates were the same as those listed above for individual visits, while the only youth characteristics included as covariates in GLLAMM models were BMI z-score and total energy intake (kcal). The analysis was repeated for our secondary outcome (A:G fat ratio). Linear mixed effects models for each visit during youth included terms for young adult characteristics including MVPA (MET-hrs/wk), age at follow-up, duration of hormone use (years), education (high school/some college, bachelor's degree, graduate degree), type of DXA scanner, and youth characteristics including total energy intake (kcal), percent calories from carbohydrates, total dietary fiber (g/1000kcal), and BMI z-score. GLLAMM models for A:G fat ratio included as covariates the same young adult characteristics in addition to youth BMI z-score and youth total energy intake (kcal).

Effect modification of associations of MVPA with %fat and A:G fat ratio by DISC treatment group was evaluated by testing the statistical significance of their cross-products terms in linear mixed effects models that also included their main effects. All *p* values reported are 2-sided. All analysis was done utilizing Stata/IC 12.0 (College Station, TX) and SAS 9.2 (Cary, NC).

Results

The demographic, health, diet, and MVPA descriptors of participants during young adulthood at the DISC06 follow-up visit are summarized in Table 1. The mean $\pm$ *SD* age of participants was 27.2 ± 1.1 years and their mean %fat and A:G fat ratio were $35.3\% \pm 8.9\%$ and 0.38 ± 0.13 , respectively. The median reported MVPA at the follow-up visit was 72 (range: 0–392) MET-hrs/wk. Health, diet, and MVPA descriptors of participants during youth when in the DISC trial are summarized in Table 2. The average age of the participants ranged from 9.1 years at the baseline visit to 16.6 years at the last youth visit. The median reported MVPA during youth increased monotonically from 36 MET-hrs/wk at baseline to 76 MET-hrs/wk at last visits.

Energy expenditure in MVPA measured at each of the DISC visits during youth was positively correlated. Spearman correlations ranged from 0.16 to 0.39. MVPA measured at

the DISC06 follow-up visit during young adulthood was significantly positively correlated with youth MVPA only at the last DISC visit ($r = .36$; $p < .001$).

Reported MVPA at the DISC06 follow-up visit when the participants were 25–29 years old was significantly inversely associated with body composition in unadjusted and adjusted analysis. In adjusted analysis, mean percent body fat decreased monotonically from 37.4% (95% confidence interval (CI) = 35.2–39.6%) in the lowest MVPA quartile to 32.8% (95% CI = 30.5–35.1%) in the highest quartile (p-trend = 0.02).

Associations of MVPA during youth with body composition in young adulthood are also shown in Table 3. MVPA at younger ages in youth at baseline, year-1, and year-3 DISC visits was not associated with young adult %fat. In contrast, MVPA at older ages during youth when participants were teenagers was significantly inversely associated with body composition. Adjusted for characteristics during youth and young adulthood, including young adult MVPA, MVPA at the year-5 DISC visit, when participants' averaged 14 years old, was borderline significantly inversely associated with young adult body composition; %fat decreased from 35.6% (95% CI = 33.8–37.4%) in the lowest MVPA quartile to 33.7% (95% CI = 31.6–35.7%) in the highest (p-trend = 0.06). The inverse association of MVPA with %fat was stronger and statistically significant at the last visit when participants averaged 16 years old; at that visit adjusted for youth and young adult characteristics, %fat decreased from 37.7% (95% CI = 35.7–39.7%) in the lowest MVPA quartile to 33.6% (95% CI = 31.6–35.6%) in the highest (p-trend = 0.004).

We used GLLAMM to evaluate the association of MVPA during youth combined across all DISC trial visits with young adult %fat. After adjustment for BMI z-score and energy intake (kcal) during youth as well as young adult characteristics including young adult MVPA, average youth MVPA was significantly inversely associated with %fat; a 10 MET-hrs/week increase in MVPA during youth was associated with a 0.4% decrease (95% CI = -0.8 to -0.05) in young adult %fat (p-trend = 0.02).

MVPA during young adulthood was not associated with young adult A:G fat ratio in adjusted or unadjusted analysis (Table 4). In general, youth MVPA also was not associated with young adult A:G fat ratio except at the year-3 visit, when it was significantly positively associated. Adjusted for young adult characteristics including MVPA and youth characteristics, the A:G fat ratio increased from 0.37 (95% CI = 0.34–0.41) in the lowest MVPA quartile to 0.41 (95% CI = 0.38–0.45) in the highest (p-trend = 0.02). In GLLAMM analyses average youth MVPA was not associated with A:G fat ratio. Adjusted for youth BMI z-score and energy intake (kcal) and young adult characteristics including young adult MVPA, a 10 MET-hrs/week increase in MVPA during youth resulted in a 0.2% decrease (95% CI = -0.5–0.07) in A:G fat ratio (p-trend = 0.13).

Tests for effect modification of associations of MVPA with %fat and A:G fat ratio by DISC treatment group at DISC trial visits and at the DISC06 follow-up visit were not statistically significant at $p < .05$.

Discussion

The results of this prospective analysis illustrate that MVPA in youth, particularly as teenagers, is associated with body composition in young adult women, and this association is independent of young adult MVPA. MVPA at the year-5 visit, when participants were on average 14.2 years old, was significantly inversely associated with young adult %fat at 25–29 years old independent of young adult MVPA. Youth MVPA remained independently inversely associated with young adult %fat at the last visit when the average age of participants was 16.6 years. When MVPA assessed at all youth visits was combined, a 10 MET-hrs/week increase, which corresponds to approximately 2.5 hr per week of very brisk walking on a level surface (1), was associated significantly with a 0.4% decrease in young adult %fat after adjusting for young adult MVPA and other covariates. In contrast, MVPA in youth generally was not associated with body fat distribution in young adult women.

We observed an inverse association of MVPA during young adulthood with young adult adiposity. Physical activity has been significantly inversely associated with BMI in young women in several studies (2,5,36) although not all (7,13). Similar to our findings, earlier studies also have reported significant inverse associations between physical activity and percent body fat (2,3,15). Chang-Ho and Wi-Young reported that obese Korean female college students who participated in a 12-week exercise training program significantly decreased their percent body fat while the control group remained unchanged (3). Furthermore, collegiate modern dancers had significantly lower total percent body fat and lower percent fat in the android and gynoid regions compared with their more sedentary counterparts (15).

Physical activity in youth is also inversely associated with indices of body fatness in some but not all studies (16,27,32). In a review by Jimenez-Pavon and colleagues, physical activity was significantly inversely associated with children's BMI or another measure of adiposity in 38 of 48 observational studies that used device-based estimates of physical activity (e.g., accelerometry, pedometry, or heart rate monitoring), suggesting "strong evidence" of the existence of an association (16). In contrast, results of studies that rely on self-reported physical activity are less consistent with some showing inverse associations between physical activity and body composition during childhood (19) and others showing positive associations (17,25). Moreover, physical activity interventions in childhood have been mostly unsuccessful in improving BMI or girth, but this has been attributed to their small effects on children's overall activity levels (24).

Results of our study suggest that MVPA during youth may have a long-term effect on body composition in young women. Both the Amsterdam Growth and Health Study and the Cardiovascular Risk in Young Finns Study showed similar results. In an analysis of the Amsterdam Growth and Health Study, Twisk and colleagues reported that "long-term exposure" to daily physical activity during the adolescent and young adult period (ages 13–21 years) was significantly inversely related to body fatness (assessed via skinfold thickness) at age 29 years (38,39). However, unlike our findings, physical activity during the adolescent period alone (age 13–16 years) was not associated with body fatness at age 29. In addition, in an analysis of the Cardiovascular Risk in Young Finns Study by Raitakari and colleagues,

young females (age 12–18 years at baseline) who reported consistently more physical activity at three examinations over a period of six years had lower adiposity, measured via subscapular skin fold, at follow-up (age 18–25 years) than consistently inactive females. However, no differences in BMI were found (31). Thus, our results add to a growing body of literature linking physical activity in youth with adiposity in adulthood.

MVPA generally was not associated with body fat distribution in our study except at the year-3 visit when MVPA was positively associated with A:G fat ratio. This unexpected finding potentially could have been due to MVPA effects on maturation, but adjustment for Tanner stage of sexual maturation did not change the association. The association also could have been a chance finding due to multiple hypothesis testing. The overall lack of an association between MVPA and A:G fat ratio could reflect the strong genetic influence on body fat distribution (43). Alternatively, MVPA could decrease adiposity in both the android and gynoid regions resulting in no net change in the A:G fat ratio. The literature on the association of physical activity with A:G fat ratio and waist-to-hip ratio (WHR) in young women is inconsistent with positive (39), negative (23,40), and null (26) associations reported. A review paper examining the association between physical activity and abdominal fat in adults reported results of 19 randomized and 8 non-randomized controlled trials. Seven of the 10 trials that used imaging methods to quantify change in abdominal fat showed significant reductions in abdominal fat (18). In contrast, in the Amsterdam Growth and Health Study long-term exposure to daily physical activity during adolescence was positively related to waist to hip ratio (WHR) in females (39). The authors hypothesized that this paradoxical finding may be due to less active females accumulating more adiposity in their lower body or thighs, thus decreasing their WHR (39).

Our study had several limitations. DISC was not designed to evaluate the potential impact of physical activity during youth on adult behaviors or development of risk of adult chronic disease. Because data were collected as part of a multiyear dietary intervention trial, participants may not be representative of the general population. Furthermore, participants were all female and had elevated LDL-cholesterol as children. However, only 17 (8.0%) participants included in analyses had high LDL-C levels at DISC06 follow-up visits based on National Cholesterol Education Program guidelines (12), and only one participant was using cholesterol-lowering medications at that time. The study included only 215 participants, and the number of participants with data for some analyses was less, reducing power. Physical activity was self-reported by participants or, at younger ages, by their parents and is subject to error. However, child physical activity assessed by questionnaires has been reported to agree well with direct observation (percent agreement = 73.4–86.3%) (34). Similarly, adult physical activity assessed by questionnaire has been shown to correlate with direct measurement by activity monitors and doubly labeled water (6,41).

Our study also had several strengths. The data were collected prospectively, which limits the potential for recall bias. Body composition and body fat distribution were assessed by DXA, which gives accurate and precise measures of adiposity (29). The average BMI of our participants at follow-up visits was 25.0 kg/m², which is similar to the mean BMI of 24.3 kg/m² in 20–29 year old females in the US (14). In addition, dietary intake was assessed by three 24-hr recalls at each visit and could be adjusted for in the analysis.

In conclusion, results of this prospective study suggest that physical activity during youth, particularly in the teen years, is an independent inverse predictor of adiposity in young women. Additional research is needed to identify the mechanism underlying this association and to determine if it translates into effects on chronic disease later in life. Comparable studies in males also are warranted.

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Figure 1 —.
DXA scanned image. The white highlights the android region and the grey highlights the gynoid region.

Table 1
Demographic, Health, Diet, and MVPA Descriptors for 215 Female Participants at the DISC06 Follow-Up Study

Descriptors	Mean (SD)
age (years)	27.2 (1.1)
% body fat	35.3 (8.9)
A:G fat ratio	0.38 (0.13)
BMI (kg/m ²)	25.0 (5.0)
parity	0.4 (0.8)
total energy intake (kcal)	1785 (928)
fat intake (%kcal) ^a	31.2 (7.5)
carbohydrate intake (%kcal) ^a	50.4 (9.1)
total dietary fiber (g/1000 kcal) ^a	9.0 (3.8)
Median (IQR)	
moderate- to vigorous- intensity physical activity (MET-hrs/wk)	72(28–124)
N (%)	
Smoking status	
current	57 (26.5%)
former	44 (20.5%)
never	114 (53.0%)
Race	
white	194 (90.2%)
black	13 (6.0%)
other	8 (3.7%)
Education	
high school	22 (10.2%)
some college	46 (21.4%)
bachelor's degree	113 (52.6%)
graduate degree	34 (15.8%)

^a N = 204

Table 2
Demographic, Health, Diet, and MVPA Descriptors of Female Participants Over the 5 Youth DISC Visits

Descriptors	Visit				
	Baseline	Year 1	Year 3	Year 5	Last
<i>N</i>	215	203	191	173	189
Age (years) ^a	9.1 (0.6)	10.2 (0.6)	12.2 (0.6)	14.2 (0.6)	16.6 (0.9)
BMI z-score ^{a,b}	0.18 (0.88)	0.20 (0.90)	0.25 (0.95)	0.35 (0.90)	0.25 (0.93)
Total energy (kcal) ^{a,c}	1658.7 (393.2)	1586.0 (390.8)	1638.8 (453.1)	1649.5 (446.3)	1663.0 (621.6)
Carbohydrates (%kcal) ^{a,c}	52.8 (6.1)	55.2 (7.0)	54.8 (6.9)	57.6 (7.0)	58.1 (7.6)
Fat (%kcal) ^{a,c}	33.9 (5.0)	30.8 (6.2)	30.9 (5.8)	28.9 (6.2)	28.0 (7.0)
Total Fiber (g/1000 kcal) ^{a,c}	6.2 (1.8)	6.6 (2.0)	6.5 (1.9)	6.5 (1.9)	6.8 (2.5)
MVPA (MET-hrs/wk) ^d	36 (18–66)	44 (28–78)	56 (26–92)	70 (34–112)	76 (28–142)

Note. Moderate- to vigorous-intensity physical activity = MVPA..

^aMean (*SD*)

^bNumber of participants with BMI z-score at year-3 = 190 and last visit = 188

^cNumber of participants with dietary data at baseline = 211, Year 1 = 197, Year 3 = 190, Year 5 = 166 and last visits = 182

^dMedian (IQR).

Table 3

Unadjusted and Adjusted Mean % Body Fat by Moderate- to Vigorous-Intensity Physical Activity Quartile During the DISC06 Follow-Up Visit and Youth DISC Visits

Variables by Visit	Physical Activity Quartile				<i>p</i>
	1	2	3	4	
Follow-Up Visit					
Range (MET-hrs/week)	0–28	32–72	76–124	128–392	
mean % body fat (unadjusted)	38.0	36.5	34.5	32.2	.003
(95% CI)	(35.9–40.1)	(34.0–38.9)	(32.0–36.9)	(29.7–34.7)	
<i>p</i> (<i>n</i> = 215)	ref	.36	.04	.001	
mean % body fat (adjusted) ^a	37.4	36.8	34.5	32.8	.02
(95% CI)	(35.2–39.6)	(34.6–39.0)	(32.2–36.8)	(30.5–35.1)	
<i>p</i> (<i>n</i> = 204)	ref	.70	.08	.006	
Baseline Visit					
Range (MET-hrs/week)	0–18	20–36	38–66	68–274	
mean % body fat (unadjusted)	36.1	35.8	35.2	34.1	.26
(95% CI)	(33.8–38.4)	(33.3–38.2)	(32.8–37.6)	(31.5–36.8)	
<i>p</i> (<i>n</i> = 215)	ref	.84	.60	.25	
mean % body fat adjusted for adult and youth characteristics ^b	35.3	35.3	35.1	36.1	.89
(95% CI)	(33.2–37.3)	(33.4–37.2)	(33.1–37.1)	(34.0–38.2)	
<i>p</i> (<i>n</i> = 200)	ref	.99	.92	.60	
Year 1 Visit					
Range (MET-hrs/week)	0–28	30–44	46–78	80–308	
mean % body fat (unadjusted)	35.9	35.3	33.9	35.8	.47
(95% CI)	(33.5–38.2)	(32.8–37.9)	(31.3–36.5)	(33.1–38.5)	
<i>p</i> (<i>n</i> = 203)	ref	.77	.26	.96	
mean % body fat adjusted for adult and youth characteristics ^b	35.4	34.8	35.9	35.2	.92
(95% CI)	(33.5–37.3)	(32.6–37.0)	(33.8–38.0)	(33.0–37.4)	
<i>p</i> (<i>n</i> = 186)	ref	.66	.77	.86	
Year 3 Visit					

Variables by Visit	Physical Activity Quartile				<i>p</i>
	1	2	3	4	
Range (MET-hrs/week)	0–26	28–56	60–92	94–296	
mean % body fat (unadjusted)	36.9	34.2	33.7	35.5	.62
(95% CI)	(34.6–39.1)	(31.5–36.8)	(31.0–36.4)	(32.6–38.4)	
<i>p</i> (<i>n</i> = 191)	ref	.13	.09	.48	
mean % body fat adjusted for adult and youth characteristics ^b	36.1	34.6	35.1	35.3	.71
(95% CI)	(34.2–38.0)	(32.7–36.4)	(33.1–37.1)	(33.1–37.4)	
<i>p</i> (<i>n</i> = 181)	ref	.26	.48	.57	
Range (MET-hrs/week)	0–34	36–70	72–112	116–348	
mean % body fat (unadjusted)	35.8	35.3	36.0	33.2	.10
(95% CI)	(33.2–38.4)	(32.4–38.1)	(33.5–38.6)	(29.9–36.6)	
<i>p</i> (<i>n</i> = 173)	ref	.79	.90	.21	
mean % body fat adjusted for adult and youth characteristics ^b	35.6	36.3	35.8	33.7	.06
(95% CI)	(33.8–37.4)	(34.4–38.2)	(34.1–37.5)	(31.6–35.7)	
<i>p</i> (<i>n</i> = 159)	ref	.60	.87	.17	
Last Visit					
Range (MET-hrs/week)	0–28	30–76	80–142	148–432	
mean % body fat (unadjusted)	36.7	37.5	33.2	33	.01
(95% CI)	(34.2–39.2)	(34.7–40.2)	(30.8–35.6)	(30.4–35.6)	
<i>p</i> (<i>n</i> = 189)	ref	.67	.05	.04	
mean % body fat adjusted for adult and youth characteristics ^b	37.7	36.1	33.3	33.6	.004
(95% CI)	(35.7–39.7)	(34.0–38.2)	(31.1–35.4)	(31.6–35.6)	
<i>p</i> (<i>n</i> = 171)	ref	.27	.004	.006	

^a Adjusted for total energy (kcal), % calories from carbohydrates (kcal), % calories from fat (kcal), total dietary fiber (g/1000kcal) # cigarettes/day, #full term pregnancies

^b Adjusted for adult characteristics: quartile moderate and intense physical activity (MET-hrs/wk), total energy (kcal), % calories from carbohydrates (kcal), % calories from fat (kcal), total dietary fiber (g/1000kcal) # cigarettes/day, #full term pregnancies; and youth characteristics: total energy (kcal), % calories from carbohydrates (kcal), total dietary fiber (g/1000kcal), BMI z-score

Table 4
Unadjusted and Adjusted Mean A:G Fat Ratio by Exercise Quartile During the DISC06 Follow-Up Visit and Youth DISC Visits

Variables by Visit	Physical Activity Quartile				<i>p</i>
	1	2	3	4	
Follow-Up Visit					
Range (MET-hrs/week)	0–28	32–72	76–124	128–392	
mean A:G fat ratio (unadjusted)	0.40	0.39	0.38	0.36	.27
(95% CI)	(0.36–0.44)	(0.36–0.43)	(0.35–0.42)	(0.32–0.40)	
<i>p</i> (<i>n</i> = 215)	ref	.72	.48	.10	
mean A:G fat ratio adjusted ^a	0.40	0.40	0.38	0.36	.24
(95% CI)	(0.36–0.43)	(0.37–0.43)	(0.35–0.42)	(0.32–0.39)	
<i>p</i> (<i>n</i> = 215)	ref	.92	.58	.10	
Baseline Visit					
Range (MET-hrs/week)	0–18	20–36	38–66	68–274	
Mean A:G fat ratio (unadjusted)	0.39	0.37	0.39	0.39	.97
(95% CI)	(0.36–0.42)	(0.34–0.40)	(0.35–0.43)	(0.35–0.42)	
<i>p</i> (<i>n</i> = 215)	ref	.48	.84	.92	
mean A:G fat ratio adjusted for adult and youth characteristics including ^b	0.38	0.37	0.4	0.4	.37
(95% CI)	(0.34–0.41)	(0.33–0.40)	(0.37–0.43)	(0.37–0.43)	
<i>p</i> (<i>n</i> = 211)	ref	.62	.38	.34	
Year 1 Visit					
Range (MET-hrs/week)	0–28	30–44	46–78	80–308	
Mean A:G fat ratio (unadjusted)	0.37	0.39	0.38	0.4	.82
(95% CI)	(0.34–0.41)	(0.35–0.43)	(0.35–0.41)	(0.36–0.44)	
<i>p</i> (<i>n</i> = 203)	ref	.61	.90	.31	
mean A:G fat ratio adjusted for adult and youth characteristics ^b	0.38	0.39	0.39	0.39	.95
(95% CI)	(0.35–0.41)	(0.35–0.42)	(0.36–0.42)	(0.36–0.42)	
<i>p</i> (<i>n</i> = 197)	ref	.86	.73	.70	
Year 3 Visit					
Range (MET-hrs/week)	0–26	28–56	60–92	94–296	

Variables by Visit	Physical Activity Quartile				<i>p</i>
	1	2	3	4	
mean A:G fat ratio (unadjusted)	0.39 (0.36–0.43)	0.37 (0.34–0.41)	0.37 (0.33–0.40)	0.41 (0.37–0.46)	.38
(95% CI)					
<i>p</i> (<i>n</i> = 191)	ref	.39	.29	.54	
mean A:G fat ratio adjusted for adult and youth characteristics ^b	0.37 (0.34–0.41)	0.38 (0.35–0.41)	0.39 (0.35–0.42)	0.41 (0.38–0.45)	.02
(95% CI)					
<i>p</i> (<i>n</i> = 189)	ref	.76	.62	.12	
Range (MET-hrs/week)	0–34	36–70	72–112	116–348	
mean A:G fat ratio (unadjusted)	0.37 (0.33–0.41)	0.39 (0.34–0.43)	0.41 (0.38–0.45)	0.36 (0.31–0.40)	.40
(95% CI)					
<i>p</i> (<i>n</i> = 173)	ref	0.64	0.12	0.57	
Mean A:G fat ratio adjusted for adult and youth characteristics ^b	0.37 (0.34–0.40)	0.4 (0.36–0.43)	0.41 (0.38–0.44)	0.36 (0.32–0.39)	.95
(95% CI)					
<i>p</i> (<i>n</i> = 166)	ref	.29	.06	.56	
Last Visit					
Range (MET-hrs/week)	0–28	30–76	80–142	148–432	
mean A:G fat ratio (unadjusted)	0.38 (0.35–0.42)	0.39 (0.34–0.43)	0.37 (0.33–0.40)	0.37 (0.34–0.41)	.52
(95% CI)					
<i>p</i> (<i>n</i> = 189)	ref	.94	.51	.72	
mean A:G fat ratio adjusted for adult and youth characteristics ^b	0.39 (0.36–0.42)	0.38 (0.35–0.41)	0.36 (0.33–0.40)	0.38 (0.35–0.41)	.58
(95% CI)					
<i>p</i> (<i>n</i> = 181)	ref	.67	.29	.70	

^a Adjusted for age at visit (years), duration of hormone use (years), education (high school/some college, bachelor's degree, graduate degree), DXA scanner type (hologic, lunar)

^b Adjusted for adult characteristics: moderate and intense physical activity (MET-hrs/wk), age at visit (years), duration of hormone use (years), education (high school/some college, bachelor's degree, graduate degree), DXA scanner type (hologic, lunar); and youth characteristics: total energy (kcal), % calories from carbohydrates (kcal), total dietary fiber (g/1000kcal), BMI z-score