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Longitudinal Changes in Body Composition by Dual Energy X-Ray Absorptiometry Among Perinatally HIV-Infected and HIV-Uninfected Youth: Increased Risk of Adiposity Among HIV-Infected Female Youth

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Abstract

Background—Combination antiretroviral therapy (cART) has allowed youth with perinatal HIV infection (PHIV+) to live into adulthood, but many youth may experience metabolic and body composition changes that predispose to greater cardiovascular disease (CVD) risk. This longitudinal study evaluated changes in body composition measured by dual x-ray absorptiometry (DXA) in a cohort of PHIV+ youth compared to HIV– controls over a 7-year period.

Methods—PHIV+ youth and HIV– controls were prospectively enrolled in a single-site study to assess nutrition and CVD risk. Anthropometrics and DXA scans were longitudinally obtained to assess percent body fat and regional fat distribution. Using general linear models, we analyzed differences in body composition and anthropometric measures by sex between PHIV+ youth and controls over time.

Results—235 participants (156 PHIV+, 79 HIV– controls) with at least one DXA performed since study enrollment were included for analysis. During the study period, 471 DXAs were

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obtained in the PHIV+ group and 95 in HIV– controls. PHIV+ females demonstrated greater increase in weight and BMI over time compared to HIV– females, and significant increases in total percent body fat (estimate=1.212 [95%CI=0.837, 1.587] percent per year, $p<0.001$) and percent trunk fat (1.3818 [95%CI=0.922, 1.84], $p<0.001$) compared to HIV– females and PHIV+ males.

Conclusion—PHIV+ females demonstrate an unfavorable change in fat redistribution and percent body fat over time that exceeds the pattern seen in PHIV+ males or HIV– females. Providers should have heightened awareness of body composition changes of PHIV+ females that may eventually lead to increased CVD risk.

Keywords

HIV; dual X-ray absorptiometry; body composition; youth

Introduction

Combination antiretroviral therapy (cART) has transformed human immunodeficiency virus (HIV) infection from a fatal to a chronic condition. As perinatally-acquired HIV-infected (PHIV+) youth live longer, they can experience metabolic abnormalities, including insulin resistance, lipid abnormalities, and body composition changes that may be attributed to prolonged exposure to antiretroviral medications, as well as HIV itself [1–3]. These metabolic abnormalities may, in turn, lead to increased cardiovascular disease (CVD) risk. Both peripheral fat wasting, or lipoatrophy, and central fat accumulation, or lipohypertrophy, have been described in PHIV+ youth, primarily associated with the use of specific antiretroviral medications [4, 5].

Studies in HIV-infected adults have shown an increase not only in CVD risk, but also in adverse cardiovascular outcomes such as myocardial infarction and stroke, that may be attributed both to HIV infection as well as traditional risk factors such as obesity, smoking, and genetic factors [6]. PHIV+ youth may be especially vulnerable, given their exposure to the virus since birth or in utero, and prolonged exposure to cART. The Bogalusa Heart study and others have described the association between childhood measures of central adiposity and other CVD risk factors, including hypertension, dyslipidemia, and insulin sensitivity with adverse CVD outcomes later in life [7–12]. Thus, it is important to track childhood body composition changes over time to help determine eventual CVD risk. The use of dual energy x-ray absorptiometry (DXA) to quantify body fat distribution in HIV+ individuals has emerged as an important tool to measure trunk fat, limb fat, and total body fat, and can therefore characterize peripheral and central fat accumulation [13–15]. Several cross-sectional and limited longitudinal studies have evaluated body composition by DXA in PHIV+ youth [3, 13, 16]. Studies following the trajectory of body composition changes in PHIV+ youth over long periods of time are lacking, however an understanding of longitudinal changes is especially important as these youth progress through multiple cART regimens and puberty.

In this prospective, longitudinal study we evaluated changes in body composition as measured by DXA in a large cohort of PHIV+ youth compared to HIV– controls over a 7-year period.

Materials and Methods

Study population and inclusion criteria

HIV+ children and adolescents followed in the Pediatric Special Immunology Program at the University of Miami Miller School of Medicine, as well as HIV-uninfected subjects (HIV–), were enrolled since August 2004 in a National Institutes of Health (NIH)-sponsored (NIDDK# P01DK45734; NHLBI# 1R01HL095127-01) longitudinal cohort study to evaluate CVD risk in perinatally HIV-infected youth. HIV infection was confirmed by repeated positive serum enzyme-linked immunosorbent assays and Western blot assays, repeated positive HIV RNA or DNA polymerase chain reaction assays, or HIV culture. The HIV– control subjects were a convenience group identified from the family members of the HIV+ cohort or from an urban general pediatrics outpatient program at the University of Miami that cares for youth of similar socioeconomic backgrounds. Control group participants had completed the screening process for perinatal HIV acquisition and were determined to be uninfected. Since we were enrolling these control participants as a convenience sample of individuals with a family or social connection to our HIV-infected participants, we did not match for age, sex, or race. HIV– subjects were excluded from enrollment if they had any other chronic illnesses or an acute infectious process.

The Human Subjects Research Office at the University of Miami approved the research protocol (protocol number 20030814), and written, informed consent from the parent or guardian and assent from the patient (when appropriate) were obtained.

Data collection

For this analysis, we included data from 235 study participants (156 PHIV+ and 79 HIV– controls) who had at least one DXA performed since study enrollment. The longitudinal study began enrolling participants in August 2004. DXA studies for evaluation of bone mineral density and body composition were added in 2005, and since then annual DXA visits have been targeted as a part of clinical care.

Sociodemographic data, anthropometric measurements, and detailed history relating to HIV disease, antiretroviral medications, and dietary intake/nutritional interventions were collected in the PHIV+ cohort. Clinical data for PHIV+ participants including disease stage [17], antiretroviral use at the time of the clinical visit, CD4+ T lymphocyte frequency (CD4%), and HIV RNA PCR (viral load) were measured as part of routine clinical care, typically every 3 to 6 months, and were recorded by study staff (DN, JKV). Height (recorded to the nearest 0.1 cm) and weight (recorded to the nearest 0.1 kg) were measured by study staff trained in applying standardized anthropometric methods [18]. BMI was calculated as weight (kg)/height² (m) [19]. Waist and hip circumferences (cm) were measured with a nonstretchable plastic tape measure according to standard methods. Waist-

hip ratio (WHR) was calculated as the waist circumference (cm) divided by the hip circumference (cm) [20].

Tanner staging was assessed as part of the clinical care visit by clinicians who routinely evaluate growth and development in our population. Tanner stage was determined by inspection of breasts and pubic hair for females and of genitalia and pubic hair for males, and was documented as part of the physical exam for each patient until Tanner stage 5 was reached. In our sample, documentation of Tanner stage was not consistently available for each clinical visit. For the purpose of analysis, therefore, we included Tanner stage within 3 broader categories – Tanner 1, Tanner 2–4, and Tanner 5 to characterize patients as pre-pubertal (Tanner 1), experiencing puberty (Tanner 2–4), or fully mature (Tanner 5).

DXA measurements

Total and regional body DXA scans were performed on a Lunar (General Electric Health Care) scanner and all scans were analyzed using Lunar GE enCORE 2006 v10.50.086 software. DXA measurements included total body mass (kg), fat mass (kg), and lean mass (kg). The body was divided into regions to measure extremity fat (kg) and trunk fat (kg). The trunk was segmented by placing regions of interest between the bottom of the chin and the top of the shoulders, through the gleno-humeral joint to separate the arms, and at the acetabulofemoral joint line to separate the legs.

Percent body fat was calculated by dividing total body fat (kg) by total body mass (kg) and multiplying by 100. Regional percentage fat measurements were calculated as the amount of fat in the region (kg) divided by total body fat (kg) and then multiplying by 100. These regional measurements included percentage extremity fat and percentage trunk fat. Trunk to extremity fat ratio was calculated as trunk fat (kg) divided by extremity fat (kg). Similarly, trunk to total fat ratios and extremity to total fat ratio were calculated by the trunk or extremity fat (kg) divided by total fat (kg).

Statistical Analysis

The sample size of 79 HIV– controls and 156 PHIV+ children (smallest group sizes for baseline comparisons of anthropometric measures yielded 80% power to detect a moderate effect size of 0.39, using a two-tailed t-test at the 0.05 alpha level. Demographic characteristics of the study cohort, including mean age, sex, and race distribution were reported. T-tests and Chi-square (exact test when appropriate) were used to test for significant differences between the PHIV+ and HIV– groups. We used a general linear model to compare differences in the following baseline outcomes between the two groups while adjusting for age, sex, race, and Tanner stage: weight, height, BMI, waist-to-hip (WHR) ratio, DXA body composition measures (percent total fat, percent extremity fat, percent trunk fat, trunk to extremity (TE) fat ratio, extremity to total fat ratio, trunk to total fat ratio). After initial univariable analysis, we used a general linear mixed model to explore the trajectories of the outcome variables over time (age). The model included fixed effects for group, sex, the interaction of sex and group, and age nested within the group*sex interaction. The nested age effect yielded separate estimates of intercept and slope for each group*sex combination. Based on differences noted between HIV+ participants and HIV–

controls at baseline, categorical covariates for race and Tanner stage were included to adjust the regression parameters of possible confounding effects. The random effect was the intercept with subjects as individuals nested within the group*sex interaction to account for the multiple measures within a person. A variance component covariance matrix was chosen to represent the correlated data structure because it gave the smallest AIC fit statistic. SAS 9.3 (SAS Institute Inc.; Cary, NC) was used for all analyses. The two-tailed 0.05 alpha level is used to determine statistical significance.

Results

A total of 235 children, 156 PHIV+ and 79 HIV– controls were included in our analysis. Between July 2005 and July 2012, 471 DXAs were obtained in the PHIV+ group and 95 DXAs were obtained in the control group. The median number of DXAs per patient was 3.0 (range 1–7 DXAs) over a median of 2.6 years (range 0–6.6 years) for the PHIV+ group, and 1.0 DXAs (range 1–3 DXAs) over a median of 0.2 years (range 0–3 years) for the HIV– participants. Demographic characteristics of the study participants at baseline by HIV status are shown in Table 1. The analysis assumptions for the t-test of age were met as were the assumptions for the Chi-square test of sex, ethnicity, and Tanner stage; however, we used an exact Pearson Chi-square test for race because 33% of the cells in the test for race had expected values less than five. We found no significant differences in age ($p=0.161$), or ethnicity ($p=0.065$) between the two groups; however, the PHIV+ group included significantly more individuals of black race (includes African-American participants and black Hispanic participants, $p=0.004$) and females ($p=0.021$) and a more advanced Tanner stage ($p=0.009$) compared to HIV– participants. Most study participants in both the PHIV+ and control groups were in their early teens at the time of enrollment, and the majority of PHIV+ participants were receiving cART. Baseline anthropometric characteristics and body composition measures of the study participants by HIV status are shown in Supplemental Digital Content 1 (table). PHIV+ youth had significantly lower weight and BMI at baseline compared to HIV– youth. Total percent body fat was also lower in PHIV+ individuals compared to controls at baseline. However, the trunk to total fat ratio was higher in PHIV+ compared to controls and the extremity to total fat ratio was lower, indicating that PHIV+ individuals had more peripheral fat wasting rather than globally lower percent body fat at baseline.

Change in anthropometry and body composition by DXA over time

Table 2 and Supplemental Digital Content 2 (figure) demonstrate the estimate changes and the overall trajectories, respectively, of anthropometric measures in the PHIV+ and HIV– groups stratified by sex. No significant differences in height trajectory were noted between PHIV+ females and control females, or PHIV+ males and control males (Supplemental Digital Content 2a). PHIV+ females demonstrated a greater increase in weight and BMI over time compared to control females (Supplemental Digital Content 2b and 2c). No significant changes over time were noted within groups for WHR (Supplemental Digital Content 2d).

Table 3 and Supplemental Digital Content 3 and 4 (figures) demonstrate the estimate change and the overall trajectory, respectively, of DXA measures in the PHIV+ and HIV–

populations stratified by sex. Similar to the anthropometric analyses, significant overall and within group differences are indicated as part of the figures. Most notably, PHIV+ females demonstrated significant increases over time from baseline in total percent body fat (parameter estimate [95% confidence interval] = 1.212 [0.837, 1.587], percent per year, $p < 0.001$) (Supplemental Digital Content 3a) and percent trunk fat (1.3818 [0.922, 1.84] percent per year, $p < 0.001$) (Supplemental Digital Content 3b). Percent fat in the extremities did not significantly change over the study interval in any of the groups (Supplemental Digital Content 3c). The increase in body and trunk fat in females was also significantly different from changes seen among the other groups. There were significant increases from baseline in trunk to total fat ratios among PHIV+ females (0.0026 [0.0013, 0.004], $p < 0.001$) and HIV– males (0.0032 [0.0012, 0.0051], $p = 0.002$) (Supplemental Digital Content 4a) during the study period. No significant changes over time were noted within groups for trunk to extremity fat ratio and extremity to total fat ratio (Supplemental Digital Content 4b, 4c).

Discussion

This study highlights changes in body composition by DXA in a cohort of PHIV+ and HIV– youth over a 7-year period. We noted remarkable differences over time among PHIV+ females in our cohort. Overall, PHIV+ females demonstrated greater weight gain and increase in BMI over time compared to HIV– controls, as well as significantly greater increases in total percent body fat and trunk fat than PHIV+ males and HIV– controls.

Whereas PHIV+ males demonstrated a trajectory of growth and body composition that is comparable to HIV– controls, longitudinal evaluation of PHIV+ females during our study period revealed an alternate trajectory with significant gains in percent trunk fat, total percent body fat, weight, and BMI over time that exceeds values in PHIV+ and HIV– males, as well as HIV– female controls. These findings indicate that PHIV+ females demonstrate not only fat redistribution, but also a global increase in body fat over time. Increasing weight and BMI over time suggests that the increase in total percent body fat among PHIV+ females can be in part explained by generalized weight gain. However there is a preferential increase in trunk fat (compared to the extremities) in PHIV+ females, suggesting a rise in CVD risk over time.

Previous studies have also noted body composition differences in PHIV+ vs. HIV– youth based on sex [3]. In a cross-sectional analysis, Jacobson et al. reported that PHIV+ males, as well as uninfected males from the National Health and Nutrition Examination Survey (NHANES) overall have lower total percent body fat compared to females. However, longitudinal studies in the pediatric PHIV+ population characterizing sex-specific differences in the trajectory of body composition changes and CVD risk have been lacking to date. Our findings are concerning in light of studies in the adult population describing significant increases in CVD risk over time among HIV+ women compared to HIV– women, even after adjusting for other CVD risk factors including hypertension, smoking, obesity, diabetes, and lipid profiles [21]. Other studies which have included both adult men and women have shown a more significant increase in relative risk of CVD among HIV+ women than in HIV+ men when compared to their respective HIV– controls, possibly due to alterations in inflammatory markers in women [22–24].

The impact of cART on improving growth in PHIV+ children has been well-described [25–27], but PHIV+ youth overall continue to have less extremity fat, trunk fat, and percent total body fat by DXA than its HIV– counterpart [3, 13, 16]. Although in our study PHIV+ youth overall demonstrate borderline lower trunk fat at baseline, the ratios of trunk to extremity fat and trunk to total fat are significantly higher in PHIV+ compared to HIV– youth suggesting a greater likelihood of truncal adiposity in the PHIV+ group. Height, weight, and BMI are also reported to be lower among PHIV+ youth compared to uninfected youth [28]. We similarly found that our PHIV+ youth overall have lower height, weight, and BMI and percent extremity fat at baseline than uninfected youth.

Within the general population, increased calorie intake, decreased physical activity, and stress or anxiety, including concerns about food insecurity, are known risk factors for overweight and obesity [29, 30]. Adolescent females, in particular, experience psychosocial challenges and mental health issues which may also predispose them to become overweight. In addition, the prevalence of obesity is markedly higher among non-Hispanic black adults, with studies showing similar racial distribution among adolescents [31]. Each of these factors, along with the potential influence of cART and HIV infection itself, likely contributes to the pattern we see within our cohort of PHIV+ females. Earlier work by our group has shown that PHIV+ youth consume more total energy than the suggested estimated energy requirements, including a higher percentage of energy from carbohydrates, following a similar pattern as has been described in otherwise healthy pediatric populations [32]. In particular, we found that PHIV+ females have increased consumption of carbohydrates and added sugars at levels that are significantly higher than PHIV+ males. Dietary intake data from NHANES III has previously demonstrated that overall energy consumption in children has not changed significantly when compared to data from NHANES I and NHANES II, but that energy intake among adolescent females has increased considerably [33]. In all groups, the proportion of caloric intake from fats has declined over time while the proportion of calories from carbohydrates, particularly sweetened beverages, has increased. Given the observations from NHANES, in combination with emerging data regarding the potential impact of high carbohydrate diets on CVD risk [34, 35], and the secular trend of a general increase energy intake by adolescent females over time, the data from our study illustrates a concerning phenomenon among PHIV+ adolescent females.

Although physical activity is considered an important modifier of CVD risk, PHIV+ adolescents may exhibit diminished exercise capacity evidenced by reduced peak oxygen consumption, decreased flexibility, and lower extremity strength-to-weight ratios [36]. This observation further complicates the ability to address the body composition changes we are observing in PHIV+ females. While these young women remain healthy from the perspective of their HIV infection, the heightened risk of obesity and premature CVD in this population will require the development of targeted interventions that take into account the many complex metabolic, dietary, and activity-associated factors that likely drive the alarming body composition trends we have identified. Furthermore, as suggested in adult studies, greater immune activation in HIV+ women, depression, and decreased estrogen states such as may be seen with substance abuse in younger women, may all further contribute to CVD risk [37, 38].

The strengths of our study include its longitudinal design of seven years duration, large sample size compared to prior studies, and consistent study personnel over the length of the study reducing interobserver variability in study measures. Our study did have some limitations in that we had fewer longitudinal observations for the HIV– control population. This increased the standard errors for controls and lowered statistical power. In spite of this limitation, we were still able to detect significant differences between the groups. We did not include details of the antiretroviral medications that our PHIV+ cohort received during the study period, given the tremendous variability of antiretroviral combinations and difficulty in accounting for medication changes at different intervals. While some previous studies have characterized the impact of individual antiretroviral medications, particularly stavudine, on body composition changes in PHIV+ children [3, 13], the interpretation of the effect of stavudine alone on body composition changes is difficult; nearly 100% of our population has received this medication previously yet body composition changes vary greatly among PHIV+ individuals. Future studies should be directed toward longitudinally assessing body composition changes in the context of other clinical CVD risk parameters in PHIV+ youth, including laboratory measures.

In conclusion, the findings from this large, longitudinal study of body composition changes measured by DXA among PHIV+ and HIV– children over time demonstrate a striking difference in body fat accrual between PHIV+ adolescent females compared to other youth. These findings are critically important in informing our approach not only to disease-specific management in this population, but also to nutritional management and overall interventions aimed toward reducing CVD risk, particularly as these youth continue to age and transition to adult care settings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic characteristics of study participants at baseline by HIV status

Participant characteristics		HIV positive (n = 156)	HIV negative (n = 79)	p-Value
Mean age (95% CI), years		14.0 (12.2 – 14.1)	13.1 (13.3 – 14.7)	0.161 ¹
Female sex (%)		86 (55)	31 (39)	0.021 ²
Race	Black (%)	122 (78)	46 (58)	0.004 ³
	White (%)	31 (20)	32 (40)	
	Other (%)	3 (2)	1 (2)	
Ethnicity	Hispanic (%)	34 (22)	26 (33)	0.065 ²
	Non-Hispanic (%)	122 (78)	53 (67)	
Tanner stage	1	14 (18)	31 (20)	0.009 ²
	2–4	40 (51)	48 (31)	
	5	25 (31)	77 (49)	
Antiretroviral therapy during study period	cART (%)	147 (94)	-----	
	Non-cART/no therapy (%)	9 (6)		
Median (interquartile range) CD4+ T cell frequency [CD4%]		30 (19 – 36)	-----	
Undetectable viral load (%)		74 (48)	-----	

CI 95% confidence interval; cART combination antiretroviral therapy

¹T-test²Chi-square³Exact Pearson Chi-square

Table 2

Longitudinal changes in anthropometric measures (adjusted ^{*})

Anthropometric measures	Group	Intercept				Slope				Pairwise comparisons of slopes by group (P-value)			
		Estimate	L95%	U95%	p	Estimate	L95%	U95%	p	CF	CM	HF	
Height (cm)	C F	2.14	0.87	3.41	0.001	-0.1917	-0.2773	-0.1061	<0.001	.	.	.	
	C M	1.17	-0.25	2.59	0.103	-0.0949	-0.2038	0.0139	0.087	0.186	.	.	
	H F	0.25	-0.49	0.99	0.499	-0.0573	-0.1031	-0.0115	0.014	0.022	0.205	.	
	H M	0.89	0.08	1.69	0.032	-0.1076	-0.1573	-0.0578	<0.001	0.128	0.182	0.229	
Weight (kg)	C F	2.41	0.42	4.40	0.018	-0.1181	-0.2537	0.0176	0.088	.	.	.	
	C M	1.53	0.05	3.01	0.042	-0.0661	-0.1817	0.0494	0.261	0.712	.	.	
	H F	-0.14	-0.93	0.66	0.729	0.0242	-0.0295	0.0780	0.375	0.024	0.436	.	
	H M	0.69	-0.37	1.74	0.197	-0.0442	-0.1172	0.0288	0.234	0.042	0.134	0.180	
BMI (kg/m ²)	C F	2.08	0.45	3.72	0.013	-0.0791	-0.1949	0.0368	0.180	.	.	.	
	C M	1.60	0.13	3.06	0.034	-0.0678	-0.1821	0.0466	0.244	0.550	.	.	
	H F	-0.05	-0.68	0.57	0.864	0.0378	-0.0031	0.0787	0.070	0.016	0.443	.	
	H M	0.76	-0.06	1.58	0.068	-0.0241	-0.0809	0.0326	0.403	0.083	0.409	0.141	
Waist/hip ratio	C F	0.92	0.84	1.00	<0.001	-0.0047	-0.0109	0.0014	0.132	.	.	.	
	C M	0.86	0.79	0.92	<0.001	0.0006	-0.0043	0.0054	0.821	0.389	.	.	
	H F	0.88	0.84	0.92	<0.001	0.0006	-0.0026	0.0038	0.711	0.054	0.130	.	
	H M	0.91	0.85	0.97	<0.001	-0.0011	-0.0051	0.0030	0.597	0.205	0.035	0.570	

^{*} Anthropometric measures adjusted for age, race, sex, and Tanner stage

CF control female; CM control male; HF HIV+ female; HM HIV+ male; L95% lower 95% confidence interval; U95% upper 95% confidence interval

General Linear Mixed Model

Table 3

Longitudinal changes in body composition measures by DXA (adjusted*)

Body composition measures	Group	Intercept				Slope				Pairwise comparisons of slopes by group			
		Estimate	L95%	U95%	p	Estimate	L95%	U95%	p	CF	CM	HF	
Total body fat (%)	C F	37.29	21.12	53.47	<0.001	-0.1759	-1.1501	0.7983	0.723	.	.	.	
	C M	27.17	15.97	38.36	<0.001	-0.2716	-1.1074	0.5642	0.523	<0.001	.	.	
	H F	12.46	6.73	18.18	<0.001	1.2120	0.8370	1.5870	<0.001	0.013	0.503	.	
	H M	18.96	10.02	27.89	<0.001	0.0491	-0.5034	0.6015	0.861	0.001	0.205	<0.001	
Trunk fat (%)	C F	38.59	19.49	57.68	<0.001	-0.3818	-1.5439	0.7802	0.518	.	.	.	
	C M	20.52	8.38	32.65	0.001	0.1700	-0.7510	1.0910	0.717	0.007	.	.	
	H F	8.88	1.92	15.85	0.013	1.3818	0.9219	1.8418	<0.001	0.014	0.403	.	
	H M	13.25	3.34	23.16	0.010	0.3812	-0.2400	1.0023	0.228	0.017	0.214	<0.001	
Extremity fat (%)	C F	48.02	43.49	52.55	<0.001	0.1416	-0.1655	0.4487	0.365	.	.	.	
	C M	49.16	47.02	51.29	<0.001	0.0112	-0.1547	0.1771	0.894	0.436	.	.	
	H F	46.47	44.36	48.59	<0.001	0.1082	-0.0539	0.2704	0.190	0.013	0.208	.	
	H M	46.83	44.29	49.38	<0.001	0.0988	-0.0631	0.2607	0.231	0.006	0.058	0.896	
Trunk/extremity fat ratio	C F	0.88	0.67	1.08	<0.001	-0.0018	-0.0154	0.0117	0.794	.	.	.	
	C M	0.76	0.68	0.85	<0.001	0.0067	0.0000	0.0135	0.051	0.504	.	.	
	H F	0.90	0.83	0.98	<0.001	0.0011	-0.0040	0.0062	0.673	0.084	0.025	.	
	H M	0.91	0.82	1.00	<0.001	-0.0012	-0.0069	0.0045	0.689	0.001	0.015	0.337	
Trunk/total fat ratio	C F	0.41	0.35	0.47	<0.001	0.0002	-0.0038	0.0042	0.930	.	.	.	
	C M	0.37	0.35	0.40	<0.001	0.0032	0.0012	0.0051	0.002	0.399	.	.	
	H F	0.40	0.38	0.41	<0.001	0.0026	0.0013	0.0040	<0.001	0.082	0.051	.	
	H M	0.41	0.39	0.43	<0.001	0.0012	-0.0001	0.0026	0.077	0.019	0.053	0.099	
Extremity/total fat ratio	C F	0.48	0.43	0.53	<0.001	0.0014	-0.0017	0.0045	0.365	.	.	.	
	C M	0.49	0.47	0.51	<0.001	0.0001	-0.0015	0.0018	0.894	0.436	.	.	
	H F	0.46	0.44	0.49	<0.001	0.0011	-0.0005	0.0027	0.190	0.013	0.208	.	
	H M	0.47	0.44	0.49	<0.001	0.0010	-0.0006	0.0026	0.231	0.006	0.058	0.896	

* Body composition measures adjusted for age, race, sex, and Tanner stage

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CF control female; CM control male; HF HIV + female; HM HIV + male; L95% lower 95% confidence interval; U95% upper 95% confidence interval
n=235; 567 observations
General Linear Mixed Model