Body Composition Changes During Lactation in HIV-Infected and HIV-Uninfected South African Women

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Background: The nutritional consequences of HIV infection in lactating women are unknown.

Objective: To measure the body composition of South African lactating women in relation to HIV status.

Methods: Fat-free mass (FFM) and fat mass (FM) using bioimpedance spectrometry (BIS) and anthropometric measurements were obtained at 8 and 24 weeks postpartum in 92 HIV-infected (HIVpos) and 50 HIV-uninfected (HIVneg) lactating mothers.

Results: At 8 weeks, HIVpos and HIVneg mothers were not significantly different in height (159.7 vs. 158.9 cm), weight (62.7 vs. 63.9 kg), body mass index (BMI; 24.6 vs. 25.3 kg/m²), FFM (40.7 vs. 42.8 kg), or FM (21.6 vs. 22.0 kg), respectively. In HIVpos women, the median CD4+ count was 621 (range: 101–1585) cells/μL; 95% had CD4+ counts >200 cells/μL. Between 8 and 24 weeks, HIVpos mothers had a mean weight loss of 1.4 kg in contrast to a 0.4-kg weight gain in HIVneg mothers (P < 0.01). There were no significant group differences with regard to change in FFM (0.3 vs. 0.1 kg; P = 0.9) and FM (−1.5 vs. −0.3 kg; P = 0.2).

Conclusion: HIVpos South African breast-feeding mothers without severe immune suppression lost weight and subcutaneous fat between 8 and 24 weeks postpartum, whereas HIVneg mothers gained weight. FFM was maintained postpartum in HIVpos and HIVneg mothers.

Key Words: breast-feeding, lactation, body composition, fat-free mass, fat mass, HIV

In southern Africa, HIV prevalence is 35% or higher among women attending antenatal clinics. Despite concerns about the risk of transmitting HIV to the infant via breast-feeding and the suggestion that breast-feeding can have a deleterious effect on HIV-positive (HIVpos) women, African mothers often consider the use of replacement milks for infant feeding to be unacceptable, unaffordable, or unsafe. Because breast-feeding remains the most common form of infant feeding for all mothers in sub-Saharan Africa, it is important to understand the effect of HIV infection on the nutritional status of breast-feeding mothers.

Body composition is an important measure of nutritional status. Accurate measurement of body composition in lactating women is challenging, especially in poorer rural communities in developing countries, where HIV is often highly prevalent. Because hydration and density of fat-free mass (FFM) do not return to prepregnancy values in breast-feeding women until 2 or more weeks postpartum, body composition measurements are more accurate when taken at least 4 to 6 weeks after delivery. We previously validated the use of bioimpedance spectrometry (BIS) to measure FFM and fat mass (FM) in HIVpos and HIV-uninfected (HIVneg) breast-feeding mothers in rural South Africa by comparing it with the deuterium dilution method. We found that the methods correlated well with each other in both sets of women. There is little information on longitudinal changes in body composition in HIVpos individuals in developing countries. Most studies of body composition have been conducted amongst HIVpos men living in industrialized countries. These studies found that wasting was related to a loss of lean body mass in those with AIDS and other concurrent illness. By contrast, in stable HIVpos individuals with weight loss, FM, FM, or both are lost, depending on the relative size of these compartments before the weight loss. Clinically stable HIVpos women with and without AIDS and with weight loss have been reported to have a greater relative loss of FM than lean tissue. HIVpos breast-feeding mothers may be particularly vulnerable to nutrient deficiencies because of inadequate reproduction of this article is prohibited.
dietary intake and the combined impact of increased nutrient requirements associated with breast-feeding, HIV, and other infections. We studied the change in body composition of breast-feeding mothers living in a poor rural community with high HIV prevalence in relation to their HIV status. We hypothesized that HIV+ breast-feeding mothers would lose more weight, FFM, and FM than HIVneg breast-feeding mothers between 8 and 24 weeks postpartum.

METHODS

This longitudinal observational prospective study measured the body composition of HIV+ and HIVneg breast-feeding mothers between 8 and 24 weeks postpartum.

Community

The study was conducted at the Africa Center for Health and Population Studies in northern KwaZulu-Natal province, South Africa. The study site is largely rural, with 1 periurban township; the inhabitants are mostly of Zulu ethnic origin. The population is characterized by a high prevalence of HIV (36.5% of women attending antenatal clinics in 2002), high unemployment (54%), poor access to clean water (87%), and high infant mortality (79 per 1000 live births).

Subjects

Mothers were consecutively enrolled at a single clinic in the periurban township and in 2 clinics in more rural areas. Mothers who were participating in an ongoing Africa Center for Health and Population Studies study to investigate the relationship between exclusive breast-feeding and HIV transmission (Vertical Transmission Study [VTS]) were offered entry into this study when they brought their infant to the clinic for routine 6-week immunizations. The HIV+ women were offered a single dose of nevirapine during labor or delivery, and none were receiving antiretroviral treatment for their HIV infection. Because most of the women enrolled in the study of HIV transmission were HIV+ and additional HIVneg mothers had to be recruited among women not participating in that study. Enrollment for this study began in May 2002, and the last 6-month follow-up visit was completed in February 2004. The field and laboratory staff members were blinded to the participants’ HIV status.

Measurements

Study participants were enrolled at 6 weeks postpartum and had subsequent study visits at 14 and 24 weeks. At these visits, maternal weight, height, and middle upper arm circumference (MUAC) were measured, and a venous blood sample was obtained. To standardize the time of the BIS measurements before the mother performed any physical activity, a morning home visit was made shortly after each clinic visit; skinfold thicknesses were also measured at this time.

Demographic and Health Information

Demographic and health information data were collected through the VTS of the Africa Center for Health and Population Studies. At each clinic visit, a nurse obtained a history of illnesses since the last visit, focusing on respiratory symptoms, diarrhea, and the presence of fever. Breast-feeding status was self-reported at each home visit.

HIV Viral Load and CD4+ T-Cell Counts

HIV viral load and CD4+ T-cell counts were determined at the Africa Center Virology laboratory in Durban. Total HIV RNA was isolated from plasma using guanidinium-silica methods (NucliSens Isolation Kit; Organon Teknika, Boxtel, The Netherlands) and an automated extractor (Organon Teknika). The NucliSens HIV-1 QT (bioMerieux, Inc., Durham, NC) assay has a quantitative range of 40 to >500,000 copies/mL of plasma. CD4+ T-cell cell counts were measured on venous blood within 24 hours of sampling using an Epic XL cell counter (Beckman Coulter, Fullerton, CA) and a 4-color protocol, with the primary gating being on CD45.

C-Reactive Protein and α-1-Acid Glycoprotein

C-reactive protein (CRP) and α-1-acid glycoprotein (AGP), measures of the acute-phase reaction, were used as proxy indicators of inflammation. Venous blood samples were collected, protected from light, and kept cool for transport to Durban. Serum was separated, frozen, and stored at −70°C until tested in the Biochemistry Department at the University of KwaZulu-Natal in Durban. CRP and AGP were measured by immunologic agglutination using a Roche Modular P800 (Basel, Switzerland). The quantitative range of detection of CRP and AGP were 0.003 to 0.24 g/L and 0.25 to 3.0 g/L, respectively.

Anthropometry

Height without shoes was measured to the nearest 0.1 cm using a stadiometer (Scales 2000, Durban, South Africa), and weight was measured to the nearest 100 g using an electronic digital scale (Scales 2000). Body mass index (BMI) was calculated as weight in kilograms per height in meters. MUAC was measured with a steel tape, and skinfold thicknesses were measured with Lange calipers (Lange, Cambridge, MA) according to standardized methods at 4 body sites: triceps skinfold (TSF), biceps skinfold (BSF), subscapular skinfold, and midline suprailliac skinfold. The sum of skinfold thicknesses was calculated as the sum of the measurements taken at all 4 body sites.

Bioimpedance Spectrometry

BIS measurements (BIS 4000 Analyzer, version 1.00d; Xitron Technologies, San Diego, CA) were taken on a morning home visit as soon as possible after the mother breast-fed. Mothers were requested not to eat or perform heavy physical labor on the morning of the visit. The impedance electrodes were placed in the standard tetrapolar positions. Multifrequency measurements were completed, and the impedance data were analyzed using the preprogrammed Cole-Cole plot for determination of FFM, FM, and percent of body fat (%BF).

Statistics

To minimize the probability of type I error attributable to testing many outcome variables, we performed multivariate analysis of variance (MANOVA) on the 11 body composition measurements taken at each time point, and multivariate analysis of covariance (MANCOVA) on the change in all
anthropometric variables (controlling for baseline values). HIV status was significant for the 6-month value and the change value; univariate results are presented.

For demographic and body composition variables, differences between HIVpos and HIVneg mothers were tested for significance using the χ² test for categoric variables and the Student t test for continuous variables. For longitudinal measures, the groups were compared using repeated-measures analysis of covariance (ANCOVA; covariates included age, number of previous pregnancies, years of education, season of enrollment, clinic location, and illness). Variables not normally distributed were transformed logarithmically.

Descriptive univariate analysis was performed to identify outliers for FFM, FM, %BF, and changes over time in these measurements. Four of 251 measurements (3 in HIVpos women and 1 in an HIVneg woman) were excluded because of implausible FM and %BF measurement results. To understand the factors associated with weight change separately for HIVpos and HIVneg mothers, we performed stepwise regression analyses with the following independent variables: fever, upper or lower respiratory illness, CRP, AGP, CD4⁺ count, viral load, change in CD4⁺ count, change in viral load, years of education, and number of previous pregnancies.

**Ethics**

This study was approved by the Research Ethics Committee of the Nelson R. Mandela School of Medicine of the University of KwaZulu-Natal, Durban, South Africa, and the Human Subjects Committee of the University of California, Davis, California. All participants provided written informed consent. No incentive or compensation was provided to participants.

**RESULTS**

One hundred forty-two mothers were enrolled: 92 were HIVpos and 50 were HIVneg. Twenty-four mothers (21.7% HIVpos women vs. 8.0% of HIVneg women; \( P = 0.03 \)) withdrew or were lost to follow-up before the 24-week observations (Fig. 1). When compared with those who completed the study, those who did not differed only in that they were younger (23.3 ± 5.0 years vs. 26.0 ± 7.3 years; \( P = 0.03 \)) and more likely to reside near to the periurban township clinic location (46.2% vs. 27.6%; \( P = 0.04 \)).

**Measurements**

The time of the first planned 6-week postpartum measurement at baseline occurred at 7.9 weeks (8 weeks) postpartum. Similarly, the planned 14- and 22-week measurements occurred closer to 16 and 24 weeks postpartum, respectively. Because the results at 16 weeks and 24 weeks were not statistically significantly different from each other, only the 24-week results are shown. The season of enrollment was not different between groups (\( P = 0.953 \)).

**Demographics and Health Information**

Mothers were between 14 and 50 years of age, with 7 mothers <18 years of age and 3 > 40 years of age. Thirty-one percent of mothers were primiparous. The HIVpos and HIVneg mothers did not differ in demographic characteristics (Table 1). Reported illness symptoms were not different between groups and were generally low (point prevalence per group: <15% with respiratory symptoms and <5% with diarrhea symptoms), although the study was not powered to detect small differences between groups in symptoms. The more severe illnesses noted during clinic visits were 2 women with tuberculosis (1 HIVpos and 1 HIVneg), 8 with clinically diagnosed lower respiratory infection (7 HIVpos and 1 HIVneg), and 4 with septic wounds (3 HIVpos and 1 HIVneg). No malarial infections were identified.

**Laboratory Results**

In HIVpos mothers, only 1.3% at 8 weeks and 3.3% at 24 weeks had CD4⁺ cell counts <200 cells/µL. The median CD4⁺ cell counts at 8 and 24 weeks were 658 and 590 cells/µL, respectively. Median log₁₀ HIV viral loads at 8 and 24 weeks were 4.02 and 3.99, respectively. For measures of acute inflammation, at 8 weeks, the mean log₁₀ AGP was higher in HIVpos women than in HIVneg women, and the percent of HIVpos versus HIVneg mothers with an acute-phase response as measured by an AGP >1.2 g/L approached statistical significance (\( P = 0.056 \)) (Table 2). At 24 weeks, there was no significant difference between groups for the mean log₁₀ CRP or AGP, although the HIVpos mothers tended to have higher CRP values (\( P = 0.056 \)), and more HIVpos mothers were having an acute-phase reaction as measured by CRP >0.01 g/L (Table 2).

**Anthropometry**

At 8 weeks, none of the mothers were considered underweight by the World Health Organization (WHO) cutoff of BMI <18.5 kg/m². Seven mothers (3 HIVpos) had a BMI <20 kg/m². At 24 weeks, 2 mothers (1 HIVpos) had a BMI of <18.5 kg/m² and 7 mothers (2 HIVpos) had a BMI <20 kg/m². At 8 weeks postpartum, 6 mothers (3 HIVpos) had MUAC measurements <23 cm (fifth percentile of US National Heath and Nutrition Examination Survey). At 24 weeks, only 3 had low MUAC measures, 1 of whom was HIVpos. Conversely, 26.4% of the HIVpos mothers and 29.8% of the HIVneg mothers were having an acute-phase reaction as measured by MUAC <23 cm.

At 8 weeks postpartum, there were no differences between HIVpos and HIVneg mothers in the mean values for any of the anthropometric measurements. At 24 weeks, mean TSF and BSF thicknesses were significantly less in the HIVpos mothers (Table 3). More HIVpos mothers than HIVneg mothers (70.0% vs. 46.7%, respectively; \( P = 0.05 \)) lost weight between 8 and 24 weeks postpartum. When comparing the mean change during this time, the HIVpos mothers lost weight, whereas the HIVneg mothers gained slightly (~1.4 ± 3.1 kg vs. 0.4 ± 3.3 kg, respectively, \( P = 0.004 \)). Likewise, HIVpos mothers’ TSF thicknesses decreased, on average, whereas HIVneg mothers’ TSF thicknesses increased. These differences between groups remained after controlling for baseline characteristics, CRP, AGP, and illness. For all mothers, those who ever reported illness during the period...
of follow-up tended to lose more weight compared with those who were never ill (-1.4 kg ever ill and -0.3 kg never ill; \( P = 0.07 \)). There were no significant differences by HIV status in the change in weight in mothers ever ill versus never ill (HIVpos mothers’ weight change if ever ill \([-1.75 \pm 3.62 \text{ kg}]\) vs. those never ill \([-1.13 \pm 2.59 \text{ kg}], P = 0.410; \) HIVneg mothers’ weight change if ever ill \([-0.57 \pm 3.62 \text{ kg}]\) vs. never ill \([0.71 \pm 3.23 \text{ kg}], P = 0.272\)).

In the HIVpos mothers, the change in weight was not correlated to the change in CD4\(^+\) cell count or viral load and was not different when controlling for initial CD4\(^+\) cell count or viral load. When comparing HIVpos mothers with a lower CD4\(^+\) cell count (using a cutoff of <350 or <500 cells/\( \mu \text{L} \)) with those with higher values (\( \geq 350 \) or \( \geq 500 \) cells/\( \mu \text{L} \)), there was no significant difference in mean change in weight (57 HIVpos mothers with CD4 count >350 cells/\( \mu \text{L} \) \([-1.4 \pm 3.3 \text{ kg}]\) vs. 7 with <350 cells/\( \mu \text{L} \) \([-1.7 \pm 2.6 \text{ kg}], P = 0.822\)).

When comparing HIVpos mothers with a normal BMI (18.5–25.9) with those with a BMI \( \geq 26\), there was no difference between groups in CD4\(^+\) count or viral load at any time point.

**Bioimpedance Spectrometry**

There were no significant differences between HIVpos and HIVneg mothers in the mean FFM, FM, and %BF results at any time point (Table 4). Although not statistically significant, the HIVpos mothers tended to lose absolute FM during the 4 months of follow-up. Controlling for age, years of education, number of previous pregnancies, initial weight, CRP, AGP, and recent illness did not affect these results. For

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**FIGURE 1.** Enrollment and follow-up of HIVpos (HIV-infected) and HIVneg (HIV-uninfected) mothers.
HIVpos and HIVneg mothers, there was a small increase in mean FFM.

In HIVpos mothers, the change in weight was significantly correlated with the change in MUAC (r = 0.60, P < 0.001), TSF (r = 0.59, P < 0.001), subscapular skinfold (r = 0.55, P < 0.001), suprailiac skinfold (r = 0.60, P = 0.001), and FM measurements as determined by BIS (r = 0.26, P = 0.037). Using regression to determine which variables were the strongest predictors of weight change in HIVpos mothers, a history of fever at 8 weeks alone (r = 0.337, P = 0.041) and a history of fever at 8 weeks and 14 weeks as well as respiratory symptoms (r = 0.578, P = 0.014) were the strongest predictors. For the HIVneg mothers, 8-week weight and any respiratory symptoms were the strongest predictors (r = 0.514, P = 0.025); women whose weight at 8 weeks was above the median weight gained more than those whose weight was below the median weight.

**DISCUSSION**

In this study, we found that HIVpos South African breast-feeding mothers, 95% of whom had CD4+ counts >200 cells/µL, on average, lost weight between 8 and 24 weeks postpartum, whereas the HIVneg mothers gained weight. The weight loss in the HIVpos mothers was attributable primarily to loss of FM. Although HIVpos and HIVneg mothers did not differ in anthropometric measurements at 8 weeks, at 14 and 24 weeks postpartum, the HIVpos mothers had less subcutaneous fat as measured by TSF and BSF thicknesses. Reported illness (fever and respiratory illness) was the strongest predictor of weight loss in HIVpos mothers, whereas baseline weight was the strongest predictor of weight change in HIVneg mothers. FFM, FM, and %BF as measured by BIS were not different by HIV status at any time point; both groups of women tended to lose FM, whereas their FFM increased slightly between 8 and 24 weeks postpartum.

Our study found little evidence of wasting in HIVpos or HIVneg breast-feeding mothers living in this region. At 24 weeks postpartum, only 3% of HIVpos mothers and 10% of HIVneg mothers were classified as slightly underweight by a BMI <20. Despite weight loss in HIVpos mothers, most continued to have normal BMIs. Indeed, the mean %BF (32%) in all mothers at 24 weeks postpartum is generally higher than that of lactating women in other countries.21–24 There is no consistent pattern of weight change during lactation in developing countries. Butte and Hopkinson25 reviewed studies of weight change in affluent and low-income populations in developing countries during the first 6 months of lactation and found the results to be highly variable, ranging from a mean loss of 0.9 kg/mo to a mean gain of 0.8 kg/mo. The mean weight loss of HIVpos mothers in the current study was 0.34 kg/mo, with a mean gain of 0.10 kg/mo in their HIVneg peers (P = 0.005), both of which were within the weight change range found in other African breast-feeding mothers of unknown HIV status.25

There is little information on the body composition of HIVpos African women or of HIVpos lactating mothers available for comparison. Compared with a study of body composition in 46 HIVpos women (breast-feeding status unknown) in Zaire, the HIVpos mothers in our study weighed approximately 15 kg more, with approximately 2 kg more FFM and 13 kg more FM, as determined by bio-impedance analysis.26 This may be partially explained by the relatively low occurrence of acute illness and HIV symptomatology among the mothers in our study. Only 3% of HIVpos mothers in this study had advanced immunosuppression as defined by a CD4 count <200 cells/µL, in contrast to most reports from mother-to-child transmission prevention trials, which have reported 8% to 15% with a CD4 count <200 cells/µL.3,27,28

**TABLE 1. Baseline Characteristics of Breast-Feeding Mothers by HIV Status**

<table>
<thead>
<tr>
<th>HIVpos Mothers (n = 92)</th>
<th>HIVneg Mothers (n = 50)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)*</td>
<td>25.8 (6.3)</td>
<td>25.0 (8.1)</td>
</tr>
<tr>
<td>Previous pregnancies*</td>
<td>1.8 (1.9)</td>
<td>1.9 (2.1)</td>
</tr>
<tr>
<td>Education (y)*</td>
<td>7.6 (4.1)</td>
<td>6.4 (3.5)</td>
</tr>
<tr>
<td>Paid employment</td>
<td>7.8%</td>
<td>12.2%</td>
</tr>
<tr>
<td>Household structure (cement)</td>
<td>50.0%</td>
<td>60.9%</td>
</tr>
<tr>
<td>Water source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pond/dam</td>
<td>23.3%</td>
<td>29.3%</td>
</tr>
<tr>
<td>Public tap</td>
<td>26.7%</td>
<td>24.4%</td>
</tr>
<tr>
<td>Toilet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>35.6%</td>
<td>48.7%</td>
</tr>
<tr>
<td>Open-pit latrine</td>
<td>53.3%</td>
<td>48.7%</td>
</tr>
<tr>
<td>Cooking fuel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>49.9%</td>
<td>65.8%</td>
</tr>
<tr>
<td>Paraffin</td>
<td>17.7%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Refrigerator use</td>
<td>33.3%</td>
<td>19.5%</td>
</tr>
</tbody>
</table>

*Mean (±SD).

**TABLE 2. Measures of Acute-Phase Reaction by HIV Status**

<table>
<thead>
<tr>
<th>HIVpos (n = 92)</th>
<th>HIVneg (n = 46)</th>
<th>8 Weeks</th>
<th>24 Weeks</th>
<th>24 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP*, g/L</td>
<td>0.006 (0.040)</td>
<td>0.004 (0.018)</td>
<td>0.010† (0.051)</td>
<td>0.005‡ (0.037)</td>
</tr>
<tr>
<td>&gt;0.01 g/L (%)</td>
<td>35.6</td>
<td>29.8</td>
<td>45.8g</td>
<td>25.0δ</td>
</tr>
<tr>
<td>AGP*, g/L</td>
<td>1.19† (0.44)</td>
<td>1.03† (0.24)</td>
<td>1.09 (0.46)</td>
<td>0.98 (0.25)</td>
</tr>
<tr>
<td>&gt;1.2 mg/dL</td>
<td>37.5‡</td>
<td>21.7‡</td>
<td>27.9</td>
<td>20.0</td>
</tr>
</tbody>
</table>

*Antilog of mean (±SD).
†P = 0.007; ‡P = 0.056; §P = 0.036.
A mean 1.4-kg weight loss between 8 and 24 weeks postpartum in HIVpos mothers in the present study represents a theoretic total deficit of approximately 10,780 kcal over 112 days (or a daily deficit of approximately 96 kcal). This theoretic deficit represents 5.6% of the calculated resting energy expenditure (1717 kcal)\(^{29}\) based on the mean height, weight, and age of the HIVpos mothers in our study. In a study of 33 HIV pos presumably non-breast-feeding women, Grinspoon et al\(^{28}\) found that the resting energy expenditure was higher (119% ± 23%) than in 26 HIVneg weight-matched control women. We are unable to determine if the weight loss observed in this population was attributable to decreased energy intake, malabsorption, increased physical activity, energy expenditure associated with HIV or other illness, or a combination of these factors.

Our finding of weight loss in HIVpos mothers was somewhat different from a study of body weight in HIVpos and HIVneg Rwandan mothers,\(^{30}\) which found that HIVpos and HIVneg mothers gained weight between 10 days and 5 months postpartum (0.7 ± 3.8 kg in HIVpos mothers and 1.9 ± 4.7 kg in HIVneg mothers; \(P = 0.003\), even though the measurement at 10 days most likely still reflects some of the fluid gained during pregnancy. Although this period of follow-up was slightly different, in our study, the HIVpos mothers lost weight, whereas the HIVneg mothers gained 75% less than their Rwandan peers. The Rwandan study did not comment on whether the mothers were breast-feeding, and body composition was not mentioned.

Nduati et al\(^{31}\) suggested that weight loss associated with lactation might be more severe in HIVpos women than in healthy women. In a randomized clinical trial of formula-feeding versus breast-feeding in Kenyan HIVpos mothers, baseline weight measured between 0.5 and 3 months postpartum was compared with weight measured between 5 and 9 months postpartum. Formula-feeding mothers lost no weight, whereas breast-feeding mothers lost 0.17 kg/mo

### TABLE 3. Anthropometric Measures by HIV Status at 8 and 24 Weeks Postpartum and Change Between 8 and 24 Weeks

<table>
<thead>
<tr>
<th>HIVpos Mean (±SD)</th>
<th>HIVneg Mean (±SD)</th>
<th>(P^*)</th>
<th>HIVpos Mean (±SD)</th>
<th>HIVneg Mean (±SD)</th>
<th>(P^*)</th>
<th>Change Between 8 and 24 Weeks†‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>8 Weeks</td>
<td>24 Weeks</td>
<td>8 Weeks</td>
<td>24 Weeks</td>
<td>8 Weeks</td>
<td>24 Weeks</td>
</tr>
<tr>
<td>92</td>
<td>8.0 (2.6)</td>
<td>24.0 (3.5)</td>
<td>0.782</td>
<td>68</td>
<td>23.48 (3.1)</td>
<td>0.472</td>
</tr>
<tr>
<td>50</td>
<td>7.9 (2.2)</td>
<td>23.48 (3.1)</td>
<td>0.472</td>
<td>45</td>
<td>21.7 (7.3)</td>
<td>0.002</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>62.7 (8.6)</td>
<td>61.1 (9.0)</td>
<td>0.092</td>
<td>62.7 (8.6)</td>
<td>65.4 (15.3)</td>
<td>0.092</td>
</tr>
<tr>
<td>BMI, kg/m(^2)</td>
<td>24.6 (3.2)</td>
<td>24.1 (3.3)</td>
<td>0.088</td>
<td>24.6 (3.2)</td>
<td>25.7 (5.6)</td>
<td>0.088</td>
</tr>
<tr>
<td>MUAC, cm</td>
<td>27.2 (2.8)</td>
<td>27.0 (3.1)</td>
<td>0.068</td>
<td>27.2 (2.8)</td>
<td>28.6 (4.5)</td>
<td>0.068</td>
</tr>
<tr>
<td>TSF, mm</td>
<td>18.1 (4.5)</td>
<td>17.6 (5.2)</td>
<td>0.002</td>
<td>18.1 (4.5)</td>
<td>21.7 (7.3)</td>
<td>0.002</td>
</tr>
<tr>
<td>BSF, mm</td>
<td>12.4 (4.1)</td>
<td>12.4 (4.1)</td>
<td>0.019</td>
<td>12.4 (4.1)</td>
<td>15.6 (6.5)</td>
<td>0.003</td>
</tr>
<tr>
<td>Subscap-SF, mm</td>
<td>20.0 (5.6)</td>
<td>19.8 (6.9)</td>
<td>0.149</td>
<td>20.0 (5.6)</td>
<td>22.1 (9.5)</td>
<td>0.149</td>
</tr>
<tr>
<td>Supra-SF, mm</td>
<td>21.0 (6.8)</td>
<td>20.1 (6.4)</td>
<td>0.067</td>
<td>21.0 (6.8)</td>
<td>21.4 (11.0)</td>
<td>0.067</td>
</tr>
<tr>
<td>Sum-SF, mm</td>
<td>71.4 (18.2)</td>
<td>69.8 (22.6)</td>
<td>0.180</td>
<td>71.4 (18.2)</td>
<td>83.4 (32.0)</td>
<td>0.180</td>
</tr>
</tbody>
</table>

Overall \(P\) value from MANOVA, including all anthropometric and BIS results: 8-week comparisons, \(P = 0.378\); 24-week comparisons, \(P = 0.039\). MANCOVA change comparisons, \(P = 0.039\).

†Results of only those women with measurements at both time points.
‡Four HIVneg mothers not represented in the change analysis between 8 and 24 weeks had significantly lower mean TSF, Subscap-SF, and Supra-SF measurements at 8 weeks than those included in the change analysis; no other significant difference.

Subscap-SF indicates subscapular skinfold thickness; Supra-SF, suprailiac skinfold thickness; Sum-SF, sum of skinfold thickness.

### TABLE 4. Body Composition (measured by BIS) by HIV Status at 8 and 24 Weeks Postpartum and Change Between 8 and 24 Weeks

<table>
<thead>
<tr>
<th>HIVpos Mean (±SD)</th>
<th>HIVneg Mean (±SD)</th>
<th>(P^*)</th>
<th>HIVpos Mean (±SD)</th>
<th>HIVneg Mean (±SD)</th>
<th>(P^*)</th>
<th>Change Between 8 and 24 Weeks†‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFM, kg</td>
<td>40.67 (5.64)</td>
<td>41.10 (6.57)</td>
<td>0.204</td>
<td>41.10 (6.57)</td>
<td>42.78 (7.75)</td>
<td>0.216</td>
</tr>
<tr>
<td>FM, kg</td>
<td>21.58 (7.38)</td>
<td>20.04 (7.07)</td>
<td>0.256</td>
<td>20.04 (7.07)</td>
<td>22.02 (10.26)</td>
<td>0.256</td>
</tr>
<tr>
<td>%BF</td>
<td>34.16 (9.16)</td>
<td>32.37 (8.83)</td>
<td>0.831</td>
<td>34.16 (9.16)</td>
<td>32.75 (9.64)</td>
<td>0.831</td>
</tr>
</tbody>
</table>

*Student \(t\) test comparisons between groups.
†Results of only those women with measurements at both time points.
‡Three HIVpos mothers not represented in the change analysis between 8 and 24 weeks had significantly lower mean FFM at 24 weeks than those included in the change analysis; no other significant difference.
(P = 0.03). The wide time span for each measurement makes interpretation of this finding difficult.

Nearly 25% of the HIVpos mothers in our study had a BMI ≥25 and were thus overweight or obese using this measure. Anyone who is overweight or obese is generally advised to lose weight to avoid obesity-related health consequences, such as diabetes and heart disease. Our data raise the dilemma regarding whether HIVpos women should try to lose weight to achieve a more healthy body composition with less body fat. Several studies have found that HIVpos women with higher BMIs were less likely to have a CD4+ cell count <200 cells/μL and more likely to have slower disease progression than their thinner counterparts, although the causal direction of this association is unknown. It is difficult to know whether weight loss would be in the best long-term interest for these overweight and obese HIVpos mothers.

There are several limitations of our study that should be noted. First, to determine the effect of breast-feeding on HIVpos mothers’ nutritional status, ideally, we would have preferred to compare their body composition with that of HIVpos non-breast-feeding mothers. Few HIVpos mothers in this population elect to formula-feed, however. Thus, we were unable to determine whether the weight loss in HIVpos women was primarily an effect of HIV or a combination of breast-feeding and the presence of HIV infection. During the 17 months of subject enrollment, only 5 HIVpos non-breast-feeding mothers were followed. The non-breast-feeding mothers were no different in body composition or changes in body fat in this group of women is unknown. Further study is needed to determine whether weight and fat loss in normal and overweight breast-feeding HIVpos mothers is associated with long-term consequences for their health.

ACKNOWLEDGMENTS

P. C. Papathakis was responsible for the study concept and design, field supervision, analysis and interpretation of results, and drafting the manuscript. K. H. Brown, M. D. Van Loan, N. C. Rollins, C. J. Chantry, and M. L. Bennish contributed to the study design, interpretation of results, and manuscript revisions. The manuscript has been reviewed and approved by all authors. This paper is written on behalf of the Child Health Group of the Africa Center for Health and Population studies; H. M. Coovadia, R. M. Bland, A. Coutoudis, M. L. Newell, and J. van den Broeck. The authors gratefully thank the Maternal Nutrition Study staff for subject recruitment; Carina Herbst and Ruth Bland for study management support; the Africa Center VTS HIV counselors, nurses, clinic assistants, and staff for study organization and data collection; the mothers who generously gave of their time and participated in this study; and the Hlabisa district clinical nursing staff at Madwaleni, Nkundusi, and KwaMsane clinics. The insightful computer programming and data management support of Arjan van Bentem and patient statistical guidance of Jan Peerson are thankfully acknowledged. The Western Human Nutrition Research Center, United States Department of Agriculture, Davis, CA, provided bioimpedance equipment.

REFERENCES


