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Objective To study the relationship between human immunodeficiency virus (HIV) infection and body weight in African women during and after pregnancy.

Methods A prospective cohort study was initiated at the Centre Hospitalier de Kigali in July 1992. Every woman seen at the antenatal clinic and with a gestational age of <28 weeks was offered HIV-1 antibody testing. Comparable numbers of HIV-infected (HIV+) and uninfected (HIV−) women were recruited. At inclusion, socio-demographic characteristics and self-reported pre-pregnancy weight were recorded; height and weight were measured. Each woman enrolled had a monthly follow-up until 9 months after delivery, with a clinical examination including weighing. Three anthropometric indices were used to answer the study objectives: weight, body mass index (BMI), and pregnancy balance.

Results As of April 1994, 101 HIV+ and 106 HIV− women were followed until 5 months after delivery. Weight and BMI during pregnancy were lower in HIV+ women than in HIV− women. After delivery, weight and BMI gains were significantly lower in HIV+ women. Until 5 months after delivery, the mean weight variation was −2.2 kg (standard deviation [SD] = 5.9 kg) in HIV+ women and +0.2 kg (SD = 6.6 kg) in HIV− women (P = 0.007) in comparison to pre-pregnancy weight. Comparisons of the slopes of the weight curves did not show statistical differences throughout the pregnancy, but it did during the post-partum period (P = 0.02).

Conclusions Our study suggests that HIV infection could impair nutritional status in pregnant women, especially during the post-partum period. Family planning and maternal and child health services including HIV testing and counselling should consider a nutritional assessment and intervention programme targeted to HIV+ pregnant women.

Keywords HIV-1, pregnancy, body weight, Africa

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This paper has been presented in part at the IXth International Conference on AIDS in Africa, Kampala, Uganda, 18–14 December 1995 (abstract no Tull123).
In sub-Saharan Africa, human immunodeficiency virus (HIV) infection spreads primarily through heterosexual contacts, with more HIV-infected (HIV+) women of child-bearing age on this continent than anywhere else.1,2

Few studies have focused on the relationship between HIV infection and pregnancy with regard to maternal health. Indeed, the consequences of pregnancy on the course of HIV infection seem to be variable according to maternal health status prior to pregnancy. Thus, except at stage IV of US Centers for Disease Control (CDC) classification of HIV infection, pregnancy does not seem to accelerate the course of HIV disease.3-6

The impact on perinatal morbidity and mortality of maternal nutritional status before pregnancy and of weight gain during pregnancy has been well documented in HIV-uninfected (HN-) mothers. Poor maternal nutritional status before and during pregnancy is related to intra-uterine growth retardation,7 low birthweight8,9 and preterm delivery.10,11 Studies carried out in industrialized countries have demonstrated an average decrease in maternal weight after delivery but a positive weight balance between the pre-pregnancy weight and the maternal weight measured beyond the early post-partum period.12,13 International recommendations have thus been formulated for improving weight gain of pregnant women and its monitoring during pregnancy.14

The nutritional status of HIV+ subjects may be impaired by different mechanisms: decreased dietary intake, malabsorption, and metabolic disturbances.15 It has therefore been speculated that nutritional status of HIV+ patients could be a prognostic factor for survival.16

To our knowledge, no study has looked at changes in maternal body weight of HIV+ women during and after pregnancy especially in developing countries. We hypothesized that maternal weight evolves differently in HIV+ and HIV- pregnant women. We studied prospectively this relationship during pregnancy and post-partum period within a cohort study, whose general aim was to evaluate the impact of HIV-1 infection on pregnancy in Kigali, the capital city of Rwanda, Central Africa.

Subjects and Methods

A prospective cohort of pregnant women, the Pregnancy and HIV cohort (EGE Study), was undertaken at the Centre Hospitalier de Kigali (CHK), between July 1992 and August 1993. The general aim of the EGE study was to evaluate the impact of HIV-1 infection on pregnancy. The main objectives were first, to document the pregnancy outcomes after screening and treatment for common genital infections, and second, to study the maternal post-partum complications in HIV+ women in comparison to HIV- women. Approval for conducting the study was obtained from the Rwandan Ministry of Health. Details about the protocol have been described elsewhere.17,18 The findings for pregnancy outcome have also been reported.19 All pregnant women attending the antenatal clinic of the CHK, living in the Kigali area and wishing to deliver at the maternity ward of the CHK were informed by a trained social worker about HIV infection, and the objectives, benefits and constraints of the study. Eligible women were examined by ultrasonography. Those with a gestational age between 24 and 28 weeks and consenting to participate were offered free HIV antibody screening by two commercial Enzyme Linked Immuno Sorbent Assays (ELISA, Vironostika HIV MixT and Vironostika Uniform, Organon Tecknika, Boxtel, the Netherlands). Discordant samples by ELISA were confirmed by a commercial Western Blot technique (Du Pont de Nemours, Delaware, USA) using the CDC criteria of interpretation.20 Pre- and post-test counselling was systematically offered in the local language (kinyarwanda) according to the methods approved by the Rwandan National AIDS Program.

Two weeks after HIV testing, all HIV+ women and an equivalent number of HIV- women were enrolled in the cohort. The two groups were made comparable in frequency in terms of maternal age (±2 years) and parity (±1 pregnancy). Baseline information on age, parity, obstetric history, socioeconomic characteristics and pre-pregnancy weight estimated by the women themselves were collected using standardized questionnaires. A clinical examination was performed by a physician, including height and weight measurement. The CD4 and CD8 lymphocyte counts were performed using a commercial immuno-magnetic method (Dynabead T4-T8 Quant., Biosys, France). Participating physicians, nurses and social workers were blinded to HIV serostatus throughout the study period. If they consented, women could know their HIV serostatus.

Until delivery, each woman enrolled was repeatedly examined, firstly between 28 and 32 weeks, and secondly between 32 and 36 weeks of gestation. These visits included a systematic clinical examination and weighing. After delivery, mothers were followed, according to the following schedule: 10 days (D10), 45 days (D45), 3 months (M3) after delivery, then every month until 9 months post-partum (M9). The relationship between HIV infection and nutritional status during pregnancy and the post-partum period was evaluated until 5 months (M5) after delivery. At each post-partum visit, the current weight was recorded. The women were weighed with the same scale and by the same study staff throughout the study period.

The following anthropometric indices were used for analysis: weight, body mass index (BMI) defined as the weight by height square (kg/m²), and pregnancy balance. Pregnancy balance was first defined as the absolute difference between each anthropometric index measured at 5 months post-partum and the value estimated before pregnancy. The balance was also computed between weight at 5 months after delivery and weight at inclusion in the cohort. The y² test and Student's t-test were used for comparisons between HIV+ and HIV- women with a significance level of 5%. Adjusted comparisons on socioeconomic and obstetric variables were made using multiple linear regression. Comparisons between the slopes of the weight curves were made using variance analysis with repeated measures and F-test.

Results

Follow-up of the cohort was interrupted by the Rwandese civil war in April 1994. Complete weight data until 5 months post-partum are available for 207 women (101 HIV+ and 106 HIV-) consecutively enrolled. They represent the study sample for the present report. We compared these women to the enrolled 558 women for whom follow-up was incomplete. There was no difference on the average, for age (26.1 years [SD = 4.8] versus 26.0 years [SD = 4.8]; P = 0.76), the number of pregnancies (2.4 [SD = 1.4] versus 2.5 [SD = 1.5]; P = 0.31), professional activity
The HIV infection occurrence was similar in the two groups (51.2% versus 49.3%; P = 0.63), and the mean number of lymphocytes CD4/mm³ was equivalent (697/mm³ [SD = 387] versus 643/mm³ [SD = 299]; P = 0.60). We also observed comparable mean weight at inclusion in the women studied in this report and in those who were not studied (60.0 kg [SD = 9.2] versus 60.1 kg [SD = 8.9]; P = 0.84).

Table 1 compares the baseline data of HIV+ and HIV− women available for this study and shows no statistical difference between the two groups. The mean CD4 lymphocyte count was 525/mm³ (SD = 344) in HIV+ women and 861/mm³ (SD = 354) in HIV− women. The proportion with <200/mm³ CD4 lymphocyte count was 8.9% in HIV+ and nil in HIV− women. No HIV+ women fulfilled the criteria of clinical AIDS at entry in the study.

The mean self-reported pre-pregnancy weight was 58.5 kg (SD = 8.6) in HIV+ women and 59.2 kg (SD = 10.3) in HIV− women (P = 0.59) (interquartile range: 53–63 kg for HIV+ women and 51–67 kg for HIV− women). The median weight was 57 kg for both groups. In the HIV+ and HIV− groups, the mean height was respectively, 156.4 cm (SD = 6.0) and 157.6 cm (SD = 5.9) (P = 0.15). The mean BMI at enrollment was 24.1 kg/m² (SD = 2.8) for HIV+ women and 24.5 kg/m² (SD = 4.1) for HIV− women (P = 0.89). Of HIV− women, 4% and 6% of HIV− women had a BMI <20 kg/m² (P = 0.40).

Figure 1 shows that the evolution of the mean weight was different during the last trimester of pregnancy and the postpartum period according to the HIV serostatus, with a more important weight gain for HIV− than for HIV+ women. However, when omitting the pre-pregnancy weight as a reference, the trend in weight gain during pregnancy was comparable between the two groups, although the difference between both groups increased. At the end of pregnancy, mean weight in HIV+ women was 60.7 kg (SD = 8.7) and 63.0 kg (SD = 10.2) in HIV− women (P = 0.08). Indeed, the comparison of the slopes did not reach statistical significance (P = 0.058).

Table 1 Socio-demographic and obstetric characteristics of human immunodeficiency virus infected (HIV+) and uninfected (HIV−) pregnant women at enrollment: Centre Hospitalier de Kigali, Kigali (Rwanda), 1992–1994 (N = 207)

<table>
<thead>
<tr>
<th>HIV+ (N = 101)</th>
<th>HIV− (N = 106)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (SD)</td>
<td>26.6 (4.6)</td>
<td>25.8 (4.9)</td>
</tr>
<tr>
<td>Mean no. of pregnancies (SD)</td>
<td>2.3 (1.2)</td>
<td>2.3 (1.6)</td>
</tr>
<tr>
<td>Primiparity (%)</td>
<td>28.7</td>
<td>39.6</td>
</tr>
<tr>
<td>Woman's occupation (%)</td>
<td>0.84b</td>
<td></td>
</tr>
<tr>
<td>Housewife</td>
<td>60.4</td>
<td>56.6</td>
</tr>
<tr>
<td>Farmer or employee or business</td>
<td>39.6</td>
<td>43.3</td>
</tr>
<tr>
<td>Woman's education (%)</td>
<td>0.20b</td>
<td></td>
</tr>
<tr>
<td>None or primary</td>
<td>39.6</td>
<td>31.1</td>
</tr>
<tr>
<td>Secondary or higher</td>
<td>60.4</td>
<td>68.9</td>
</tr>
<tr>
<td>Matrimonial status (%)</td>
<td>0.55b</td>
<td></td>
</tr>
<tr>
<td>Single or widowed</td>
<td>9.9</td>
<td>7.5</td>
</tr>
<tr>
<td>Married or free-union</td>
<td>90.1</td>
<td>92.5</td>
</tr>
</tbody>
</table>

Notes: 
a χ² test.
b Student's t-test.
Table 2 summarizes weight gains and BMI gains for the two following periods: between pre-pregnancy and the second antenatal visit, and between the inclusion visit and the second antenatal visit (the latter indicator looks specifically for the evolution in the third trimester of pregnancy). Compared to the pre-pregnancy values, the gain in anthropometric indicators at the end of pregnancy was less important in HIV+ than in HIV− women, especially BMI gain (P = 0.049). However, no difference was measurable between the two groups when looking at the evolution during the third trimester only.

Similarly, Table 2 shows also the evolution of weight and BMI between the first post-natal visit (D10) and the last post-natal visit (M5). Weight gain was significantly higher in HIV− women than in HIV+ women. The comparison of slopes reached statistical difference (P = 0.021) and the evolution was different between the two groups (P = 0.025). After delivery, mean weight reached statistical significant difference from 3 months of follow-up (HIV+ women: 55.8 kg [SD = 9.2] versus HIV− women: 58.7 kg [SD = 10.6]; P = 0.04) to the end of follow-up (P = 0.03). When looking at the evolution until 9 months after delivery for a smaller sample (82 HIV+ and 91 HIV− women), the difference of mean weight gain between the two groups was always observed, but without statistical significance (1.1 kg [SD = 4.6] versus 1.8 kg [SD = 4.8]; P = 0.28).

With regard to the pregnancy balance, the anthropometric indices were negative in HIV+ women and slightly positive in HIV− women when using the pre-pregnancy weight as baseline. Differences between the two groups were always statistically significant (Table 2). The weight balance between inclusion and M5 post-partum, however, was negative in both groups, being lower in HIV+ women than in HIV− women. The same trend was noticed for the BMI (Table 2).

Table 3 Univariate and multivariate linear regression for the difference between weight at M5 and weight at D10 after delivery in human immunodeficiency-infected and uninfected women: Centre Hospitalier de Kigali, Kigali (Rwanda), 1992–1994 (N = 207)

| Univariate analysis | Multivariate analysis
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F-test</td>
<td>Partial F-test</td>
</tr>
<tr>
<td>HIV serostatus</td>
<td>4.83</td>
</tr>
<tr>
<td>Age</td>
<td>2.27</td>
</tr>
<tr>
<td>No. of pregnancies</td>
<td>0.39</td>
</tr>
<tr>
<td>Primiparity</td>
<td>0.36</td>
</tr>
<tr>
<td>Woman's occupation</td>
<td>0.77</td>
</tr>
<tr>
<td>Woman's education</td>
<td>0.13</td>
</tr>
<tr>
<td>Matrimonial status</td>
<td>0.21</td>
</tr>
</tbody>
</table>

The HIV− women tended to recover their pre-pregnancy weight by M5 post-partum (Figure 1), while HIV+ women never recovered their initial weight during the study period (even after 9 months of follow-up when this information was available) although none of them developed full-blown AIDS. Finally, adjustments on socio-demographic and obstetric data did not modify the observed difference for weight gains between D10 and M5 visits of post-partum period (Table 3), and for the difference between pre-pregnancy and M5 visit (data not shown).

**Discussion**

In this study, mean weight in HIV+ women was lower than in HIV− women during pregnancy. During the post-partum period, both groups of mothers gained weight, but the increase was significantly less important in HIV+ mothers. The overall pregnancy balance was negative for HIV+ women and almost nil for HIV− women.

In our study, women did not seem to suffer chronic energy deficiency before pregnancy, according to the value of their pre-pregnancy weight. Weight and BMI gains during pregnancy were low in both groups. The values of these indicators were lower than in studies performed in developed countries and lower than those recommended in published guidelines. However, these results were consistent with weight gains observed in some West African countries. The hypothesis of a mobilization of maternal fat stores for fetal growth should be related with the progressive weight increase during the post-partum period, in contrast to what has been reported in developed country studies.

Surprisingly, few HIV+ women had chronic energy deficiency before pregnancy (only 4% had a BMI <20 kg/m²) compared to HIV− women. This could be related to the good clinical and immunological status of this sample of HIV+ women. However, the difference in weight between the two groups increased during the last trimester of pregnancy, but in a non significant manner.

A potential recall bias may have influenced the quality of the pre-pregnancy weight data collected by interview in this study. A weight overestimation cannot be ruled out in HIV+ women who could have lost weight progressively without noting it and...
reported consciously or not, a pre-pregnancy weight higher than reality. This may explain the observed difference of weight gain between HIV+ and HIV− women during pregnancy. We have to note that women did not know their HIV serostatus when they were asked their pre-pregnancy weight. Other studies have shown, independently of HIV serostatus, that overweight women had a tendency to underestimate their pregravid weight (which could be the case here with a mean BMI equal to 24.0 kg/m² in HIV+ women) and underweight women to overestimate it. However, this potential bias does not modify the main result, which was the observed difference in weight gain during post-partum period.

Abrams et al.27 and Tang et al.28 suggested that diet micro-nutrient deficiency is associated with HIV disease progression. In our study, no data are available to analyse the relation between nutritional status and diet during pregnancy and post-partum.29,30 The fact that in our study, no difference was found after adjustment on socioeconomic characteristics is an indirect argument against selected dietary differences which could have influenced the comparison between groups.

We suggest that HIV infection tends to impair weight gain during pregnancy and especially during the post-partum period. Beside HIV testing and counselling, integration of nutritional surveillance into maternal health care by simple anthropometric measurements and monitoring should be recommended in the context of the rapid spread of HIV infection in Africa. Furthermore, the clinical significance of these weight changes on maternal health and pregnancy outcome remains to be studied.

Acknowledgements

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