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Dietary calcium, dairy food intake and metabolic abnormalities in HIV-infected individuals

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Abstract

Background: Epidemiological data suggest that calcium intake may influence lipid metabolism. It is unknown whether this influence also occurs in individuals with HIV/AIDS. The present study aimed to assess the relationship between dietary calcium, dairy food intake and metabolic parameters in individuals with HIV/AIDS.

Methods: A cross-sectional study was conducted with 100 individuals with HIV/AIDS. Calcium intakes and food group consumption were determined by a food 24-h dietary recall and a food frequency questionnaire, respectively. The level of physical activity was determined with the international physical activity questionnaire and metabolic syndrome (MS) was defined by National Cholesterol Education Program Adult Treatment Panel III (2001). Student's *t*-test, one-way analysis of variance and chi-square were used to compare the groups.

Results: The mean (SD) calcium intake was 559.5 (298.84) mg day^{-1} and dairy food consumption was 1.73 (0.78) servings per day. Dietary calcium intake below 700 mg day^{-1} had greater waist circumference, body mass index (BMI) but not significant and higher systolic blood pressure (SBP) ($P < 0.05$) and diastolic blood pressure (DBP) ($P = 0.07$). Dairy food consumers (>2 servings per day) showed lower BMI ($P < 0.01$), waist circumference ($P = 0.05$), SBP and DBP ($P < 0.05$). There was a significant association between calcium intake, MS and hypertension. The odds ratio for MS was 2.0 [95% confidence interval (CI) = 1.23–3.32] and for hypertension was 2.25 (95% CI = 1.44–4.44). Only 21% of the individuals were categorised in the moderate/intense physical activity level.

Conclusions: The results obtained suggest that a dietary pattern with higher proportion of calcium and fruits/vegetables may protect against abdominal obesity and hypertension in HIV-infected individuals.

Introduction

Today, the health profile of HIV-infected individuals frequently includes dyslipidaemias, insulin resistance, being overweight, obesity and the so-called metabolic syndrome (MS) (Wand *et al.*, 2007), even in countries such as Brazil (Leite & Sampaio, 2008), resulting in a more atherogenic and high cardiovascular risk profile (Reeds, 2008). In the same subject, MS definitions associate a number of metabolic abnormalities, such as: central obesity, decrease in high-density lipoprotein cholesterol (HDL) cholesterol, increase in plasma triglycerides, glucose intolerance and hypertension (Kahn, 2007).

The aetiology of these metabolic abnormalities in individuals with HIV/AIDS is not entirely known. The accepted hypothesis is that the aetiology includes a combination of factors, such as the use of antiretroviral drugs, especially protease inhibitors (Chêne, 2005) and

behavioural factors such as smoking, inactivity and unhealthy eating habits (Hendricks *et al.*, 2006).

Studies that assessed the dietary habits of individuals with HIV/AIDS showed that these individuals consumed diets rich in saturated fats and poor in fibres, which could contribute to hypertriglyceridaemia among HIV patients who have developed metabolic abnormalities (Joy *et al.*, 2007; Arendt *et al.*, 2008). None of these studies investigated a possible association between dietary calcium intake and the presence of metabolic abnormalities.

The importance of dietary calcium in the regulation of body weight and lipid metabolism has been the object of scientific investigations throughout the years. This relationship was first studied by Zemel *et al.* (2005) and Zemel (2003; 2005), and today it continues to be an object of scientific interest (Astrup, 2008; Major *et al.*, 2008).

The most widely accepted hypothesis for this relationship proposes that dietary calcium influences $1,25(OH)_2$ vitamin D3 plasma concentration. According to this hypothesis, low calcium intake inhibits lipolysis and stimulates *de novo* synthesis, reducing fat oxidation, which results in an increased waist circumference. Through these mechanism, a low dietary calcium intake leads to weight gain, whereas a high dietary calcium intake exerts the opposite effects (Astrup, 2008). Another hypothesis suggests that calcium may have a modulating effect on the foecal excretion of fats (Parikh & Yanovski, 2003).

Although these effects are not entirely understood, some epidemiological studies show that, in the general population, a high calcium and dairy product intake were associated with less fat accumulation and higher insulin sensitivity. It also presents an inverse relationship with MS components, especially hypertension (Marques-Vidal *et al.*, 2006; Beydoun *et al.*, 2008).

On the other hand, the results of other investigations have indicated that calcium supplementation (1500 mg day^{-1}) did not induce changes in body weight or lipid metabolism, suggesting that dietary calcium has a more expressive contribution (Sampath *et al.*, 2008).

The identification of dietary factors that influence energy and lipid metabolism is an important research field of nutrition science and has become a growing requirement in the context of the HIV/AIDS epidemic in an attempt to attenuate the metabolic abnormalities and cardiovascular risk associated with antiretroviral therapy.

Studies that assess the role of dietary calcium in the presence of metabolic abnormalities in individuals with HIV/AIDS under antiretroviral therapy have not been found in the literature. The present study aimed to assess the relationship between dietary calcium, dairy food consumption and metabolic abnormalities in individuals with HIV/AIDS.

Materials and methods

Subjects

A cross-sectional descriptive study was conducted using dietary and lifestyle questionnaires. A convenience sample of 100 adult individuals with HIV who were being treated at a university hospital in Rio de Janeiro from 1997 to 2008 was used. The individuals were invited to participate in an interview with a nutritionist, the purposes of the study were fully explained and the participants provided their written informed consent. All aspects of the present study were reviewed and approved by the Federal University of Rio de Janeiro Ethics Committee (Brazil), protocol number 08 (26 March 2008). Data were collected from May to September 2008.

Anthropometric measurements

Weight and height was measured at the time of the nutrition interview with an anthropometric balance (Welmy 110CH; Welmy, São Paulo, Brazil) to the nearest 100 g with light undergarments and without shoes. Body mass index (BMI) was calculated as weight (kg) divided by $height^2$ in metres. Waist circumference was measured with the subject standing erect with the abdomen relaxed, using an inelastic tap at the level of natural waist.

MS definition

The MS prevalence was determined by the definition given by the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III, 2001), reviewed in 2005 (Grundy *et al.*, 2005), which states that two or more of the following must be present: abdominal obesity (waist circumference ≥102 cm for men or ≥ 88 cm for women); triglyceride ≥150 mg dL^{-1}; HDL-cholesterol <40 mg dL^{-1} for men or <50 mg dL^{-1} for women; fasting glucose ≥100 mg dL^{-1}; blood pressure ≥135/85 mmHg or taking antihypertensive drugs.

Demographic and clinical information

The information collected from the medical records comprised: gender and age group (years); clinical information: time elapsed since diagnosis of HIV infection (years); use of antiretroviral drugs (yes/no); time using antiretroviral drugs (years); T-CD4 lymphocyte count (cells mL^{-1}), viral load (copies mL^{-1}); biochemical data: total cholesterol (mg dL^{-1}), triglycerides (mg dL^{-1}), fasting glucose (mg dL^{-1}) and HDL (mg dL^{-1}). Blood pressure (mmHg) was obtained after medical evaluation at the time of the nutrition interview.

Food intake assessment

A 24-h dietary recall was used to assess the dietary calcium intake because the food records has the potential to provide more accurate quantitative information about food intake and is considered as a good method compared to others (Hendricks *et al.*, 2005). This method can be used in clinical settings where a 24-h period is an impractical and inexpensive means for assessing diet.

To discriminate between dairy and nondairy dietary sources of calcium ingested by the patients, the consumption of foods and food groups was recorded based on a food frequency questionnaire validated for the Brazilian population by (Sichieri & Everhart, 1998) by day, week and month as well as never and almost never. Daily frequencies were calculated by considering never and almost never as zero. Dairy food consumption was calculated based on servings per day of milk products recorded. The size servings were recorded for each item according to the dietary guidelines for the Brazilian population (Ministry of Health, Brazil, 2005). For most items, there were two or more choices (soup spoon, cup, rice spoon, slices, glass of milk or added to coffee and usual portions for meats, fish, poultry, pork, eggs, fruits, bread and beverages). Alcohol beverages were recorded as drinks by week. The instruments were administered by a trained nutritionist. The data were converted into energy and nutrients using the software NUTWIN, version 1.5 (Federal University of São Paulo, São Paulo, Brazil).

Dietary calcium intake was assessed bearing in mind the recommended daily intake of 1000 mg for adult men and women (Institute of Medicine, 1997). To compare the groups, the cut-off points of <350, 350–700 and >700 mg day^{-1} and one serving per day and ≥2 servings per day of dairy foods consumption were used as specified by Zemel *et al.* (2008). Dietary fibre consumption was evaluated based on the recommendation established by the Brazilian Society of Cardiology (20–30 g fibre per day) (BSC, 2007). The cut-off points were (<21 g and more than 21 g) dietary fibre per day.

Lifestyle questionnaire

The level of physical activity was determined with the Short Form International Physical Activity Questionnaire (IPAQ, 2003). The IPAQ questionnaire was administered at the time of nutrition interview. The levels were categorised as light (<30 min of moderate physical activity per day), moderate (from 30 min to 1 h of moderate physical activity per day) and intense (>1 h of vigorous physical activity per day). Individuals who smoked one or more cigarettes per day were considered as smokers.

Statistical analysis

All data were entered into a computer database and analysed using SPSS, version 11.0 (SPSS Inc., Chicago, IL, USA). The data were expressed as the mean (SD) and frequencies. Categorical variables were compared using the chi-square test and continuous variables were compared using Student's *t*-test and one-way analysis of variance. The association between calcium intake and metabolic abnormalities was assessed by calculating the odds ratio with a 95% confidence interval (CI). $P < 0.05$ was considered statistically significant.

Results

Demographic, clinical and lifestyle characteristics

A total of 100 adult HIV-infected individuals receiving treatment at a university hospital in Rio de Janeiro participated in the study. Most were males (63%) with a mean (SD) age of 41.78 (9.86) years (range 22–65 years); mean (SD) time elapsed since HIV infection was 6.0 (3.38) years. The baseline prevalence of overweight/obesity was 47%, and 52% of the individuals studied presented three or more metabolic parameters for the diagnostic of MS as defined by NCEP ATP III (2001).

The level of physical activity determined by IPAQ questionnaire (2003) showed that only 21% were categorised as having moderate/intense activity levels. Baseline characteristics are summarised in Table 1.

Dietary intake

The HIV-infected individuals studied had a mean energy intake of 9.0 MJ day (2151.7 kcal day), with mean (SD) percentages of energy intakes of carbohydrate, protein and lipid, and saturated fatty acids of 52.91% (7.9%), 18.82% (4.58%) and 28.29% (7.0%), and 6.96% (3.01%), respectively. Mean (SD) dietary intakes were 220.97 (154.66) mg day^{-1} for cholesterol, 21.69 (10.85) g day^{-1} for fibre and 559.5 (298.84) (range 39–1600) mg day^{-1} for calcium, with a dairy food consumption of 1.73 (0.78) servings per day. None of the participants reported taking calcium supplements at the time of the study. Ninety-two percent of the patients were below the recommended intake of 1000 mg day^{-1} for calcium.

A high percentage of HIV patients did not meet the dietary recommendations for primary cardiovascular prevention for lipids (<30% total fat) (35%), dietary fibres (21–30 g day^{-1}) (50.0%), saturated fatty acids (<7%) (38.0%) and cholesterol (<300 mg day^{-1}) (20.0%).

Table 1 Demographic, clinical and lifestyle characteristics of individuals with HIV/AIDS in a University Hospital of Rio de Janeiro-Brazil

Demographic characteristics	%
Gender	
Male	63
Female	37
Age groups (years)	
18–25	6
26–39	36
40–59	54
>60	4
Clinical characteristics	**Mean (SD)**
T-CD4 lymphocyte count (cells mm^{-3})	525.34 (270.39)
Time since HIV diagnosis (years)	6.0 (3.38)
Time under antiretroviral therapy (years)	4.18 (3.47)
Viral load (copies mL^{-1})	%
<400	70
Currently taking antiretroviral	77
Current taking protease inhibitor	30
Metabolic syndrome (ATP III, 2001)	52
Body mass index >25 kg m^{-2}*	47
Lifestyle	
Smokers	23
Practice regular physical activity†	21

*National Cholesterol Education Program Adult Treatment Panel III (2001): abdominal obesity (waist circumference ≥102 cm for men or ≥88 cm for women); triglyceride ≥150 mg dL^{-1}; high-density lipoprotein-cholesterol <40 mg dL^{-1} for men or <50 mg dL^{-1} for women; fasting glucose ≥100 mg dL^{-1}; blood pressure ≥135/85 mmHg or taking antihypertensive drugs.

†Internacional Physical Activity Questionnaire. Short Form (2003): moderate (from 30 min to 1 h of moderate physical activity per day) and intense (>1 h of vigorous physical activity per day).

Dietary calcium, dairy foods products intake and MS components

The diet characteristics were categorised into three levels of dietary calcium consumption (<350, 350–700, >700 mg day^{-1}). Patients in the >700 mg day^{-1} group had a higher but not significant energy intake 9.6 MJ (2311.93 kcal) versus 9.1 MJ (2180.61 kcal) versus 8.0 MJ (1918.04 kcal) day ($P = 0.09$), and greater cholesterol consumption [236.4 (163.8) mg day^{-1} versus 250.0 (159.2) mg day^{-1} versus 153.8 (116) mg day^{-1}] ($P = 0.03$) and saturated fat consumption [7.57% (2.61%) versus 7.34% (2.65%) versus 5.62% (3.76%)] ($P = 0.029$). Another trend observed in this group was higher fibre consumption [24.63 (13.6) g day^{-1} versus 21.77 (8.86) g day^{-1} versus 18.15 (9.56) g day^{-1}] ($P = 0.08$) compared to the lower calcium intake groups (Table 2).

When the foods and food groups consumed by the population under study were compared according to the calcium intake brackets, some differences between the groups were observed. Individuals in the >700 mg day^{-1} bracket displayed higher milk consumption ($P = 0.05$) and higher fruit consumption ($P < 0.05$). Other noted differences were the higher consumption of dairy products (cheeses/yogurt), vegetables, fish, bread and alcoholic beverages; however, these differences were not significant (Table 3).

Among dairy foods, milk was the most important product consumed, with 56% of the individuals eating one or two servings per day (e.g. a whole glass milk or milk added to coffee), followed by cheese (33%) and yogurt (14%).

Patients in the <700 mg day^{-1} calcium intake group presented enlarged, but not significant, waist circumference [92.73 (10.70) cm versus 92.29 (9.0) cm versus 88.23 (9.5) cm] ($P = 0.10$), higher BMI [26.0 (4.2) kg m^{-2} versus 26.15 (4.53) kg m^{-2} versus 24.80 (3.74) kg m^{-2}] ($P = 0.31$), higher systolic blood pressure [124.6 (11.74) mmHg versus 123.38 (16.22) mmHg versus 116.50 (14.2) mmHg] ($P = 0.04$) and diastolic blood pressure levels [82.31 (8.15) mmHg versus 82.50 (12.9) mmHg versus 77.25 (10.4) mmHg] ($P = 0.07$) (Table 4).

When comparing the groups by fibre consumption (<21 g day^{-1} versus more than 21 g day^{-1}), no significant differences were observed in terms of waist circumference [90.8 (8.8) cm versus 90.68 (10.82) cm] ($P = 0.92$) and BMI [25.78 (3.98) kg m^{-2} versus 25.36 (4.33) kg m^{-2}] ($P = 0.61$) (data not shown).

Higher dairy foods consumption (≥2 servings per day) was significantly related with lower BMI [24.12 (3.7) versus 26.83 (4.30)] ($P = 0.01$), waist circumference [87.68 (8.4) cm versus 92.48 (10.6)] ($P = 0.05$) and blood pressure levels ($P < 0.05$). When comparing dairy product consumption according to demographic and lifestyle characteristics, no significant differences were observed (Table 5).

A risk association was found between dietary calcium intake and MS components. Those with a dietary calcium intake lower were two-fold more likely to have MS (95% CI = 1.23–3.24; $P = 0.001$) and hypertension (95% CI = 1.14–4.44; $P = 0.01$) than those with higher dietary calcium intake (data not shown).

Discussion

The present study was the first to investigate an association between dietary calcium intake, body weight and metabolic parameters in individuals with HIV/AIDS under antiretroviral therapy. Today, it is well known that patients with HIV/AIDS have a significant prevalence of unfavourable nutritional parameters and cardiometabolic profiles, characterised by the presence of being overweight

Table 2 Dietary characteristics according to calcium intake of individuals with HIV/AIDS in a University Hospital of Rio de Janeiro-Brazil

Characteristics	Mean (SD)			*P*-value*
	<350 mg day^{-1} (n = 26)	350–700 mg day^{-1} (n = 44)	>700 mg day^{-1} (n = 30)	
Energy intake (MJ)	8.0	9.1	9.6	0.09
Carbohydrates (%)	51.46 (11.36)	53.66 (6.71)	53.07 (5.71)	0.53
Proteins (%)	18.04 (4.7)	19.07 (5.01)	19.13 (3.78)	0.60
Lipids (%)	30.38 (10.3)	27.43 (6.13)	27.43 (4.2)	0.21
SFA (%)	5.62 (3.76)	7.34 (2.65)	7.57 (2.61)	0.029
Cholesterol (mg)	153. 8 (116)	250.0 (159.2)	236.4 (163.8)	0.033
Calcium (mg)	207.08 (82.35)	524.48 (98.14)	916.4 (199.8)	<0.001
Fibres(g)	18.15 (9.56)	21.77 (8.86)	24.63 (13.6)	0.08
Folate (μg)	248.96 (150)	311.0 (143.4)	353.23 (23)	0.04
Iron (mg)	11.73 (4.41)	13.82 (5.3)	14.63 (6.37)	0.12
Vitamin C (mg)	36.58 (44.6)	89.84 (144)	89.50 (104)	0.13
Thiamin (mg)	1.36 (0.64)	1.50 (0.70)	1.80 (0.92)	0.08
Sodium (mg)	3374.46 (1867)	4202.45 (1439)	3879.3 (2033)	0.16

SFA, saturated fatty acids.

Table 3 The consumption of foods and food groups based on the food frequency questionnaire according to dietary calcium intake of HIV/AIDS patients at a University Hospital in Rio de Janeiro-Brazil

Food group	Mean (SD)			*P*-value*
	<350 mg day^{-1} (n = 26)	300–700 mg day^{-1} (n = 44)	>700 mg day^{-1} (n = 30)	
Meat (servings per week)	2.77 (1.27)	2.37 (1.31)	2.54 (1.07)	0.43
Fish (servings per week)	1.18 (0.40)	1.50 (0.52)	1.61 (0.70)	0.15
Poultry (servings per week)	3.58 (1.03)	3.64 (0.94)	3.80 (1.0)	0.67
Pork (servings per week)	2.50 (1.29)	1.40 (0.70)	1.0 (0.0)	0.05
Eggs (servings per week)	2.07 (1.62)	2.15 (1.08)	2.0 (1.0)	0.93
Beans (servings per day)	1.64 (0.57)	1.78 (0.47)	1.52 (0.51)	0.10
Rice (servings per day)	1.95 (1.43)	1.95 (0.63)	1.63 (0.49)	0.29
Pasta/pastry (servings per week)	2.55 (1.9)	1.90 (1.41)	1.89 (1.19)	0.22
Fruits/juice fruits (servings per day)	1.69 (1.08)	2.86 (1.53)	2.52 (1.27)	0.025
Vegetables (servings per day)	1.41 (0.62)	1.38 (0.50)	1.55 (0.80)	0.66
Potatoes/starchy vegetables (servings per week)	2.91 (1.95)	2.28 (1.70)	2.54 (1.44)	0.38
Milk (servings per day)	1.29 (0.49)	1.34 (0.48)	1.68 (0.57)	0.05
Milk products (servings per day)	1.33 (0.70)	1.67 (0.87)	1.95 (0.63)	0.11
White bread/biscuits (servings per day)	2.33 (1.19)	2.59 (1.18)	2.79 (1.45)	0.48
Whole grains (servings per day)	1.10 (0.0)	1.8 (1.6)	1.4 (0.53)	0.68
Sugar/sugary foods (servings per day)	3.04 (1.63)	2.95 (1.47)	3.04 (1.49)	0.96
Sweet beverages (servings per day)	1.94 (1.53)	1.96 (1.84)	1.0 (0.47)	0.23
Margarine/butter (servings per day)	1.23 (0.43)	1.39 (0.73)	1.46 (0.51)	0.4
Vegetables oils (servings per day)	1.32 (0.48)	1.19 (0.40)	1.20 (0.41)	0.59
Olive oil (servings per day)	1.09 (0.30)	1.04 (0.34)	1.05 (0.22)	0.88
Alcoholic beverages (drinks per week)	4.55 (3.0)	7.56 (7.1)	8.0 (7.0)	0.43

Size servings foods based on the 'Dietary guideline for the Brazilian population' (Ministry of Health. Health Support Secretary. Food and Nutrition Coordination, 2005).
*One-way analysis of variance.

(Hendricks *et al.*, 2006; Leite & Sampaio, 2008), dyslipidaemias and the so-called MS, which is defined as an association of at least three metabolic parameters, such as central obesity, a decrease in HDL cholesterol, an increase in plasma triglycerides, glucose intolerance or hypertension (Kahn, 2007; Wand *et al.*, 2007; Reeds, 2008), and are at higher risk for cardiovascular disease and type 2 diabetes.

In the present study, 52% of the sample presented MS components according the NCEP ATPIII (2001) definition. Beyond these patients, many presented a dietary consumption and lifestyle that failed to meet the

Table 4 Characteristics according to dietary calcium intake of HIV/AIDS patients at a University Hospital in Rio de Janeiro-Brazil

Characteristics	Mean (SD)			*P*-value*
	<350 mg day^{-1} (n = 26)	300–700 mg day^{-1} (n = 44)	>700 mg day^{-1} (n = 30)	
Age (years)	41.15 (7.59)	43.0 (10.32)	41.15 (10.86)	0.6
BMI (kg m^{-2})	26.0 (4.2)	26.15 (4.53)	24.80 (3.74)	0.31
Waist circumference (cm)	92.73 (10.7)	92.29 (9.0)	88.23 (9.54)	0.10
Triglycerides (mg dL^{-1})	229. 96 (159.5)	217.79 (156.2)	210.0 (167.8)	0.88
HDL (mg dL^{-1})	37.62 (10.2)	40.12 (8.40)	38.08 (7.24)	0.45
Fasting glucose (mg dL^{-1})	91.77 (17.56)	91.50 (13.5)	91.08 (12.64)	0.98
SBP (mmHg)	124.62 (11.74)	123.38 (16.22)	116.50 (14.2)	0.04
DBP (mmHg)	82.31 (8.15)	82.50 (12.98)	77.25 (10.4)	0.07
Total cholesterol (mg dL^{-1})	183.55 (35.35)	199.58 (49.98)	192.58 (52.2)	0.47
Duration of HIV infection (years)	5.69 (3.27)	5.94 (3.83)	6.33 (3.09)	0.74
Antiretroviral therapy (years)	2.92 (2.81)	4.53 (3.85)	4.70 (3.39)	0.097

BMI, Body mass index; HDL, high-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 5 Characteristics according to dairy foods consumption of individuals with HIV/AIDS in a University Hospital of Rio de Janeiro-Brazil

Variables	Mean (SD)		*P*-value*
	One serving day^{-1} (n = 29)†	≥2 servings day^{-1} (n = 34)†	
Demographic			
Gender			
Female	45	55	0.82
Male	47	53	
Age (years)	42.34 (10.5)	41.2 (9.7)	0.65
Lifestyle			
Smokers			
Yes	38	62	0.53
No	48	52	
Physical activity			
Light	46	54	0.96
Moderate-intense	47	53	
Metabolic			
Waist circumference (cm)	92.48 (10.6)	87.68 (8.4)	0.05
BMI (kg m^{-2})	26.83 (4.38)	24.12 (3.79)	0.01
Triglycerides (mg dL^{-1})	236.5 (213.0)	198.53 (110.0)	0.36
HDL (mg dL^{-1})	38.62 (9.7)	38.32 (7.1)	0.88
Fasting glucose (mg dL^{-1})	90.55 (13.52)	90.76 (11.17)	0.94
SBP (mmHg)	124.83 (12.4)	114.12 (15.3)	0.04
DBP (mmHg)	84.31 (10.3)	75.0 (10.8)	0.001
Total cholesterol (mg dL^{-1})	195.14 (54.29)	196.85 (50.5)	0.89
HIV-related			
Duration of HIV infection (years)	6.41 (3.30)	6.56 (3.0)	0.85
Antiretroviral therapy (years)	4.55 (3.7)	4.65 (3.1)	0.91

BMI, Body mass index; HDL, high-density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.
*Student's *t*-test; chi-square.
†Were included in analysis only 63 patients. Thirty-seven patients did not meet at least one dairy food product consumption per day.

recommendations for primary cardiovascular prevention (De Backer *et al.*, 2003; Goldstein *et al.*, 2006; Lundgren *et al.*, 2008), half of the studied population consumed low fibre diets and 30–38% failed to meet the recommendations of consuming diets containing <30% of fats and <7% of saturated fats, respectively, and only 21% were categorised as having moderate/intense physical activity levels. This dietary and lifestyle pattern resembles those

described in previous studies showing an association with being overweight and metabolic alterations in HIV/AIDS patients (Batterham *et al.*, 2000; Hendricks *et al.*, 2006; Arendt *et al.*, 2008).

The mean calcium intake among the studied individuals was a little more than 50% of the recommended daily intake for adults of 1000 mg day^{-1} (DRI, 1997; Institute of Medicine, 1997) and 63% of the patients consumed at least one or two servings of dairy products per day, a dietary pattern that is considered as being poor in dietary calcium (Zemel *et al.*, 2008). A Brazilian study that assessed the dietary patterns of individuals with HIV/AIDS also found that calcium and milk product intakes were below the recommended levels, although their relationship with being overweight and metabolic abnormalities was not investigated (Duran *et al.*, 2008).

The results obtained in the present study suggest that dietary calcium and dairy products could have a potential role in the presence of metabolic abnormalities such as central obesity and being overweight in an HIV-infected population. Individuals with higher dietary calcium intake and habitual dairy products consumers showed lower waist circumference and blood pressure levels, although this was significant only for the highest habitual dairy products consumers group.

These observations are consistent with others studies conducted in HIV-negative populations that demonstrated an inverse relationship between body weight, abdominal adiposity, calcium intake and dairy product consumption (Marques-Vidal *et al.*, 2006; Dicker *et al.*, 2008).

Some dietary pattern differences were noted between groups. Patients in the >700 mg day^{-1} of calcium group had higher daily intakes of energy, saturated fats and cholesterol, as well as higher intake of fruits/vegetables. The <350 mg day^{-1} group had a higher total percentage fat intake and lower fibre intake.

The results obtained in the present study demonstrate that, despite the higher global energy intake, as well as a higher saturated fatty acid and cholesterol consumption in the >700 mg day^{-1} calcium group, these individuals presented lower BMI ($P = 0.10$) and waist circumference levels ($P = 0.31$). These results suggest that these individuals may have benefited from greater fat oxidation and dietary patterns with a higher proportion of calcium, dairy food consumption and fruit/vegetable intakes, and this may have influenced the energy balance compared to other groups.

In an animal model of diet-induced obesity, it was observed that high calcium diets attenuate adipocyte lipid accretion and weight gain during periods of overconsumption of an energy-dense diet (Shi *et al.*, 2001). In another study, similar results were described with respect to the body fat and trunk fat of obese African-Americans individuals after an increase in dairy product intake for 6 months, in the absence of energy restriction (Zemel *et al.*, 2005).

In addition, a dietary study of an HIV-positive population showed that individuals without fat deposition had greater energy, protein and fibre intakes. The authors suggest that an overall high-quality diet may be beneficial in preventing the development of fat deposition and metabolic abnormalities in HIV-positive individuals (Hendricks *et al.*, 2003).

For Azadbakht *et al.* (2005), the inverse relationship between dietary calcium intake and the MS components demonstrated in a number of studies could be explained by a healthier lifestyle of individuals who have calcium-rich diets.

The effects of lifestyle confounders such as physical activity and smoking habits were not significant between the two groups. On the other hand, food group intake (e.g. vegetables, fruits and milk products) did differ between groups.

The most promising finding of the presemt study was the potential protective role of calcium intake against MS and hypertension in patients receiving antiretroviral therapy. Patients with a lower dietary calcium intake were twice as likely to suffer MS components such as an enlarged waist circumference and hypertension.

The results obtained in the present study do not support a significant association between dietary calcium, dairy food consumption and cholesterol, triglyceride, HDL-cholesterol and glucose levels; however, the group with a lower calcium intake tended to have higher such levels, although these were not significant. These results are at least partially similar to other studies of HIV-negative populations. No significant differences for HDL cholesterol, low-density lipoprotein cholesterol, triacylglycerol or total cholesterol were found between the groups, whereas there is a potential effect of calcium intake on body weight and body fat mass (Jacqmain *et al.*, 2003; Azadbakht *et al.*, 2005).

A study of an HIV-positive population also demonstrated lower dietary calcium intake among obese or overweight individuals. Although the present study did not explore this relationship, no significant differences were observed in the lipid profile, except for the level of triglycerides, which was higher among obsese men compared to men with a normal BMI (Hendricks *et al.*, 2006).

Several limitations should be considered when examining the results of the present study. We used cross-sectional data to identify the association of calcium intake, dairy food consumption and metabolic abnormalities in HIV-infected persons, whereas future studies that use longitudinal data will provide stronger evidence for this association. In addition, the use of a single 24-h

recall to estimate the usual intake of calcium for individuals may be prone to error (Venti *et al.*, 2005), and may explain why a difference was found in the highest dairy food consumption group and the MS components but not with the 24-h intake data. Indeed, a high dietary intake of calcium and dairy foods appears to reflect an overall healthier lifestyle, which may not have been accurately captured and controlled for in our analysis, and this omission would result in residual confounding.

Although it was not possible to show a direct association between dietary calcium consumption and the presence of hyperlipidaemia in HIV-infected individuals under antiretroviral therapy, we consider that the potential effects of dietary calcium and dairy products in regulating body weight and fat deposition demonstrated in the present study could serve as a basis for modifications to the dietary patterns followed by HIV/AIDS patients in the highly active antiretroviral therapy era, giving preference to nutrients with acknowledged modulator effects on the lipid metabolism, such as dietary calcium and fibres.

Many questions about the role of calcium and dairy product intake in relation to obesity and weight management in HIV-infected population are still unclear, and remain to be answered before large-scale recommendations on dietary modifications or supplementation can be formulated. Future studies are necessary to determine whether there is a causal relationship between dietary calcium and metabolic abnormalities in individuals with HIV/AIDS and the role of different calcium sources (dietary or otherwise) in changing this unfavourable cardiometabolic profile.

The present study showed that calcium or dairy product intake was suboptimal for most of the patients, not reaching the dietary reference intake for calcium in adults of 1000 mg day^{-1} (DRI, 1997). On the basis of this result and from a practical perspective, it appears reasonable to recommend dietary measures to promote adequate calcium intake, aiming to meet the actual recommendations of 1000 mg day^{-1} for calcium (DRI, 1997) or two to three servings per day from the milk products, with preference for low-fat dairy products (Zemel *et al.*, 2008).

Conflicts of interests, source of funding and authorship

The authors declare that they have no conflicts of interest.

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LHML was responsible for the design of the study, field work, data input and analysis, as well as the writing of the manuscript. ABMMS was also responsible for the analysis, discussion and writing of the manuscript. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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