

# Risk factors associated with overweight and obesity in HIV-infected people

## Aging, behavioral factors but not cART in a cross-sectional study

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### Abstract

Identifying risk factors associated with overweight and obesity in HIV-infected patients.

A cross-sectional study analyzing data from patients attending an HIV outpatient unit. Overweight was defined as body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>;  $< 30$  kg/m<sup>2</sup>, obesity was  $\geq 30$  kg/m<sup>2</sup>. Patients' characteristics contemporary to BMI assessment were collected. Multivariate logistic regression identified risk factors associated with overweight/obesity.

Eight hundred sixty-two patients, median age 51 years, 21.5 years of HIV infection follow-up, 585 (68%) male, 829 (96%) receiving combined antiretroviral therapy (cART) for median 16.7 years, 768 (91%) HIV load  $< 40$  copies/mL, 618 (73%) CD4<sup>+</sup>  $\geq 500$  cells/mm<sup>3</sup>; 266 (31%) HCV<sup>+</sup> serology, 110 (13%) had detectable HCV-RNA. Overweight affected 191 (22%) patients and obesity 46 (5%). Overweight and obesity were associated with age, HIV follow-up duration, and HIV transmission risk group. Overweight was also associated with gender and HCV status. In patients with substance use data, overweight was associated with alcohol and nonsmoking status. Obesity was associated with nonsmoking and ex-smoker status. Overweight/obesity were not found associated with cART or immune cell counts.

In HIV-infected people, aging, alcohol consumption, nonsmoking, and ex-smoker status, the absence of HCV coinfection and to have cleared HCV infection are associated with overweight and/or obesity. Clinicians should be aware of these trends and consider introducing weight management programs as part of routine HIV care.

**Abbreviations:** BMI = body mass index, cART = combined antiretroviral therapy, CVD = cardio vascular disease, DAA = direct antiviral agents, HBV = hepatitis B virus, HCV = hepatitis C virus, HIV = human immunodeficiency virus, IVDU = intravenous drug use, MSM = men who have sex with Men.

**Keywords:** cleared HCV management, HIV, nutritional support, obesity, overweight, smoking cessation

### 1. Introduction

Highly active antiretroviral therapy has drastically reduced the number of deaths and AIDS-defining events among HIV-infected people, including wasting syndrome.<sup>[1]</sup> Nowadays, HIV-infected patients who receive combined antiretroviral therapy (cART) live longer but comorbidities emerge earlier and more frequently. Among them, metabolic and cardiovascular diseases are 2 leading causes of death for HIV-infected patients living in high-income

countries.<sup>[2]</sup> Overweight and obesity are 2 risk factors for diabetes, hypertension, cardiovascular disease, and cancer in the general population<sup>[3,4]</sup> that increasingly affect HIV-infected people.<sup>[5-7]</sup> Moreover, obesity seems to have a detrimental effect on immune recovery after cART initiation.<sup>[8]</sup>

Few studies have investigated the factors associated with overweight and obesity in HIV-infected people, and the concomitant incidence of overweight/obesity and metabolic/cardiovascular diseases in this population. The aim of this study was to determine the risk factors associated with overweight and obesity in a large cohort of HIV-infected patients.

### 2. Methods

#### 2.1. Patients and study design

This cross-sectional study was conducted in an HIV outpatient unit in France, using an electronic medical record for HIV, HBV- or HCV-infected adults.<sup>[9,10]</sup> Subjects provided written informed consent for the use of their medical records on NADIS. This electronic medical record was approved by the French Commission National Informatique et Liberté (Registration number: 2001/762876/nadiscnil.doc). Patient data were recorded during medical visits, and data quality was controlled systematically during capture, annual assessments, and ad hoc processes prior to analyses. We selected patients with body mass index (BMI, kg/m<sup>2</sup>) measured at least once between January 1, 2015 and December 31, 2015.

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According to the World Health Organization, obesity was defined as a BMI  $\geq 30$  kg/m<sup>2</sup>, and overweight is BMI  $\geq 25$  and  $< 30$  kg/m<sup>2</sup>. Demographic characteristics, comorbidities (past or ongoing) including diabetes, hypertension, myocardial infarction/coronary artery disease, peripheral arteriopathy and stroke, CD4<sup>+</sup> and CD8<sup>+</sup> T cell count, HIV viral load (VL), cART exposure and regimen, and HCV/HBV serologies were collected at the time of BMI measurement. Behavioral factors such as alcohol and tobacco consumption were collected when available.

## 2.2. Statistical analysis

Patients' characteristics by BMI groups were analyzed using the Kruskal–Wallis test for quantitative variables, and Pearson  $\chi^2$  test or Fischer test for categorical variables.

We studied associations between BMI (dependent variable) in 3 classes ( $< 25$  kg/m<sup>2</sup>/overweight/obesity) and socio-demographic characteristic (gender, age); HIV-related variables (CDC stage C, HIV transmission risk group, duration of HIV infection follow-up, CD4<sup>+</sup> (cells/mm<sup>3</sup> and  $< 350$  cells/mm<sup>3</sup>; yes/no) and CD8<sup>+</sup> T cell count and %, nadir CD4<sup>+</sup>, HIV-VL, duration of HIV suppression, cART exposure and status (naive, ongoing, previous), cART regimen and cumulative exposure to PI, NNRTI and INSTI); hepatitis coinfection (AgHBs, anti-HBc, and HCV serologies); behavioral factors (alcohol consumption; yes/no; never-smoker/smoker/ex-smoker). Based on the observations, HIV transmission risk groups were analyzed as 3 categories: homosexual/bisexual, intravenous drug use (IVDU), and heterosexual/others. All variables associated with the outcome that had a *P* value lower than .20 in bivariate analysis were considered eligible to enter the multivariate model using multinomial regression. These multivariate models were built using a stepwise procedure with a *P* value at entry of .20 and a *P* value to stay of .10. As data on behavioral factors was not available for all patients, a subanalysis on patients with this available data was built using the same stepwise procedure. All data were analyzed using SPSS 20 Statistics (IBM, Madison, WI).

## 2.3. Ethics statement

All subjects provided written informed consent for the use of their medical records on NADIS. This electronic medical record was approved by the French Commission National Informatique et Liberté (Registration number: 2001/762876). This study was carried out in compliance with international guidelines for human research protection as per the Declaration of Helsinki and ICH-GCP.

## 3. Results

Eight-hundred eighty-four HIV-infected patients attended at least 1 medical visit during the study period, of whom 862 patients fulfilled selection criteria. Among them, 191 patients (22.2%) were overweight and 46 patients (5.3%) were obese. Patients' characteristics by BMI are described in Table 1. Overall, 67.9% were males, with a median age 51.2 [46; 56] years and a median duration of HIV infection follow-up of 21.5 [12.3; 26.5] years. Gender differences for the prevalence of overweight and obesity were not significant, neither was the duration of HIV infection follow-up. Nevertheless, the prevalence of overweight and obesity increased with age. Among HIV-related variables, the proportion of patients contaminated heterosexually/others transmission risk group was significantly higher among patients with overweight and obesity (56% and 56.5%, respectively,

versus 41.9% in patients  $< 25$  kg/m<sup>2</sup>; *P* = .01). Conversely, the duration of cART exposure, cART regimen, CD4<sup>+</sup> or CD8<sup>+</sup> T cell counts, and CD4/CD8 ratio were comparable across BMI groups, although patients with obesity had the lower percentage of CD8<sup>+</sup> T cells. Furthermore, the proportion of patients with undetectable HIV plasma viral load was significantly higher in patients with overweight and obesity. Patient status regarding hepatitis C coinfection also differed across BMI groups, with the prevalence of negative HCV serology being significantly higher among patients with overweight and obesity, whereas the prevalence of chronic HCV infection (HCV+ serology with detectable HCV-RNA) was lower in patients with overweight. Data on alcohol and tobacco consumption were available in 417 (48%) and 471 (54.6%) patients, respectively, and both were available for 374 (43%) patients. The proportion of alcohol consumers was significantly higher among patients with overweight, whereas the proportions of never- and ex-smokers were significantly higher in patients with obesity.

### 3.1. Prevalence of diabetes and cardiovascular comorbidities

The prevalence of diabetes and cardiovascular comorbidities by BMI are reported in Table 2. Three hundred nine patients (35.8%) presented at least 1 comorbidity, of whom 125 (52.7%) were overweight or obese. The distribution of comorbidities differed according to BMI. Indeed, the prevalence of hypertension, diabetes, and peripheral arteriopathy was significantly higher among overweight and patients with obesity, and the prevalence of acute myocardial infarction was significantly higher in patients with overweight.

### 3.2. Multivariate analysis of factors associated with overweight and obesity

First, we used a multivariate model that considered the entire study cohort (Table 3), which revealed associations of overweight with negative HCV serology (OR: 2.84 [95% IC: 1.23; 6.54]), cleared HCV infection (OR: 2.61 [95% IC: 1.20; 6.67]) compared to active HCV infection, heterosexual/others transmission risk group (OR: 2.59 [95% IC: 1.60; 4.18]) compared with men who have sex with men (MSM), male gender (OR: 1.91 [95% IC: 1.22; 2.99]), and age (OR: 1.06 [95% IC: 1.03; 1.08]). Compared with MSM, the IVDU transmission risk group was found to be associated with obesity (OR: 5.73 [95% IC: 1.01; 32.51]) but not overweight. Obesity was also associated with age (OR: 1.06 [95% IC: 1.03; 1.1]). Obesity and overweight were both negatively associated with the duration of HIV infection follow-up (OR: 0.94 [0.91; 0.98]) and 0.97 [0.95; 0.99] respectively).

In a multivariate model considering only those patients for whom alcohol and smoking data were available (Table 4), overweight was associated with alcohol consumption (OR: 2.39 [95% IC: 1.28; 4.46]), never-smoker status (OR: 2.14 [95% IC: 1.07; 4.26]). Obesity was found to be associated with ex-smoker status (OR: 6.97 [95% IC: 2.02; 23.99]) and nonsmoker status (6.38 [95% IC: 1.64; 24.76]). Heterosexual transmission risk group, being a man and age, remain associated as found in the general multivariate model.

## 4. Discussion

This cross-sectional study explored the risk factors associated with overweight and obesity in a large cohort of HIV-infected

**Table 1**  
**Patients' characteristics by BMI.**

n (%) / median [IQR]	BMI <25 kg/m <sup>2</sup>	25 ≤ BMI <30 kg/m <sup>2</sup>	BMI ≥30 kg/m <sup>2</sup>	P*
	n=625	Overweight n=191	Obesity n=46	
Males	417 (66.7%)	140 (73.3%)	28 (60.9%)	.14
Females	208 (33.3%)	51 (26.7%)	18 (39.1%)	
Age, years	50.6 [45.2; 54.6]	53.8 [48.4; 59.8]	54.0 [50.1; 60.4]	<.001
<40	93 (14.9%)	13 (6.8%)	2 (4.3%)	<.001
40–50	196 (31.4%)	51 (26.7%)	9 (19.6%)	
50–60	275 (44%)	80 (41.9%)	23 (50%)	
≥ 60	61 (9.7%)	47 (24.6%)	12 (26.1%)	
CDC stage C	136 (21.8%)	43 (22.5%)	8 (17.4%)	.75
Nadir CD4 <sup>+</sup> T cell count (/mm <sup>3</sup> )	205 [96; 306]	197 [103; 279]	220 [120; 314]	.52
HIV transmission risk group				
Heterosexual and others†	262 (41.9%)	107 (56%)	26 (56.5%)	.01
MSM	216 (34.6%)	49 (25.7%)	11 (23.9%)	
IVDU	147 (23.5%)	35 (18.3%)	9 (19.6%)	
Time of HIV-infection				
follow-up, years	22.2 [13.3; 26.8]	20.3 [12.3; 26.2]	18.3 [9.0; 25.3]	.16
CD4 <sup>+</sup> T cell count (/mm <sup>3</sup> )	709 [473; 946]	749 [545; 944]	682 [453; 933]	.36
CD4 <sup>+</sup> T cell count <350 /mm <sup>3</sup>	77 (12.6%)	15 (8.1%)	4 (8.7%)	.20
CD4 <sup>+</sup> T cell count, %	35 [28; 43]	35 [28; 41]	33.5 [22.7; 43]	.78
CD8 <sup>+</sup> T cell count (/mm <sup>3</sup> )	804 [580; 1101]	814 [591; 1051]	772 [529; 1027]	.69
CD8 <sup>+</sup> T cell count, %	40 [33; 49]	38 [31; 47]	36 [27; 43]	.02
CD4/CD8 ratio	0.88 [0.58; 1.26]	0.93 [0.62; 1.26]	0.98 [0.55; 1.35]	.33
CD4/CD8 ratio <1	364 (60.1%)	107 (57.8%)	23 (50%)	.38
HIV-pVL <40 copies/mL	548 (89.5%)	176 (95.7%)	44 (95.7%)	.02
Duration of HIV suppression, years	5.4 [1.6; 9]	5.8 [1.8; 8.8]	5 [1.4; 8.4]	.66
Antiretroviral therapy				
Naive	12 (1.9%)	3 (1.6%)	—	.32
Ongoing cART	598 (95.7%)	187 (97.9%)	44 (95.7%)	
Previous cART	15 (2.4%)	1 (0.5%)	2 (4.3%)	
cART exposure, years	16.9 [8.9; 19.7]	16.8 [9.1; 19.6]	14.2 [7.0; 19.5]	.69
Cumulative PI exposure, years	6.4 [1.4; 11.3]	6.9 [1.7; 12.4]	6.2 [2.8; 11.4]	.68
Cumulative NNRTI exposure, years	1.6 [0.1; 6.1]	2.7 [0.7; 6.7]	1.7 [0.2; 5.4]	.16
Cumulative INSTI exposure, mo	0 [0; 7.8]	0 [0; 10.5]	0 [0; 19.1]	.19
cART regimen				
2 NRTI + 1 NNRTI	248 (41.5%)	77 (41.2%)	20 (45.4%)	.40
2 NRTI + 1 PI/b	150 (25.1%)	40 (21.4%)	5 (11.4%)	
2 NRTI + 1 INSTI	111 (18.5%)	43 (23%)	10 (22.7%)	
3 NRTI	16 (2.7%)	2 (1%)	1 (2.3%)	
Others	73 (12.2%)	25 (13.4%)	8 (18.2%)	
Alcohol consumption	n <sup>‡</sup> = 301	n = 91	n = 25	
Yes	188 (62.4%)	71 (78%)	17 (68%)	.02
Tobacco consumption	n = 335	n = 103	n = 33	
Nonsmoker	62 (18.5%)	30 (29.1%)	14 (42.4%)	<.001
Ex-smoker	72 (21.5%)	29 (28.2%)	13 (39.4%)	
Smoker	201 (60%)	44 (42.7%)	6 (18.2%)	
HCV status				
Negative HCV serology	415 (66.5%)	144 (75.4%)	36 (78.3%)	.01
HCV + serology/ Undetectable HCV-RNA	116 (18.6%)	36 (18.8%)	4 (8.7%)	
HCV + serology/ Detectable HCV-RNA	93 (14.9%)	11 (5.8%)	6 (13%)	
HBV serology				
AgHBs+	18 (2.9%)	4 (2.1%)	—	.73
Anti-HBc+	259 (42.9%)	70 (37.2%)	24 (53.3%)	.12

cART = combination antiretroviral therapy, INSTI = integrase strand transfer inhibitors, IVDU = intravenous drug users, MSM = men who have sex with men, NNRTI = non-nucleoside reverse transcriptase inhibitor, NRTI = nucleoside reverse transcriptase inhibitor, PI/b = boosted protease inhibitor.

\* Kruskal–Wallis test for quantitative variables, and Pearson  $\chi^2$  test or Fischer test for categorical variables.

† Others: Blood transfusion + mother-to-child transmission + accidental viral risk + unknown.

‡ n: number of available data.

people who have received care for over 20 years with fairly successful HIV suppression. The data obtained showed that aging, gender, HIV transmission risk group, alcohol consumption, absence of active HCV coinfection and tobacco intoxication, but not cART regimen or CD4<sup>+</sup> T cell count, are associated

with overweight and/or obesity in this cohort of HIV-infected patients.

The advent of antiretroviral therapy has radically changed the course of body weight in HIV-infected patients. Indeed, weight loss and the concomitant wasting syndrome, which were

**Table 2****Prevalence of diabetes and cardiovascular comorbidities according to BMI.**

n (%)	BMI <25 kg/m <sup>2</sup> n = 625	25 ≤ BMI <30 kg/m <sup>2</sup> Overweight n = 191	BMI ≥30 kg/m <sup>2</sup> Obesity n = 46	P*
Hypertension	112 (17.9%)	57 (29.8%)	23 (50.0%)	<.001
Diabetes	28 (4.5%)	36 (18.8%)	11 (23.9%)	<.001
Coronary artery disease	16 (2.6%)	6 (3.1%)	2 (4.3%)	.56
Acute Myocardial infarction	18 (2.9%)	13 (6.8%)	1 (2.2%)	.05
Peripheral arteriopathy	60 (9.6%)	31 (16.2%)	12 (26.1%)	<.001
Stroke	15 (2.4%)	6 (3.1%)	0	.60

\*Kruskal–Wallis test for quantitative variables, and Pearson  $\chi^2$  test or Fischer test for categorical variables.

**Table 3****Factors associated with overweight and obesity in HIV-infected patients; multivariate analysis.**

Variables	P	Overweight versus BMI <25 kg/m <sup>2</sup>		Obesity versus BMI <25 kg/m <sup>2</sup>	
		OR [CI]	P	OR [CI]	P
Age, years	<.001	1.06 [1.03; 1.08]	<.001	1.06 [1.03; 1.10]	<.001
Heterosexual transmission	.001	2.59 [1.60; 4.18]	<.001	2.33 [0.97; 5.60]	.06
IVDU transmission		2.22 [0.97; 5.09]	.06	5.73 [1.01; 32.51]	.05
Homosexual transmission		1		1	
Time follow-up HIV, years	.002	0.97 [0.95; 0.99]	.01	0.94 [0.91; 0.98]	.01
Negative HCV antibodies	.009	2.84 [1.23; 6.54]	.01	2.57 [0.53; 12.58]	.24
Negative HCV RNA		2.61 [1.20; 6.67]	.02	0.46 [0.12; 1.70]	.24
Positive HCV RNA		1		1	
Sex: be a man	.014	1.91 [1.22; 2.99]	.01	0.96 [0.45; 2.06]	.91

observed in most untreated patients at the beginning of the epidemic, are observed in fewer than 10% of patients receiving cART in 2013.<sup>[11]</sup> In our study, only 7.5% of patients were underweight (BMI < 18.5 kg/m<sup>2</sup>), while obesity and overweight affected 27.5%, mirroring the progression of these conditions in HIV-infected patients.

Concern about overweight and obesity is growing worldwide. In a cross-sectional population-based survey performed between 2011 and 2013 and including 48,741 adults from several countries on different continents, the prevalence of overweight and obesity totaled 31.7% and 12.4% respectively.<sup>[12]</sup> In France, the trends in the general population were similar in 2008, with 30.6% of subjects with overweight and 13.1% with obesity,<sup>[13]</sup> and the prevalence of obesity increased steadily, reaching 15% in

2012.<sup>[14]</sup> The rising prevalence of overweight and obesity in HIV-infected people has been observed in many countries.<sup>[6,15,16]</sup> As in the general population, overweight and obesity are associated with a number of detrimental health conditions in HIV-infected patients, including cardiovascular diseases and diabetes.<sup>[16–20]</sup> This study confirms that the prevalence of diabetes and cardiovascular disease is high in HIV-infected patients, and that overweight and obesity increasing in this population add excess risk of these comorbidities. BMI distribution of patients starting cART is similar to that of the general population, but there is a significant risk of BMI gain during the first years after cART initiation.<sup>[15,21]</sup> Overweight or obesity was shown to affect half of patients initiating cART, and 1 in 5 patients appeared to move to a higher BMI category within 2 years of cART initiation.<sup>[15]</sup> This

**Table 4****Factors associated with overweight and obesity in HIV-infected patients with data tobacco and alcohol consumption; multivariate analysis.**

Variables	P	Overweight versus BMI <25 kg/m <sup>2</sup>		Obesity versus BMI <25 kg/m <sup>2</sup>	
		OR [CI]	P	OR [CI]	P
Age, years	.001	1.05 [1.01; 1.08]	.003	1.07 [1.02; 1.12]	.01
Never smoker	.002	2.14 [1.07; 4.26]	.03	6.38 [1.64; 24.76]	.01
Past smoker		1.20 [0.60; 2.39]	.61	6.97 [2.02; 23.99]	.002
Current smoker		1		1	
Sex: be a man	.004	2.76 [1.34; 5.54]	.004	0.63 [0.21; 1.89]	.41
Heterosexual transmission	.004	3.50 [1.70; 7.19]	.001	2.00 [0.55; 7.32]	.29
IVDU transmission		1.19 [0.54; 2.63]	.67	1.32 [0.31; 5.67]	.71
Homosexual transmission		1		1	
Heterosexual transmission		2.95 [1.45; 5.99]	.003	1.52 [0.45; 5.10]	.50
Homosexual transmission		0.84 [0.38; 1.87]		0.76 [0.18; 3.27]	.71
IDVU transmission	.004	0.34 [0.17; 0.69]	.003	0.66 [0.20; 2.20]	.50
Homosexual transmission		0.29 [0.14; 0.59]		0.50 [0.14; 1.83]	
Alcohol consumption (yes)	.014	2.39 [1.28; 4.46]	.01	1.75 [0.66; 4.67]	.26

gain in BMI after cART initiation was associated with an increase in the subsequent risk of cardiovascular disease (CVD) and diabetes.<sup>[22]</sup> Our study found that 44.3% of HIV-infected patients with overweight/obesity had cardiovascular disease, including hypertension (33.7%), and 19.8% are diabetic. This prevalence is higher than previous observations in a younger cohort of HIV-infected patients,<sup>[20]</sup> suggesting a foreseeable age-related aggravation of this risk.

Multiple data have shown that patients receiving antiretroviral therapy have a higher BMI compared with naive ones,<sup>[11]</sup> and a significant gain in body weight has been observed shortly after cART initiation.<sup>[15,21]</sup> Nevertheless, a significant association between overweight/obesity and cART was not observed in our study, consistent with a previous meta-analysis on the HIV-infected population.<sup>[11]</sup> Therefore, risk factors for excessive weight gain other than cART should be monitored to avoid an over-risk of comorbidities in the HIV-infected population. Initial attempts to identify such risk factors for overweight and obesity in HIV infection found that Black African women and Hispanic people seem to be at a higher risk of obesity.<sup>[23,24]</sup> Unfortunately, ethnicity could not be documented in our study due to local regulations. In the general population, overweight and obesity are associated with aging, and observed more frequently over the age of 60.<sup>[12]</sup> Consistently, our study and others found that aging was significantly associated with overweight and obesity in HIV-infected patients.<sup>[6,15]</sup> Nevertheless, 17.6% of patients under 50 years old were also affected by overweight in our study. Previously, it was reported that obesity favors recovery of CD4+ T-cell counts in cART naive patients and those initiating cART.<sup>[18,25,26]</sup> Although no association between immune cell counts and obesity was found in our study, its cross-sectional design does not allow the impact of excessive weight on immune reconstitution over time to be excluded.

Among new risk factors for overweight and obesity found in this study, the absence of active HCV coinfection (either never coinfecting or cleared coinfection) deserves particular interest. A lower BMI in HCV-co-infected subjects was also reported recently in a large study evaluating changes in body composition among HIV-infected patients.<sup>[24]</sup> Although the prevalence of HCV coinfection is high (15–30%) among HIV-infected patients,<sup>[27]</sup> and concerns a third of our cohort, the recent evolution of HCV-infection management with the advent of direct antiviral agents (DAA) allows a sustained viral response in more than 94% of HIV-HCV coinfecting patients.<sup>[28–30]</sup> Since the conditions for the eradication of HCV-co-infection are now met in locations where DAA are available, it is predictable that the prevalence of overweight and obesity will rise in this population.

We found that several behavioral factors including transmission risk group and substance use (tobacco and alcohol) have a significant link with overweight and obesity. The data available on the role of transmission risk group on excessive weight is scant. A recent study comparing lifestyle and health behavior in MSM and heterosexual men found that MSM are more likely to perform intense physical training, which might limit overweight and obesity in this population compared with heterosexual men.<sup>[31]</sup> There is evidence that IVDU have an increased risk of low BMI in the general population,<sup>[32]</sup> and HIV-infected IVDU females have a lower BMI compared with their noninjected drug user counterparts.<sup>[33]</sup> Nevertheless, these studies did not consider other transmission risk groups and therefore, their results and ours cannot be compared. Regarding smoking, our observations in HIV-infected patients are consistent with patterns in the general population where smoking cessation was previously

associated with both overweight and obesity, while light or moderate smoking was inversely associated with obesity.<sup>[12]</sup> In the same study, moderate alcohol intake was associated with both overweight and obesity. In our study, alcohol consumers were more likely to be overweight but not obese. However, as the amount of alcohol consumed was not available in our study, the impact of the consumption level remains elusive.

Our study has limitations. As mentioned above, the cross-sectional design of our study did not allow the impact of overweight and obesity on several biological and clinical variables, including immune reconstitution, to be evaluated. Moreover, data on exercise habits, diet, personal income, and education level were unavailable and could not be evaluated.

Altogether, the risk factors for excessive weight identified in this study of a long-lived cohort of HIV-infected patients reflect the impact of improvements in the management of HIV infection over the history of the epidemic. The availability of highly active antiretroviral drugs and DAA for hepatitis treatment, closer monitoring of comorbidities, and the implementation of educational programs for preventing substance abuse, including tobacco and alcohol, contribute to an extended lifespan and quality of life in HIV-infected patients. Nevertheless, the risk of obesity and excess weight also increased with age, HCV clearing, and smoking cessation.

With a longer lifespan, overweight in the HIV-infected population is increasing and associated with serious adverse medical consequences. Clinicians should be aware of these trends and consider introducing weight management programs as part of routine HIV care. As some risk behaviors appear to be associated with overweight and obesity, specific interventions targeting these factors have to be initiated, especially among smokers included in smoking cessation programs.

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