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Heavy injection drug use is associated with lower percent body fat in a multi-ethnic cohort of HIV-positive and HIV-negative drug users from three U.S. cities

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Abstract

Background—The clinical implications of lower body weight in drug using populations are uncertain given that lower mean weights may still fall within the healthy range.

Objectives—To determine the effect of type, mode and frequency of drug use on underlying body composition after accounting for differences in body shape and size.

Methods—We conducted a cross-sectional analysis of 511 participants from the Tufts Nutrition Collaborative (TNC) Study. Data included measures of body composition, a 24-hour dietary recall, and a detailed health history and lifestyle questionnaire. Multivariate regression analysis was used to determine the independent effect of drug use on percent body fat (BF) after adjusting for BMI and waist circumference.

Results—Heavy injection drug users (IDUs) had a 2.6% lower percent BF than non-users after adjusting for BMI, waist circumference, and other confounders. ($p=0.0006$). Differences in percent BF were predominantly due to higher lean mass, rather than lower fat mass. Cocaine and heroin had similar effects on body composition.

Conclusions—In the U.S., where the general population is prone to over-nutrition, the average percent BF for heavy injectors does not fall into a range low enough to suggest harmful effects. However, in populations with substantial levels of under-nutrition, small differences in percent BF among drug users will have a greater impact on health status.

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DECLARATION OF INTEREST
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Scientific Significance—Differences in BMI, weight and body composition are not always straightforward. Accounting for underlying nutritional status and relative differences in fat and FFM is critical when interpreting results.

INTRODUCTION

While the evidence base is still relatively limited, it is generally believed that nutrition and metabolic complications are of significant concern to the health of drug users who are prone to chaotic lifestyles and multiple comorbidities[1–5]. The etiology of malnutrition in drug addicts is likely multifactorial and may include inadequate dietary intake, altered metabolism, inadequate storage of nutrients in damaged livers, and increased nutrient excretion through diuresis and diarrhea[1,6]. Use of illicit drugs affects appetite and food security, often leading to the development of eating disorders.

Weight and body mass index (BMI) are often used as indicators of malnutrition and are generally linked to poor health outcomes. However, in some cases, a simple measure of weight does not tell the complete story. Individuals with the same BMI can have vast differences in absolute and relative amounts of fat and fat free mass (FFM). These differences can vary greatly by gender, health status, and underlying nutritional state. This has been nicely demonstrated in studies among HIV-infected populations where early untreated AIDS patients (many of whom were wasted) showed greater losses of body cell mass than fat mass[7], and later studies showed that the relative proportion of FFM loss depended on initial body fat, with preferential loss of FFM occurring primarily in patients with low initial levels of body fat[8,9]. Antiretroviral therapy (ART) may also affect the composition of weight loss in HIV infection. In a retrospective study, Maia et al. found that the composition of weight loss in patients with a documented weight loss of ≥10% was predominantly fat (75–82% fat loss) among those treated with dual NRTI therapy or HAART, but relatively more lean (55% FFM loss) among patients who were ARV-naïve or treated with a single NRTI[10]. Studies also showed that relative loss of fat and fat free mass differs by gender[9–11].

Studies of drug using populations commonly use weight and BMI as indicators of nutritional status. In many studies (HIV-positive and HIV-negative populations), drug use is associated with lower mean weight or BMI[2,3,12–18]. In terms of differential effects of drugs, studies in two different drug using populations in Boston have shown that cocaine use (alone or mixed with opiates) is associated with lower BMI, while opiate use alone is not[19,20]. A couple of studies have incorporated further measures of body composition into their analyses. In HIV-positive adults in Boston, current injection drug users had a significantly lower percent body fat (BF) than participants who had never used drugs[16]. In Baltimore, Cofrancesco et al. found that females in the highest tertile of drug use had significantly less visceral and subcutaneous body fat compared to both non-drug users and those in the lower two tertiles of drug use[18].

The clinical implications of lower body weight in drug using populations are uncertain. Most of the current published literature on this topic are from studies in developed countries where drug users may be more prone to over-nutrition than under-nutrition. Lower mean weights in drug users in these populations may still fall within healthy limits. In addition, since body weight and percent BF are strongly correlated with each other, it is unclear from previous studies whether drug use has an additional impact on percent BF after accounting for lower body weight.

In the present analysis, we expand on previous findings by exploring the independent effects of drug use on body composition (percent BF) after accounting for the previously described differences in BMI. Our approach uses statistical modeling to hold BMI constant in order to elucidate the additional effects of drug use on percent BF. We examine the effects of particular types, modes of administration (injection vs. noninjection), and frequency of drug use on underlying body composition.

METHODS

Study Population

The Tufts Nutrition Collaborative (TNC) Study is a study of the nutritional and metabolic status of an ethnically diverse group of drug users (with and without HIV-1 infection) living in three US cities (Baltimore, Boston, Providence). Between 2005 and 2007, individuals who were between ages 18 and 65, not pregnant, and reported use of illicit drugs in the past 5 years were enrolled. In Boston, Hispanic drug users were recruited from an ongoing parent study (the BIENESTAR study)[17,21]. In Providence and Baltimore, HIV-positive participants were recruited by word-of-mouth and physician referral through HIV clinics. HIV-negative participants were recruited through flyers, word-of-mouth, and cross-recruitment from other research studies.

Study Procedures

Data collected included measures of body composition, a 24-hour dietary recall, and a detailed questionnaire on sociodemographics, lifestyle including drug and alcohol use, and a detailed medical history. The questionnaire was administered using an audio computer-assisted self-interview (ACASI) system programmed in both English and Spanish. All subjects provided written informed consent. This study was approved by the Institutional Review Boards of Tufts Medical Center, Miriam Hospital, and Johns Hopkins Medical Institutions.

Assessment of body composition

All participants were weighed without shoes and in light clothing, using a calibrated standing balance beam scale. Height was measured using a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (in kg) divided by height (in meters) squared. Skinfold measurements were taken at three sites (triceps, subscapular and suprailiac) using the Lange skinfold caliper (Beta Technology, Inc., Santa Cruz, California)[22]. Total BF was calculated from the skinfold measures using the age- and sex-specific equations of Durnin and Womersley[23]. Percent BF was then calculated as total BF divided by total body weight.

Resistance and reactance were obtained by bioelectrical impedance analysis (BIA) using the BIA-101A (RJL Systems, Detroit MI)[24]. Fat free mass (FFM) was derived from BIA resistance and reactance measurements using the sex- and weight-specific equations of Lukaski[25]. Fat mass was obtained by subtracting FFM from total body weight. Percent BF by BIA was calculated as fat mass divided by total body weight.

Waist circumference was taken without outer clothing, using a tape measure in light contact with, but not compressing the skin[26]. All study personnel were trained and standardized twice yearly on all measurements by an experienced research nutritionist.

Assessment of substance use

Frequency and amount of alcohol intake over the past 30 days was assessed. Responses were recoded into none, light, moderate, and heavy drinking categories. Light drinking was defined as drinking ≤3 days per week and having ≤2 drinks at a time on average. Moderate drinking was defined as either of the following: 1) drinking ≤3 days per week and having ≥3 drinks at a time on average, or 2) drinking 4 to 7 days per week and having ≤2 drinks at a time on average. Heavy drinking was defined as drinking 4 to 7 days per week and drinking ≥3 drinks at a time on average.

Questions were also asked about the use of specific types of illicit drugs (ever and in the last 6 months). For participants who used specific drugs in the last 6 months, average frequency was assessed.

Statistical Analysis

Baseline characteristics were examined by study site to assess comparability of data between sites. Simple linear regression was performed to assess the relationship between percent BF and each type of drug. Since the dependent variable was assessed using two different methods, we conducted all analyses using data from both methods. Results were similar between the two methods; therefore only the results using percent BF by BIA are presented in this paper.

Drug use was analyzed using different methods in order to distinguish the effects of individual drugs, polydrug use, mode of administration (injection vs. non-injection), and frequency of use. First, each drug was entered into the models separately. Next, the drugs were grouped as follows: 1) Cocaine and Heroin with Other drugs; 2) Cocaine with Other drugs (no heroin); 3) Heroin with Other drugs (no cocaine); 4) Other drugs only (no cocaine or heroin); and 5) no drug use. To examine the effect of mode of administration, we grouped the individual drugs into injection vs. non-injection drugs. Further, we categorized frequency of injection and non-injection drug use into heavy (reported use of at least one drug in the category several times a week or more) vs. light use.

Multivariate least squares regression analysis was then performed. Since we were interested in the independent effect of drug use on percent BF after accounting for differences in body shape and size, BMI and waist circumference were chosen *a priori* as variables to be adjusted for in the multivariate models. Other strong predictors or potential confounding variables, such as HIV status, gender, and strength training were also included in the initial multivariate models (base models). Each drug use variable was then entered into separate base models. We assessed for further confounding by site, race/ethnicity, alcohol intake, cigarette smoking, self report of various health conditions (stroke, high cholesterol, high blood pressure, high triglycerides, tuberculosis, heart disease, osteoporosis, diabetes, Hepatitis B and Hepatitis C), symptoms of illness (fever, pain in the mouth, lips or gums, white patches in the mouth, nausea, vomiting, stomach pain, and diarrhea), aerobic exercise, dietary intake (total energy and fat intake), housing insecurity, and food insecurity. We also assessed for effect modification by study site, race, gender, and HIV status.

Health conditions, symptoms of illness, and aerobic exercise were determined from the ACASI questionnaire. Total energy and fat intake were assessed through 24-hour dietary recalls. Food items from the recalls were converted to macro- and micronutrients using the Nutrition Data System for Research (NDSR 2007) software (Nutrition Coordinating Center, University of Minnesota). Housing insecurity was defined as living on the streets, in a rooming, boarding or halfway house, in a shelter or welfare hotel, in jail, or in a drug treatment facility. Food insecurity, a measure of access and availability of food, was determined using a modified version of the Six-Item Food Security Scale developed by researchers at the National Center for Health Statistics[27]. All analyses were conducted using SAS v9.2 (Cary, NC).

RESULTS

This analysis includes 511 of the 522 participants enrolled. Eleven participants were excluded due to missing BIA measurements. Table 1 shows selected characteristics by study site. Participants were of similar age across the three sites. Overall, the cohort was 35% female. Participants from Baltimore were predominantly African American, the Boston site was 100% Hispanic, and there was representation of all three races in Providence. Participants at the Boston site had lower levels of formal education. Approximately one third was homeless or had insecure housing, and significant proportions of participants reported some level of food insecurity. Few participants (14–23%) were currently employed.

More than half the participants were HIV-positive. Of these, 60–70% were on HAART. There were fewer reports of Hepatitis C in Baltimore. Average BMI was similar and in the overweight range for all three sites. Percent BF by both BIA and skinfolds were also similar across sites. Between 30–40% of participants reported engaging in regular strength training and nearly 50% engaged in regular aerobic exercise. Given the comparability of most of the key characteristics shown in Table 1, we felt comfortable combining data from the three sites for analysis.

Table 2 shows the burden of self-reported substance use at each site. Over 80% of participants at all sites currently smoked cigarettes and approximately 30% reported moderate to heavy alcohol intake within the past 30 days. While reports of ever use of some of the drugs were quite high (over 70% for marijuana, crack, speedball – data not shown), reports of current drug use were lower in all three sites. Marijuana, crack and cocaine by snorting were the most common drugs currently used in Baltimore and Providence. In Boston, current drug use was low overall, with marijuana and injection heroin being most common. Non-injection drug use was also more common than injection drug use in both Baltimore and Providence.

Table 3 shows the results of the regression models of percent BF on each of the different drug use variables, both unadjusted and after adjusting for BMI, HIV status, gender, and strength training. Several of the individual drugs were significantly associated with lower percent BF. Use of cocaine and heroin with other drugs was significantly associated with lower percent BF compared to no drug use. However, the other combinations of polydrug use were not significant. Heavy use of either injection or non-injection drugs were significantly associated with lower percent BF in the adjusted model.

Table 4 shows the results from the final multivariate models examining the association of the drug use groupings with percent BF after adding waist circumference to the models. As shown, those who used cocaine and heroin with other drugs had a 2.4% (95% confidence interval (CI) = 1.1%, 3.7%) lower percent BF compared to those who were not current drug users. In a separate model, those who injected drugs more frequently had a 2.6% (95% CI=1.1%, 4.1%) lower percent BF compared to those who did not use drugs. In both models, higher BMI and waist circumference were significantly associated with higher percent BF. As expected, percent BF in females was significantly higher than in males. HIV status, dietary intake (total energy or fat intake), symptoms of illness, hepatitis B, and hepatitis C were not predictors or confounders in any of the multivariate models. There was also no significant effect modification by study site, gender, HIV status or race.

DISCUSSION

Fat regulates body temperature, cushions and insulates organs and tissues and is the main form of the body's energy storage. The ideal weight and fat-lean ratio varies considerably by gender and age, but the minimum percent BF considered safe for health is 5% for males and 12% for females. Average adult body fat is 15%–18% for men and 22%–25% for women.

We found lower percent BF among polysubstance users of cocaine and heroin. Heavy injectors of these drugs had significantly lower percent BF than non-users. By adjusting for both BMI and waist circumference in the final model we show that, given two people of similar body shape and size, the person who injects drugs frequently will have significantly lower percent BF than the person who does not use drugs. We did not find differences in body composition between those who used cocaine only vs. those who used heroin only. This suggests that the effect of drug use on body composition may be more related to the behavior patterns of drug users, rather than to a biological effect of a particular type of drug. To the best of our abilities, we were able to rule out differences between injectors, non-injectors, and non drug users in terms of symptoms of illness, co-infections, and dietary intake (total energy and fat intake) as playing a significant role in the association.

Understanding the composition of percent BF differences (relative amounts of fat and lean tissue) between drug users and non-drug users is critical for interpreting the clinical significance of the above findings. There are three possible explanations for the lower percent BF found in heavy injectors: 1) heavy injectors have a lower fat mass but similar FFM compared to non drug users; 2) heavy injectors have similar fat mass but higher FFM; or 3) heavy injectors have both lower fat mass and higher FFM compared to non drug users. In order to determine which of these scenarios explains our findings, we conducted further multivariate regression models with fat mass and FFM as the outcomes and drug use groupings as the predictors, adjusting for the same covariates as used in the previous models (data not shown). We found that FFM was significantly higher in heavy injectors vs. non drug users (+2.6 kg, p=.002), and fat mass was only slightly lower (−1.2 kg, p=0.06) than non drug users. This finding suggests that the lower percent BF in heavy drug users in this population is predominantly due to higher levels of FFM compared to non drug users. This could be the result of a more active lifestyle among IDUs (other than formal strength training or aerobic exercise) which could not be quantified in this study. While these results imply that heavy injectors in our population are not at increased risk of adverse outcomes due to a lower percent BF, these conclusions may not apply to other populations where initial nutritional status is poor. For example, in our studies of drug using populations in Vietnam and India, where percent BF for men fall in the range of 6–11% (Tang AM, et al. unpublished data), a 2–3% difference in percent BF among current injectors would be detrimental.

Other variables that were significant determinants of percent BF included gender and strength training, with both males and people engaging in regular strength training having lower percent BF than females or non-strength trainers. We found no significant effects of age or dietary intake on percent BF. Nor did we find any differences in the associations by race/ethnicity or study site. In agreement with Cofrancesco et al.[18], we found that HIV itself was not predictive of differences in percent BF after adjusting for BMI. HIV-positive participants had significantly lower BMI levels than HIV-negative participants. However, once adjusted for BMI, there was no independent effect of HIV on percent BF. In contrast to the findings of Cofrancesco et al., we found that the associations between drug use and percent body fat, fat mass, and FFM were similar in men and women.

Our study has a few limitations. First, the cross sectional nature of the analysis does not allow us to conclude a causal association between increasing use of drugs and decreasing percent BF. Secondly, our outcome for this analysis was percent BF based on BIA. BIA measures the electrical impedance of the body’s tissues, through properties of resistance and reactance, and indirectly estimates fat mass through equations derived from data for specific reference populations. Although BIA is quick and convenient for use in clinical settings, BIA data rely on several critical assumptions and can be affected by various external factors. In this study, we had a second measure of percent BF based on skinfold measurements and, as stated earlier, all results were similar between the two methods. While this was reassuring, neither of these methods are considered a gold standard and future studies are needed to validate these methods against a gold standard in this population.

In addition, while we were able to eliminate potential confounding by several health status and lifestyle variables using the measures that we had, there may be remaining confounding by other behavior patterns unmeasured in our study that might explain the relationships we found.

In summary, the clinical implications of our findings are variable. Our results suggest that heavy injection drug users have a lower percent BF than non-drug users, but that the differences in percent BF were predominantly due to higher fat free mass, rather than lower fat mass. These results highlight the fact that differences in BMI, weight and body composition are not always straightforward and accounting for underlying nutritional status and relative differences in fat and FFM is critical when interpreting results. In our population, the average percent BF for most of the population did not fall into a range low enough to suggest increased risk for medical morbidity and a higher FFM may even suggest a more positive nutritional profile. However, as stated earlier, these results would have a different interpretation in populations of drug users living in resource-limited countries, where underlying health and nutritional status differ greatly from the U.S. population. In these populations, small differences in percent BF among drug users will make a much larger impact on health status and the underlying relative changes in fat and FFM may not be the same as what we found in our study. More studies are needed to determine the behavioral and lifestyle differences that are driving these results.

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Table 1

Socio-demographic and clinical characteristics of 511 participants enrolled in the three sites of the Tufts Nutrition Collaborative (TNC) study

	Mean ± SD or N(%)			
	Baltimore (N=206)	**Providence (N=145)**	**Boston (N=160)**	**p-value**
Sociodemographics:				
Age	43.3 ± 6.4	43.0 ± 7.8	42.3 ± 8.2	0.47
Female	78 (38%)	59 (41%)	41 (26%)	.01
Race[1]**:**				
White	23 (11%)	82 (57%)	0 (0%)	Differences due to study design
African-American	180 (88%)	41 (28%)	0 (0%)	
Hispanic	1 (0.5%)	21 (14%)	160 (100%)	
Other	1 (0.5%)	1 (0.7%)	0 (0%)	
Education[2]**:**				
Less than High School	60 (30%)	45 (31%)	78 (50%)	<.0001
High School or GED	83 (41%)	59 (41%)	60 (38%)	
College plus	60 (30%)	40 (28%)	19 (12%)	
Homeless or Housing Insecure	73 (35%)	51 (35%)	55 (34%)	0.98
Food Insecure	110 (53%)	88 (61%)	108 (67%)	.002
Currently Employed	47 (23%)	29 (20%)	22 (14%)	0.09
Clinical Status:				
HIV-positive	102 (50%)	88 (61%)	88 (55%)	.012
Diagnosed with AIDS	33 (33%)	28 (32%)	23 (27%)	0.65
On HAART	58 (57%)	59 (68%)	54 (64%)	0.32
Self report of Hepatitis B [3]	29 (14%)	23 (16%)	28 (18%)	0.63
Self-report of Hepatitis C [4]	78 (38%)	69 (48%)	79 (50%)	0.04
Body composition:				
Body Mass Index (BMI)	27.5 ± 6.3	27.6 ± 6.9	27.9 ± 6.3	0.83
% Fat (BIA)	27.4 ± 11.6	27.4 ± 12.2	26.9 ± 11.0	0.90
Physical Activity:				
Strength training (≥ once/week)	75 (36%)	43 (30%)	62 (39%)	0.23
Aerobic exercise (≥ once/week)	97 (47%)	68 (47%)	79 (49%)	0.89

[1] Data missing on 1 participants (n=1 from Baltimore)

[2] Data missing on 7 participants (n=3 from Baltimore, n=1 from Providence, n=3 from Boston)

[3] Data missing on 7 participants (n=1 from Baltimore, n=3 from Providence, n=3 from Boston)

[4] Data missing on 3 participants (n=1 from Providence, n=2 from Boston)

Table 2

Substance use characteristics of 511 participants enrolled in the three sites of the Tufts Nutrition Collaborative (TNC) study

	Mean ± SD or N(%)		
VARIABLE	**Baltimore (N=211)**	**Providence (N=149)**	**Boston (N=160)**
Current cigarette smoker[1]	166 (81%)	117 (82%)	133 (84%)
Alcohol Use (Last 30 days):			
Heavy Drinker	14 (7%)	15 (10%)	8 (5%)
Moderate Drinker	39 (19%)	32 (22%)	39 (24%)
Light Drinker	52 (25%)	28 (19%)	16 (10%)
Non-Drinker	101 (49%)	70 (48%)	97 (61%)
Individual Drugs (Last 6 months) [2]:			
Marijuana	64 (31%)	57 (39%)	36 (23%)
Crack	113 (55%)	76 (52%)	23 (14%)
Speedball	32 (16%)	11 (8%)	23 (14%)
Injected Cocaine	28 (14%)	22 (15%)	16 (10%)
Snorted Cocaine	78 (38%)	67 (46%)	23 (14%)
Injected Heroin	43 (21%)	33 (23%)	43 (27%)
Smoked or Snorted Heroin	56 (27%)	20 (14%)	19 (12%)
Street Methadone	12 (6%)	11 (8%)	4 (3%)
Amphetamines	1 (0.5%)	3 (2%)	0 (0%)
Sedatives	15 (7%)	19 (13%)	1 (0.7%)
Poppers	3 (1%)	12 (8%)	0 (0%)
Club Drugs	3 (1%)	5 (3%)	1 (0.6%)
Drug use groupings:			
Cocaine + Heroin + Other drugs [2]	79 (38%)	35 (24%)	33 (21%)
Cocaine + Other drugs [2]	57 (28%)	59 (41%)	18 (11%)
Heroin + Other drugs [2]	9 (4%)	5 (3%)	23 (14%)
Other drugs only [2]	7 (3%)	13 (9%)	14 9%)
No drug use [2]	54 (26%)	33 (23%)	71 (45%)
Non-injection drug use (light) [3]	36 (18%)	32 (22%)	23 (14%)
Non-injection drug use (heavy) [3]	60 (29%)	40 (28%)	13 (8%)
Injection drug use (light) [3]	15 (7%)	19 (13%)	22 (14%)
Injection drug use (heavy) [3]	39 (19%)	21 (14%)	30 (19%)
No drug use[3]	54 (26%)	33 (23%)	71 (45%)
On Methadone Maintenance or Buprenorphine treatment[4]	55 (27%)	58 (40%)	53 (33%)

[1]Data missing on 4 participants (n=1 from Baltimore, n=1 from Providence, n=2 from Boston)

[2]Data missing on 1 participant (n=1 from Boston)

[3]Data missing on 3 participants (n=2 from Baltimore, n=2 from Boston)

[4]Data missing on 3 participants (n=1 from Baltimore, n=1 from Boston)

Table 3

Substance use determinants of percent body fat (dependent variable) among 511 participants of the Tufts Nutrition Collaborative (TNC) Study.

	Unadjusted		Adjusted[1]	
	Difference in % body fat ± SE	p-value	Difference in % body fat ± SE	p-value
Moderate to heavy alcohol use	−4.0 ± 1.1	0.0004	−0.9 ± 0.6	0.13
Current cigarette smoking	−2.2 ± 1.3	0.10	−1.1 ± 0.7	0.12
Individual drugs (self-reported use in last 6 months (yes/no)):				
Marijuana	−2.6 ± 1.1	0.02	−0.8 ± 0.6	0.17
Speedball (combination of cocaine and heroin by injection)	−3.9 ± 1.5	0.01	−1.9 ± 0.8	0.02
Crack cocaine	−2.3 ± 1.0	0.03	−1.1 ± 0.6	0.05
Cocaine by snorting	−2.7 ± 1.1	0.01	−1.4 ± 0.6	0.01
Cocaine by injection	−3.3 ± 1.5	0.03	−1.9 ± 0.8	0.02
Heroin by smoking or snorting	−3.8 ± 1.3	0.004	−1.6 ± 0.7	0.02
Heroin by injection	−5.0 ± 1.2	<.0001	−1.8 ± 0.7	0.007
Street methadone	−2.4 ± 2.3	0.29	−1.0 ± 1.2	0.43
Amphetamines	−11.2 ± 5.8	0.05	−3.8 ± 3.1	0.22
Sedatives	−2.4 ± 2.0	0.24	−0.2 ± 1.1	0.85
Poppers	−8.8 ± 3.0	0.003	−1.4 ± 1.6	0.38
Club drugs	−6.6 ± 3.9	0.09	−1.1 ± 2.1	0.61
Drug use groupings:				
No drug use	Ref	---	Ref	---
Cocaine + Heroin + Other	−6.2 ± 1.3	<.0001	−2.9 ± 0.7	<.0001
Cocaine + Other	−1.6 ± 1.3	0.23	−1.3 ± 0.7	0.08
Heroin + Other	−3.5 ± 2.1	0.09	−1.5 ± 1.1	0.20
Other	1.3 ± 2.1	0.56	0.2 ± 1.1	0.89
No drug use	Ref	---	Ref	---
Non-injection drug use (light)	−2.1 ± 1.5	0.17	−1.1 ± 0.8	0.19
Non-injection drug use (heavy)	−2.5 ± 1.4	0.08	−1.6 ± 0.8	0.04
Injection drug use (light)	−4.7 ± 1.8	0.009	−1.4 ± 1.0	0.14
Injection drug use (heavy)	−5.2 ± 1.5	0.0007	−3.0 ± 0.8	0.0002

[1]Each model is adjusted for body mass index, HIV status, gender, and strength training

Table 4

Determinants of percent body fat among 511 participants of the Tufts Nutrition Collaborative (TNC) Study: Final multivariate regression models

	Model 1		Model 2	
	Difference in % body fat ± SE	**p-value**	**Difference in % body fat ± SE**	**p-value**
Drug use groupings:				
No drug use	Ref	---		
Cocaine + Heroin + Other	−2.4 ± 0.7	0.0003		
Cocaine + Other	−1.3 ± 0.7	0.07		
Heroin + Other	−1.6 ± 0.9	0.07		
Other	0.04 ± 1.0	0.97		
No drug use			Ref	---
Non-injection drug use (light)			−1.1 ± 0.8	0.17
Non-injection drug use (heavy)			−1.4 ± 0.7	0.06
Injection drug use (light)			−1.4 ± 0.8	0.09
Injection drug use (heavy)			−2.6 ± 0.8	0.0006
Other determinants:				
Body Mass Index (kg/m^2)	0.5 ± 0.11	<.0001	0.5 ± 0.1	<.0001
Waist circumference (cm)	0.3 ± 0.05	<.0001	0.3 ± 0.05	<.0001
HIV-positive	−0.6 ± 0.6	0.30	−0.5 ± 0.6	0.37
Female gender	11.2 ± 0.6	<.0001	11.2 ± 0.6	<.0001
Strength training (≥ once/week)	−1.1 ± 0.5	0.04	−1.1 ± 0.5	0.04