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Nutritional Status of Deceased Illicit Drug Addicts in Stockholm, Sweden—A Longitudinal Medicolegal Study

ABSTRACT: Autopsy investigations, toxicological analyses, and calculation of body mass index were performed in 1180 deceased illicit drug addicts (IDAs) in Stockholm, Sweden during 1988–2000, i.e., during a period of time when the general population in numerous countries showed a dramatic increase in the prevalence of overweight. Nutritional deficit in IDAs has been pointed out as a threat to their health as well as to their quality of life.

The prevalence of overweight in deceased IDAs increased from 27.4% in 1988 to 45.5% in 2000. The prevalence of overweight among all heroin users, heroin injectors, methadone, cocaine, and amphetamine users was 36.0, 38.4, 43.1, 45.0 and 50.9%, respectively, the lowest prevalence being among users of cannabis alone and HIV-positive IDAs (22.0 and 16.1%, respectively).

In conclusion, Stockholm's IDAs are affected by the past decade's dramatically increased prevalence of overweight, at least to the same degree as the general population. The increased body weight seems not to influence the danger of dying upon heroin administration.

KEYWORDS: forensic science, illicit drug addicts, postmortems, nutritional status, body mass index

A dramatic increase in the prevalence of overweight has been noted in a number of countries during the last decades (1–7). Overweight is clearly associated with increased morbidity and mortality, particularly due to diabetes, cardiovascular disease, and high blood pressure (8,9). Simultaneously, nutritional deficit in illicit drug addicts (IDAs) was reported in London, New York City, Glasgow, Canary Islands, Madrid, and Dhaka (10–15) and was pointed out as a threat to their health as well as to their quality of life. During the same time period the IDAs got exposed to human immunodeficiency virus (HIV), which influenced their drug administration habits and mortality (11).

In 1978 the median body mass index (BMI) for 93 methadone users and self-injecting opiate addicts in London was 20.9 and 22.6, respectively (10). These figures corresponded with the general impression from a medicolegal autopsy room during that time, i.e., that the “typical IDA” was a long-haired individual with numerous injection marks and reddish and bluish injection scars, tattoos, skin infections and—above all—had a body constitution suggesting poor nourishment. However, during the nineties, the autopsy personnel in Stockholm became uncertain whether this picture was still valid. On the contrary, the subjective impression in Stockholm was that corpses of IDAs are frequently conspicuously well built, often displaying a tan and with the needle marks located in hidden places.

Longitudinal surveys of nutritional status of the IDAs, to the best of our knowledge, have not previously been reported. Nor are there any reports on a relationship between nutritional status and the drug

of abuse, HIV-status, or sudden unexpected death in connection with heroin administration, usually called “overdose death” (16).

The aim of this study was to survey the BMI of all deceased IDAs over a longer period of time and evaluate whether there is a connection between BMI and the drug of abuse, the HIV status and the sudden, unexpected death upon heroin administration.

Methods

The study is based on routine medicolegal death investigations at the Department of Forensic Medicine in Stockholm, Sweden, during the 13-year period 1988–2000. Measurement of height and weight of deceased persons was introduced as a routine in Stockholm on 1 January 1988. During the study period the regulations have been unchanged, stating that a medicolegal investigation in accordance with Swedish regulations must be made on persons who have died as a result of obvious or suspected violence, poisoning, alcohol and/or substance abuse or otherwise suddenly, without previously known fatal disease, or under unclear circumstances. This implies that over 90% of all deceased IDAs in Stockholm area have to go through a medicolegal autopsy (Statistics Sweden).

The IDAs were identified on the basis of the following criteria:

1. Postmortem findings indicating drug addiction, such as needle marks or scars;
2. Results of toxicological analyses;
3. Police reports about drug use and circumstances of death, such as findings of drugs, syringes, etc., at the place of death;
4. Hospital records; and
5. Information from relatives and connections of the deceased persons.

There were just a few IDAs who tested positively for LSD or ecstasy and they were excluded from this study. Also, IDAs whose

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corpses developed autolytic changes that might influence the body weight were excluded, as well as IDAs whose height and weight were not registered. Complete postmortem examination was performed with complementary microscopic and toxicological analyses in all cases with exception of some deaths of HIV-positive IDAs, where the postmortem examination was reduced according to criteria previously described (17). Toxicological analyses were made with the purpose of disclosing alcohol, therapeutic medicines and illicit drugs, as suggested by the circumstances, at the Department of Forensic Chemistry in Linköping according to routine forensic chemical procedures (17). Blood samples were analyzed for HIV antibodies at the National Bacteriological Laboratory in Stockholm according to the routines described elsewhere (18). Deceased persons with positive results of enzyme-linked immunosorbent assay and Western blotting tests were considered as HIV-positive.

Relatives and other connections of the deceased IDAs were contacted in the majority of cases, mostly by telephone and—when possible—in person. A detailed past history concerning drug-career could not be obtained for all subjects. No detailed information about their eating, drinking and smoking habits, use of anabolic androgenic steroids (AAS), or treatment for drug abuse or HIV infection could be obtained.

In the text that follows, the subjects will be denoted as:

- A. *All IDAs*: All subjects identified as IDAs according to the criteria described above;
- B. *Included (studied) IDAs*: IDAs included in this study according to criteria above; and
- C. *HIV-positive and HIV-negative IDAs*: Included IDAs according to the blood tests for HIV.

Included IDAs were subdivided based on the results of chemical tests:

1. *Heroin users*: IDAs, regardless the cause of death, with positive chemical tests for 6-monoacetylmorphine (6-MAM) or morphine or other heroin derivatives. The group is further subdivided into *heroin injectors (HIs)*, i.e., heroin users who collapsed and died suddenly and unexpectedly in connection with, or were found after administration of heroin, in the vast majority by intravenous injection. This part of the subdivision included only subjects in which 6-MAM could be detected in blood from the femoral vein;
2. *Methadone users*: IDAs with positive chemical tests for methadone;
3. *Amphetamine users*: IDAs with positive chemical tests for amphetamine;
4. *Cocaine users*: IDAs with positive chemical tests for benzoylecgonine; and
5. *Cannabis users*: IDAs with positive chemical tests for tetrahydrocannabinol (THC) or its derivatives. When no other illicit drugs were detected, the subjects were defined as *Only cannabis users (OCUs)*.

This classification implies some overlap between the groups, for instance, when two or more illicit drugs were found at the chemical testing of an individual. Additional findings of AAS, ethanol, and therapeutic medicines did not influence this classification.

The bodies were undressed and heights and weights were measured directly before autopsy. The weighing machine was calibrated once a year; during the study period no remarkable deviations were noted.

BMI was calculated using the formula:

$$\text{BMI} = \text{Body weight (kg)} : \text{Height (meters)}^2$$

The nutritional stages were classified according to World Health Organization (WHO) recommendations (19):

Underweight	BMI <18.5
Normal range	BMI 18.5–24.9
Overweight	BMI >25
Pre-obese	BMI 25–29.9
Obese class I	BMI 30.0–34.9
Obese class II	BMI 35.0–39.9
Obese class III	BMI >40.0

The term “prevalence of overweight” denotes the proportion of studied IDAs who were overweight/obese, e.g., with BMI >25 during the period of one year (1). No attention was paid to descriptions in postmortem records concerning state of the muscular mass or distribution of the fat tissue. The subjects were divided into four age groups: 16–24 years, 25–34 years, 35–44 years, and older than 44 years.

Statistics

Nonparametric statistical procedures were used throughout this paper. Associations were established by the Spearman rank correlation coefficient. Trends in data over time were analyzed by Cusum plots (20). The Mann-Whitney U-test was used for the comparison of two independent populations. The Kruskal-Wallis one-way analysis of variance by ranks with Dunn’s posttest was used for the comparison of several independent samples. The variance ratio test and the Bartlett’s test were used for the comparison of dispersion of data in two and several populations. Classified data from two independent populations were compared by Fisher’s exact test. *P*-values <0.05 were considered as statistically significant.

Slopes and their 95% confidence intervals (95% CI) of plots of body mass index versus case number for various types of IDAs were calculated by ordinary linear regression.

Results

During the 13-year study period 1988–2000, a total of 1322 IDAs (188 females, 14.2%) were identified by medicolegal investigations. Of these, 1180 subjects (89.2%) fulfilled the inclusion criteria for this study, of which 171 were females (14.5%) (Fig. 1). The male/female ratio ranged during the years studied between 2.6 and 10. The median age was 34 years (range 17–73 years) (females 35 years and males 35 years). There were 134 (11.3%) subjects below 25 years. Eighty-one (6.9%) of the IDAs were HIV-positive, of which 15 were females (18.5%).

Of the 1180 included IDAs, 736 (62.4%) were classified as heroin users (109 females, 14.8%; male/female ratio 5.8). The median age of the heroin users at death was 34 and 33 years for females and males, respectively. Of the 736 heroin users 318 (43.2%) were classified as HIs. Of the remaining included IDAs 50 (4.2%) were classified as methadone users, 332 (28.1%) as amphetamine users, 20 (1.7%) as cocaine users, 296 (25.1%) as cannabis users, 100 as OCUs (8.5%) and in 93 included IDAs (7.9%) no illicit drug could be detected. All 81 HIV-positive IDAs could be included in this study.

The yearly distribution of the BMI of the studied IDAs as a whole is presented in Fig. 2. The prevalence of overweight subjects increased during the study period (*p* = 0.0021); 14/51 (27.4%) were overweight during the first study year, 1988, compared with 50/110

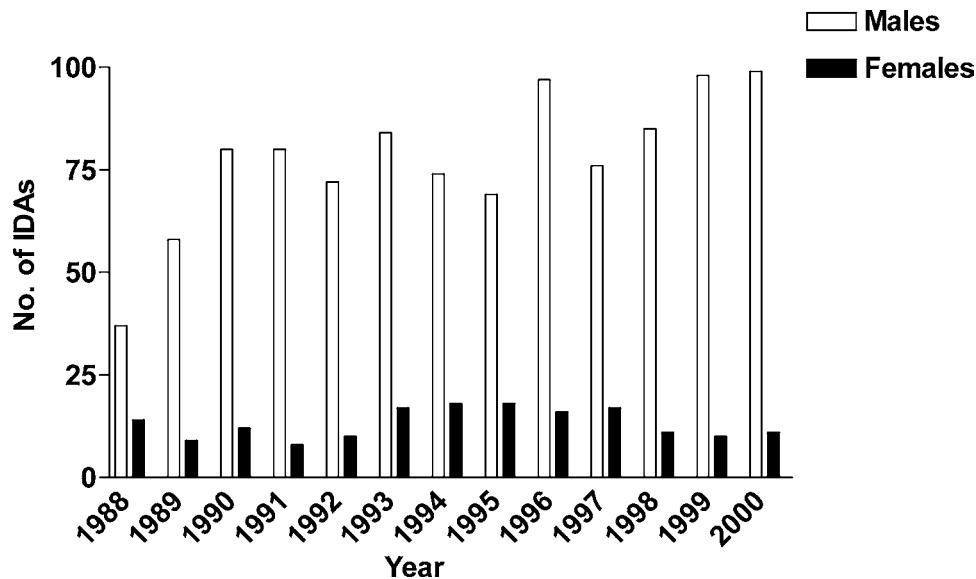


FIG. 1—Number of autopsied intravenous drug addicts during the period 1988–2000 included in this study.

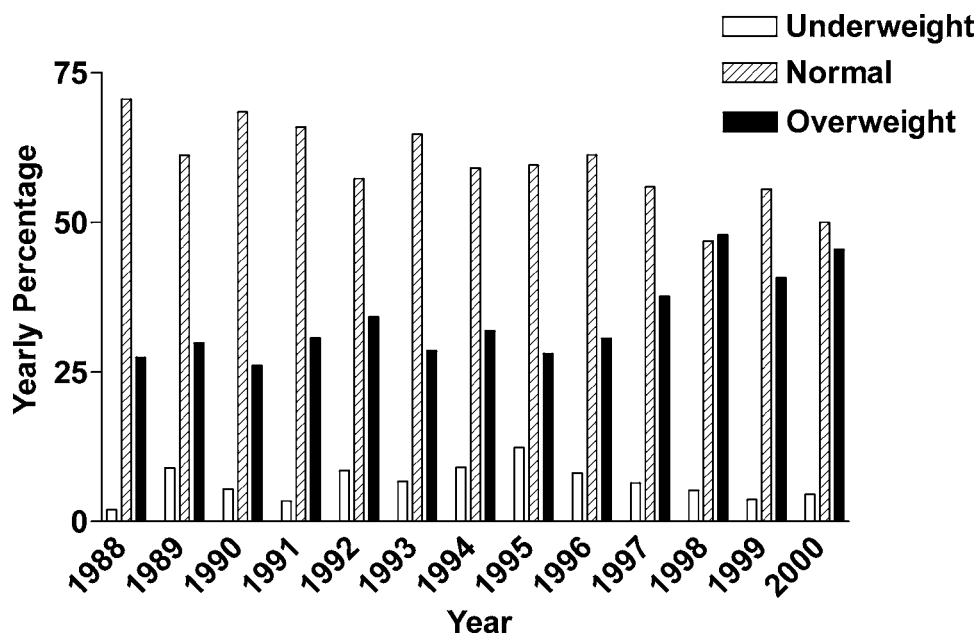


FIG. 2—Proportion of underweight, normal weight and overweight drug addicts included in this study.

(45.5%) during the last year, 2000 ($p = 0.0377$). The median increase of BMI of the IDAs who died during the first study year (1988) and who died during the last year (2000) was 0.5 and 1.7 units for males and females, respectively. The interindividual variability in BMI tended to be larger in 2000 than in 1988 ($p = 0.06$ and 0.11 , for males and females, respectively).

A dramatic increase of the prevalence of overweight IDAs started during 1997, as outlined by a Cusum plot. The fraction of underweight IDAs started to decrease two years earlier. The “typical IDA-appearance” became a rarity and was replaced by a clean, well-coiffured, normally nourished or more or less overweight individual with occasional injection marks located between toes or in other hidden places and minimal, pale, often dubious scars.

BMI of included IDAs increased during the study period ($p = 0.0007$; slope: 0.001287 ; 95% CI: 0.000615 ; 0.001959)

(Fig. 3a). A closer examination of the data revealed an increase of BMI during the study period for the heroin users (slope: 0.002159 ; 95% CI: 0.000775 ; 0.003543), HIs (slope: 0.005292 ; 95% CI: 0.000904 ; 0.009680), methadone users (slope: 0.255600 ; 95% CI: 0.172100 ; 0.339200), and amphetamine users (slope: 0.024660 ; 95% CI: 0.020520 ; 0.028800) (Figs. 3b–e); but not for the users of cocaine (slope: 0.090550 ; 95% CI: -0.257500 ; 0.438600) or OCUs (slope: -0.004057 ; 95% CI: -0.283400 ; 0.020220) (Figs. 3f,g). Nor did the BMI of the HIV-positive patients increase during the study period (slope: 0.010770 ; 95% CI: -0.023370 ; 0.044900) (Fig. 3h). Cusum plots of the data in Figs. 3b–e indicated that a more pronounced increase in BMI started in the beginning of 1997 and 1996 for the heroin users, HIs and methadone users, respectively. The BMI started to increase earliest, already in 1993, for amphetamine users, i.e., the subdivision with the highest prevalence of overweight of all studied IDAs.

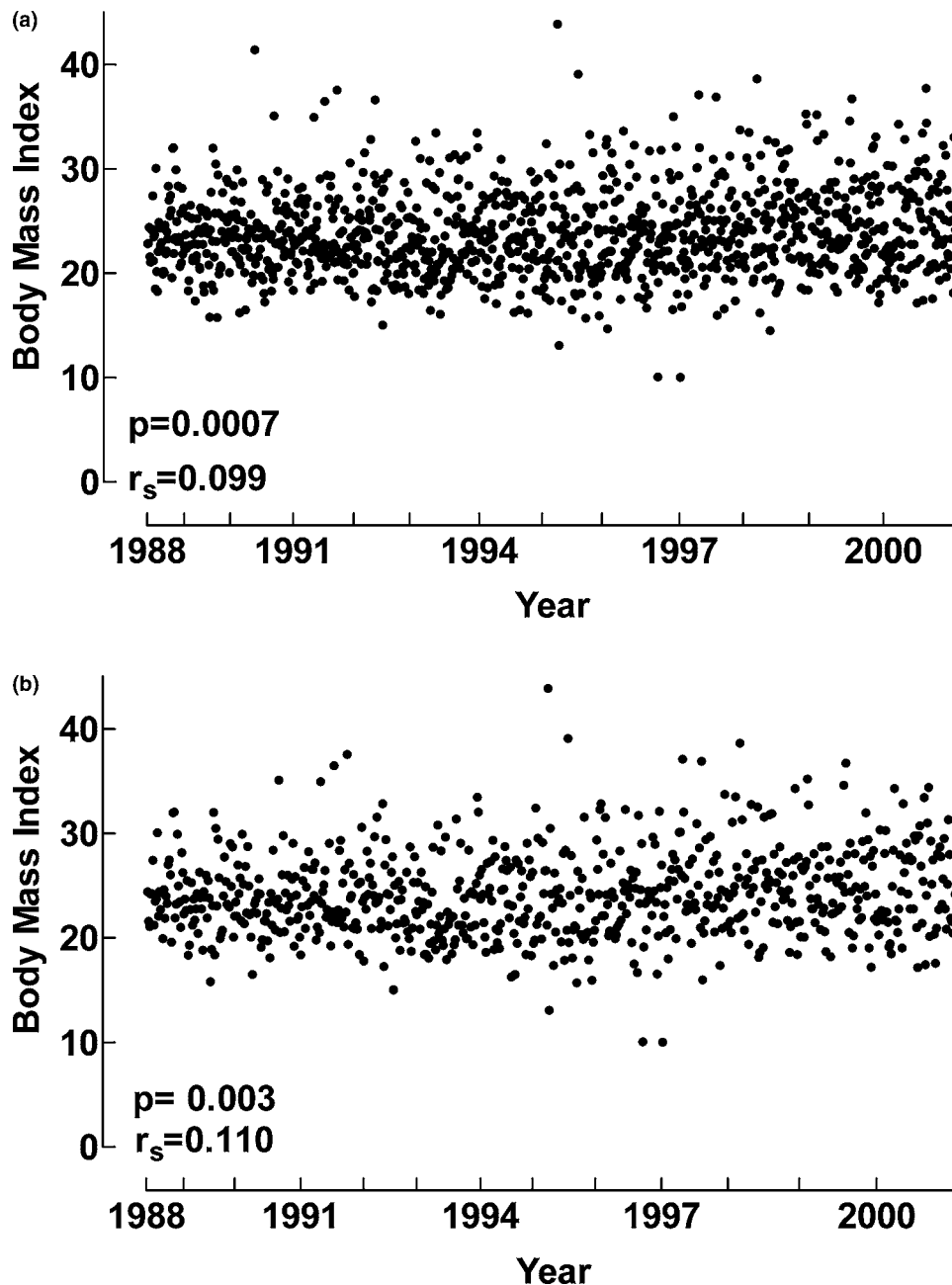


FIG. 3—Body Mass Index during the study period for all drug addicts studied (a), for heroin users (b), for heroin injectors (c), for users of methadone (d), for users of amphetamine (e), for users of cocaine (f), cannabis only (g) and for HIV-positive drug addicts (h). The Spearman ranking correlation coefficients, r_s , and corresponding p -values are given.

Female IDAs were more often underweight than males (12 and 5% for females and males, respectively) (Fig. 4). The difference is even greater when comparing HIV-positive females with HIV-negative males (27 and 9%, respectively). The difference was also great among HIs with 7% of the females being underweight but only 2% of the males. In the whole study cohort, male IDAs were more often overweight than the females ($p = 0.0185$).

There was a trend toward increasing prevalence of overweight among IDAs with increasing age, with a concomitant decrease of the fraction of subjects with normal BMI. The fraction of the underweight IDAs was not affected by age. These observations are valid for both genders (Figs. 5a and b).

A statistically significant difference ($p < 0.001$) in BMI was observed between groups of IDAs classified according to the find-

ings of drugs in postmortem chemical tests (Fig. 6). The BMI of OCUs was lower than that of the amphetamine or methadone users ($p < 0.001$ and $p < 0.05$, respectively). The heroin users also had lower BMI than amphetamine users ($p < 0.01$).

The distribution of underweight, normal range of BMI and overweight/obese IDAs according to the findings of illicit drugs and HIV-antibodies is given in Table 1. The prevalence of overweight IDAs in all drug categories was higher than the fraction of underweight, albeit less pronounced among HIV-positive IDAs. Notably, the prevalence of overweight was highest among users of the central stimulants amphetamine and cocaine. Particularly the share of pre-obese was higher than in any other illicit drug group. The fraction of IDAs belonging to obese group I and II was highest among methadone users, totally 27.5%. However, the total prevalence of

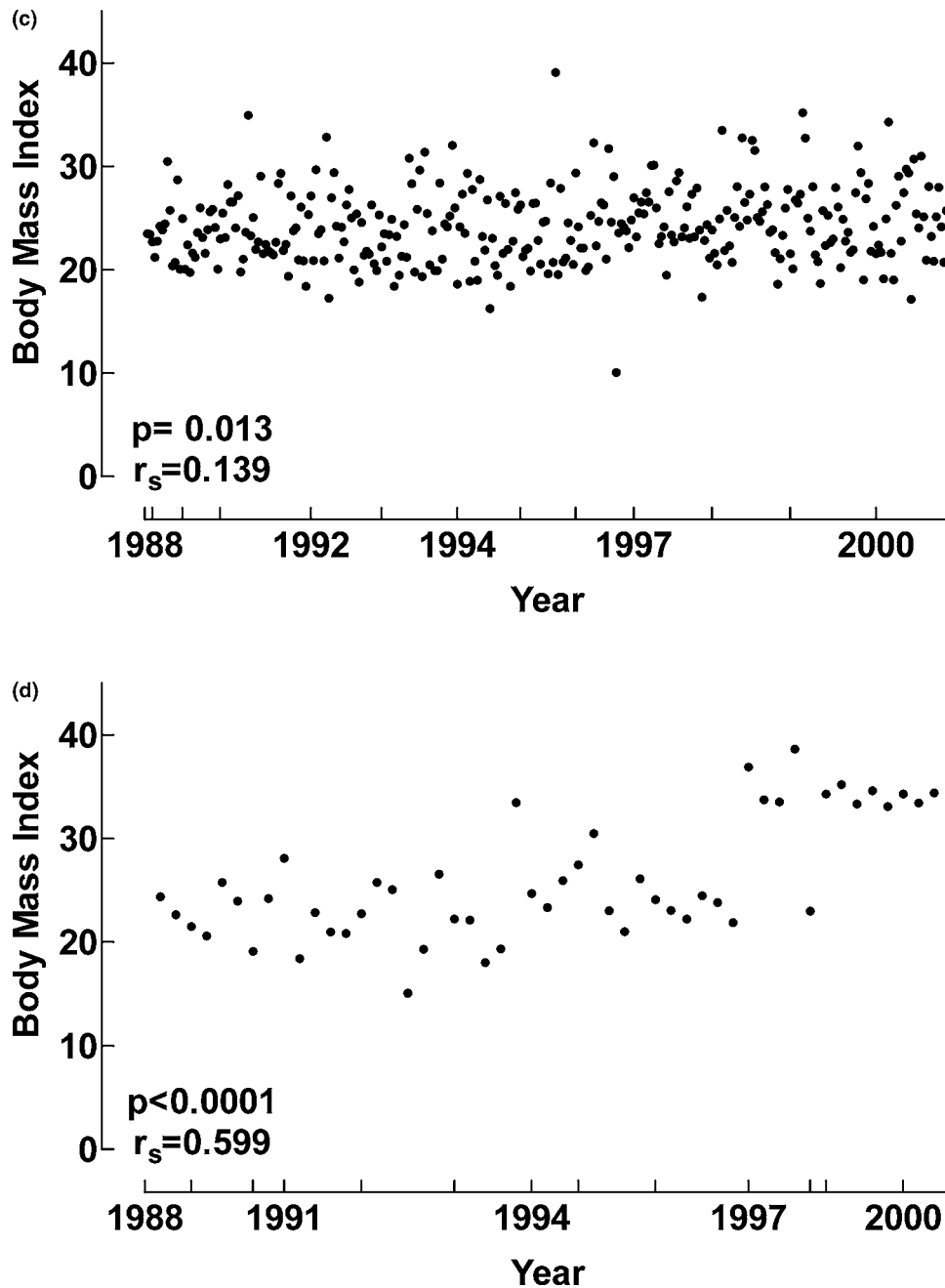


FIG. 3—Continued.

overweight subjects among methadone users was somewhat lower than that of the users of central stimulants.

No significant difference between the median concentration of 6-MAM in femoral vein blood nor in morphine concentrations was found when HIs of different weight classes were compared, i.e., IDAs who collapsed and died suddenly upon heroin injection, divided in four different BMI groups (data not shown).

Discussion

Reports on body weight of populations in different countries are not numerous and can scarcely be regarded as standardized, as they employ a variety of methods, criteria and age of the participants. Moreover, some reports are based on self-reported data, which

makes them awkward to compare with each other. One approach to make such studies more comparable is the use of the BMI-formula recommended by WHO (19), with some reservations concerning gender and infants (2). Despite these caveats, the reports agree that during the last decades there has been a pronounced trend of increasing prevalence of overweight subjects, mostly in Western industrial and Eastern European former socialist countries, and they also agree that obesity is currently one of the primary health problems (8,9). Simultaneously, it was reported that IDAs are not included in this general trend and that their malnutrition may pose a threat to their health and life quality (10–15). Furthermore, direct effects of some illicit drugs on feeding behavior have been observed, such as increased appetite and food intake among marijuana smokers with a consequent decrease in dietary quality leading to signs of nutritional deficiency (21) or anorectic effects of cocaine (22).

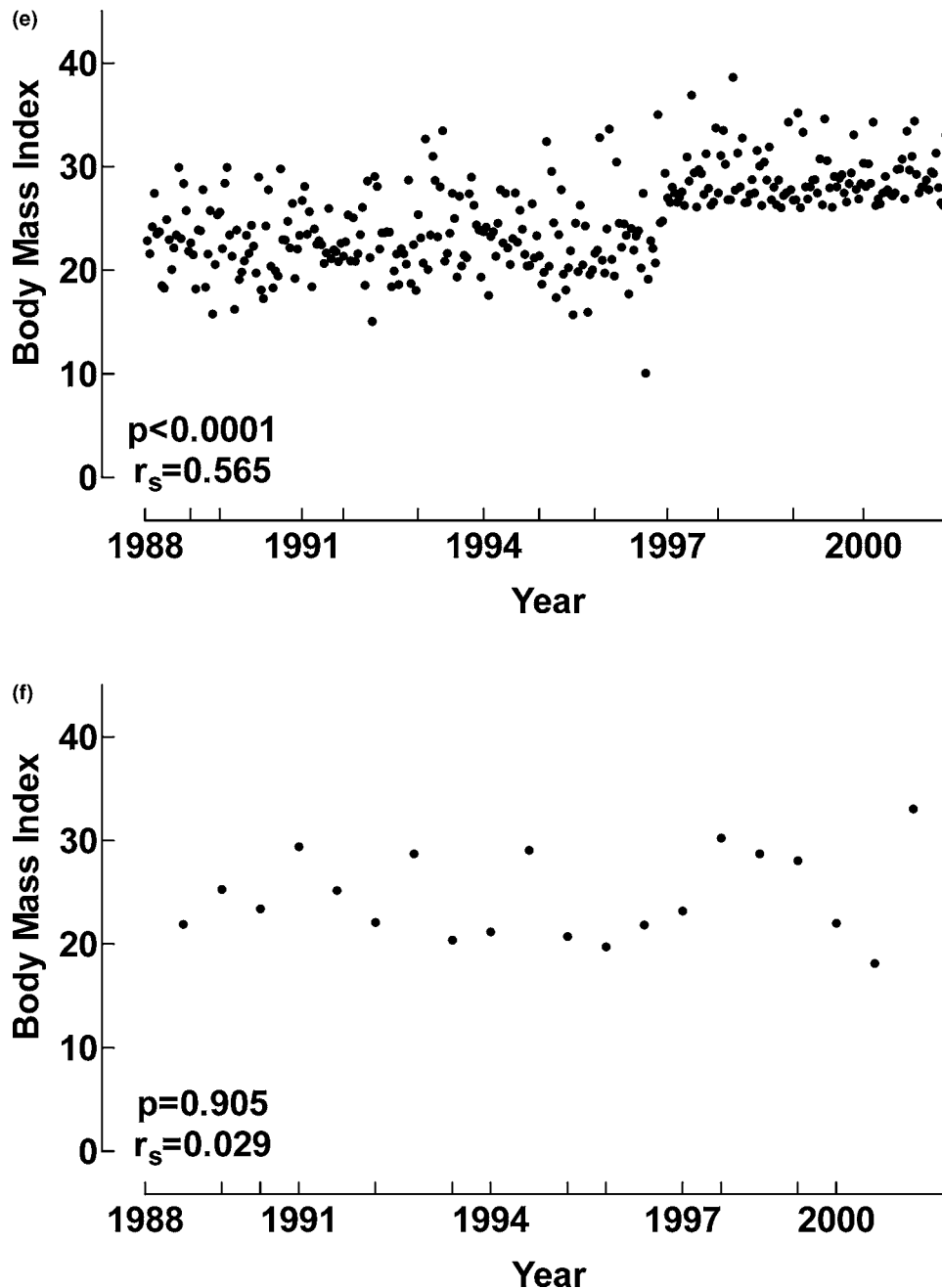


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This study is based on postmortem investigations and its findings are compared with results obtained by investigation of the living population. An age-old experience of forensic pathologists is that the postmortal body weight is lower and the length is longer than the in vivo measurements due to agonal loss of urine and/or feces and to postmortal flaccidity. Thus, the figures obtained at postmortem determination of BMI can be expected to be somewhat lower than their in vivo equivalents.

We are aware that the subdivision technique we have used—classing autopsied IDAs according to the postmortem chemical tests for illicit drugs—is neither informative about their drug career nor about the duration of use of the actual drug. In a previous cohort study of IDAs in Stockholm during the period 1981–1992 it was shown that 15 of 87 (17.2%) IDAs who died in connection with heroin injection were before death registered as amphetamine users

(23). The hypothesis for the present grouping of the IDAs was that the majority of IDAs with findings of illicit drugs at postmortem chemical tests used the drug in question for a period of time that might have varied from individual to individual. Differences found between these subdivisions indicate that the dividing was relevant.

The main finding in the present study was the increase of the prevalence of overweight subjects among Stockholm's IDAs from an already high level in 1988 (27.4%) to 45.5% in 2000, while the fraction of IDAs with normal range BMI decreased from 70.6 to 50.0%. Another conspicuous result was that the fraction of underweight IDAs increased continuously from 1.0% in 1988 to 11.0% in 1995, but thereafter fell, also continuously, to 5.0% in 2000.

These figures may be compared with those concerning prevalence of overweight subjects in the adult population of France, which increased between 1980 and 1991 from 39.2 to 40.8% for males

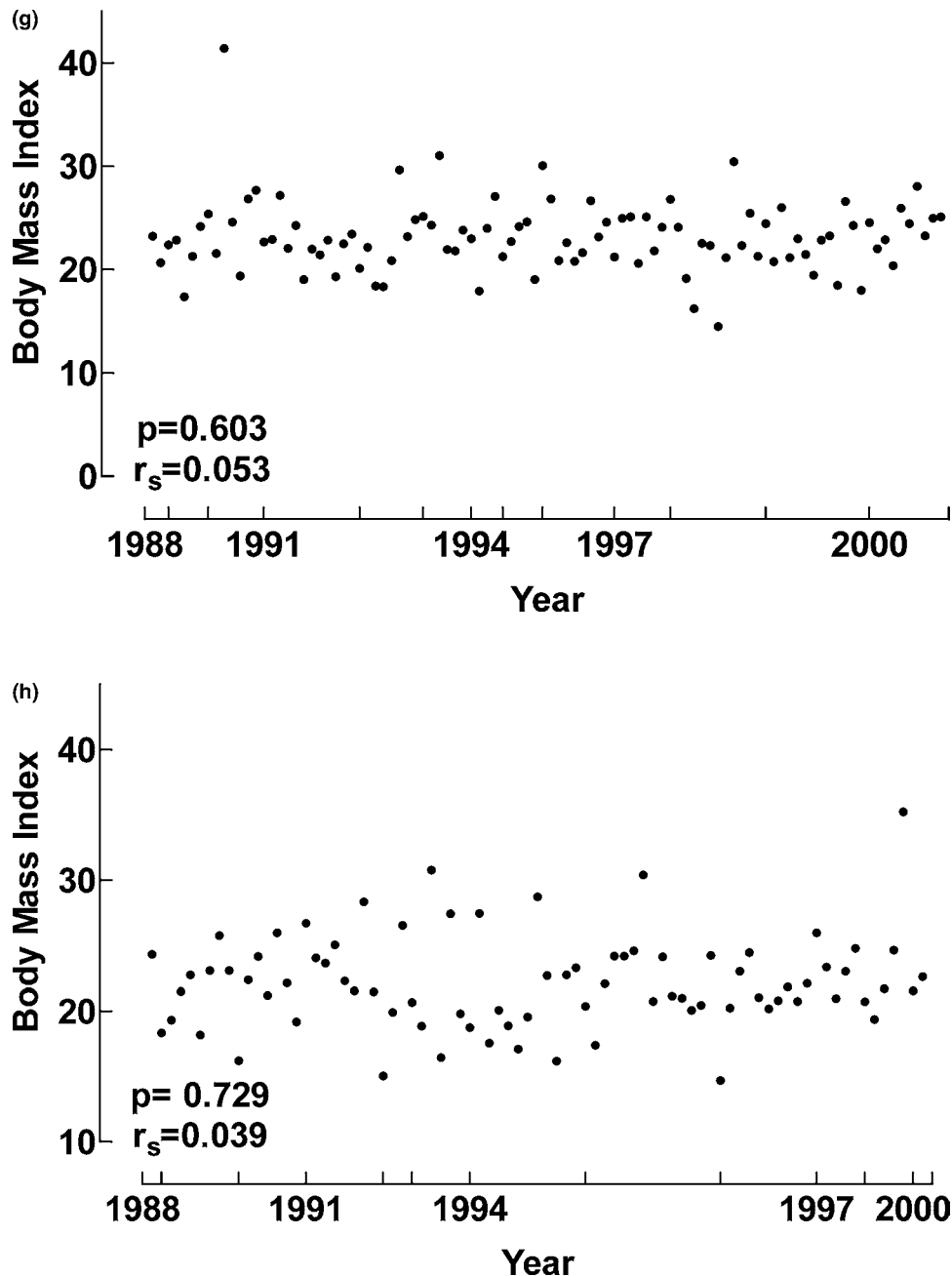


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and from 26.8 to 28.9% for females (3). In England they increased between 1980 and 1993 from 39.0 to 57.0% for males and from 32.0 to 48.0% for females, and in Italy the figures for 1990/91 were 46.2% for males and 30.6% for females (1). According to the same report, the prevalence of overweight among subjects in the United States was 25.4% in 1976–1980 and 33.3% in 1988–1991, being highest for black females for 1988–1991 (37.6%) (1). A 20-year follow-up from 1979 to 1999 of a cohort of 506 children with median age of 13 years in Norway showed that the prevalence of overweight subjects in 1999 was 53% for males and 26% for females (25).

The median BMI of 18-year-old conscripts in Sweden was 21.9 in 1986 and 22.4 in 1995, the prevalence of overweight subjects being 13.0% and 19.5%, respectively (7). The prevalence of overweight among Swedish males and females aged 16–84 years, based on

self-estimated data, increased from 37.0% and 27.1% in 1980–81 to 49.0% and 35.9% in 1997–98, respectively, as estimated according to histograms (7).

Thus, the dramatic increase of prevalence of overweight subjects among the deceased IDAs in Stockholm corresponds to prevalence of overweight subjects in the Swedish general population or populations of affected countries like the United States, France and Italy, though it does not reach the figures for England (1).

It is a generally accepted opinion that Swedish society takes care of its outcasts, a term that does not necessarily apply to all IDAs. This, together with the clean appearance of the subjects examined in this study—with minimal injection marks and scars—indicates food security and proper hygienic habits of Stockholm's IDAs. Available reports show much lower BMI for IDAs in New York City as reported in 1990—22.7 (males) and 22.3 (females), on the Canary

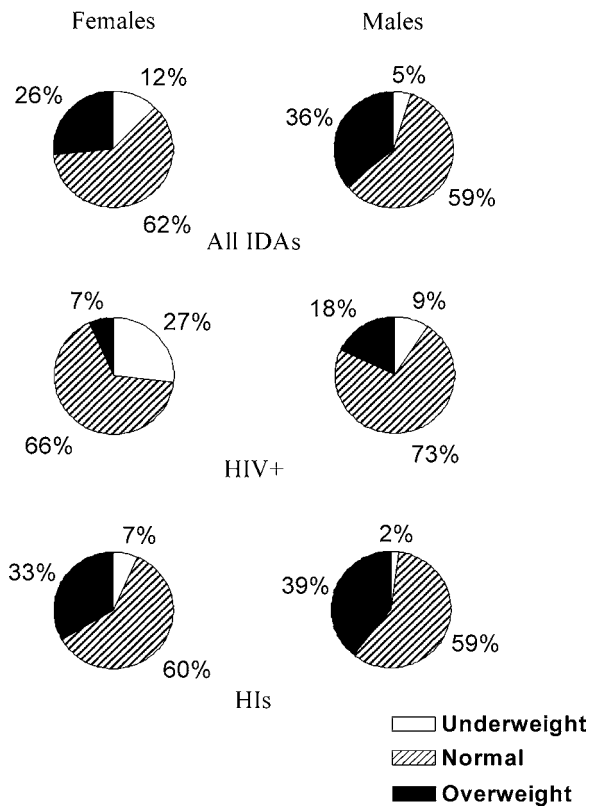


FIG. 4—Proportion of the underweight, normal weight and overweight drug addicts according to sex for included IDAs, HIV+ and His.

Islands, reported in 1995—20.9, in Madrid, Spain—22.9 (reported in 1997), and in Dhaka, Bangladesh for 1998/9—only 18.3 (11,13–15). The highest mean BMI was reported for Hispanic female IDAs in Connecticut—24.8 in 1996 (24). Not surprisingly, the prevalence of overweight subjects amongst IDAs in Dhaka for the same period was as low as 3.2% (15).

The turning point for Stockholm’s IDAs seemed to come in 1993 for amphetamine users and in 1996–97 for users of heroin and methadone. However, it is beyond our reach to analyze the complex socioeconomic, legislative, public health and individual variables influencing the nutritional status of IDAs. The differences between the nutritional status in relation to findings of illicit drugs may also indicate differences between the life styles of the users of different drugs.

The comparisons between the different groups of drug addicts revealed some interesting patterns. Thus, the BMI of deceased heroin and cannabis users seemed to mirror that of the general population as reported for 1988–89, 23.4 for females and 24.4 for males (5,6), whereas the users of central stimulants, like amphetamine and cocaine, had the highest prevalence of overweight subjects of all IDAs. Most underweight were the HIV-positive IDAs, particularly females, a finding probably pointing out the socioeconomically least favored IDA subpopulation in this area. The group with the highest figures for obesity was methadone users, with a particularly large share of the Obese I and II (27.5%). A report about effects of methadone treatment of 14 opiate and cocaine users in the Czech Republic described how the treatment resulted in an increase of BMI from 22.8 ± 3.2 to 25.5 ± 5.0 within 18 months (26).

Heroin has few documented direct nutritional effects (21), which can explain that the development of BMI among IDAs mirrors that

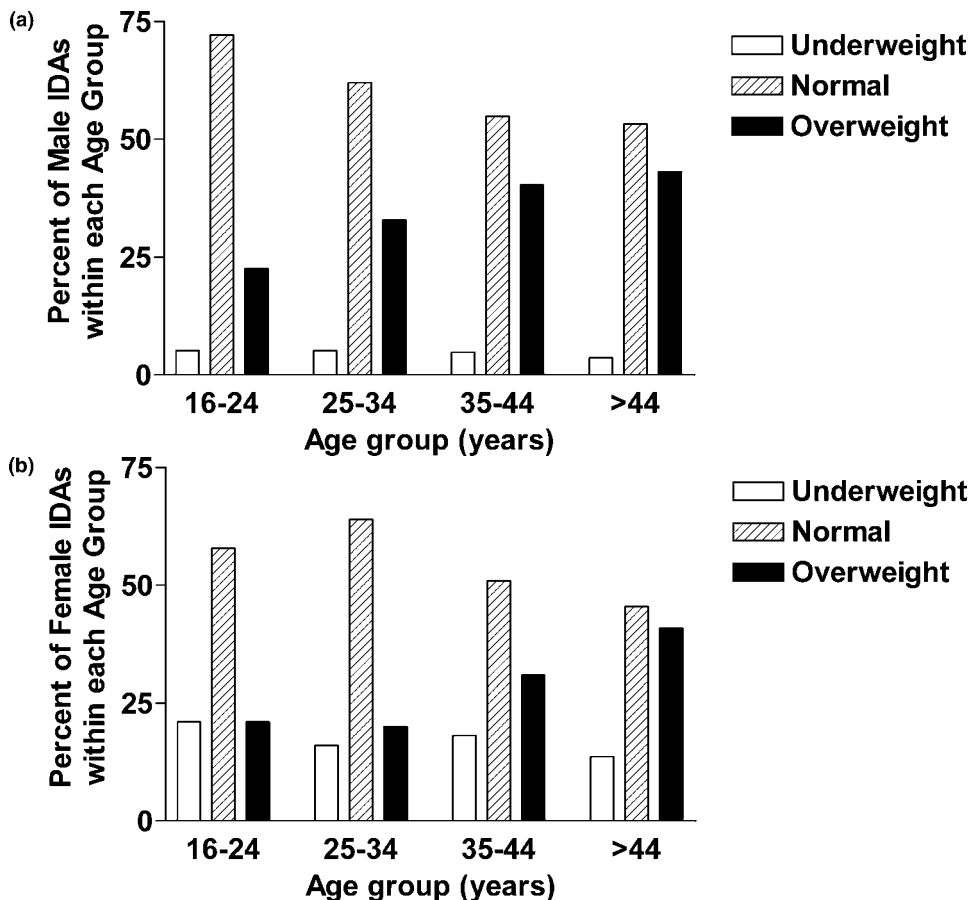


FIG. 5—Proportion of underweight, normal weight and overweight drug addicts according to age. Males (a) and females (b).

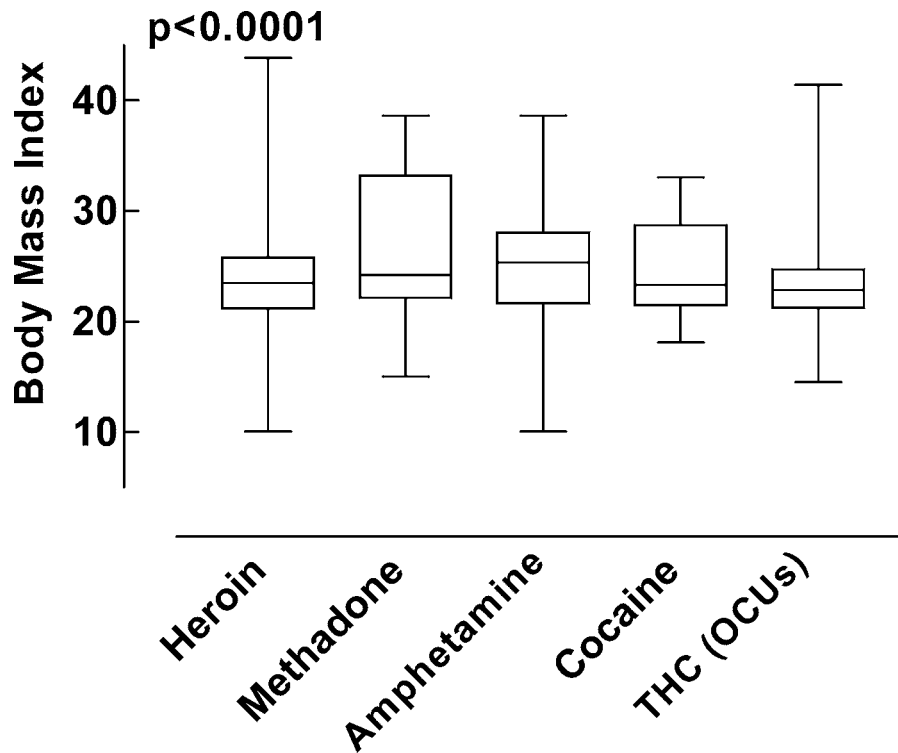


FIG. 6—Comparison of Body Mass Index of heroin, methadone, amphetamine, cocaine, and cannabis (only) users.

TABLE 1—Nutritional stage and subdivisions of IDAs.

	Percent of Patients						Overweight
	Underweight	Normal	Pre-obese	Obese I	Obese II	Obese III	
Included IDAs	6.51	59.22	26.73	6.18	1.18	0.17	34.26
Heroin users	5.71	58.29	6.93	27.58	1.36	0.14	36.00
Heroin injectors (HIs)	2.52	59.12	31.76	5.97	0.63	0.00	38.36
Methadone users	5.88	50.98	15.69	21.57	5.88	0.00	43.14
Amphetamine users	5.72	43.37	39.46	10.24	1.20	0.00	50.90
Cocain users	5.00	50.00	35.00	10.00	0.00	0.00	45.00
All THC users	4.73	67.57	22.97	3.72	0.68	0.34	27.70
THC (OCUs)	8.00	70.00	18.00	3.00	0.00	1.00	22.00
.....							
HIV +	12.35	71.60	12.35	2.47	1.23	0.00	16.05

of the general population in a country with an adequate socioeconomic level. This study confirms, however, the results of our recent study (17) that the nutritional status of heroin addicts, as expressed in terms of BMI, has no connection with their sudden collapse and death upon heroin administration.

The positive correlation between BMI and central stimulants may be interpreted as an additional indication that health care and the social situation of drug addicts are factors of great importance for their nutritional status, since cocaine intake has been associated with food deprivation and/or nutritional imbalance in other countries (21). Another possible contributory factor to the surprisingly high BMI among the users of central stimulants could be the existence of a subpopulation of body-builders who simultaneously use doping agents. Thus, high prevalence of use of various central stimulants, such as ephedrine, amphetamine, and cocaine was reported among deceased users of AAS (27)—persons who often had BMI corresponding to the Pre-obese and Obese class. Their overweight was probably in a majority of instances rather due to increase of

the body muscle mass than of the fat tissue. From these reasons we preferred to use throughout the term “prevalence of overweight” instead of “prevalence of obesity” (cf. the Method section). One notable result of this study is the low prevalence of overweight subjects among the OCUs compared with those cannabis users who additionally used other illicit drugs and with all the other illicit drug users (cf. Table 1), an observation for which we have no explanation.

The prevalence of overweight subjects among HIV-positive IDAs did not increase during the study period, despite the additional beneficial influence of the highly active antiretroviral therapy (HAART), introduced in mid-1990s, on the state of health of treated patients (28). HAART is, however, also linked with a metabolic syndrome including redistribution of subcutaneous fat to abdominal viscera and some weight loss (29). We could not obtain more up-to-date data on this item.

In conclusion, a 13-year follow-up of postmortems of IDAs in Stockholm showed a noticeable increase of their body weight, the

prevalence of overweight subjects increasing from 27.4% in 1988 to 45.5% in 2000. The prevalence of overweight subjects among all heroin users, heroin injectors, users of methadone, cocaine, and amphetamine, was as high as 36.0, 38.4, 43.1, 45.0 and 50.9%, respectively, the lowest being for those who used only cannabis, and HIV-positive IDAs, 22.0 and 16.1%, respectively.

At this stage, it was not possible to evaluate the mortality of the IDAs in relation to their nutritional status. However, it seems evident that a clean appearance and a high BMI do not protect heroin injectors from sudden death following heroin administration. Further studies are necessary to evaluate the causes of the increasing body weight in the drug addict population as well as its significance for their quality of life.

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