Progress in Nutrition 2018; Vol. 20, Supplement 2: 5-28 DOI: 10.23751/pn.v20i2-S.5632

Review

An analysis of food consumption status, body weight change and body composition in individuals with substance use disorders: a systematic

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Summary. This is a systematic literature review. The review aimed to examine the nutritional habits and status of individuals with a substance use disorder during their substance use and during treatment for substance use. The literature review was conducted using the databases Medline, Cochrane Library, Ovid, and Science Direct with no limitations as to dates. The researcher used the combinations of the keywords "substance abuse, substance addiction, illicit drugs, nutrition, diet, weight loss, weight gain, dietary patterns, malnutrition, anthropometry" to do the searching. Using these keywords, the search provided access to 86 studies. Twenty-seven of these studies fit the criteria and were taken under examination. The data produced by this examination demonstrated that the individuals that suffered from substance use disorder had poor dietary habits, and as a result, they had a range of nutritional problems, from malnutrition to obesity. These individuals commonly skipped meals, and mainly preferred high-fat foods as well as sugar and food containing sugar. The treatment process also has its unique problems, and crucial increases in body weight were observed during this period.

Key words: Substance Use Disorders, Substance abuse, Nutrition, Anthropometry, Malnutrition

Alcohol and substance use is one of the most serious national health problems in the world (1, 2). Low education levels of parents, the desire of adolescents to be accepted by their peers, their desire to appear superior, and to have new experiences direct individuals to abuse alcohol and other substances (3) Studies have shown that the number of individuals who use substances has been gradually increasing since 2008. There are 246 million users in the global scale. The annual prevalence in the population between the ages of 15 and 64 was determined to be 5.2%, and the most commonly used drug is marijuana. There is no difference in marijuana use regarding gender (4)

Substance use causes serious problems in the lives of individuals. Professional and social activities are interrupted, and the control mechanisms regarding substance use are deactivated. Individuals may spend their entire day obtaining and using drugs and alcohol, and then attempting to get rid of the effects of the substance use. Individuals develop tolerance for the amount of drugs they use, they become disoriented as to time, place and the amount they use. They have withdrawal symptoms when they stop using the substance, or decrease the amount. They often have other mental disorders (5). Depression is frequently observed in those who abuse alcohol and drugs. Studies have found that the prevalence of sustained, lifelong depression in substance users is between 23% and 27%. The rate of depression, anxiety and other mental disorders in women who are substance users is between 40% and 70% (6,7). Diseases that have a negative effect on nutritional wellbeing, such as cardiovascular disease, hepatitis B and C, tuberculosis and HIV, are also common in these individuals. Moreover, changes in lifestyle caused by substance addiction may also affect appetite and eating habits. Factors that are related to chronic substance use, including mental disorders and heavy smoking, make poor diet even worse (8-10). Inaccurate nutritional practices are common in sub-

stance users. Individuals addicted to drugs and alcohol usually have altered nutritional habits. They rarely have more than one meal a day, and they lose interest in everything except acquiring the substance they use (11). It is known that these patients are at a high risk for malnutrition, despite the fact that there are few studies of the nutritional status of substance addicts. In general, the relevant data indicate that the causes of malnutrition in substance users are anorexia, the changes in daily nutritional pattern and a lifestyle related to substance addiction. This may include living in poverty, being homeless , and suffering from infectious diseases (9). The aim of this literature review is to make a systematic evaluation of the results of the studies that analyze the effects of illegal substances with different pharmacological effects that are used by individuals with substance use disorder on individuals' nutritional condition, anthropometric measurements and biochemical findings, and the results of the studies that analyze the body weight changes in the individuals that are in the detoxification process.

Methodology

This systematic literature review has made a backward screening of the relevant publications without any limitations regarding dates. With this purpose, the researcher searched the databases Medline, Cochrane Library, Ovid and Science Direct using the combinations of the keywords "substance abuse, substance addiction, illicit drugs, nutrition, diet, weight loss, weight gain, dietary patterns, malnutrition and anthropometry". The researcher also evaluated the titles and abstracts of the studies found in the search, and conducted additional research by examining the references of the selected publications. The review included only the studies that were written in English. Reviews related to the subject, case reports, interpretations, guides, animal studies, thesis, and posters and oral presentations in conventions were not included in this review.

Inclusion Criteria

The inclusion criteria of this review includes: 1) the studies that evaluate the food intake of the individuals (who are not undergoing treatment) that use illegal substances, including marijuana, hallucinogens (phencyclidine was included in this group and the groups were divided into two as phencyclidine and other hallucinogens), stimulants (amphetamine, cocaine and other stimulants), and opiates. 2) The studies that evaluate the biochemical parameters and anthropometric measurements of the individuals that have substance use disorder. 3) The studies that evaluate the nutritional condition and body weight changes during the treatment process in individuals that have a substance use disorder. The review did not include the studies that examined the effects of the legal substances that cause addiction, such as alcohol and caffeine, nor did it include the studies that examine the relation between substance use disorders and eating disorders. The literature review, selection of the studies and exclusion of the studies were conducted by two researchers. The researchers used PRISMA Flow Diagram for the study protocol (Figure 1).

The Evaluation of the Study Quality

Fifty-eight publications were included in the study. The researchers used 12 of the evaluation criteria that were suggested by Polit and Beck in order to evaluate the study quality (12). These criteria made it possible to complete a general evaluation of the study,

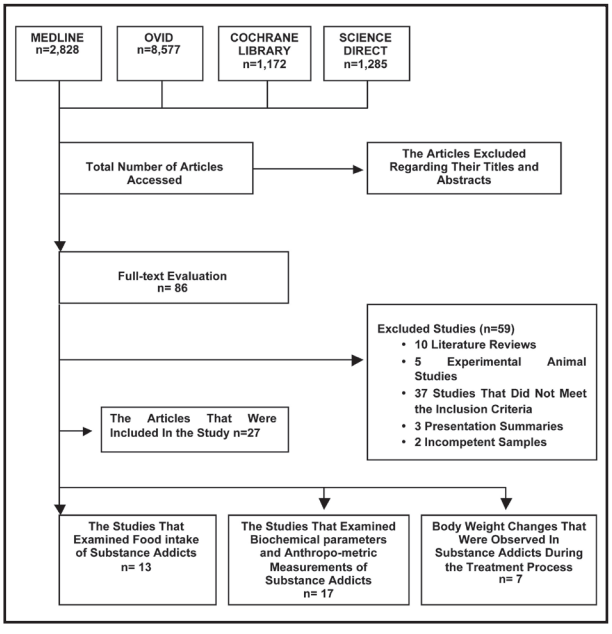

Figure 1. PRISMA Flow Diagram

taking into consideration its objective, method, sample characteristics, finding analysis, conclusion and discussion. Each study was evaluated by the two researchers independently, considering all of the criteria. The study was given 1 point when it met each item, and 0 when it did not.

The evaluation made by the researcher revealed that the highest score was 12, and the lowest score was 9. The reliability between the scorers was calculated using "fit analysis kappa value" on SPSS 22.0 software. The kappa value for all of the items was 0.858, which means that the reliability between the scorers is high.

Results

Literature Search Results: As a result of the literature search, the researchers described 13, 862 studies that had the potential to be relevant to the subject (Medline: 2,828, Ovid: 8,577, Cochrane Library: 1,172, Science Direct: 1,285). After the titles and abstracts were examined, 13, 776 studies were excluded from the study, and the researchers examined the full texts of the remaining 86 studies. The researchers did not find any different articles in the review of the references. After the examination, the researcher included 27 articles in the evaluation that fit the inclusion criteria (Figure 1). The articles were categorized into three groups to be evaluated. The first group included 10 studies examining the food intake habits of substance addicts; the second group included 16 studies that evaluated the biochemical parameters and anthropometric measurements indicating the nutritional condition of these individuals; and the third group included five studies that examined the changes in the anthropometric measurements of the patients that were receiving treatment. Nine studies (9,13,16,17,19,21-24) were included in groups 1 and 2 since they met the criteria of both groups.

The Studies That Examine the Food intake In Substance Addicts

Sample Characteristics: As described in Figure 1, 13 studies that examined the nutritional status of substance addicts were not included in this review. Of these studies, seven were conducted in the US (9,15-20), three were conducted in Norway (21,22,24), and the others were conducted in Switzerland (13), Spain (14) and the UK(23) between 1989 and 2014. Twelve studies were cross-sectional (9,13-22,24), and one of them was a case-control study (23). The individuals that participated in the study were aged 18 and older, and their average age generally ranged between 33 and 45 years. In the group that consisted of substance users, the smallest sample included 35 persons (23), and the largest sample included 1,365 persons (19). The control group which consisted of individuals that did not use substances included 12, 379 persons. The substances that were used most commonly were marijuana, heroin and cocaine. The use of multiple substances was very common as well. In addition to substance addiction, approximately 475 individuals were HIV positive. The substance-addicted individuals also suffered from hepatitis B, hepatitis C, depression, subcutaneous abscess, endocarditis, and asthma. In order to evaluate food intake, four studies used 24-hour dietary recall (14,21,22,24), two studies used diet history (13,19), two studies used food intake frequency (9,23), and two studies used a 24-hour dietary recall together with food intake frequency (15,17). The other two studies used a 24-hour dietary recall together with a three-day food intake history (16,18). Another study investigating the best method to determine the food intake of substance-using patients used a 24-hour dietary recall, a recording of food intake frequency, and a three-day food recording (20).

Food intake: Table 1 demonstrates the data of 10 studies that evaluated the intake levels of energy and macro and micro nutrients in substance addicts. An evaluation of all individuals as a group indicated that the lowest energy intake of substance addicts was 919±76 kcal/day (14), and their highest energy intake was 4,370 kcal/day (15). The lowest and highest energy intakes in females were 978 kcal/day (14) and 2,741 kcal/day (13), respectively. The lowest and highest energy intakes in males were 1,265 kcal/day (14) and 4,474 kcal/day (15), respectively. The researchers also made a ranking by the frequency of use, and found that the energy intake of the individuals that used marijuana less frequently was 2,823 kcal/day (17),

Table 1The Evaluation of the Nutritional Status of the Patients Who Have Substance Use Disorder

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Food intake-Assessment Method	Conclusion
Morabia (1989)[13]	Switzerland	Cross-sectional	Substance-users Males: 30 Individuals Females: 8 Individuals Age:26.1 M/23.0 F Non-users of Substance Males: 66 Females: 61 Age:20-35	Heroin: 37 Ind. Heroin+Methadone:11 Ind.		Diet History	In male addicts; energy intake was 3,693kcal/day, protein intake was 93 gr/day (66 gr animal protein), fat intake was 109 gr/day, carbohydrate intake was 381 gr/day, and sucrose intake was 107 gr/day. In males who did not use substances; these intakes were 2,738 kcal/day, 100 gr/day (68gr/day animal protein), 118 gr/day, 301 gr/day and 52 gr/day. In female addicts; energy intake was 2,741 kcal/day, protein intake was 65 gr/day (48 gr/day animal protein), fat intake was 87 gr/day, carbohydrate intake was 292 gr/day, and sugar intake was 86 gr/day. In females who did not use substances, these intakes were 2,178 kcal/day, 81 gr/day (56 gr/day animal protein), 99 gr/day, 227 gr/day, and 38 gr/day. In substance addicts, the consumption of iron, fiber and vitamin C was lower than the non-user individuals. The males that used heroin consumed less animal fat, cheese, fish, lean meat and vegetables than non-user males, and they consumed more cakes, desserts, fruit, yogurt, sweet beverages and beer.
Santolaria-Fernandez[14] **(1995)**	Spain	Cross-sectional	Substance Addicts Who Do Not Have Organic Pathology In Their Brains 140 Ind. Age 26.2±0.3 Substance Addicts Who Do Have Organic Pathology In Their Brains 18 Ind 24.2±0.8	Heroin Males: 78 Heroin Females: 38 Cocaine+Heroin Males: 18 Cocaine+Heroin Females: 4 Cocaine Males: 2 Injection:109 Inhalation:31 Heroin: 15 Cocaine:3 Injection:17 Inhalation:1	Acute, non-fulminant viral hepatitis, chronic active hepatitis, fulminant hepatitis, subcutaneous abscess, bacterial pneumonia, tricuspid valve endocarditis (3 cases), acute episode of asthma, thrombocytopenia related to HIV infection and pyrogen-related fever.	24-h dietary recall	Those who do not have organic pathology in their brains take 1,188±53 kcal/day energy (75.7% of the energy they should take daily) and 47±2.2 gr/ day (0.77 gr/kg) protein, while those who have organic pathology in their brains take 919±76 kcal/day energy (60.4% of the energy they should take daily) and 34±4.1 gr/day protein (0.63 gr/kg). In women, daily energy intake is 978±89 kcal/day (70.9% of the energy they should take daily), and in men, it is 1,265±64 kcal/day (77.4% of the energy they should take daily). Protein intake is 39.3±3.3 gr/day in women and 49.7±2.7 gr/day in men. Based on the severity of substance addiction, moderate users take 1,218±62 kcal/day energy and 48.1±2.2 gr/day protein, while heavy users take 1,095±105 kcal/day and 42.8±4.1 gr/day protein.
Smit(1996)[15]	the US	Cross-sectional	Individuals Who Used Substance By Inhalation n=104 HIV (+): 45 Ind. Age: 39.4±6.7 HIV (-): 59 Ind. Age: 40.6±7.8	Heroin+Cocaine: 76% Marijuana: 59% Crack Cocaine: 34%	HIV (+)	24-h dietary recall 116-items Food intake Frequency (FFQ)	***HIV(+)-24h recall***: Energy: 3,306±1341 kcal/day, Protein: 132±66 gr/day, Fat: 132±65 gr/day, CHO: 372±179 gr/day, Sucrose: 49.±38.0 gr/day, Fiber: 10.3±8.2 gr/day ***HIV(+)-FFQ:*** Energy 4,370±1871 kcal/day, Protein: 148±70 gr/day, Fat: 162±77 gr/day, CHO: 532±270 gr/day ***HIV(-) 24-h recall:*** Energy: 3,030±1674 kcal/day, Protein: 125±150 gr/day, Fat: 162±77 gr/day, CHO: 271±232 gr/day, Sucrose: 39±38 gr/day, Fiber: 10.5±7.3 gr/day ***HIV(-) FFQ:*** Energy: 3,904±1777 kcal/day, Protein: 145±73 gr/day, Fat: 146±76 gr/day, CHO: 466±217 gr/day

Table 1 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Food intake Assessment Method	Conclusion
Himmelgreen (1998)[9]	the US	Cross-sectional	Substance Users 41 Ind. Age 33.5±5.7 Non-users of Substance 41 Ind. Age 33.1±5.1	Individuals using heroin, cocaine and speedball by injection 29% Crack Cocaine Smoke or İnhalation 10% Injection+Inhalation/ Smoke 54% Amphetamine 7%		Food intake Frequency	The daily frequency of vegetable consumption is lower in substance users than non- users. However, the frequency of consuming different types of dessert is higher in substance users. Vegetable and fish consumption in substance users who have distrust in food is lower than that of the healthy individuals in the control group. The number of weekly meals is 11.4±4.9 in substance users while it is 15.6±4.6 in non-users. Substance users consume fewer breakfast and lunch meals than the other group. Substance users mainly preferred fried foods while non- users preferred to consume food cooked in ovens or steamed.
Forrester (2000)[16]	the US	Cross-sectional	Never used substance HIV(+): 61 Ind. (35M,26F) Age:44.3±11.2 Substance addicts who do not use intravenous (IV) substances HIV(+): 239 Ind. (197M,42F) Age:39.8±7.4 Individuals who used IV substances in the past HIV(+): 103 Ind.(52M, 51F) Age:42.7±6.9 Individuals using IV substances currently HIV(+):39 Ind(28M,11F) Age: 23.1±6.1	Heroin Ecstacy	HIV(+)	3-day food record (In 85% of those who do not use any substances in 86% of those who do not use IV, in 76% of those who used IV in the past, in 91% of those who are using IV currently) 24-h food intake (15%, 14%, 24%, 9%, respectively)	Energy intake is 36.4 kcal/kg and 27.7 kcal/kg in men and women that do not use any substances, respectively; 40.2 kcal/kg and 35.0 kcal/kg in the addicts that do not use IV substances, 36.1 kcal/kg and 34.6 kcal/kg in those that used IV substances in the past, and 46.2 kcal/kg and42.4 kcal/kg in those who are using IV substances currently. The daily intakes of protein, carbohydrates and fat in the users of IV substances were higher than those who did not use any substances. The micro-nutrient intakes in all groups, except for zinc, was higher than the suggested daily reference intake in those who used IV substances in the past and who are using substances currently. Similarly, the intakes of zinc were under the daily reference intake level in the women who do not use any substances, who do not use IV substances and who used IV substances in the past.
Smit(2001)[17]	the US	Cross-sectional	Ind. with substance use disorder: 852 Ind. Non-users of substance: 9771 Ind. 20-59 years age	Marijuana: 852 Ind. Ind. using four times a month or less: 541 Ind.(Slight) Ind. using 5-10 times a month: 135 Ind. (Moderate) Ind. using 11 times a month or more: 176 Ind.(Heavy)		24-h dietary recall FFQ	Heavy users have the highest amount of energy intake (3,196±18kcal/day). The energy intake in slight (2,823±78kcal/day), moderate (2,917±130 kcal/day) and heavy users is higher than non- users (3,196±181kcal/day) with rates of 24%, 28% and 41%, respectively. Although the percentage of energy derived from fat in heavy users is lower than non-users, the percentage of energy derived from alcohol is higher in the former group. The intake of micro-nutrients in males that use marijuana is higher than those that do not use this substance. The same condition was determined in females as well. In addition, the intakes of thiamine, riboflavin, folate, vitamin B6, vitamin B12, phosphorus, zinc, potassium and iron is lower in those who do not use marijuana than it is in heavy users. The intakes of vitamin C and carotene from the regulation of energy are significantly lower in heavy users than in those who do not use this substance.

Table 1 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Food intake Assessment Method	Conclusion
Forrester (2004)[18]	the US	Cross-sectional	1st Group Non-users of Substance HIV(+): 97 Ind. (60M, 37F) 2nd Group Substance-user HIV(+): 85 Ind. (71M,14 F) 3rd Group Substance-user HIV(-) 102 Ind.(81M, 21F) 18 years of age and older	Heroin Cocaine Amphetamine: 13 Ind. (together with heroin and cocaine)	HIV(+)	24-h dietary recall 3-day food record	***Females (according to the group rank):*** Energy: 2171±158 kcal/day, 1,852±99kcal/day, 2102±37 kcal/day 13.2%). Protein (of energy) 13.2±0.73%*, 15.4±0.46%*, 13.3±0.60%*. Carbohydrate: 56.6±2.0%, 54.1±1.3%, 54.5±1.7% Simple CHO (of energy): 26.5±2.4, 23.3±1.5*, 28.1±2.0*, Fat (of energy): 31.4±1.5, 31.6±0.94, 33.4±1.2. Vitamin A (% DRI): 110±80%, 23,107±51%, 19, 79±565, 11%; Vitamin B6 (% DRI): %187±120, 21*, %140±104, 20*, %107±77, 13. ***Males (according to the group rank):*** Energy: 2671±108 kcal/day, 2,536±118 kcal/day, 2734±107 kcal/day, Protein(energy): 15.1±0.36, 15.9±0.39*, 14.7±0.35*, CHO(%): 54.2±0.83, 52.2±0.91*, 54.9±0.82*, Fat (energy %): 31.6±0.63, 32.6±0.69, 31.1±0.62, Simple CHO: 24.0±1.0, 23.0±0.96*, 26.1±0.95*, Vitamin A (% DRI): 116 ±66.18%,149 ±80,21%, 103 ±64,14%, Vitamin B6 (% DRI): 205 ±139,26%, 197±143,27%, 168±135, 21%
Rodondi (2006)[19]	the US	Cross-sectional	Substance Users:1365 persons Age: 40 Non-users of Substance: 2252 Ind. Age:40.3 years	Marijuana:1365 persons In 15 years: Those who used it for ≥180 days=610 persons Those who used it for 180-1799 days: 601 Ind. Those who used it for ≥1800 days: 154 Ind. Marijuana+cocaine: 37 Ind. Marijuana+Opiate: 16 Ind.		Diet History	Energy intake is significantly higher in marijuana users than non-users. The highest energy intake was determined in those who used substance for 180-1,799 days (3.428 kcal/day), and they were followed by those who used substance ≥1,800 days (3,365 kcal/day). Energy intake is 2,746 kcal/day in those who do not use substance. There is no significant difference between the groups regarding the percentages of the energy derived from saturated or unsaturated fat. Carbohydrate intake decreased as marijuana use increased, while the consumption of alcohol increased in inverse proportion with marijuana use. Weekly beer consumption is 3.6 times more in heavy users than in the group of non-users.
Sahni(2007)[20]	the US	Cross-sectional	1st Group Non-users of Substance HIV(+) 2nd Group Substance-user HIV(+): 3rd Group Substance-user HIV(-) Total: 286 Ind. 18 years of age and older	Heroin Cocaine Amphetamine: 13 Ind. (together with heroin and cocaine)	HIV(+)	FFQ (n=260 Ind.) 24-h dietary recall (n=251 Ind.) 3-day diet record (n=141 Ind.)	***FFQ Values:*** Energy: 2,627±996 kcal/day, Protein: 92±40 gr/day, CHO: 349±146 gr/day, Fiber: 19.5±10.2 gr/day, Total fat: 93.0±4.0 gr/day, Saturated Fat: 30.8±14.3 gr/day, vitamin A: 1,245±1,441 µgr RE, vitamin B6: 2.60±1.30 mg/day, vitamin C: 168±131 mg/day, Calcium: 879±514 mg/gr, Iron: 19 mg/day, Caffeine: 263±777 mg/day ***24-h Recall:*** Energy: 2,460±922 kcal/day, Protein: 88±42 gr/day, CHO: 336±146 gr/day, Fiber: 17.3±9.4 gr/day, Fat: 86.0±40.0 gr/day, Saturated fat: 28.8±14.6, vitamin A: 970±1013 µgr RE, vitamin B6: 2.00±1.00 mg/day, vitamin C: 146±175 mg/day, Niacin: 27.2±13.4 mg/day, Calcium: 784.9±516 gr/day, Iron: 18.0±11 mg/day, Caffeine: 215±357 mg/day ***3-day Diet Record:*** Energy: 2,245±733 kcal/day, Protein: 85±30 gr/day, CHO: 292±106 gr/day, Fiber: 15.3±7.2, Fat: 80±30, Saturated fat: 26.6±11.2 gr/day, vitamin A: 893±815 µgr RE, vitamin B6: 2.00±1.00 mg/day, vitamin C: 146±175 mg/day, Niacin: 24.6±12.0 mg/day, Niacin: 23.6 mg/day, Calcium: 726±387 mg/day, Iron: 15.9±7 mg/day, Caffeine: 166±150 mg/day.

Table 1 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Food intake Assessment Method	Conclusion
SSæland(2008)[21]	Norway	Cross-sectional	Substance addict Male:123 Age:36.2±7.0 Substance addict Female:72 Age:34.5±7.4	Heroin Male: 72% Heroin Female:78% Amphetamine Male:32% Amphetamine Female:32% Marijuana Male: 27% Marijuana Female: 14% Rohypnol Male: 52% Rohypnol Female: 63%	Hepatitis C 85% of all Hepatitis B 6% of males HIV Positive 2% of males	24-h dietary recall	Males eat on average 2.6±1.4 meals a day while females eat 2.7±1.6 meals on average. A majority of males eat three meals a day, and females eat mainly two or three meals a day. Only 10% of the participants eat five or more meals daily. Of males and females, 6% had not eaten or drunk anything in the last 24 hours. A meal here means eating and drinking any kinds of food including snacks. Although they have the suitable conditions, 40% of the participants never prepare a hot meal.
Sæland(2011)[22]	Norway	Cross-sectional	Substance addict Male:123 Age:36.2±7.0 Substance addict Female:72 Age:34.5±7.4	Heroine Male: 72% Heroine Female:78% Amphetamine Male:32% Amphetamine Female:32% Marijuana Male: 27% Marijuana Female: 14% Rohypnol Male: 52% Rohypnol Female: 63%		24-h dietary recall	Daily energy intake of the .individuals is 23% lower than the general population of Norway. Only 20% of substance addicts fulfilled the reference values regarding their vitamin and mineral intakes. The energy derived from proteins was only 11%, and the contribution of animal proteins to this rate was only 3%. However, the most interesting finding of this study is heroin addicts' excessive interest in sugar and sugary foods. It was emphasized that 60% of individuals' daily energy was derived from carbohydrates, and 30% of it consisted of sugar. Moreover, the rate of the individuals saying that they specifically preferred sugary foods reached 61%, and more than 50% of the participants did not consume any other food group, except for sugary beverages and bread/cereals for breakfast.
Ersche(2013)[23]	UK	Cross-sectional	Substance addict Males: 35 Ind. Non-users of Substance Males: 30 Ind.	Cocaine: 35 Ind. Comorbid use Opiate: 43% Marijuana: 20% Amphetamine 3%		FFQ-131 item	In cocaine addicted males, the habit of skipping breakfast is more frequent than healthy males (86% and 20%). Alcohol and energy intake of cocaine users is significantly higher than the others (pi0.017). It was found that addicts consumed fatty foods significantly more than the other groups, and they had increased consumptions of monounsaturated fat acids and saturated fat acids. Moreover, carbohydrate consumption of cocaine addicts was significantly higher, while their sugar consumption (e.g. fructose, glucose) was less than that of the other groups.

Table 1 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of I ndividuals	Other Diseases Determined	Food intake Assessment Method	Conclusion
Sæland(2014)[24]	Norway	Cross-sectional	47 Ind. that used multiple substances and had abscess infection Age: 36.9±7.7 years	Heroin: 94% Amphetamine: 45% Rohypnol: 83% Benzodiazepine: 30% Marijuana: 51% Injection: 94%	Hepatitis C: 85% Hepatitis A: 41% Helicobacter pylori: 36% Depression:	24-h dietary recall	The limitation of access to food is 75% in those who have abscess infection, and they consumed on average 2±1.3 meals in the last 24 meals; these values are 62% and 3 meals, respectively, in those who do not have abscess infection. In those who have abscess infection, the percentage of the energy derived from fat*(22%(10,36) vs 29%(18,37), protein*(9%(6,12) vs 11%(8,15) and fiber* (1%(0.4,1.5) vs 1.3%(0.7,2.1)) was lower than the other group, and the percentage of the energy derived from carbohydrates*(63%(51,77) vs 57%(48,68) and sugar* (35%(19,49) vs 23%(12,34)) is higher than the other group. The daily intakes of vitamins A, E, D, B12, B1, B6 and C, folic acid, copper, zinc, selenium and iron are lower in those who have abscess infection than those who do not have it. Daily vitamin and mineral intakes of the substance addicts in both groups are under the Nordic Nutritional Recommendation. * Median(P25,P75)
			141 Ind. that used multiple substances and did not have abscess infection Age: 35.1±7.6 years	Heroin: 85% Amphetamine: 46% Rohypnol: 63% Benzodiazepine: 30% Marijuana: 47% Injection: 85%	Hepatitis C: 83% Hepatitis A: 49% Helicobacter pylori:35% Depression:		

and 3,365 kcal/day (19) in heavy users. In heroin users, the lowest daily energy intake was 1,188 kcal/day (14), and the highest daily energy intake was 3,693 kcal/day (13). The lowest and highest intakes in the 24-hour reminder method were 1,188 kcal/day (14) and 3,306 kcal/day (15). The lowest and highest energy intakes in food intake frequency were 2,627 kcal/day (20) and 4,370 kcal/day (15). An evaluation of the energy coming from carbohydrates indicated that it ranged between 44.7% (17) and 60% (22) in the entire group, between 41% (13) and 54.9% (18) in males, and between 42.6% (13) and 54.5% (13) in females. The rates of the energy coming from proteins were 10.1%(13)-15.1%(18), 10.1%(13)-15.9%(15), 9.4% (13)-16.0% (15) respectively, and the rates of the energy coming from fat were 30%-33% (15,17,20), 27% (13)-34% (15), and 28% (13)-33.4% (18) on average. The fiber intake for the entire group was 10.4 (15)-20.9 (17) gr, while it was 11.8 (15)-18.9 (18) gr in males and 10.4 (15)-18.9 (18) gr in females. Sugar consumption was 23 (18) -46 (15) gr. Sæland et al. (22) reported that 30% of the daily energy of substance addicts is derived from sugar. An analysis of the intake levels of vitamins and minerals produced different results. Morabia et al. (13) stated that the iron, thiamine and vitamin C intake of males and females were lower than the control group (the group of healthy individuals) although their energy intakes are higher than the control group. Smit et al. (15) reported that the intake of vitamin A, vitamin E and calcium were lower in both males and females than the Recommended Dietary Allowance (RDA), and copper and zinc levels were also low in females in addition to these micro-nutrients. In their other study, Smit et al. (17) found that only the folate consumption was below the Dietary Referance Intake (DRI), and the values of vitamin B12, vitamin B6, thiamine, riboflavin, niacin, calcium, iron and zinc were above the DRI values. A relevant study found that substance addicts' consumption of vitamin E, vitamin K, magnesium and calcium were below the DRI (20) Also, the intake of vitamin A, vitamin D, vitamin E, thiamine, folic acid, vitamin B6, vitamin C, zinc, selenium and iron of Norwegian substance addicts was below Nordic Nutritional Recommendations (15)

It was determined that the males who used heroin consumed more cakes, desserts, sweet beverages

and alcohol than those who did not use heroin (13). Similarly, Himmelgreen et al.(9) found that the individuals that used heroin and cocaine consumed foods with sugar more than those who did not use these substances. In addition, the number of weekly meals they consumed was higher than that of the individuals who did not use these substances (11.4±4.9 meal/week vs. 15.6±4.6 meal/week). Rodondi et al. (19) reported that the weekly beer consumption of marijuana users was 3.6 times more than those that did not use this substance. Sælend et al. (21) determined that 6% of the individuals in their study sample had not eaten or drank anything in the last 24 hours, and the number of the daily meals they ate was insufficient. A study conducted with cocaine addicts found that 80% of the addicts skipped breakfast (23).

The Studies That Examined Biochemical parameters and Anthropometric Measurements of Substance Addicts

Sample Characteristics: In this section, 17 studies were included in the literature review. Of these studies, 15 examined the anthropometric measurements (9, 13, 16, 17, 19, 21, 23, 24, 26-32) and 10 evaluated the biochemical parameters (17, 19, 21-25, 27-29) These studies were conducted in the US (9, 16, 17, 19, 30), Norway (21, 22, 24), Bangladesh (27-29), UK (23, 26), Switzerland (13), Austria (31) and Australia (32) between 1979 and 2014. Of these studies, 13 were cross-sectional (9, 13, 16, 17, 19, 21, 22, 24-26, 30-32), two were case-control studies, (23,29) and two were longitudinal (27,28) studies. The substances that were used most commonly were marijuana, heroin and cocaine. The use of multiple substances was also very common. The diseases determined in substance-users were high transaminase, angular stomatitis, steatorrhea, gingival bleeding, HIV, hepatitis B, hepatitis C, depression and helicobacter pylori.

Anthropometric Measurements: Table 2 includes a summary of the studies that examined the anthropometric measurements of substance addicts. This study included 38 heroin-users, and found that the body weight (66.3±10.1 kg) and BMI (21.5±2.1 kg/m^2) of the males were significantly lower than those of the healthy individuals in the control group (69.7±92 kg; 22.7 kg/m^2, respectively) (13) ($p<0.05$). In contrast, Forrester et al. (16) found that the body weight (78.7±8.6 kg), BMI (25.1±3.1), percentage of fat in the body and the amount of non-fat tissues in substance-addicts were higher than the healthy individuals in the control group ($p>0.05$). Morabia et al. (13) did not find significant differences between the body weight and BMI values of substance addicts and healthy individuals in the control group. However, the other study determined a significant difference between individual body weight, BMI and fat percentage in the body. The body weight of the women that used heroin was on average 13.7 kg (19%) lower than the non-users, and their BMI was 5.6 kg/m^2 (20.4%) lower than the non-users (16). Smit et al (17) conducted a study with marijuana-users only, and found that the BMI values of heavy users of marijuana were significantly lower than those of the healthy individuals in the control group (24.7±0.3 kg/m^2 vs 26.6±0.1 kg/m^2). An evaluation regarding the frequency of use indicated that the BMI values of the light users (1-4 times a month) and heavy users (11 times and more in a month) were lower than those of the moderate users (5 to 10 times a month). The results which were derived by Rodondi et al. (19) did not support these data. This study did not find a difference between the BMI values of the individuals that did and did not use marijuana intensively (28.9±0.33 kg/m^2 vs 28.8±0.1 kg/m^2). An evaluation regarding the frequency of use did not indicate a difference between the BMI values of light and heavy users as well. The studies conducted with cocaine-users determined that their BMI values were in the normal interval, or in the upper limit of the normal interval (23,30). The studies evaluating the results of the samples that included individuals using different substances, as well as multiple substance users, assessed the BMI values of the individuals between an interval of 11.5-40.0 kg/m^2 (21, 31). Islam et al (28) found that 60.8% of the individuals using heroin, marijuana and codeine had BMI values below 18.5 kg/m^2 , and 14.6% of these individuals had a BMI lower than 16 kg/m^2, while 18.2% had BMI values between 16.0 and 16.9 kg/m^2 and 27.3% had BMI values between 17.0 and 18.5 kg/m^2. Similarly, Sæland et al (21) reported that 7% of the females who used heroin, marijuana, amphetamines and flunitrazepam had ≤16.5 kg/m^2

Table 2. Biochemical parameters and anthropometric measurements in patients with substance use disorder

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Biochemical Parameters	Anthropometric Measurements
Nakah (1979)[25]	the US	Cross-sectional	Substance Users:149 persons (17-60 Years Age) Non-users of Substance: 204 Ind. (17-60 Years Age)	Heroin: 149 Ind.	Liver Diseases (Serum transaminase level): 54 Ind.	Of the addicts, 76% had hypovitaminosis. Of them, 45% had vitamin B6 deficiency, 37% had folate deficiency, and 13-19% had thiamine, B12, riboflavin and nicotinamide deficiency. In addition, 50% of the addicts had deficiencies for two or more important vitamins.	
Morabia (1989)[13]**S**	Switzerland	Cross-sectional	Substance-user Males: 30 Individuals Females: 8 Ind. Age:26.1 M/23.0 F Non-users of Substance Males: 66 Females: 61 Age:20-35	Heroin: 37 Ind. Heroin+Methadone:11 Ind.			Average body weight of substance addict males was 66.3±10.1 kg and average BMI was 21.5±2.1 kg/m^2; these values were 69.7±9.2 kg and 22.7 kg/m^2, respectively, for the males in the control group. The BMI difference between the two groups was statistically significant. Average body weight of female addicts was 50.4±8.3 kg and average BMI was 19.4±2.7 7 kg/m^2. The average body weight of the women in the control group was 54.6±10.1 kg and average BMI was 20.6 kg/m^2. There was no difference between the females in the two groups.
McCombie (1995)[26]	UK	Cross-sectional	Substance users: 364 Ind. Male:193 Ind., Female: 171 Ind. (20-29 Years Age) Non-users of substance: 2156 kili Males: 1053 Ind., Female: 1103 Ind.	Using substance by injection: 364 Ind. (Substance type not stated)			Substance user males between 20 and 24 years age: BMI≤20:29%, BMI=20-25: 63 and BMIİ25:8% Substance user males between 25 and 29 years age: BMI≤20:2%, BMI=20-25: 64% and BMIİ25:9% Males between 20 and 24 years age, not using substance: BMI≤20:14%, BMI=20-25: 62% and BMIİ25:22% Males between 25 and 29 years age, not using substance: BMI≤20:9%, BMI=20-25: 62% and BMIİ25:29% Substance user females aged between 20 and 24: BMI≤20:36%, BMI=20-25: 56 and BMIİ25:8% Substance user females aged between 25 and 29: BMI≤20:20, BMI=20-25: 68 and BMIİ25:12% Females between 20 and 24 years age, not using substance: BMI≤20:56%, BMI=20-25: 51% and BMIİ25:21% Males between 25 and 29 years age, not using substance: BMI≤20:18%, BMI=20-25: 63% and BMIİ25:19% In male substance users, the rate of individuals with ≤20 BMI is significantly higher in both age groups. In female users, however, only the rate of having a low BMI in 20-24 years age group is significantly lower than the control group individuals.
Himmelgreen (1998)[9]	the US	Cross-sectional	Substance Users 41 Ind. Age 33.5±5.7 Non-users of Substance 41 Ind. Age 33.1±5.1	Those using heroin, cocaine and speedball by injection 29% Crack cocaine inhalation or sniffing 10% Injection+Sniffing/Inhalation 54% Amphetamine 7%			Average body weight of substance users was 59.6±19.2 kg and their average BMI was 24.8 kg/m^2, and the average body weight of the individuals in the control group was 70.1±19.7 kg and their average BMI was 28.5 kg/m^2 (pİ0,05). There were significant differences (pİ0.05) between upper arm circumferences (27.8±5.3 cm vs 31.2±5.3 cm), triceps (18.6±9.8 mm vs 20.3±10.2 mm), suprailiac (13.1±9.9 mm vs 20.3±10.2 mm) and subscapular skinfold thickness (15.2±9.4 vs 22.7±9.4mm). In addition, total upper arm area and upper arm muscle area values were significantly lower in substance addicts than the other group.

Table 2 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Biochemical Parameters	Anthropometric Measurements
Forrester (2000)[16]	the US	Cross-sectional	Never used substance HIV(+): 61 Ind. (35M,26F) Age:44.3±11.2 Substance addicts who do not use intravenous (IV) substances HIV(+): 239 Ind. (197M,42F) Age:39.8±7.4 Individuals who used IV substances in the past HIV(+): 103 Ind. (52M, 51F) Age:42.7±6.9 Using IV substances currently HIV(+):39 Ind. (28M,11F) Age: 23.1±6.1	Heroine Ecstasy	HIV(+)		Females: *Not Using Any Substances* BW:71.4 ±19.2kg, BMI:27.5±7.5, Lean tissue:45.5±10.2 kg, Body fat %:35.6±6.6; *Substance addicts not using IV*: BW:69.2±20.6, BMI:26.3±7.1, Lean tissue: 43.4±7.0, Body fat %: 34.7±7.0; *Used IV in the past:* BW: 66.7±13.5 kg, BMI: 25.7±5.2, Lean tissue: 43.4±7.0, Body fat %: 34.5±6.0; *Using IV substance currently:* BW: 57.7±8.6 kg, BMI: 21.9±3.0, Lean tissue: 41.7±5.8kg, Body fat %: 29.4±5.1. Males: *Not Using Any Substances:* BW:75.7±13.5 kg, BMI: 24.3±3.9, Lean tissue: 57.6±8.9 kg, Body fat %:23.5±6.5; *Substance addicts not using IV:* BW: 76.4±12.6, BMI: 24.6±3.5, Lean tissue: 58.8±8.2, Body fat %: 22.3±6.1; *Used IV in the past:* BW:76.8±12.6, Lean tissue: 57.2±6.8, Body fat %: 24.8±6.6; *Using IV substance currently:* BW: 78.0±10.6kg, BMI: 25.1±3.1, Lean tissue: 59.7±6.9 kg, Body fat %: 23.1±6.1.
Islam (2001)[27]S	Bangladesh	Longitudinal	Substance user 253 Males Age: 18-45 years age 100 males not using substance Age:18-45 years	Heroin Marijuana Codeine, Ephedrine Buprenorphine Pethidine Injection		In substance addicts, serum İ-tocopherol (12.60±3.70 µmol/L vs 16.3±3.37µmol/L), ascorbic acid (21.59±10.5 µmol/L vs 38.3±13.6 µmol/L) and retinol 1.15±0.39 µmol/L vs 1.33±0.30 µmol/L) values were significantly lower than the other group. Moreover, increased number of types of the substance used as well as the duration of using are correlated with the low levels of vitamin E, vitamin A and vitamin C.	Substance users: BMIİ18.5 kg/m²: 154 Ind. (60.8%) BMI18.5-25 kg/m²: 92 Ind. (36.4%) BMIİ25 kg/m²: 7 Ind. (2.8%) †*The BMI values of the control group were not presented.*
Smit (2001)[17]	the US	Cross-sectional	Ind. with substance use disorder: 852 Ind. Non-users of substance:9771 kili 20-59 years age	Marijuana: 852 Ind. Ind. using four times a month or less: 541 Ind. (Slight) Ind. using 5-10 times a month: 135 Ind. (Moderate) Ind. using 11 times a month or more: 176 Ind. (Heavy)		Serum hemoglobin (149±0.3 gr/L vs) and serum hematocrit levels are slightly higher in clinical terms in marijuana users than the non-users. There is no difference between the groups regarding serum albumin, cholesterol and triglyceride levels. Serum carotenoid (beta carotene, lutein, lycopene, kryptoxanthin) levels are lower in heavy users of marijuana than the control group individuals.	*BMI values:* Non-users of marijuana: 26.6±0.1 kg/m² Ind. using 1-4 times a month: 25.0±0.4 kg/m² Ind. using 5-10 times a month: 26.1±0.6 kg/m² Ind. using 11 times a month and more:24.7±0.3 kg/m²
Islam (2002)[28]S	Bangladesh	Longitudinal	Substance user 253 Males Age: 18-45 years age 100 males not using substance Age:18-45 years	Heroin Marijuana Codeine, Ephedrine Buprenorphine Pethidine Injection	Angular Stomatitis steatorrhea gingival bleeding S	In substance users, the levels of hemoglobin (118±26.3 gr/L vs 141.0±15 gr/L), total protein (62.9±11.8 gr/L vs 73.6±8.8 gr/L) and albumin 37.6±6.9 gr/L vs 42.6±6.9 gr/L) were significantly lower than the healthy individuals in the control group. Of the substance users, 60.8% had hemoglobin levels below the normal level, 37.8% had albumin levels below the normal level, and 60% had total protein levels below the normal level.	*Substance users-BMI* □16 kg/m² 14.6% 16.0-16.9 kg/m² 18.2% 17.0-18.4 kg/m² 27.3% 18.5-25.0 kg/m² 36.7% □25 kg/m² 3.2% *Non-users of substance-BMI* □16 kg/m² 2.0% 16.0-16.9 kg/m² 3.0% 17.0-18.4 kg/m² 10.0% 18.5-25.0 kg/m² 74.0% □25 kg/m² 11.0% pİ0.001

Table 2 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Biochemical Parameters	Anthropometric Measurements
Rodondi (2006)[19]	the US	Cross-sectional	Substance Users:1,365 persons Age: 40 Non-users of Substance: 2,252 Ind. Age:40.3 years	Marijuana:1,365 persons In 15 years: Those who used it for İ180 days= 610 Ind. Those who used it for 180-1799 days: 601 Ind. Those who used it for İ1,800 days: 154 Ind. Marijuana+cocaine: 37 Ind. Marijuana+Opiate:16 Ind.		There was no difference between those who used substance more than 1800 days and those who had never used any substances regarding their cholesterol (184.2±0.8 mg/ld. vs 186.1±2.3 mg/ld.), HDL-cholesterol (50.6±0.4 mg/ld. vs 51.4±0.8 mg/ld.), triglyceride (86.7±0.9 mg/ld. vs 92.9±0.9 mg/ld.) and fasting blood glucose (86.7±0.4 mg/ld. vs 86.1±1.6 mg/ld.) levels.	*BMI* The ones who do not use any substances at all 28.8±0.1 kg/m² The ones who used it <180 days 28.6±0.2 kg/m² The ones who used it for 180-1799 days 28.8±0.2 kg/m² The ones who used it for >1800 days 28.9±0.3 kg/m²
Hosaain (2007)[29]S	Bangladesh	Case Control	Substance user 253 Males Age: 18-45 years age 100 males not using substance Age:18-45 years	Heroin Marijuana Codeine, Ephedrine Buprenorphine Pethidine Injection	Angular Stomatitis steatorrhea gingival bleeding S	Compared to non-users, substance users' levels of serum copper (21.6±5.8 µmol/L vs 15.2±4.1 µmol/L) and serum zinc (13.8±4.5 µmol/L vs 12.3±4.1 µmol/L) were significantly higher, while their serum iron level (20.5±6.5 µmol/L vs 32.4±8.9 µmol/L) was significantly lower.	The average BMI level in 65.6% in substance users was between 11.5-18.4 kg/m², and in 34.42% of substance users, the average BMI level was between 18.5-28.5 kg/m², while 15.0% of non-users had 11.5-18.4 kg/m² average BMIs and 85% had 18.5-28.5 kg/m² BMIs.
Quach (2008)[30]	the US	Cross-sectional	HIV (+) 562 Ind. Age: 18 years old and older	Cocaine: 74 Ind. Heroin+Cocaine: 60 Ind. Marijuana/Sedative: 139 Ind. Not using at all: 289 Ind.	HIV(+) Hepatitis B Hepatitis C		In cocaine users25.0±4.1 kg/m² In heroin+cocaine users 25.9±4.5 kg/m² In Marijuana/Sedative users 25.3±5.5kg/m² In those who do not use at all 27.4±6.0 kg/m²
SSæland(2008)[21]	Norway	Cross-sectional	Substance addicted Male:123 Age:36.2±7.0 Substance addicted Female:72 Age:34.5±7.4	Heroin Male: 72% Heroin Female:78% Amphetamine Male:32% Amphetamine Female:32% Marijuana Male: 27% Marijuana Female: 14% Rohypnol Male: 52% Rohypnol Female: 63%	Hepatitis C 85% of all Hepatitis B 6% of males HIV Positive 2% of males	Of males, 20% (43±5.1 gr/L on average) had albumin levels that were below the normal level, while this rate was 30% in females (41±3.0 gr/L). Of females, 26% (12.1±1.6 g/100 mL) had hemoglobin levels that were below the normal level, and this rate was 20% (13.6±1.2 g/100 mL) in males. The serum CRP levels were above the normal level in 55% of females and 43% of males.	Average BMI of male addicts was 22.4±2.7 kg/m² and the average BMI of the female addicts was 21.7±4.4 kg/m². The BMI of seven females was below 16.5, and 20% had BMIs between 16.5İBMIİ18.5. On the other hand, only 3% of males had BMIs between 16.5İBMIİ18.5. In addition, 22 of females and 14% of males were overweight/obese (BMIİ25).
Blüml(2011)[31]	Austria	Cross-sectional	General population Males: 1864 Ind. Age: 18	Marijuana: 95 Ind. Opiate: 50 Ind. Cocaine: 7 Ind. Amphetamine: 5 Ind. Benzodiazepine: 3 Ind.			*BMI values of the entire population:* □18.5 kg/m² 124 Ind. (6.7%) 18.5-25 kg/m² 1232 Ind. (66.1%) 25-30 kg/m² 379 Ind. (20.3%) ≥ 30 kg/m² 129 Ind. (6.9%) There was a significant inverted correlation between BMI and illegal substance use (pİ0.13).

Table 2 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Biochemical Parameters	Anthropometric Measurements
Sæland (2011)[22]	Norway	Cross-sectional	Substance addicted Male:123 Age:36.2±7.0 Substance addicted Female:72 Age:34.5±7.4	Heroin Male: 72% Heroin Female:78% Amphetamine Male:32% Amphetamine Female:32% Marijuana Male: 27% Marijuana Female: 14% Rohypnol Male: 52% Rohypnol Female: 63%		There were no significant differences between males' and females' levels of (respectively) triglyceride(1.37±0.61 mmol/L vs 1.37±0.67 mmol/L), total cholesterol (4.85±0.9 mmol/L vs 4.14±0.88 mmol/L), HDL (1.14±0.33 mmol/L vs 1.24±0.44 mmol/L), LDL(2.29±0.81 mmol/L vs 2.23±0.70 mmol/L), tocopherol (21.8±4.8 vs 22.5±5.7 µmol/L), vitamin C (56.6±30.2 µmol/L vs 58.4±32.2 µmol/L), and thiamine(90.0 nmol/L vs 84.9±22.8 nmol/L). The levels of retinol (1.59±0.55µmol/L vs 1.33±0.63 µmol/L) and selenium (0.78±0.16µmol/L vs 0.72±0.16 µmol/L) were significantly higher in males, while the levels of copper (22.63±3.84 µmol/L vs 24.81±3.98 µmol/L) and HbA1c (5.8±0.7 vs 5.9±0.9) were significantly higher in females.	
Ersche (2013)[23]	UK	Case control	Substance addict Males: 35 Ind. Non-users of Substance Males: 30 Ind.	Cocaine: 35 Ind. Comorbid use Opiate: 43% Marijuana: 20% Amphetamine 3%		In cocaine users Plasma Leptin level:4.7±5.4 µgr/L Healthy Group: Plasma Leptin level: 2.9±3.0 p=0.098	Body weight (70±10.7 kg vs 80.1±13.4 kg), biceps skinfold thickness (5.2±2.0 mm vs 7.1±3.9 mm) and body fat percentage (19.8±8.7 vs 24.8±8.0) of cocaine users were significantly lower than those of the healthy individuals. There were no significant differences between the groups regarding their BMI (23.9±3.4 kg/m^2 vs 25.4±3.5kg/m^2), waist circumference (84.7±8.8 cm vs 89.4±10.7 cm), rate of waist/hip (0.89±0.06 vs 0.90±0.07), triceps skinfold thickness (9.4±4.2 mm vs 11.4±4.4 mm), lean tissue (57.6±5.1 kg vs 58.8±7.4 kg), and bone mineral density (3.0±0.4 vs 3.2±0.5).
McIlwraight (2014)[32]	Australia	Cross-sectional	Substance addicted Females: 252 Ind. Males: 525 Ind. Total: 777 Ind. 18-64 years age General Population Females: 6095 Ind. Males: 6509 Ind. Total: 12,604 Ind. 18-64 years age	Heroin: 32.2% Morphine: 43.3% Amphetamine: 24.5%			*Substance users entire group BMI (Ind. %):* İ18.5 kg/m^2 8%*, 18.5-25 kg/m^2 56%*, 25-30 kg/m^2 25%*, ≥30 kg/m^2 11%*. *Non-users of substance entire group BMI (Ind. %):* □18.5 kg/m^2: 2.6%, 18.5-25 kg/m^2 42.2%, 25-30 kg/m^2 33.9%, ≥30 kg/m^2 21.3%. *Substance user female BMI (Ind. %):* İ18.5 kg/m^2 16%*, 18.5-25 kg/m^2 47%, 25-30 kg/m^2 21%*, ≥30 kg/m^2 16%. *Non-user of substance female BMI (Ind. %):* □18.5 kg/m^2 3.7%, 18.5-25 kg/m^2 49.1%, 25.0-30.0 kg/m^2 27.2%, ≥30 kg/m^2 20.0%. *Substance user male BMI (Ind. %):* □18.5 kg/m^2 4%*, 18.5-25 kg/m^2 60%*, 25-30 kg/m^2 27%*, ≥30 kg/m^2 9%. *Non-user of substance male (Ind. %):* 18.5 kg/m^2 %1.4, 18.5-25 kg/m^2 35.8%, 25-30 kg/m^2 40.2%, ≥30 kg/m^2 22.6%.

Table 2 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Other Diseases Determined	Biochemical Parameters	Anthropometric Measurements
Sæland (2014)[24]	Norway	Cross-sectional	47 Ind. that use multiple substances and do not have abscess infection Age: 36.9±7.7 years	Heroin: 94% Amphetamine: 45% Rohypnol: 83% Benzodiazepine: 30% Marijuana: 51% Injection: 94%	Hepatitis C: 85% Hepatitis A: 41% Helicobacter pylori: 36% Depression:	The individuals who had abscess infection had higher levels of S-CRP(11 mg/L vs 9 mg/L), HbA1c(6.0 vs 5.7 (p=0.012)), homocystein (17.6µmol/L vs 13.8 µmol/L(p=0.000), ascorbic acid (62 µmol/L vs 55 µmol/L), while they had lower levels of vitamin B12 (290 pmol/L vs 310 pmol/L), folate(9.6 nmol/L vs 11.0 nmol/L), vitamin B6(17.0 nmol/L vs 19.5 nmol/L), and vitamin D (27 nmol/L vs 35.0 nmol/L). Of the individuals that had abscess infection, 73% had hyperhomocysteinaemia, while this rate was 41% in those who did not have this infection.	Those who had abscess infection had BMIs (20.4 kg/m^2 vs 22.0 kg/m^2 (p=0.002) and upper medium arm circumference (24.5±3.6 cm vs 26.8±3.1 cm (p=0.002)) were significantly lower.
			141 Ind. that used multiple substances and did not have abscess infection Age: 35.1±7.6 years	Heroin: 85% Amphetamine: 46% Rohypnol: 63% Benzodiazepine: 30% Marijuana: 47% Injection: 85%	Hepatitis C: 83% Hepatitis A: 49% Helicobacter pylori: %35 Depression:		

BMI values, and 20% had BMI values between 16.5 and 18.5 kg/m^2. A relevant study found that 16% of the females had ≤18.5 kg/m^2 BMI values. On the other hand, 16% of the females had İ30 kg/m^2 BMI values. Of the males, 60% had BMI values in the normal interval, and 27% were overweight (32). Only one study evaluated waist circumference and waist/hip ratio, and two studies measured skinfold thickness (Table 2) (9, 23).

Biochemical parameters: Three studies assessed blood lipid profile (17, 19, 22), three other studies assessed albumin and hemoglobin levels (17, 21, 28), and four studies assessed serum vitamin and mineral levels (22, 25, 27, 29). It was found that total cholesterol, triglyceride, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) levels of individuals with a substance use disorder were in the interval of reference values. Smit et al. (17) determined that total cholesterol and triglyceride levels of substance users were lower than those of the non-users. Rodondi et al. (19) found that there was no correlation between the frequency of marijuana use and the blood lipid profile. Sæland et al. (22) determined that the blood lipid levels of male addicts were slightly higher than those of female addicts. The blood sugar level of the addicts was euglycemic (19). The HbA1c level was in the recommended reference interval (22, 24). Albumin and hemoglobin levels were in the interval of 37.2±6.9-43.1±5.1 gr/L and 118±26.3-149±1.8 gr/L (17, 21, 28). Nakah et al. (25) demonstrated that B6, folate, thiamine, riboflavin and vitamin B12 levels were low in heroin users, and 76% of the patients had hypovitaminosis. Another study determined that vitamin C, vitamin E and retinol levels were lower than those of the healthy individuals, and the levels of these vitamins decreased in inverse proportion with the duration of substance use (17). Sæland et al. (22) reported that the vitamin and mineral levels of substance users were in the interval of reference values, and only the vitamin D level was lower than this interval. It was determined that serum copper and zinc levels were higher in the users of heroin, marijuana and codeine than those who did not use these substances, and iron levels were lower in substance users than they were in non-users (29).

The Studies That Examined the Body Weight Changes in Substance Addicts During Treatment Process

Sample Characteristics: As a result of the examination, seven studies that met the required conditions were included in the study (33-39). Of these studies, four were conducted in the US (33-36), and the others were conducted in Iran (37), Australia (38) and Israel (39). An analysis of the study designs showed that three studies were retrospectives (33, 35, 36), two were longitudinal studies (34, 39) and two were cross-sectional studies (37, 38). One of these studies was conducted with adolescents (34). The other studies included adults. The samples included a minimum of 36 persons (35), and a maximum of 264 persons (33). Two studies did not indicate the treatment methods they used (33, 34), five studies used methadone for treatment (35-39), and one study used naltrexone (35) in order to make a comparison with methadone.

Body Weight Changes In the Treatment Process: Table 3 shows the studies that examined the body weight changes in the treatment process. These studies determined body weight changes between 1.84 kg and 12.7 kg during the treatment. Hodgkins et al. (34) determined the fastest increase in body weight. They conducted their study with marijuana addicts, and the participants gained 8.01 kg during the three-month treatment process. (At the beginning of treatment body weight was 67.09, and after three months it was 75.10.) In the same process, their BMI values increased by 1.77 kg/m^2. (The beginning of the treatment: 23.26±4.84 kg/m^2, after three months: 25.03±4.23 kg/m^2 on average.) The BMI value which was in the normal interval at the beginning of the treatment moved into the overweight interval after three months. At the beginning of the study, 5.8% of the group was overweight; this rate increased to 10.3% in the third month. Mysels et al. (35) found that there was only a 1.5 kg increase in the body weight of the heroin addicts that received methadone treatment. In this group, the weight increase in the sixth month was 3 kg on average. The smallest increase in body weight was observed in the individuals that used multiple substances. The average weight increase of these patients in the six-month period in which they received methadone treatment was 1.84 kg in females and 1.9 kg in males (37). The largest weight increase was in the patients that received methadone treatment and were monitored for 1.8±0.9 years on average. During this process, the females gained 12.7 kg. The average BMI increased from 27.5 kg/m^2 to 32.7 kg/m^2. This means that the patients moved into the obese group from the overweight group. The body weight increase in males was lower. The males that received treatment in the same timeframe gained 5.45 kg. An evaluation of the entire group indicated that the average weight increase in the treatment process was 8.08 kg (80.55 kg vs 88.63 kg), and the average BMI reached 30.1±7.7 kg/m^2, with an increase of 2.9 kg/m^2 (25). Mysels et al. (35) examined the effects of methadone and naltrexone on weight gain, and observed that the patients receiving methadone treatment gained 3 kg during six months, and the patients that received naltrexone treatment gained 6.7 kg. A recent study conducted with 114 patients that used heroin found that the BMI level increased from 22.05±3.9 kg/m^2 to 24.3±4.5 kg/m^2 in day 270.3±167.6 of the methadone treatment. The largest increases were in the group that had an average of 17.1 kg/m^2 BMI at the beginning of the study, with an increase of 2.8 kg/m^2 , and also in the group that had an average of 31.9 kg/m^2 BMI at the beginning of the study, with an increase of 1.9 kg/m^2 (39).

Discussion

This systematic literature review is the first to examine food intake, nutritional status and body weight changes in individuals that have a substance use disorder. After a review of the relevant literature, 27 studies that met the inclusion criteria were included in the study. Of these studies, 10 examined food intake in substance addicts, 17 examined anthropometric measurements and biochemical parameters, and seven examined the body weight changes observed during the treatment process. These studies found controversial results about energy intakes of the substance users, consumption rates of macro and micro nutrients, BMI values, and the increases in body weight during the treatment process. The methodological differences among the studies are the main cause of these results.

Table 3. Body weight changes during the treatment of substance use disorder

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Treatment	Diet-Nutrition Information	Conclusion
Fontaine (2001)[33]	the US	Retrospective Longitudinal Study	264 Substance addicted males Age: 21 and older	Cocaine: 108 Ind. Heroin: 120 Ind. Marijuana+Nicotine 27 Ind. Cocaine+Opiate:9 Ind.	*Not stated*	Standard hospital meal (Of the energy; 55% was carbohydrate, 30% was fat, 15% was protein) Free access to snacks	The BMI values in first hospitalization in therapy center Cocaine group: 23.8±4.8 kg/m^2, Heroin group: 24.0±4.8 kg/m^2, Marijuana+Nicotine group: 23.5±2.8 kg/m^2, Cocaine+Opiate group: 23.9±4.4 kg/m^2. Body weight increase after hospitalization for minimum seven days: Cocaine group:0.19±0.12 kg/day, Heroin group: 0.08±0.29 kg/day, Marijuana+Nicotine group: 0.14±0.20 kg/day, Cocaine+Opiate group: 0.14±0.22 kg/day
Hodgkins (2004)[34]	the US	Longitudinal	Substance addicted 148 Males 67 Females Total: 215 Ind. Age: 13-17	Marijuana: 76.8% Multiple Substances: 23.2%	*Not stated*	*Not stated*	Body weight in first hospitalization in therapy center: 67.09 kg, BMI: 23.26±4.84 kg/m^2, persons with the risk of being overweight %: 7.1, overweight persons %:5.8 60th day after hospitalization: Body weight: 72.70 kg, BMI: 24.90±4.65 kg/m^2, persons with the risk of being overweight %: 12.2, overweight persons %: 9.6% 90the day after hospitalization: Body weight: 75.10 kg, BMI=25.03±4.23 kg/m^2, persons with the risk of being overweight %: 14.7%, overweight persons %: 10.3
Mysels (2011)[35]	the US	Retrospective Longitudinal Study	Substance addicted 36 Ind. Males:27 Females:9	Heroin: 36 Ind.	Methadone: 16 Ind. Naltrexone: 20 Ind.	*Not stated*	The group using methadone: Initial weight: 76 kg, 3rd month: 77.5 kg (Increase: 1.86%), 6th month: 79 kg (Increase: 3.86%) Difference between ini.w. and 6th m. p<0.05 The group using Naltrexone: Initial weight: 79 kg, 3rd month: 83 kg (Increase:4.63%), 6th month: 85.7 kg (Increase:%6.69), Difference between ini.w. and 6th m. p<0.05
Fenn (2015)[36]	the US	Retrospective	Substance User n=96 Ind. Males: 64% Females: 36% Age:38±9.2	Opioid: 48% Heroine: 24% Opioid+Heroin: 28%	Methadone: 116 mg (30-260 mg)		***At the Beginning of the Treatment***: Entire group BMI: 27.2±6.8 kg/m^2, Body Weight: 80.55 kg, Females: 27.5 kg/m^2, Body Weight= 72.53 kg Males: 26.9 kg/m^2, Body Weight: 85.13 kg/m^2 ***In year 1.8±0.9 of the treatment***: Entire group BMI: 30.1±7.7 kg/m^2, Body Weight: 88.63 kg Female BMI: 32.7 kg/m^2, Body Weight: 85.23 kg Male BMI: 28.6 kg/m^2, 90.58 kg
Parveresh (2015)[237]	Iran	Cross-sectional	Substance User Males: 180 Ind. Females: 19 Ind. Total:199 Ind.	Multiple Substances: 139 Ind. Glass: 4 Ind. Opium sap: 33 Ind. Amphetamine: 1 Ind. Opium: 13 Ind.	Methadone (30-140 mg)		Beginning of Treatment: Females: 59.21 kg, Males: 62.84 kg Sixth month of treatment: Females: 61.05 kg, Males: 64.74 kg (p<0.01) Of the patients who used methadone, 13.1% reported that they had appetite loss.

Table 3 - Continued

Reference	Location	Study Design	Sample Size Age	Type of Substance Used Number of Individuals	Treatment	Diet- Nutrition Information	Conclusion
Waddington(2015)[39]	Australia	Cross-sectional	Substance users =60 Ind. Females: 30 Ind. Males: 30 Ind.	Heroin: 60 Ind.	Opioid Replacement Therapy	***Females:*** Energy: 1,034.49 kcal/day(33% less than the estimated average requirement of energy - EAR), Protein: 78.1 gr/day(30% less than EAR), fat: 69.9 gr/day, CHO: 199.9 gr/day, Fiber: 9.8 gr/day (100% below AI), vitamin A: 552.1 µg/day(55% below EAR), vitamin C: 90.5 mg/day(45% below EAR), vitamin E: 3.6 mg/day(79% below AI), Calcium: 722.3 mg/day(73% below), Iron: 6.2 mg/day(70% below EAR) ***Males:*** Energy: 1,774.22 kcal/day(36% less than EAR of energy), Protein: 135.9 gr/day(6% less than EAR), Fat: 100.4 gr/day, CHO: 287.6 gr/day, Fiber: 13.3 gr/day(97% less than AI), vitamin A: 702.1 µg/day(61% less than EAR), vitamin C: 59.5 mg/day(40% less than EAR), vitamin E: 4.5 mg/day(91% less than AI), Calcium: 1052 mg/day(46% less than EAR), Iron: 9.9 mg/day(30% less than EAR)	
Peles(2016)[39]	Israel	Longitudinal	Substance User Males: 87 Ind. Females: 27 Ind. Total: 114 Ind.	Heroine: 114 Ind.	Methadone		Beginning of the Treatment: İ18.5 kg/m² 15 ,Ind.(17.1±0.9), 18.5-24.9 kg/m² 74 ,Ind.(21.8±1.9), 25.0-29.9 kg/m² 22 ,Ind.(27.5±1.5), ,Ind. aged 30 years and older (31.9±2.5) On average 270.3±167.6 days of treatment: □18.5 kg/m² 15 ,Ind.(19.9±2.8), 18.5-24.9 kg/m² 74 ,Ind.(23.8±3.5), 25.0-29.9 kg/m² 22 ,Ind.(28.1±2.8), 3 ,Ind. aged 30 years and older kg/m² (33.8±3.4) The group with an average BMI of 22.05±3.9 kg/m² increased their average BMI to 24.3±4.5 kg/m² on day 270.3±167.6. of the treatment.

EAR: Estimated Average Requirements, DRI: Dietary Referance Intake, AI:Adequate Intake

Some studies had samples that included a group that used only one substance (17), and some other studies that included the users of multiple substances (14, 21). As is widely recognized , the varied pharmacological characteristics of addictive substances can have different effects on individual body weight and appetite. Heroin, cocaine and amphetamines usually suppress the appetite, while marijuana stimulates it (40). In addition to the type of the substance, different factors such as the manner of use (e.g. inhalation, injection), the age that the individual began using the substance, and the duration of use contribute to these varied results. Also, comorbid diseases within the individuals, (e.g. HIV (+), Hepatitis C, Hepatitis B), as well as the methods used to evaluate food intake (e.g. FFQ, 24-hour dietary recall, diet history, 3-day food intake) contributed to this difference. The researchers believe that one of the most important limitations of the studies that examine the energy intake and BMI levels is not being able to determine the daily energy consumption. Daily energy consumption plays a crucial role in the regulation of body weight. For all these reasons, study results should be interpreted carefully.

The studies that analyzed the individuals who used cocaine, amphetamine or Methylenedioxymethamphetamine (MDMA), together with heroin, found that the BMI values of these individuals were lower than those of the healthy individuals in the control group. Also, there were more individuals included in the low-weight group. In addition, it was determined that the food intake among these individuals was insufficient; they skipped meals, and did not eat the number of meals required for a healthy diet (9, 14, 21, 22). Fernandez et al.(14) reported that the individuals who were substance users ate only one meal during the day. An analysis of these poor eating habits revealed that the primary reasons were homelessness, low education level, unemployment and low income (18, 21, 32). In one study, substance addicts stated that they had poor diet since they did not have enough money to buy food. Eleven % stole their food from supermarkets, and 4% retrieved leftover food from garbage bins (22). Sæland et al. (21) suggested that homelessness causes a deterioration in nutrition. This can be both the cause and the result of fatigue and diseases, as the individuals do not have access to food and other necessities, such as a suitable place to sleep and warm clothes. The comorbid diseases (e.g. HIV (+), hepatitis B and hepatitis C) which are common in these individuals are also recognized as an important factor in poor diet (41). Heavy smoking and mental illness are also causes of poor diet (42).

One of the most notable findings related to heroin users is the over-consumption of sugar and foods that contain sugar. Morabia et al. (13) found that the amount of sugar consumed by the addicts was significantly higher in males than in the healthy individuals in the control group. This rate was in the significance threshold in females. Himmelgreen et al. (9) determined that the consumption frequency of sweet-sugary foods was significantly higher in the addicts. Sæland et al. (22) stressed that 60% of the daily energy among the general population is derived from carbohydrates, and 30% of this consisted of sugar. Moreover, the rate of the individuals with substance use disorder who reported that they specifically preferred sugar added foods reached 61%, and more than 50% of the participants did not consume any other food, except for sugary beverages and bread or cereal for breakfast. Why do heroin users consume more sugar and/or sugary added foods? As is widely known, heroin is a semi-synthetic opiate. These types of illegal substances perform their activities via endogenous opioid systems which regulate many functions through three types of G-protein couple receptors, including Mu (μ), Delta (δ), and Kappa (κ) receptors. Heroin is a potential agonist for the Mu receptor (44). It is commonly believed that the activation of the opioid system which plays an important role in the neural rewarding process is the reason for the increased sugar consumption in individuals who use heroin. Of the opioid receptors, the mu-opioid system is specifically effective in the rewarding process. Preclinical animal studies have found that the direct activation of mu-receptor agonists (e.g. heroin, methadone, codeine) in the shell of the paraventricular nucleus, hypothalamus and nucleus accumbens is related to the development of sugar preference. It has been reported that chronic exposure to mu-opiate agonists leads to the preference of foods that include high amounts of sugar (43-47).

Marijuana is the illegal substance that is most commonly used throughout the world. It is made of

cannabis sativa. It provides its effect by Δ (9) (tetrahydrocannabinol - THC), which is a cannabinoid with a psycho-active effect that is included in the structure of this plant. The endocannabinoid receptors which are located in THC, hypothalamus and periphery tissues show their effect by interacting with type 1 (CB1) and type 2 (CB2) cannabinoid receptors. The CB1 cannabinoid receptor deals with the regulation of eating behavior, appetite and body weight. This receptor stimulates appetite and eating behavior (48, 49). Oral rimonabant, which is a new CB1 selective receptor antagonist, has been proved to decrease appetite and body weight (50). The results of the studies that were conducted with marijuana users confirm this information. Smit et al. (17) determined that daily intakes of energy increase in individuals in direct proportion with the frequency of their marijuana use. The energy intake of the group with the most amount of marijuana use was 41% more than those who did not use this substance at all (3,196±181kcal/day vs 2271±22 kcal/day). However, the BMI results are just the opposite. The BMI values of non-users of marijuana were included in the overweight group, while these values were in the upper limit of the normal weight in those who were heavy marijuana users. Rodondi et al. (19) found similar results in their study. In this study, the daily energy intake of those who use marijuana extensively was 22.5% more than those who did not use it. Yet, their BMI values were the same. Arcan et al. (51) reported that marijuana use had a positive correlation with the intake of high-fat foods. They believed that high intake of energy in marijuana users was related to the high consumption of high-energy snacks in these individuals. In addition, a relevant study which made a measurement based on dioxide consumption found that the basal metabolism of marijuana users showed an increase of 28% (17). This result might explain why marijuana users did not have higher BMIs than non-users, although they had higher intakes of energy. A study by Hayatbakhsh et al. contrasted these results. In a study conducted with adults, Hayatbakhsh et al. (52) determined that it is unlikely for marijuana users to be categorized in a BMI≥25 group, and that the possibility of having a low BMI increased in direct proportion with the frequency of marijuana use. In comparison with heroin users, marijuana users were mainly included in the overweight group, while heroin users were generally included in the bottom limits of thin and normal intervals.

Cocaine is a drug with a high potential for addiction. This is due to cocaine's strong reinforcing effect and short half-life, which leads to compulsive use (48). It has a pharmacological effect that prevents the formation of stimulation in peripheral nerves, as well as the transfer of this stimulation. This is the manner in which some of the local anesthetic qualities of cocaine are developed. Cocaine stimulates the central nervous system directly. This stimulation is achieved by preventing the retaining of catecholamine in nerve endings, and the retaining of dopamine in brain synapses. It has an effect on the serotonin as well. This situation leads to hyperactivity, an increase in energy, euphoria, decreased appetite, stereotypical movements and awareness. Cocaine users develop tolerance to medication in a very short time. Specifically, euphoria, decreased appetite, feeling good, and cardiovascular symptoms disappear in a short time. The symptoms that are tolerated as a result of chronic use are replaced by different symptoms, including dysphoria and depression. Cocaine is also related to cardiovascular pathology, such as left ventricular hypertrophy, sudden death and myocardial infarction (53, 54). Animal studies have also demonstrated that the anorexic effect of cocaine is relatively temporary, which supports these observations . In fact, food intake is not reduced but delayed, and this process is followed by the accompanying increase in fat and carbohydrate consumption. Paradoxically, an increase in body weight is usually related to the increase in fat intake, and the high amount of calories. However, this was not observed in the animals which were given cocaine. A similar observation was noted for human beings as well. Individuals who use cocaine regularly consume fewer balanced meals than their peers, and they have reported that they prefer food with high amounts of fat. However, this was not accompanied by an increase in body weight (References: The skinny cocaine, paragraph 2) (12, 55). Ershe et al. (12) found that 86% of cocaine addicts did not have the habit of eating breakfast, and their daily nutrition patterns were significantly different from those of their peers. The intake of energy, the consumptions of carbohydrates and foods with a high fat con-

tent were significantly higher in cocaine addicts than in other individuals. However, there was no difference between the groups regarding classical anthropometric measurements, including BMI, the ratio of waist and pelvis, and skinfold thickness. On the other hand, a Dual-Energy X-Ray Absorptiometry (DEXA) evaluation revealed that there were significant changes in the body composition of cocaine addicts. The amount of adipose tissue in these patients was significantly lower than that of their lean tissues. The sample taken from the CARDIA study revealed that lifelong substance use was not related to anthropometric measurements and physical activity, its effects on cardiovascular risk factors were temporary, and it did not show any long term effects (56)

Although cocaine addicts consume high-energy and high-fat foods, this consumption is not accompanied by an increase in body weight. It is widely believed that this situation is the result of the metabolic disorders that cocaine causes, as these disorders affect the regulation and storage of fat intake (57). Cocaine stimulates the dissemination of Cocaine and amphetamine regulated transcript (CART) with anorexia effect, and increases lipid oxidation and mobilization. CART causes this effect by reducing the lipoprotein lipase activity in adipose tissues, as well as the upregulation of uncoupling proteins. It stimulates the CART dissemination in leptin, such as arcuate nucleus in the brain. Cocaine modulates the hypothalamic–pituitary–adrenal axis (HPA) pathway; this pathway leads to the increase in the dissemination of glucocorticoid and adrenocorticotropic hormone (ACTH) in circulation. Glucocorticoids cause the alteration of homeostatic and non-homeostatic factors, together with the dietary intake of increased calories/fat in chronic cocaine users. Cocaine also increases noradrenergic signals which lead to thermogenesis and fast metabolism (58). Preclinical studies have found that the central administration of CART reduced food intake is short term (57). Poor diet habits, which are very common in individuals with substance use disorder, have caused problems in biochemical parameters. Morabia et al. (13) determined that 76% of substance users had hypovitaminosis, and specifically, they had low vitamin B6, vitamin B12 and folate levels. Similarly, Sæland et al. (24) found that 73% of the substance users that had high vitamin B12, vitamin B6 and folate levels, and 73% of the substance users that had an abscess infection, had a high level of homocystein, while this rate was 41% in the substance users who did not have an abscess infection. Vitamin B6, vitamin B12 and folic acid act as co-factors in homocystein methylation. An increase in the levels of these vitamins results in a decrease in homocystein levels. In addition, some lifestyle factors such as physical inactivity, smoking, and excessive intakes of alcohol and coffee might modulate plasma homocystein levels. Increased homocystein levels are related to a variety of medical conditions such as epilepsy, Parkinson's disease, dementia-cognitive disorder, atherosclerosis, myocardial infarction and depression (59-61). Studies have found that the levels of vitamin E, vitamin C, vitamin A, albumin, total protein and hemoglobin were low (17, 21, 27). This situation, which is created by poor eating habits, leads to malnutrition. Malnutrition is one of the leading causes of immune dysfunction (62). The combination of malnutrition and HIV infection, which is especially common in individuals who use drugs through injection, reduces the survival rate of the patients (9, 30, 63).

Many studies have shown that individuals who stop using substances gain significant amounts of weight during the recovery process. This can increase the rates of overweight and obese persons (33-37, 39.)

One of the main reasons for this weight gain is the high consumption of fast food by individuals undergoing treatment. This fast food, which contains high amounts of fat, can replace alcohol and substance use. Also, fast food is the primary preference of individuals because it is cheap. Excessive eating also plays a role in weight gain (35, 64, 65). The prevalence of poor diet within this population might be due to the lack of an environment in treatment centers that supports healthy eating habits. Other causes may be the lack of sufficient cooking skills, and a lack of education on good nutrition. Another reason is a reduction in physical activity. Individuals in treatment no longer need to walk a lot in order to find the substance they are abusing. This may enhance the passage to sedentary living (35). The adaptation to a social life during the treatment process is an additional factor that contributes to this sedentary lifestyle (37). Similar outcomes

were observed after treatment began for patients with certain psychiatric diseases who shared the problems of homelessness, poverty, and difficulty in securing food to eat. Schizophrenia patients who did not have a normal domestic life, and who did not receive any environmental support, were observed to undergo significant body weight gains when they were hospitalized and treated (66). Another cause attributed to body weight increase is pharmacological treatment. Methadone, which is an antagonist of opiate, is one of the most commonly used drugs in treatment, and it plays a major role in decreasing morbidity and mortality rates in these individuals (39). However, studies have demonstrated that individuals gain 1.84 kg to 12.7 kg during the process of methadone treatment (36, 37). Methadone is a strong antagonist of the mu receptor, and the activation of mu receptors is related to: 1) the increased preference of sweets, 2) hyperglycemia due to the direct activation on pancreatic islet cells, and 3) the development of insulin resistance caused by the preference of sugary foods. The preference for sweets and an increase in the consumption of desserts and other sugary foods leads to an increase in body weight (47). It has been reported that methadone causes a considerable decrease in testosterone levels in men (67). Apparently, decreased testosterone level is related to the weakening of muscles and increased adiposity (68). The researchers believe that the current model used for the treatment of substance addicts is not sufficient to achieve the desired level of success, and it is necessary to employ different modes of treatment. Studies have proved the effectiveness of behavioral modification techniques that are used in therapy centers in order to prevent these common problems that could emerge (69-71). Cowan et al. (69) provided training in healthy nutrition and cooking to patients being treated for cocaine, heroin and alcohol addiction in therapy centers. A comparison of food intake before and after training revealed that there was an important increase in the amount of vegetables and fruit that individuals consumed daily, and there was an important decrease in the percentage of daily energy that was derived from sugar and sugar added foods. There was also a decrease in the waist circumference measurements of the individuals.

Conclusion

Substance addiction is a serious problem that has a negative effect on all factors of human health. There are several types of addictive substances with varied pharmacological qualities which cause a wide range of nutritional problems, from malnutrition to obesity. These problems increase the risk of comorbid diseases. Their combination with other diseases more commonly seen in substance users leads to an increase in the rate of mortality. The studies that were included in this review revealed the important information that the nutritional status of substance addicts is very poor. Thus, the primary aim should be to organize wide-scale educational programs to prevent substance use, including informing children and adolescents about the dangers and risks of substance use. The nutritional status of the individuals that are undergoing treatment should definitely be examined using suitable evaluation tools (e.g. Subjective Global Assessment, Nutritional Risk Score 2002, anthropometric measurements, biochemical findings). Personal nutrition education programs should be provided to individuals, in addition to pharmacological treatment. Studies have shown that well-designed nutrition programs, along with behavioral modification techniques provided in therapy centers, are quite effective (69-71). For this reason, it is necessary to create nutrition programs that are specific to this patient group. These programs should be made an integral part of medical treatment after being standardized. This systematic literature review found that the studies that have been conducted so far are not sufficient, and there is need for studies that are designed better in methodological terms.

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