ORIGINAL ARTICLE

A Behavioral Weight-Loss Intervention in Persons with Serious Mental Illness

Gail L. Daumit, M.D., M.H.S., Faith B. Dickerson, Ph.D., M.P.H., Nae-Yuh Wang, Ph.D., Arlene Dalcin, R.D., Gerald J. Jerome, Ph.D., Cheryl A.M. Anderson, Ph.D., Deborah R. Young, Ph.D., Kevin D. Frick, Ph.D., Airong Yu, M.S., Joseph V. Gennusa III, Ph.D., R.D., L.D.N., Meghan Oefinger, B.S., Rosa M. Crum, M.D., M.H.S., Jeanne Charleston, R.N., Sarah S. Casagrande, Ph.D., Eliseo Guallar, M.D., Dr.P.H., M.P.H., Richard W. Goldberg, Ph.D., Leslie M. Campbell, B.A., and Lawrence J. Appel, M.D., M.P.H.

ABSTRACT

BACKGROUND

Overweight and obesity are epidemic among persons with serious mental illness, yet weight-loss trials systematically exclude this vulnerable population. Lifestyle interventions require adaptation in this group because psychiatric symptoms and cognitive impairment are highly prevalent. Our objective was to determine the effectiveness of an 18-month tailored behavioral weight-loss intervention in adults with serious mental illness.

METHODS

We recruited overweight or obese adults from 10 community psychiatric rehabilitation outpatient programs and randomly assigned them to an intervention or a control group. Participants in the intervention group received tailored group and individual weight-management sessions and group exercise sessions. Weight change was assessed at 6, 12, and 18 months.

RESULTS

Of 291 participants who underwent randomization, 58.1% had schizophrenia or a schizoaffective disorder, 22.0% had bipolar disorder, and 12.0% had major depression. At baseline, the mean body-mass index (the weight in kilograms divided by the square of the height in meters) was 36.3, and the mean weight was 102.7 kg (225.9 lb). Data on weight at 18 months were obtained from 279 participants. Weight loss in the intervention group increased progressively over the 18-month study period and differed significantly from the control group at each follow-up visit. At 18 months, the mean between-group difference in weight (change in intervention group minus change in control group) was −3.2 kg (−7.0 lb, P=0.002); 37.8% of the participants in the intervention group lost 5% or more of their initial weight, as compared with 22.7% of those in the control group (P=0.009). There were no significant between-group differences in adverse events.

CONCLUSIONS

A behavioral weight-loss intervention significantly reduced weight over a period of 18 months in overweight and obese adults with serious mental illness. Given the epidemic of obesity and weight-related disease among persons with serious mental illness, our findings support implementation of targeted behavioral weight-loss interventions in this high-risk population. (Funded by the National Institute of Mental Health; ACHIEVE ClinicalTrials.gov number, NCT00902694.)

From the Welch Center for Prevention, Epidemiology, and Clinical Research, Johns Hopkins University (G.L.D., N.-Y.W., R.M.C., J.C., E.G., L.J.A.), Division of General Internal Medicine (G.L.D., N.-Y.W., A.D., G.J.J., A.Y., J.V.G., M.O., J.C., L.M.C., L.J.A.) and Department of Psychiatry (G.L.D., R.M.C.), Johns Hopkins University School of Medicine, Departments of Epidemiology (G.L.D., R.M.C., E.G., L.J.A.), Health Policy and Management (G.L.D., K.D.F.), Mental Health (G.L.D., R.M.C.), and Biostatistics (N.-Y.W.), Johns Hopkins Bloomberg School of Public Health, Department of Veterans Affairs Capitol Health Care Network (VISN 5) Mental Illness, Education, and Clinical Research Center (R.W.G.), and Department of Psychiatry, University of Maryland School of Medicine (R.W.G.), Baltimore; Sheppard Pratt Health System (F.B.D.), and Department of Kinesiology, Towson University (G.J.J.), Towson; and Social and Scientific Systems (S.S.C.), Silver Spring — all in Maryland; Division of Preventive Medicine, Department of Family and Preventive Medicine, University of California, San Diego, La Jolla (C.A.M.A.); Department of Research and Evaluation, Kaiser Permanente Southern California, Pasadena (D.R.Y.); and the National Center for Cardiovascular Research, Madrid (E.G.). Address reprint requests to Dr. Daumit at Johns Hopkins Medical Institutions, 2024 E. Monument St., Baltimore, MD 21287, or at gdaumit@jhmi.edu.

This article was published on March 21, 2013, at NEJM.org.

N Engl J Med 2013;368:1594-602.
DOI: 10.1056/NEJMoa1214530
Copyright © 2013 Massachusetts Medical Society.

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

Persons with serious mental illness, such as schizophrenia, bipolar disorder, and major depression, have mortality rates that are two to more than three times as high as the rate in the overall population, and the primary cause of death in such persons is cardiovascular disease.[1-4] Concomitantly, this vulnerable population has an extremely high prevalence of obesity, nearly twice that of the overall population.[5-9] Therefore, it is not surprising that persons with serious mental illness have an increased burden of weight-related conditions, including heightened risk of diabetes mellitus, hypertension, dyslipidemia, and certain cancers.[10-15]

Obesity is multifactorial in persons with serious mental illness. Physical inactivity and unhealthy diets are commonplace.[16-18] In addition, many psychotropic medications, often required for long-term symptom control, cause weight gain, in part through increased appetite and the resultant high caloric intake.[19-22] Hence, lifestyle interventions to modify diet and activity should have a central role in stemming the epidemic of obesity and obesity-related conditions[23-25] in this group.

Yet persons with serious mental illness, particularly schizophrenia, often have impairments in memory and executive function, as well as residual psychiatric symptoms, that impede learning and adoption of new behaviors.[26] Furthermore, low socioeconomic status probably contributes to reduced access to healthy foods and lack of affordable, safe places to exercise.[17,27,28] Stigma associated with mental illness may also contribute to low levels of participation in mainstream leisure-time physical activities.[29,30]

Lifestyle interventions for overweight or obese persons with serious mental illness must address these special needs. Owing to concerns about adherence and ability to participate in groups, lifestyle-intervention trials in the general population typically exclude persons with serious mental illness.[24,31-36] The few behavioral weight-loss trials targeting persons with serious mental illness have had short study periods, small samples, and other limitations.[37,38] The purpose of our trial was to determine the effectiveness of an 18-month tailored behavioral weight-loss intervention in adults with serious mental illness who were attending community outpatient psychiatric rehabilitation programs.

METHODS

STUDY OVERSIGHT

Institutional review boards at Johns Hopkins University and Sheppard Pratt Health System and an independent data and safety monitoring board approved the protocol for the Randomized Trial of Achieving Healthy Lifestyles in Psychiatric Rehabilitation (ACHIEVE). All participants provided written informed consent. The first author designed the study, wrote the manuscript, and vouches for the accuracy of the data and analyses. The study was conducted according to the study protocol (available with the full text of this article at NEJM.org). No commercial weight-loss entity was associated with this study.

SETTING AND STUDY POPULATION

We placed the trial in outpatient psychiatric rehabilitation programs, settings that provide potentially unrealized opportunities to deliver lifestyle interventions. These programs serve large numbers of persons with serious mental illness and offer vocational and skills training, case management, and other services. Programs typically have commercial kitchens and communal space that can be used for multiple functions, including group exercise. Program enrollees often attend these programs multiple times each week, which facilitates the delivery of lifestyle interventions that involve frequent contact.

The study population consisted of overweight or obese adults (≥18 years of age) who attended 1 of 10 community psychiatric rehabilitation programs in central Maryland or their affiliated outpatient mental health clinics. The eligibility criteria were minimal; we aimed to enroll a broad population that would be representative of persons with serious mental illness attending community mental health programs.[39] We excluded persons with a medical contraindication to weight loss, a cardiovascular event within the previous 6 months, an inability to walk, or an active alcohol-use or substance-use disorder (see the Supplementary Appendix, available at NEJM.org).

Participants were enrolled between January 2009 and February 2011. Study staff recruited participants by means of presentations at study sites and received referrals from rehabilitation-program staff.

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

Individual participants were randomly assigned to the intervention or control group. Randomization was stratified according to sex and study site; assignments were generated in blocks of two and four. Data collectors were unaware of the study assignments.

Rehabilitation programs routinely provided breakfast and lunch to all program attendees. To facilitate the availability of reduced-calorie food choices for participants in the intervention group, we advised kitchen staff on offering healthier meals at the programs (see the Supplementary Appendix).

INTERVENTION GROUP

The conceptual framework of the intervention incorporated social cognitive and behavioral self-management theories and was congruent with psychiatric rehabilitation principles of skill building and environmental supports.[40-42] The intervention built on lifestyle interventions that studies have shown to be effective in the general population.[32,36] In addition, it was tailored to address deficits in memory and executive function (e.g., by dividing information into small components and targeting skills repeatedly).[43,44]

The intervention was composed of three contact types: group weight-management sessions, individual weight-management sessions, and group exercise sessions. The goals for the intervention group included the following: reducing caloric intake by avoiding sugar-sweetened beverages and junk food (e.g., candy and high-fat snacks), eating five total servings of fruits and vegetables daily, choosing smaller portions and healthy snacks, and participating in moderate-intensity aerobic exercise (see the Supplementary Appendix).

Group exercise started at a level appropriate for sedentary persons, with gradual increases in duration and intensity.[45] Trained members of the study staff led all exercise classes for the first 6 months. Subsequently, a trained member of the rehabilitation-program staff offered some exercise sessions using a video specifically prepared for this trial.

To reinforce the intervention goals, we asked participants to monitor key behaviors with the use of a simplified tracking tool and to meet with intervention staff to monitor their weight. Session attendance was incentivized with points that participants traded for small reward items.

Standardized procedures and materials promoted fidelity of the study staff to the intervention. Ongoing training and quality assurance included regular observation of intervention staff.

CONTROL GROUP

Participants in the control group received standard nutrition and physical-activity information at baseline. Health classes were offered quarterly, with content unrelated to weight (e.g., cancer screening).

DATA COLLECTION

Data collectors visited the rehabilitation programs to determine study eligibility, to collect baseline data, and to perform follow-up assessments at 6, 12, and 18 months. Height was measured at study entry. At each visit, weight was measured with the use of a high-quality, calibrated digital scale, with the participant wearing indoor clothing and no shoes. Measurements of blood pressure, waist circumference, and fasting blood chemical levels were obtained at baseline and at 6 and 18 months. Information on sociodemographic characteristics and medications were obtained from participant self-reports and program records; psychiatric diagnoses were abstracted from program records.

STATISTICAL ANALYSIS

Analyses were conducted according to the intention-to-treat principle. Primary outcomes were changes in weight from randomization to 6 months and 18 months. Other weight-related outcomes included percentage of weight change from baseline, percentage of participants at or below baseline weight, percentages of participants who lost at least 5% of their initial weight and those who lost at least 10%, and change from baseline in body-mass index (BMI; the weight in kilograms divided by square of height in meters). Weight data obtained within a 45-day window before or after the data-collection points and data obtained before a protocol-defined censoring event (e.g., pregnancy) were included in the primary analysis, which was conducted with the use of a likelihood-based mixed-effects model, with weight as a function of study-group assignment and study visit (at baseline and at 6, 12, and 18 months) and with missing data treated as missing at random. The model was adjusted for study site and sex. An unstructured covariance structure was used to relate repeated measures, with the use of robust standard errors for statistical inferences.

The same modeling approach was applied to

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

the change in BMI and to the percentage of weight change, with log-transformed weights used as outcome values. Percentages of participants in the two groups who met various weight-loss criteria were compared with the use of chi-square tests. Sensitivity analyses were performed by including weight data collected outside the data-collection window and were also conducted with adjustment for number of psychotropic medications.

The original enrollment target was 320 participants. The initial study design assumed a 20% loss to follow-up, resulting in an effective sample size of 256. This study design provided 86% power to detect a between-group difference in weight change of 2.0 kg (4.5 lb) at 18 months.

RESULTS

STUDY PARTICIPANTS

A total of 417 persons provided written informed consent for screening in the trial; of these, 291 underwent randomization (Fig. 1). The mean age was 45.3 years; 49.8% of the participants were men, and 38.1% were black (Table 1). More than half the participants lived in supported housing, and almost 80% were unable to work. A total of 58.1% of the participants had schizophrenia or a schizoaffective disorder, 22.0% had bipolar disorder, and 12.0% had major depression. The mean number of psychotropic medications was 3.1. On average, there were 29 participants per study site (range, 18 to 45). Follow-up weights were obtained from 279 participants, out of 280 for whom data were not censored at 18 months. At follow-up visits, 93.3% of the participants had their weight measured within the data-collection windows.

WEIGHT LOSS

As compared with the control group, the mean net weight loss in the intervention group increased progressively over the 18-month study period. At 6 months, the mean change in weight from baseline was −0.3 kg (95% confidence interval [CI], −1.0 to 0.5 [−0.6 lb; 95% CI, −2.3 to 1.1]) in the control group and −1.8 kg (95% CI, −2.5 to −1.0 [−4.0 lb; 95% CI, −5.6 to −2.3]) in the intervention group. At 18 months, the mean change in weight from baseline was −0.2 kg (95% CI, −1.7 to 1.3 [−0.5 lb; 95% CI, −3.7 to 2.8]) in the control group and −3.4 kg (95% CI, −4.7 to −2.1 [−7.5 lb; 95% CI, −10.3 to −4.7]) in the intervention group (Fig. 2, and Table S2 in the Supplementary Appendix).

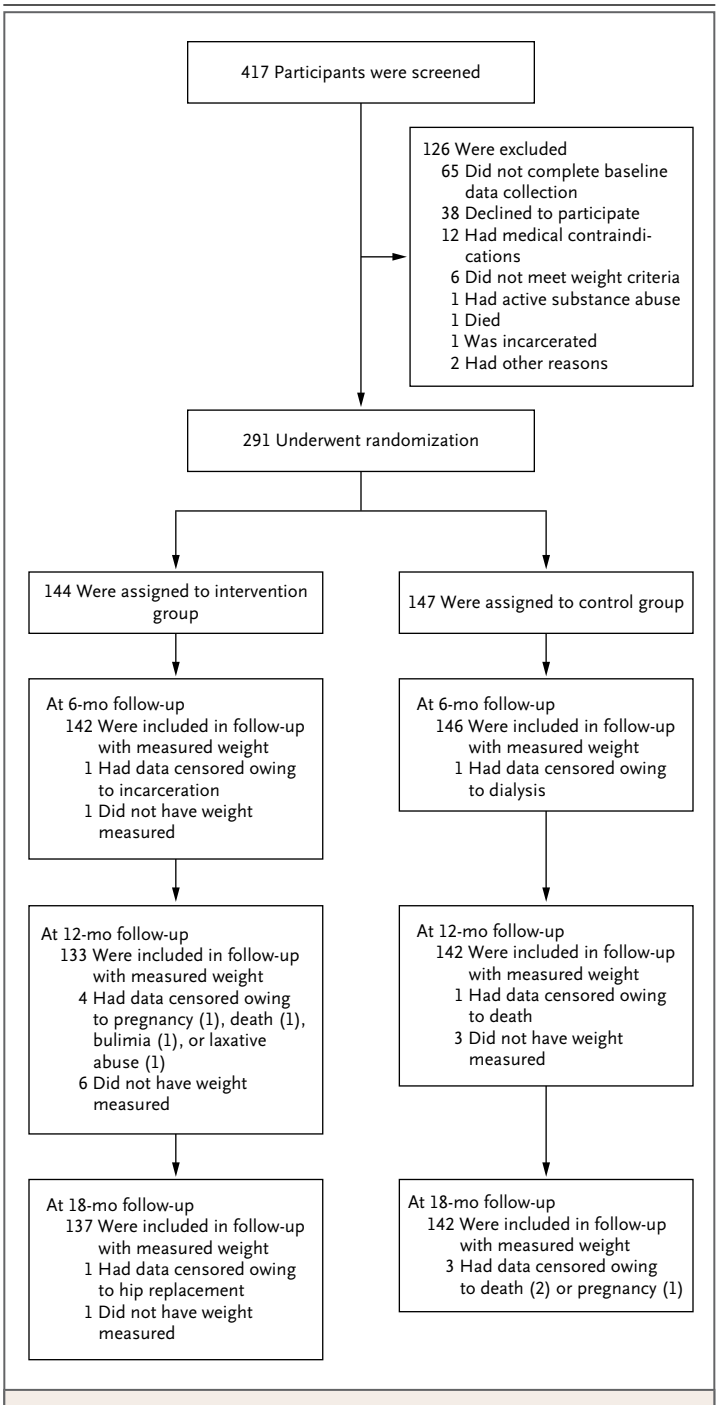


Figure 1. Screening, Randomization, and Follow-up of Study Participants.
Participants who had data censored at an earlier follow-up visit were excluded from analyses of later follow-up visits. Primary outcomes included the 6-month and 18-month follow-up visits but not the 12-month visit.

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

Table 1. Baseline Characteristics of the Study Participants.*

Characteristic	Total (N=291)	Intervention Group (N=144)	Control Group (N=147)
Age — yr	45.3±11.3	46.6±11.5	44.1±11.0
Male sex — no. (%)	145 (49.8)	70 (48.6)	75 (51.0)
Weight — kg†	102.7±21.1	101.3±21.5	104.0±20.7
Body-mass index‡	36.3±7.3	36.0±7.2	36.5±7.3
Race — no. (%)§			
White	163 (56.0)	82 (56.9)	81 (55.1)
Black	111 (38.1)	52 (36.1)	59 (40.1)
Other	17 (5.8)	10 (6.9)	7 (4.8)
Hispanic ethnic group — no. (%)§	13 (4.5)	5 (3.5)	8 (5.4)
Not a high-school graduate — no. (%)	87 (29.9)	45 (31.2)	42 (28.6)
Never married — no. (%)	216 (74.2)	104 (72.2)	112 (76.2)
Lives in residential program or with care provider — no. (%)	159 (54.6)	72 (50.0)	87 (59.2)
Unable to work — no. (%)	229 (78.7)	112 (77.8)	117 (79.6)
Health insurance — no. (%)			
Medicaid	240 (82.5)	122 (84.7)	118 (80.3)
Medicare	146 (50.2)	70 (48.6)	76 (51.7)
Psychiatric diagnosis — no. (%)			
Schizophrenia	85 (29.2)	44 (30.6)	41 (27.9)
Schizoaffective disorder	84 (28.9)	41 (28.5)	43 (29.3)
Bipolar disorder	64 (22.0)	28 (19.4)	36 (24.5)
Major depression	35 (12.0)	18 (12.5)	17 (11.6)
Other	23 (7.9)	13 (9.0)	10 (6.8)
History of alcohol or other substance abuse — no. (%)	150 (51.5)	76 (52.8)	74 (50.3)
No. of psychotropic medications	3.1±1.5	2.8±1.3	3.3±1.6
Any antipsychotic medication — no. (%)	261 (89.7)	130 (90.3)	131 (89.1)
Atypical antipsychotic medication — no. (%)¶	241 (82.8)	119 (82.6)	122 (83.0)
Clozapine or olanzapine — no. (%)	65 (22.3)	35 (24.3)	30 (20.4)
Lithium or other mood stabilizer — no. (%)	132 (45.4)	60 (41.7)	72 (49.0)
Antidepressant medication — no. (%)	175 (60.1)	84 (58.3)	91 (61.9)
Psychiatric measures			
BASIS-24 score‖	1.12±0.61	1.10±0.61	1.15±0.60
CES-D score**	19.9±11.2	19.7±11.3	20.1±11.2
RBANS score††	69.6±14.5	70.7±13.7	68.4±15.1

* Plus–minus values are means ±SD. There were no significant between-group differences in the baseline characteristics, except for mean number of psychotropic medications (P=0.006 by the two-sample t-test).

† To convert values for weight to pounds, multiply by 2.2.

‡ The body-mass index is the weight in kilograms divided by the square of the height in meters.

§ Race and ethnic group were self-reported. Other races included Asian and American Indian.

¶ Atypical antipsychotic medication included clozapine, olanzapine, aripiprazole, risperidone, paliperidone, quetiapine, ziprasidone, and asenapine. However, not all possible atypical antipsychotic medications were represented in the participants.

‖ Overall summary scores on the Behavior and Symptom Identification Scale (BASIS-24) range from 0 to 4, with higher scores indicating greater severity of symptoms.[46]

** Scores on the Center for Epidemiologic Studies Depression Scale (CES-D) range from 0 to 60, with higher scores indicating more depressive symptoms; a score of 16 points is considered to be a cutoff point for depression.[47]

†† Data were missing for 16 participants in the intervention group and 16 in the control group. Total scores on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) range from 40 to 160, with higher scores indicating better cognitive functioning. Published mean scores are 70 for patients with schizophrenia and 85 for those with bipolar disorder; a nonpsychiatric sample had a mean score of 95.[48]

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

The mean net weight change (change in weight in the intervention group minus change in weight in the control group) at 6 months was −1.5 kg (95% CI, −2.6 to −0.4 [−3.3 lb; 95% CI, −5.7 to −0.9]). At 18 months, the net change was −3.2 kg (95% CI, −5.1 to −1.2 [−7.0 lb; 95% CI, −11.3 to −2.7]). These absolute differences in weight correspond to a percentage weight change of −1.7 percentage points (95% CI, −2.7 to −0.5) in favor of the intervention group at 6 months and −3.4 percentage points (95% CI, −5.4 to −1.4) at 18 months (see the Supplementary Appendix).

Table 2 displays the percentages of participants meeting certain weight-loss thresholds at 6, 12, and 18 months after randomization. Among participants in the intervention group, 63.9% had a weight at 18 months that was at or lower than their baseline weight, as compared with 49.2% of those in the control group. The percentage of participants who lost at least 5% of their baseline weight was 37.8% in the intervention group, as compared with 22.7% in the control group. At 18 months, the net difference in change in BMI for participants in the intervention group, as compared with those in the control group, was −1.1 (95% CI, −1.8 to −0.5) (see the Supplementary Appendix).

In sensitivity analyses, the findings were robust. An analysis that included weights obtained outside the data-collection windows had results that were consistent with those of the primary analysis (see the Supplementary Appendix), as did an analysis with adjustment for the number of psychotropic medications. Results for adiposity-related outcomes, including cardiovascular risk factors, are provided in the Supplementary Appendix.

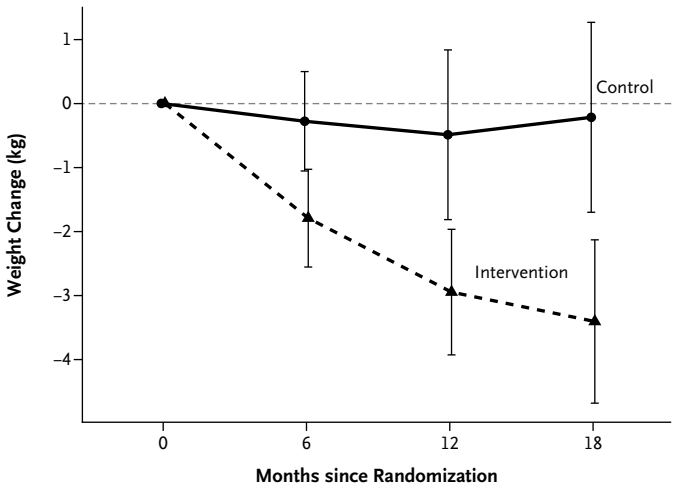


Figure 2. Mean Weight Change, According to Study Group.

The model-based estimates of the mean difference in changes in weight (the change in the intervention group minus the change in the control group) between the two groups at 6, 12, and 18 months were −1.5 kg (95% CI, −2.6 to −0.4; P=0.007), −2.5 kg (95% CI, −4.1 to −0.8; P=0.004), and −3.2 kg (95% CI, −5.1 to −1.2; P=0.002), respectively. To convert values for weight to pounds, multiply by 2.2.

INTERVENTION PARTICIPATION

Table 3 displays data on the numbers of group and individual weight-management sessions and group exercise sessions that were offered to and attended by participants in the intervention group. The median number of total attended sessions was 46 in the first 6 months and 31 in months 7 through 18. Attendance at the group exercise sessions contributed most to the total number of contacts.

Although the proportion of attended sessions, as compared with offered sessions, was lower after the first 6 months, the median number of contacts in the intervention group was approximately 2.5 per month. The percentage of participants in the intervention group who were absent from the rehabilitation program for 30 or more consecutive days was 27.3% during the first 6 months and 51.5% during months 7 through 18.

ADVERSE EVENTS

There were two deaths in the intervention group and three in the control group (see the Supplementary Appendix). A total of six cardiovascular events occurred in the intervention group, and eight occurred in the control group. No events were deemed to be probably or definitely study-related. At data-collection visits, 18.3% of the participants in the intervention group and 13.0% of those in the control group reported a medical hospitalization, and 14.8% of the participants in the intervention group and 20.6% of those in the control group reported a psychiatric hospitalization.

DISCUSSION

In overweight and obese adults with serious mental illness who were participating in psychiatric rehabilitation programs, a behavioral weight-loss intervention incorporating weight-management counseling and group exercise significantly reduced participant weight over a period of 18 months. In contrast to the findings in most

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

Table 2. Weight-Loss Outcomes at 6, 12, and 18 Months.*

Outcome	Intervention Group	Control Group	P Value
	percent		
At or below baseline weight			
6 mo	62.6	51.1	0.05
12 mo	73.0	53.4	0.001
18 mo	63.9	49.2	0.02
≥5% below baseline weight			
6 mo	19.4	10.6	0.04
12 mo	32.5	24.1	0.13
18 mo	37.8	22.7	0.009
≥10% below baseline weight			
6 mo	5.0	2.1	0.19
12 mo	9.5	5.3	0.19
18 mo	18.5	7.0	0.007

* The analysis of weight-loss outcomes at each time point was based on all available data.

Table 3. Offered and Attended Sessions for the Intervention Group.

Session Type	Months 1–6		Months 7–18	
	Offered	Attended	Offered	Attended
	number			
Group weight-management session				
Median	16	10	13	7
Interquartile range	15–17	3–13	12–14	3–10
Individual weight-management session				
Median	5	4	12	4
Interquartile range	5–5	3–5	11–13	1–9
Group exercise session				
Median	61	30	141	24
Interquartile range	58–67	12–46	135–148	2–76
All sessions				
Median	82	46	164	31
Interquartile range	77–90	19–63	158–173	10–92

studies of lifestyle intervention in the general population,[24,32,34,36,49] weight loss did not peak early in the intervention group in this study population but instead progressed over the course of the trial. This finding suggests that despite substantial challenges, persons with serious mental illness are able to lose weight with a tailored intervention.

The amount of weight loss achieved in our trial — namely, a mean of 3.2 kg (7.0 lb) at 18 months — compares favorably with weight loss in lifestyle-intervention trials in the general population. This extent of weight loss, albeit modest, has been shown to have beneficial effects, such as a reduced risk of cardiovascular disease among persons with an initially elevated risk.[23-25] However, the pattern of weight loss over time was distinct. The net weight loss at 18 months was 2.7 kg (6.0 lb) in Trials of Hypertension Prevention Phase II and PREMIER and 3.6 kg (8.0 lb) in the Trial of Nonpharmacologic Interventions in the Elderly.[24,32,36] In these trials and others,[24,32,34,36,49] weight loss was typically maximal at 6 months, with weight regained thereafter. In contrast, participants in the intervention group in ACHIEVE continued to lose weight after 6 months and did not regain weight, even with a reduced frequency of weight-management contact sessions and with rehabilitation staff assuming responsibility for some exercise classes. One possible explanation is that persons with serious mental illness take longer than those without serious mental illness to engage in an intervention and make requisite behavioral changes.

To date, few randomized trials of behavioral weight-loss interventions in persons with serious mental illness have been published, and all were short-term.[37,38,50-52] A 2007 Cochrane review on weight loss in patients with schizophrenia identified five nonpharmacologic studies, none with a study period of more than 4 months.[38] A trial involving 53 Taiwanese psychiatric inpatients that controlled caloric intake and offered group physical activity showed a mean weight loss of 5.2 kg (11.5 lb) at 6 months.[53] Another trial in China that involved persons with new-onset schizophrenia with weight gain after the initiation of antipsychotic medication showed a net mean weight loss of 4.5 kg (9.9 lb) with a 3-month intervention.[54] Most of the other studies were uncontrolled, and many had small samples.[37,50,52]

An important feature of our trial is the setting — namely, psychiatric rehabilitation programs. Although not all persons with serious mental illness attend these types of programs, they are often affiliated with outpatient clinics and therefore could serve as a hub for this or similar lifestyle interventions. We recognize that incorporating lifestyle interventions into rehabilitation programs

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

or placing such programs in other mental health settings would require financial and organizational resources.

This trial has several strengths. First, we enrolled a diverse population of patients with serious mental illnesses from multiple community-based programs. We enrolled persons with a range of psychiatric diagnoses and did not require that patients be receiving treatment with a specific psychotropic regimen. In fact, the use of psychotropic medications that lead to weight gain[19-22] was commonplace. A large proportion of participants had substantial psychiatric symptoms, as evidenced by baseline scores on the Behavior and Symptom Identification Scale,[46] the Center for Epidemiologic Studies Depression Scale,[47] and the Repeatable Battery for the Assessment of Neuropsychological Status.[48] Despite psychotropic-medication use and ongoing psychiatric symptoms, participants in the intervention group had significant weight loss. Second, throughout the trial, we attained high follow-up rates for outcome data. Very few missing data and high correlations between weight measures allowed for robust statistical inferences (see the Supplementary Appendix). Third, the intervention was offered over a period of 18 months, in contrast to the short-term interventions in previous randomized trials of behavioral weight-loss interventions in this population.

Our trial has limitations. Over the course of the study, attendance at the intervention sessions and rehabilitation programs decreased; reasons included hospitalizations and social issues. However, the large number of offered contact opportunities allowed for continued exposure to the intervention sessions, even for persons with infrequent attendance. Thus, the trial reflects actual attendance patterns of persons with serious mental illness, who often have competing intercurrent issues.[26] Second, the trial was not designed or powered to determine the effects of weight reduction on cardiovascular risk factors in this population. Hence, nonsignificant changes in blood pressure and fasting lipid and glucose levels (see the Supplementary Appendix) should be interpreted cautiously. Third, the trial was not designed to influence the prescribing of medication. In clinical practice, the consideration of psychotropic medications with less obesogenic potential for appropriate patients may help them reach weight goals. Fourth, our efforts to provide healthy meal options were available to all participants in the rehabilitation programs. This may have influenced weight in the control group. If so, the trial results are conservative.

In conclusion, our results show that overweight and obese adults with serious mental illness can make substantial lifestyle changes despite the myriad challenges they face. Given the epidemic of obesity and weight-related disease among persons with serious mental illness, our findings support implementation of targeted behavioral weight-loss interventions in this high-risk population.

Supported by the National Institute of Mental Health.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

REFERENCES

1. Colton CP, Manderscheid RW. Congruencies in increased mortality rates, years of potential life lost, and causes of death among public mental health clients in eight states. Prev Chronic Dis 2006; 3:A42.
2. Daumit GL, Anthony CB, Ford DE, et al. Pattern of mortality in a sample of Maryland residents with severe mental illness. Psychiatry Res 2010;176:242-5.
3. Druss BG, Zhao L, Von Esenwein S, Morrato EH, Marcus SC. Understanding excess mortality in persons with mental illness: 17-year follow up of a nationally representative US survey. Med Care 2011; 49:599-604.
4. Saha S, Chant D, McGrath J. A systematic review of mortality in schizophrenia: is the differential mortality gap worsening over time? Arch Gen Psychiatry 2007; 64:1123-31.
5. Allison DB, Newcomer JW, Dunn AL, et al. Obesity among those with mental disorders: a National Institute of Mental Health meeting report. Am J Prev Med 2009;36:341-50.
6. Coodin S. Body mass index in persons with schizophrenia. Can J Psychiatry 2001;46:549-55.
7. Daumit GL, Clark JM, Steinwachs DM, Graham CM, Lehman A, Ford DE. Prevalence and correlates of obesity in a community sample of individuals with severe and persistent mental illness. J Nerv Ment Dis 2003;191:799-805.
8. Dickerson FB, Brown CH, Kreyenbuhl JA, et al. Obesity among individuals with serious mental illness. Acta Psychiatr Scand 2006;113:306-13.
9. McElroy SL. Correlates of overweight and obesity in 644 patients with bipolar disorder. J Clin Psychiatry 2002;63:207-13.
10. Bresee LC, Majumdar SR, Patten SB, Johnson JA. Prevalence of cardiovascular risk factors and disease in people with schizophrenia: a population-based study. Schizophr Res 2010;117:75-82.
11. Carney CP, Jones L, Woolson RF. Medical comorbidity in women and men with schizophrenia: a population-based controlled study. J Gen Intern Med 2006;21:1133-7.
12. Carney CP, Jones LE. Medical comorbidity in women and men with bipolar disorders: a population-based controlled study. Psychosom Med 2006;68:684-91.
13. Himelhoch S, Lehman A, Kreyenbuhl J, Daumit G, Brown C, Dixon L. Prevalence of chronic obstructive pulmonary disease among those with serious mental illness. Am J Psychiatry 2004;161:2317-9.
14. McEvoy JP, Meyer JM, Goff DC, et al. Prevalence of the metabolic syndrome in

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.

patients with schizophrenia: baseline results from the Clinical Antipsychotic Trials of Intervention Effectiveness (CATIE) schizophrenia trial and comparison with national estimates from NHANES III. Schizophr Res 2005;80:19-32.
15. McGinty EE, Zhang Y, Guallar E, et al. Cancer incidence in a sample of Maryland residents with serious mental illness. Psychiatr Serv 2012;63:714-7.
16. Daumit GL, Goldberg RW, Anthony C, et al. Physical activity patterns in adults with severe mental illness. J Nerv Ment Dis 2005;193:641-6.
17. Dipasquale S, Pariante CM, Dazzan P, Aguglia E, McGuire P, Mondelli V. The dietary patterns of patients with schizophrenia: a systematic review. J Psychiatr Res 2013;47:197-207.
18. Jerome GJ, Young DR, Dalcin A, et al. Physical activity levels of persons with mental illness attending psychiatric rehabilitation programs. Schizophr Res 2009; 108:252-7.
19. Depression Guideline Panel. Depression in primary care. Vol. 2. Rockville, MD: Agency for Health Care Policy and Research, 1993. (AHCPR publication no. 93-0551.)
20. Allison DB, Mentore JL, Heo M, et al. Antipsychotic-induced weight gain: a comprehensive research synthesis. Am J Psychiatry 1999;156:1686-96.
21. Lieberman JA, Stroup TS, McEvoy JP, et al. Effectiveness of antipsychotic drugs in patients with chronic schizophrenia. N Engl J Med 2005;353:1209-23. [Erratum, N Engl J Med 2010;363:1092-3.]
22. Macritchie KAN, Geddes JR, Scott J, Haslam DRS, Goodwin GM. Valproic acid, valproate and divalproex in the maintenance treatment of bipolar disorder. Cochrane Database Syst Rev 2001;3: CD003196.
23. Stamler R, Stamler J, Gosch FC, et al. Primary prevention of hypertension by nutritional-hygienic means: final report of a randomized, controlled trial. JAMA 1989;262:1801-7. [Erratum, JAMA 1989; 262:3132.]
24. Stevens VJ, Obarzanek E, Cook NR, et al. Long-term weight loss and changes in blood pressure: results of the Trials of Hypertension Prevention, phase II. Ann Intern Med 2001;134:1-11.
25. Tuomilehto J, Lindström J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001;344:1343-50.
26. Mueser KT, McGurk SR. Schizophrenia. Lancet 2004;363:2063-72.
27. Agerbo E, Byrne M, Eaton WW, Mortensen PB. Marital and labor market status in the long run in schizophrenia. Arch Gen Psychiatry 2004;61:28-33.
28. Hudson CG. Socioeconomic status and mental illness: tests of the social causation and selection hypotheses. Am J Orthopsychiatry 2005;75:3-18.
29. Hinshaw S. The mark of shame: stigma of mental illness and an agenda for change. New York: Oxford University Press, 2007.
30. Thornicroft G, Brohan E, Rose D, Sartorius N, Leese M. Global pattern of experienced and anticipated discrimination against people with schizophrenia: a cross-sectional survey. Lancet 2009;373: 408-15.
31. Appel LJ, Clark JM, Yeh HC, et al. Comparative effectiveness of weight-loss interventions in clinical practice. N Engl J Med 2011;365:1959-68.
32. Elmer PJ, Obarzanek E, Vollmer WM, et al. Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18-month results of a randomized trial. Ann Intern Med 2006;144:485-95.
33. Hollis JF, Gullion CM, Stevens VJ, et al. Weight loss during the intensive intervention phase of the Weight Loss Maintenance trial. Am J Prev Med 2008;35:118-26.
34. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. N Engl J Med 2009;360:859-73.
35. Wadden TA, Volger S, Sarwer DB, et al. A two-year randomized trial of obesity treatment in primary care practice. N Engl J Med 2011;365:1969-79.
36. Whelton PK, Appel LJ, Espeland MA, et al. Sodium reduction and weight loss in the treatment of hypertension in older persons: a randomized controlled Trial of Nonpharmacologic Interventions in the Elderly (TONE). JAMA 1998;279:839-46.
37. Cabassa LJ, Ezell JM, Lewis-Fernandez R. Lifestyle interventions for adults with serious mental illness: a systematic literature review. Psychiatr Serv 2010;61:774-82.
38. Faulkner G, Cohn T, Remington G. Interventions to reduce weight gain in schizophrenia. Cochrane Database Syst Rev 2007;1:CD005148.
39. Casagrande SS, Jerome GJ, Dalcin AT, et al. Randomized Trial of Achieving Healthy Lifestyles in Psychiatric Rehabilitation: the ACHIEVE trial. BMC Psychiatry 2010;10:108.
40. Bandura A, ed. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall, 1986.
41. Heinssen RK. The cognitive exoskeleton: environmental interventions in cognitive rehabilitation. In: Corrigan PW, Yudofsky SC, eds. Cognitive rehabilitation for neuropsychiatric disorders. Washington, DC: American Psychiatric Press, 1996: 395-423.
42. Mueser KT, Corrigan PW, Hilton DW, et al. Illness management and recovery: a review of the research. Psychiatr Serv 2002;53:1272-84.
43. Green MF, Nuechterlein KH. Should schizophrenia be treated as a neurocognitive disorder? Schizophr Bull 1999;25: 309-19.
44. Velligan DI, Bow-Thomas CC, Huntzinger C, et al. Randomized controlled trial of the use of compensatory strategies to enhance adaptive functioning in outpatients with schizophrenia. Am J Psychiatry 2000;157:1317-23.
45. American Heart Association, National Heart, Lung, and Blood Institute. Exercise and your heart: a guide to physical activity. Bethesda, MD: National Institutes of Health, 1993.
46. Eisen SV, Normand SL, Belanger AJ, Spiro A III, Esch D. The Revised Behavior and Symptom Identification Scale (BASIS-R): reliability and validity. Med Care 2004; 42:1230-41.
47. Weissman MM, Sholomskas D, Pottenger M, Prusoff BA, Locke BZ. Assessing depressive symptoms in five psychiatric populations: a validation study. Am J Epidemiol 1977;106:203-14.
48. Dickerson F, Boronow JJ, Stallings C, Origoni AE, Cole SK, Yolken RH. Cognitive functioning in schizophrenia and bipolar disorder: comparison of performance on the Repeatable Battery for the Assessment of Neuropsychological Status. Psychiatry Res 2004;129:45-53.
49. Foster GD, Wyatt HR, Hill JO, et al. Weight and metabolic outcomes after 2 years on a low-carbohydrate versus low-fat diet: a randomized trial. Ann Intern Med 2010;153:147-57.
50. Bartels SJ, Desilets R. Health promotion programs for people with serious mental illness (prepared by the Dartmouth Health Promotions Research Team). Washington, DC: SAMHSA-HRSA Center for Integrated Health Solutions, January 2012.
51. McKibbin CL, Patterson TL, Norman G, et al. A lifestyle intervention for older schizophrenia patients with diabetes mellitus: a randomized controlled trial. Schizophr Res 2006;86:36-44.
52. Verhaeghe N, De Maeseneer J, Maes L, Van Heeringen C, Annemans L. Effectiveness and cost-effectiveness of lifestyle interventions on physical activity and eating habits in persons with severe mental disorders: a systematic review. Int J Behav Nutr Phys Act 2011;8:28.
53. Wu MK, Wang CK, Bai YM, Huang CY, Lee SD. Outcomes of obese, clozapine-treated inpatients with schizophrenia placed on a six-month diet and physical activity program. Psychiatr Serv 2007;58: 544-50.
54. Wu RR, Zhao JP, Jin H, et al. Lifestyle intervention and metformin for treatment of antipsychotic-induced weight gain: a randomized controlled trial. JAMA 2008; 299:185-93.
Copyright © 2013 Massachusetts Medical Society.

The New England Journal of Medicine
Downloaded from nejm.org on April 29, 2013. For personal use only. No other uses without permission.
Copyright © 2013 Massachusetts Medical Society. All rights reserved.