



Original Article

Effects of a behavioural weight loss intervention in people with serious mental illness: Subgroup analyses from the ACHIEVE trial



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ARTICLE INFO

Article history:

Received 11 December 2018

Received in revised form 1 February 2019

Accepted 8 February 2019

Keywords:

Obesity

Serious mental illness (SMI)

Behavioural weight loss intervention

ABSTRACT

Background: Persons with serious mental illnesses (SMI) such as schizophrenia and bipolar disorder have an increased risk of obesity and related chronic diseases and die 10–20 years earlier than the overall population, primarily due to cardiovascular disease. In the ACHIEVE trial, a behavioural weight loss intervention led to clinically significant weight loss in persons with SMI. As the field turns its attention to intervention scale-up, it is important to understand whether the effectiveness of behavioural weight loss interventions for people with SMI, like ACHIEVE, differ for specific subgroups.

Methods: This study examined whether the effectiveness of the ACHIEVE intervention differed by participant characteristics (e.g. age, sex, race, psychiatric diagnosis, body mass index) and/or their weight-related attitudes and behaviours (e.g. eating, food preparation, and shopping habits). We used likelihood-based mixed effects models to examine whether the baseline to 18 month effects of the ACHIEVE intervention differed across subgroups.

Results: No statistically significant differences were found in the effectiveness of the ACHIEVE intervention across any of the subgroups examined.

Conclusions: These findings suggest that the ACHIEVE behavioural weight loss intervention is broadly applicable to the diverse population of individuals with SMI.

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Introduction

Persons with serious mental illnesses (SMI) such as schizophrenia and bipolar disorder experience a high burden of obesity and related chronic diseases [1,2], and have a mortality rate two times higher than the general population, largely due to cardiovascular disease [3]. Multiple factors contribute to the high prevalence of obesity and cardiovascular disease in this population, includ-

ing metabolic side effects of psychotropic medications and adverse health risk behaviours including poor diet and physical inactivity [4–6].

A recent systematic review concluded that behavioural weight loss interventions can lead to clinically significant weight loss, i.e. weight loss of at least 3% that decreases risk for obesity related conditions [7], in people with SMI [8]. Several elements of such interventions were identified as contributors to weight loss success, including tailoring to address memory and executive function deficits that are common among those with SMI; social support; behavioural self-management skills training; and environmental supports [9,10]. Effective behavioural weight loss interventions for people with SMI had high frequency of intervention contact and

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an extended intervention duration compared to similar interventions for the general population. The ACHIEVE behavioural weight loss intervention was one of the interventions identified as leading to clinically significant weight loss, with a mean of seven lbs. weight loss over 18 months compared to controls; 37.8% of intervention group participants lost at least 5% of their baseline weight at 18 months relative to 22.7% in the control group ($p = 0.009$) [11].

While shown to be effective in clinical trials, little is known about whether successful behavioural weight loss interventions like ACHIEVE are effective for specific subgroups of people with SMI [12]. In the general population, individual characteristics have been shown to be associated with greater weight loss, including male gender, older age, and non-Hispanic white ethnicity [13,14]. While shown to be effective in clinical trials, evidence-based behavioural weight loss interventions for people with SMI have not yet been widely disseminated. As the field turns its attention to intervention scale-up, it is important to understand whether the effectiveness of behavioural weight loss interventions for people with SMI, like ACHIEVE, differ for specific subgroups. If such interventions are more effective for some subgroups than others, adaptations may be needed prior to broad-scale dissemination. This study examined whether the effectiveness of the ACHIEVE intervention differed by participants' characteristics and/or their weight related attitudes and behaviors.

Materials and methods

Design and participants

This analysis was based on data from the ACHIEVE trial, a randomised, controlled trial of a behavioural weight loss intervention in persons with SMI. A complete description of the ACHIEVE trial has been published [11]. Briefly, participants included overweight or obese adults aged 18 and over with serious mental illness (SMI)—including schizophrenia, bipolar disorder or major depression—attending one of 10 community psychiatric rehabilitation programs in Maryland. Two hundred ninety-one participants were randomised to the intervention ($N = 144$) or control ($N = 147$) group. The mean age of ACHIEVE participants was 45.3 years, 49.8% of participants were male, and mean BMI was 36.3.

The ACHIEVE intervention was based on lifestyle interventions demonstrated to be effective in the general population and modified for persons with SMI who often face challenges with memory and executive function [10,11,15–17]. Intervention components included group weight-management, individual weight-management, and group exercise sessions. The moderate intensity physical activity goal was 150 min per week. The goals of the intervention were to help participants lose weight by consuming fewer sugar-sweetened beverages and high-calorie processed foods; consume five servings of fruits and vegetables daily; select smaller portions and healthy snacks; and participate in physical activity. Control group participants received nutrition and physical activity information at baseline and were offered quarterly health classes with content unrelated to weight loss.

Data

Participant data were collected at baseline, 6, 12, and 18 months at the rehabilitation programs [11]. Weight was measured with a calibrated digital scale at each data collection point. Data on participant sociodemographic characteristics and weight-related attitudes and behaviours were collected at baseline. Sociodemographic information was collected through self-report and psychiatric rehabilitation program records. Medication usage and psychiatric diagnoses were obtained from medical records. Data

on participants' perceived neighbourhood characteristics and weight-related attitudes and behaviours were collected through interviewer administered surveys.

Measures

Independent and dependent variables

The independent variable was group assignment (i.e. intervention or control group). The dependent variable of interest was change in body weight (lbs.) from baseline to 18 months.

Subgroups

Subgroups were defined using participant characteristics and weight-related attitudes and behaviours (see Tables 1 and 2 for specific measures). The Neighbourhood Questionnaire was used to measure walking environment (a score calculated as the mean of ten items) and availability of healthy food (a score calculated as the mean of four items); see Table 1 footnotes for measure details [18]. Weight-related attitudes and behaviours included measures of eating, food preparation and shopping habits; weight loss history; and weight loss attitudes. We measured dietary habits, food preparation, and shopping using 10 items from the Eating, Food Preparation and Shopping Habits Questionnaire developed by the ACHIEVE study team. We measured participants' weight loss history and weight loss attitudes using the Weight Loss History Questionnaire, which was adapted from the questionnaire used in the Weight Loss Maintenance Trial [19]. Weight loss history was measured using a single item, and weight loss attitudes were measured by sixteen items. All subgroup measures were assessed at baseline, allowing us to examine whether participants' characteristics, attitudes and behaviours at study outset influenced ACHIEVE effectiveness.

For each subgroup variable, we created subgroup indicators to contrast each designated subgroup against the reference group (e.g., female vs male) and interaction terms by multiplying the corresponding subgroup indicators and the dichotomous indicator of intervention vs control group (e.g., female*intervention).

Co-variates

Consistent with the analytic models used in the ACHIEVE trial, participant sex and study site were included as covariates in all statistical models.

Analysis

We used an analytic approach expanding from the approach used in the ACHIEVE primary outcome analysis, where a likelihood-based mixed-effects model with weight change from baseline modelled as a function of study-group (indicator for intervention vs. control) and study visit (indicators for 6, 12, and 18 months vs baseline), adjusting for study site and sex, was used as the base model [4]. Expanding on base model, the mean models for the subgroup analyses additionally included subgroup indicator(s) and intervention group*subgroup interaction term(s), time*subgroup group interaction term(s), and intervention group*time*subgroup interaction term(s). A p -value < 0.05 for an intervention group*time*subgroup indicator coefficient was considered statistically significant and indicated the effects of the ACHIEVE intervention differed between the respective subgroup vs the reference subgroup. Weight change from baseline to 18 months was determined for each subgroup, as well as difference in weight changes between subgroups other than the reference subgroup. Missing data were treated as missing at random given the small amount of missing weights and very high correlations between body weight measurements over time. To account for repeated

Table 1
Differences in effects of the 18 month ACHIEVE behavioural weight loss intervention on body weight change by baseline participant characteristics (N = 291).

Characteristic	N (%)	Intervention effect: mean difference in change in weight from baseline to 18 months in the intervention versus control groups (lbs.)	Differences in intervention effect across subgroups (95% confidence interval)
Age¹			
18–34	54 (19)	–12.05	Reference group
35–54	178 (61)	–6.99	5.06 (0.400)
55+	59 (20)	–3.93	8.12 (0.258)
Sex			
Male	145 (50)	–5.26	Reference group
Female	146 (50)	–8.91	–3.65 (–12.28, 4.98)
Race			
White	163 (56)	–10.05	Reference group
Black	111 (38)	–4.00	6.04 (–2.98, 15.06)
Other	17 (6)	2.59	12.64 (–5.77, 31.05)
Ethnicity			
Hispanic	13 (4)	–13.5	Reference group
Not Hispanic	278 (96)	–7.03	6.49 (–26.85, 13.88)
Education			
Not a high school graduate	87 (30)	–7.76	Reference group
High school graduate	204 (70)	–6.69	1.06 (–8.37, 10.50)
Marital status			
Never married	216 (74)	–8.81	Reference group
Ever married	75 (26)	–2.05	6.75 (–3.04, 16.55)
Living situation			
Does not live in a residential program or with a care provider	132 (45)	–6.90	Reference group
Lives in a residential program or with a care provider	159 (55)	–7.45	–0.56 (–9.24, 8.13)
Employment status			
Unemployed	247 (85)	–8.40	Reference group
Employed	44 (15)	1.63	10.02 (–1.88, 21.93)
Disability			
Able to work	62 (21)	–1.40	Reference group
Unable to work	229 (79)	–8.47	–7.07 (–17.45, 3.31)
Health insurance			
Medicaid			
No	51 (18)	–6.77	Reference group
Yes	240 (82)	–7.13	–0.36 (–11.73, 11.01)
Medicare			
No	145 (50)	–6.86	Reference group
Yes	146 (50)	–7.28	–0.42 (–9.06, 8.21)
Psychiatric diagnosis			
Schizophrenia	85 (29)	–10.48	Reference group
Schizoaffective disorder	84 (29)	–8.60	1.88 (–9.24, 13.00)
Bipolar disorder	64 (22)	–0.80	9.68 (–2.40, 21.75)
Major depression	35 (12)	–12.13	–1.66 (–16.00, 12.69)
Other	23 (8)	–1.42	9.06 (–8.20, 26.32)
History of substance use			
No	141 (48)	–9.56	Reference group
Yes	150 (52)	–4.59	4.96 (–3.64, 13.57)
Any antipsychotic medication			
No	30 (10)	–13.20	Reference group
Yes	261 (90)	–6.18	7.01 (–7.27, 21.30)
Atypical antipsychotic medication			
No	50 (17)	–13.55	Reference group
Yes	241 (83)	–5.64	7.91 (–3.38, 19.20)
Lithium or other mood stabilizer medication			
No	159 (55)	910.64	Reference group
Yes	132 (45)	–3.05	7.59 (–1.02, 16.20)
Antidepressant medication			
No	116 (40)	–7.28	Reference group
Yes	175 (60)	–6.82	0.46 (–8.35, 9.26)
BMI			
Overweight (25–29.9)	57 (20)	–0.80	Reference group
Obese (30+)	234 (80)	–8.32	–7.53 (–18.76, 3.71)

Table 1 (Continued)

Characteristic	N (%)	Intervention effect: mean difference in change in weight from baseline to 18 months in the intervention versus control groups (lbs.)	Differences in intervention effect across subgroups (95% confidence interval)
Neighborhood characteristics			
Walking environment ²	291 (100)	−7.062	−5.062
Availability of health foods ³	290 (100)	−6.433	−0.783

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

¹ We conducted sensitivity analyses with age as a continuous variable. Consistent with the results presented in the table, this analysis showed no statistically significant differences in ACHIEVE intervention effects by age.

² Walking environment is the mean of 10 individual items measured on 5-point Likert scales. Possible values range from 1–5 with 1 indicating high walking environment quality and 5 indicating low walking environment quality. In this table, we report the mean difference in change in weight (lbs.) from baseline to 18 months in the intervention versus control arms for someone with an average score of 3 on the scale (column 3) and the regression coefficient for the intervention*group*time interaction term testing whether a one unit change on the scale was associated with differences in the ACHIEVE intervention's effects on weight loss (column 4).

³ Availability of health foods is the mean of 4 individual items measured on 5-point Likert scales. Possible values range from 1–5 with 1 indicating high availability of health foods quality and 5 indicating low availability of health foods quality. In this table, we report the mean difference in change in weight (lbs.) from baseline to 18 months in the intervention versus control arms for someone with an average score of 3 on the scale (column 3) and the regression coefficient for the intervention*group*time interaction term testing whether a one unit change on the scale was associated with differences in the ACHIEVE intervention's effects on weight loss (column 4).

Table 2
Differences in effects of the 18 month ACHIEVE behavioural weight loss intervention on body weight change by weight-related attitudes and behaviours at baseline (N = 291).

Baseline Characteristic	N (%)	Intervention effect: mean difference in changes in weight from baseline to 18 months in the intervention versus control groups (lbs.)	Differences in intervention effect across dietary categories (95% confidence interval)
Eating, food preparation and shopping habits			
When I attend the day program, I usually eat or drink something before I arrive, other than water			
No	121 (42)	−4.84	Reference
Yes	168 (58)	−8.48	−3.64 (−12.45, 5.17)
I usually eat breakfast at the day program: X days per week			
0 or 1	109 (37)	−6.44	Reference
2 or 3	78 (27)	−4.96	1.48 (−9.47, 12.43)
4 or 5	104 (36)	−9.27	−2.83 (−12.86, 7.21)
When I do not eat breakfast at the day program, I get food for breakfast at home or the home of someone I know			
No	70 (24)	−8.39	Reference
Yes	221 (76)	−7.03	1.36 (−9.00, 11.71)
I usually eat lunch at the day program: X days per week			
0 or 1	77 (26)	−4.86	Reference
2 or 3	84 (29)	−3.3	1.56 (−10.07, 13.19)
4 or 5	130 (45)	−10.69	−5.83 (−16.32, 4.66)
I do all of my food shopping by myself			
No	183 (63)	−10.15	Reference
Yes	108 (37)	−1.54	8.61 (−0.28, 17.50)
I go food shopping with others but decide what to buy myself			
No	208 (71)	−6.62	Reference
Yes	83 (29)	−8.09	−1.46 (−10.98, 8.05)
I usually shop at a grocery store (like Giant or Safeway)			
No	63 (22)	−2.76	Reference
Yes	228 (78)	−8.25	−5.49 (−15.99, 5.00)
The main person who buys groceries for the household usually shops at a grocery store (like Giant or Safeway)			
No	31 (11)	−0.93	Reference
Yes	260 (89)	−7.90	−6.96 (−21.56, 7.63)
I prepare all of my own food when I eat at home			
No	118 (41)	−10.08	Reference
Yes	173 (59)	−4.97	5.11 (−3.64, 13.85)
Someone prepares meals for me			
No	234 (80)	−5.22	Reference
Yes	57 (20)	−14.60	−9.37 (−20.14, 1.40)
Weight loss history			
I have gained and lost weight many times over the years (“yo-yo”)			
No	197 (68)	−10.91	Reference
Yes	94 (32)	−5.37	5.54 (−3.68, 14.76)
Weight loss attitudes			
Love of eating has to do with my being overweight			
No	109 (37)	−11.37	Reference
Yes	182 (63)	−4.49	6.88 (−1.99, 15.74)

Table 2 (Continued)

Baseline Characteristic	N (%)	Intervention effect: mean difference in changes in weight from baseline to 18 months in the intervention versus control groups (lbs.)	Differences in intervention effect across dietary categories (95% confidence interval)
Eating food from restaurants, fast food places, convenience stores, vending machines may get in the way of changing my eating habits			
No	105 (36)	−11.35	Reference
Yes	186 (64)	−4.63	6.72 (−2.25, 15.69)
Too much high calorie food available at home or work may get in the way of changing my eating habits			
No	135 (46)	−7.46	Reference
Yes	156 (54)	−6.65	0.804 (−7.81, 9.42)
Too little time to prepare and eat healthy food may get in the way of changing my eating habits			
No	178 (61)	−8.08	Reference
Yes	113 (39)	−5.52	2.55 (−6.28, 11.39)
Too little money to buy healthy food may get in the way of changing my eating habits			
No	154 (53)	−8.76	Reference
Yes	137 (47)	−4.86	3.90 (−4.74, 12.54)
Feeling hungry much of the time may get in the way of changing my eating habits			
No	168 (58)	−4.54	Reference
Yes	123 (42)	−10.18	−5.64 (−14.41, 3.13)
Used to eating a certain way may get in the way of changing my eating habits			
No	94 (32)	−8.50	Reference
Yes	197 (68)	−6.50	2.00 (−7.07, 11.07)
Difficulties such as stress or depression may get in the way of changing my eating habits			
No	122 (42)	−8.76	Reference
Yes	169 (58)	−5.83	2.93 (−5.81, 11.67)
Being with others who overeat may get in the way of changing my eating habits			
No	183 (63)	−6.38	Reference
Yes	108 (37)	−8.20	−1.81 (−10.74, 7.12)
Too little time may get in the way of changing physical activity habits			
No	165 (57)	−7.14	Reference
Yes	126 (43)	−6.41	0.736 (−7.93, 9.40)
Too little money may get in the way of changing physical activity habits			
No	170 (58)	−7.98	Reference
Yes	121 (42)	−5.65	2.33 (−6.41, 11.08)
Safety concerns may get in the way of changing physical activity habits			
No	188 (65)	−7.73	Reference
Yes	103 (35)	−5.91	1.81 (−7.18, 10.81)
Difficulties such as stress, depression, etc. may get in the way of changing physical activity habits			
No	136 (47)	−10.42	Reference
Yes	155 (53)	−4.06	6.36 (−2.26, 14.97)
Do not like to exercise may get in the way of changing physical activity habits			
No	199 (68)	−5.44	Reference
Yes	92 (32)	−10.73	−5.29 (−14.56, 3.98)
Daily habits or routines that do not include exercise may get in the way of changing physical activity habits			
No	158 (54)	−9.19	Reference
Yes	133 (46)	−4.37	4.82 (−3.83, 13.46))
Too tired may get in the way of changing physical activity habits			
No	141 (48)	−7.80	Reference
Yes	150 (52)	−6.36	1.44 (−7.19, 10.07)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

measures over time, the models used an unstructured variance-covariance structure. STATA Version 14 was used for data analysis.

Results

There were no statistically significant ($p < 0.05$) differences in the effectiveness of the ACHIEVE intervention across any of the subgroups examined (Tables 1 and 2).

Discussion

We found no statistically significant differences in the effects of the ACHIEVE intervention on weight loss among people with SMI by baseline participant characteristics or weight-related atti-

tudes and behaviors. While previous literature has found that male, older, and non-Hispanic white participants lost more weight than their counterparts in behavioural weight loss interventions [13,14], our analysis found no significant differences in ACHIEVE intervention effects by sex, age or race/ethnicity. Previous research has also considered how contextual factors may influence health in the SMI population [20]; examined the relationship between participation in a behavioural weight loss intervention and depressive symptoms [21]; and shown that baseline BMI did not affect weight loss success in a behavioural weight loss intervention [22]. We also found no significant differences in intervention effectiveness among participants with varying baseline eating, food preparation and shopping habits; weight loss history; and weight loss attitudes. Our findings suggest that the ACHIEVE behavioural weight loss intervention has the potential to benefit the diverse population with SMI.

While our results do not suggest a need for further adaptation of the ACHIEVE intervention to meet the needs of these specific subgroups of participants, other activities are needed to support widespread implementation of effective behavioural weight loss interventions like ACHIEVE in community mental health settings. The intervention curriculum used in the trial needs to be modified for easy delivery by mental health program staff, and staff training programs need to be developed and disseminated [23]. At the policy level, billing mechanisms to allow mental health programs to be reimbursed for delivery of evidence-based behavioural weight loss interventions are a critical component of dissemination.

Our results should be interpreted in the context of certain limitations. The ACHIEVE trial was not powered for subgroup analyses. Sample sizes were small in some subgroups of interest, and we limited our analyses to subgroups defined using single versus multiple characteristics, e.g. our analyses examined ACHIEVE's effects in women versus men and among participants who were employed versus unemployed, but not among unemployed women, employed men, etc. Study results should therefore be considered exploratory. We did not examine non-psychotropic medication types as potential moderators; diabetes medications in particular may affect weight [24]. The instruments used have not been validated in populations with SMI. The limitations of the ACHIEVE RCT have been described in detail previously [11].

Our findings suggest that the ACHIEVE behavioural weight loss intervention worked well for a diverse group of people with SMI. Considering the high prevalence of obesity in people with serious mental illness, scaling up ACHIEVE for implementation in community mental health settings across the U.S. is a public health priority.

Conflict of interest

The authors have nothing to disclose.

Funding

National Institute of Mental Health, grant K24MH093763.
National Institute of Mental Health, grant R01MH080964.
National Center for Advancing Translational Sciences, grant UL1TR001079.

Ethical statement

This study was approved by the Johns Hopkins University School of Medicine Institutional Review Board. All subjects gave written informed consent. The IRB protocol number is NA.00015231.

Acknowledgment

None.

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