**Impact of a One-Year Behavioral Weight Management Program
on Depressive Symptoms in Older Adults**

by

Rebecca Naomi Thompson

BS in Civil and Environmental Engineering, Cornell University, 2008

Submitted to the Graduate Faculty of

Epidemiology

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2019

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

This essay was submitted

by

Rebecca Naomi Thompson

on

April 26, 2019

and approved by

Essay Advisor: Elizabeth M. Venditti, PhD, Associate Professor, Psychiatry and Epidemiology,
School of Medicine, University of Pittsburgh

Essay Reader: Nancy W. Glynn, PhD, Assistant Professor, Epidemiology, Graduate School of
Public Health, University of Pittsburgh

Essay Reader: Robert M. Boudreau, PhD, Assistant Professor, Epidemiology, Graduate School
of Public Health, University of Pittsburgh

Elizabeth M. Venditti, PhD

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Abstract

While it has been widely recognized that both exercise and weight loss benefit older adults with obesity and depressive symptoms, the ability of these individuals to complete and benefit from lifestyle programs is unknown. This essay looks at whether older adults with mild depressive symptoms (Center for Epidemiological Studies-Depression/CES-D score of 11 or more) benefit from a one-year lifestyle intervention in terms of change in depressive symptoms, weight loss, and physical activity measured at either 5, 9, or 13 months. In the Mobility and Vitality Lifestyle Program (MOVE UP) study, no statistically significant difference was found between the drop-out rate of participants with mild depressive symptoms compared to those without mild depressive symptoms. The overall dropout rate from the study was 13.6% over 13 months. In addition, participants with mild depressive symptoms showed statistically significant improvements in their mean CES-D scores of -3.9 points at 5 months ($p<0.001$) and -3.1 points at 13 months ($p=0.004$). These changes were independent of weight loss or a change in activity levels. Although regression to the mean may play a role in this finding, the amount of change suggests a meaningful effect. Overall, this study supports the inclusion of older adults with mild depressive symptoms in lifestyle improvement programs. Our findings show that the majority of

participants were able to successfully complete the program, and that over the course of the

intervention, they lost weight and had a decrease in depressive symptoms.

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1.0 Introduction

1.1 Overview of Depression

Depression is a common disorder, affecting over 350 million people worldwide (Ledford, 2014). In the United States, it is estimated that each year, 7.1% of adults experience a major depressive episode. In addition, 64% of those who had a major depressive episode experienced impairments in their ability to carry out major life activities due to their depression (National Institute of Mental Health, 2019). Depression is also a serious condition that can be disabling, and is sometimes fatal. Symptoms of depression can include sad mood, feelings of hopelessness, feelings of guilt, loss of interest in hobbies or activities, difficulty concentrating, and thoughts of suicide, among others (National Institute of Mental Health, 2018). There are several forms of depression, including major depression, persistent depressive disorder, psychotic depression, postpartum depression, and seasonal depressive disorder. Among adults in the United States with depression, about 50% had some difficulty with work, home, or social activities because of their symptoms. Another 30% had moderate or extreme difficulty due to their symptoms (Brody, Pratt, & Hughes, 2018). Worldwide, depression is the leading cause of disability, accounting for 10% of all years lost to disability (Smith, 2014).

1.2 Measurement of Depression in Epidemiological Studies

Diagnosis of major depressive disorder requires an in-person interview. In many epidemiology studies, interviews would be prohibitively expensive, so self-report questionnaires of depressive symptoms are often used to assess population-level associations and trends of depression. Among the tools for the measurement of self-reported depressive symptoms, the Center for Epidemiology Depression Scale (CES-D) and the Geriatric Depression Scale (GDS) are the most widely used in older adults. The CES-D correlates with major depression and is widely used across many age groups (Radolf, 1977). It has high sensitivity and moderate specificity for depressive symptoms (Center for Innovative Public Health Research, n.d.). The GDS correlates with mild depression and moderate depression. It is useful for medically ill and mild to moderately impaired older adults in particular and focuses less on somatic symptoms. Questions in the GDS are simplified compared to the CES-D and BDI, which in part makes them better suited for this population. Many of the commonly-used self-report tools to measure depression, such as the Beck Depression Inventory (BDI) and Patient Health Questionnaire (PHQ-9) are meant for screening and lack specificity.

The definition of clinically meaningful change in CES-D score is a subject of debate. In general, an individual with a CES-D score of 16 or greater would be considered to have depressive symptoms (Jacobson, Follette, & Dirk, 1984). A score of 11 or greater is sometimes used to indicate minor depressive symptoms or subsyndromal depression. For assessment of major depressive disorder, a score of 16 or more is sometimes used, but this creates many false positives. In a community-based observational study, Vernon et al. found that a CES-D score of 16 or greater yielded a false positive rate of 16.6% and a false negative rate of 40% for current major depression (Roberts & Vernon, 1983). A score of 23 or more is considered a more conservative indicator of

major depressive disorder (Busch, Wagener, Gregor, Ring, & Borrelli, 2011). In the GDS, scores of 11 to 19 correlate with mild depression, and scores of 20 or greater correlate with moderate depression.

1.3 Epidemiology of Depression

1.3.1 General Population

Depression is a common condition around the world that often disproportionally affects marginalized groups. A meta-analysis by Lim, et al found that among 30 countries, the prevalence of lifetime depression was 12.9%. Among women the point prevalence was 14.4% (Lim et al., 2018). Rates of depression have also been found to be higher among low-income groups. For example, in the 2013-2016 National Health and Nutrition Examination Survey data, point prevalence of depression among those who has a family income below the federal poverty level was 15.8%. Among those whose family income was at or above 4 times the federal poverty level, point prevalence was much lower at 3.5% (Brody, Pratt, & Hughes, 2018). A study by Ma et al. used data from the National Health and Nutrition Examination Survey to examine the association between overweight and obesity and depression. A statistically significant association between overweight and obesity and depression was found (Ma & Xiao, 2010).

Globally, rates of major depression have been found to be highest in high income countries and lowest in low income countries (Bromet et al., 2011). Between the years of 2007 and 2016, the point prevalence of depression in the United States did not change significantly when looking at the 5 NHANES surveys conducted over this period of time (Brody et al., 2018). In addition,

depression is commonly comorbid with a variety of other physical and mental conditions. For example, a study of low and middle income countries, depression was found to be associated with angina pectoris, arthritis, asthma, chronic lung disease, diabetes mellitus, hypertension, stroke, and vision impairment (Arokiasamy et al., 2015). In addition, depression often impacts the course of comorbid physical conditions, leading to worse outcomes and higher mortality (Kang et al., 2015).

1.3.2 Older Adults

Depression is a significant problem among older adults, as between 10% and 15% of community-dwelling older adults have clinically significant depressive symptoms (Kok & Reynolds, 2017). Older adults are more likely than younger populations to experience physical and cognitive conditions that can trigger or exacerbate depression(Alexopoulos et al., 2002). For example, in a study of factors related to prevalence of depression in older adults, researchers in Sweden found dementia and being physically dependent were correlated with higher rates of depression using the Geriatric Depression Scale (GDS-15). Other factors that were associated with higher rates of depression were older age (81-104 vs 60-79), female sex, and not having a partner(Sjöberg et al., 2017). In addition, depression in individuals aged 60 years and older has been found to have a lower remission rate and an increased risk of relapse when compared depression in early or middle adulthood (Payne, 2010). While it has often been thought that depressive symptoms were a normal part of the aging process, depression, including subsyndromal depression, is a treatable condition and should be recognized as such (Casey, 2017).

1.4 Treatments for Depression

1.4.1 General Population

Treatments for depression include medication, psychotherapy and other lifestyle or behavior modification interventions, and brain stimulation therapies, such as electroconvulsive therapy (ECT) and transcranial magnetic stimulation (TMS). Selective serotonin reuptake inhibitors (SSRIs) are often the first line of pharmacological treatment for depression because they usually have less side effects than other medications. Other classes of medications that are often used to treat depression include serotonin-norepinephrine reuptake inhibitors, tricyclic antidepressants, monoamine oxidase inhibitors (MAOIs), and atypical antidepressants (Mayo Clinic, 2019).

Extensive evidence has mounted that exercise can be effective in treating depression. Research suggests that the effective "dose" of exercise to create a meaningful change in depression is three to four sessions a week of low to moderate intensity exercise lasting 30–40 mins each. An intervention as short as nine weeks has been sufficient to see a change in depressive symptoms (Stanton & Reaburn, 2014). A study by Belvederi, et al, assessed change in depressive symptoms in older adults with depression who underwent interventions of medication alone, medication plus aerobic exercise, and medication plus lower-intensity exercise. They found that both of the intervention groups that included exercise experienced remission rates of 75% or more, compared to a remission rate of 45% in the arm undergoing pharmacotherapy alone (Belvederi Murri et al., 2015). This evidence is based on supervised exercise interventions. The effects of unsupervised exercise interventions and lifestyle interventions and their effect on depression are not as well established.

Obesity and depression are commonly comorbid. In the United States, 43% of adults with depression were obese, while 33% of adults without depression were obese (Pratt & Brody, 2014). The relationship between obesity and depression is widely recognized to be bidirectional. Several factors have been found to be associated with the relationship between obesity and depression, including body image, physical health and interpersonal effectiveness (Siette, Cassidy, & Priebe, 2017). In behavioral interventions for diet, activity and weight loss may be able to both lower obesity and improve mood. One clinical trial in obese adults with depressive symptoms found that an intervention of behavioral weight loss treatment and problem solving therapy did in fact lower depressive symptoms as well as weight (Ma et al., 2019).

In addition, multicomponent lifestyle interventions for obesity may impact depressive symptoms in adults with comorbidities such as diabetes mellitus, hypertension, and arthritis. These conditions, which have been found to be associated with depression(Arokiasamy et al., 2015), may also improve through a lifestyle improvement program.

1.4.2 Older Adults

There are some additional considerations when aiming to prevent or treat depression in older adults, particularly those who are overweight and obese. Treatment of depression via pharmacotherapy may impart more risk in this age group because of comorbidities and polypharmacy (Kok & Reynolds, 2017). Therefore, other modalities of treatment, including exercise, may be preferred for members of this population. Depressed older adults, who are at increased risk of cognitive impairment, might see an improvement in their cognition as well as their depression by participating in an exercise regimen (Neviani et al., 2017). However, for older adults with dementia, pharmacotherapy may be less effective (Kok & Reynolds, 2017).

Beyond exercise, engaging in social activities and staying busy are thought to have a positive influence on the process of aging. In a study by Juang, et al, an occupational therapy lifestyle intervention aimed to help older adults engage in more activities. This study found that the intervention was helpful for treating depression, and that the intervention may have been mediated by social interaction and perceived control (Juang et al., 2018).

Additionally, there is some evidence that a lifestyle intervention can prevent depression in older adults. One study by Stahl, et al, suggested that dietary coaching may alleviate depressive symptoms in older adults. The study was designed to evaluate whether problem-solving therapy could prevent of major depression, mitigate depressive symptoms, and enhance quality of life in older adults with mild depressive symptoms. Coaching in healthy dietary practices was intended as a control for this study, but study findings suggested that the coaching in fact benefited participations as well. These participants experienced a 40%–50% improvement in depressive symptoms, as Beck Depression Inventory scores decreased from 9.92 to 5.93 after treatment (Stahl, Albert, Dew, Lockovich, & Reynolds, 2014).

One important question when considering implementing a lifestyle intervention in older adults with depressive symptoms is the drop-out rate for these participants. In the dietary coaching intervention described above, 78% of participants completed the two-year study year. The baseline CES-D score in this study was 21.2, which indicates likely major depression (Stahl et al., 2014). In a RCT evaluating exercise as an adjunct therapy to pharmacotherapy in older adults with depression, the drop-out rate in the exercise groups was 9%. This was actually a lower drop-out rate than for the pharmacotherapy-only arm, which had a drop-out rate of 14% (Belvederi Murri et al., 2015).

1.5 Gaps in Knowledge

Many studies have shown that exercise can be an effective treatment for depression (Stanton & Reaburn, 2014). The study by Stahl et al focused on dietary coaching, and in this study participants who received dietary coaching showed improvements in their depressive symptomology (Stahl et al., 2014). However, there have not been studies evaluating whether a lifestyle improvement program that incorporates education about both diet and exercise could benefit obese older adults with depressive symptomology. In addition, possible differences in the effectiveness of programs delivered by community health workers versus medical practitioners for older adults with depressive symptomatology in particular. This study aims to accomplish those two things.

1.6 Public Health Significance

Depression in older adults is a serious concern, affecting, affecting 10-15% of older adults who are community dwelling (Kok & Reynolds, 2017). Particularly in light of the disabling nature of depression, this is a serious concern. Given that the risk of depression is greater in those who are obese (Ma & Xiao, 2010), there are many older adults with depressive symptoms who would be good candidates for a lifestyle change program. Gaining a better understanding of the feasibility and possible benefits of a lifestyle change program in obese older adults with depressive symptoms is of great importance to public health.

2.0 Objectives

The first aim of this paper was to examine whether participants with mild depressive symptoms at baseline have a different drop-out rate than participants without these symptoms. This aim was meant to answer the question of whether participants with mild depressive symptoms were able to successfully complete the intervention. The second aim was to evaluate if participants with mild depressive symptoms experience a change in their CES-D score over the course of the intervention. The third aim was to examine if any change in CES-D score associated with weight loss or increased physical activity.

3.0 Methods

3.1 Parent Study

Mobility and Vitality Lifestyle Program (MOVE UP)

This paper examines changes in depressive symptoms at 5, 9, and 13 months post-baseline during a lifestyle intervention. The intervention, Mobility and Vitality Lifestyle Program (MOVE UP), was a healthy aging and behavioral weight management intervention in community-dwelling older adults that took place over a period of 13 months. During this time, the intervention included 32 sessions with a community health worker at locations throughout Allegheny County, Pennsylvania. The primary outcome of MOVE UP was physical function, and secondary outcomes were weight change, self-reported physical activities, medical history, diet history, exercise self-efficacy, weight loss self-efficacy, health status, and health-related quality of life, and depressive symptoms. Accelerometer measurements were taken in a proportion of the sample (Venditti et al., 2018).

The MOVE UP study was used to evaluate the feasibility and effectiveness of a four-phase, 13-month, 32-session healthy aging and behavioral weight management intervention among community-dwelling adults, aged 60–75 years. The study is described in more detail elsewhere (Venditti et al., 2018). All eligible and consented participants who were overweight or obese were given the same intervention. The MOVE UP primary outcome was change in physical function performance at 13 months. Secondary outcomes included weight change, accelerometer measurement in a proportion of the sample, self-reported physical activities, medical history, diet history, exercise self-efficacy, health status, and HRQoL. Qualitative data were also collected.

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3.2 Inclusion Criteria

To be included in the study, MOVE UP participants had to be 60–75 years of age, have a BMI of 27–45 kg/m^2, be able to walk either with or without an assistive device (e.g., cane), and be able to consent. Other inclusion and exclusion criteria have been previously described (Venditti et al., 2018). Notably, those with significant cognitive or psychiatric impairment, as determined by the investigators, were excluded from the study.

3.3 Interventions

The intervention was implements by community health workers, who received a small stipend for travel expenses. Phase 1, lasting one month, involved weekly group sessions that focused on screening and self-management to multiple health risk factors. This was based on the 10 Keys to Healthy Aging (Newman et al., 2010). Content related to cholesterol and exercise were addressed later in the study. Phase 2, comprising months 2–5 of the study, also involved weekly meetings with the community health worker. This phase of the intervention focused on weight loss. Structured, goal-based materials derived from the Diabetes Prevention Program, among others (Diabetes Prevention Program (DPP) Research Group, 2002). Social cognitive-behavioral principles that were a part of the curriculum included goal setting, self-monitoring and feedback, managing environmental and social cues, problem-solving, responding to self-defeating thoughts and lapses, and seeking social support (Venditti, 2016). Participants met twice a month during months 6 to 8 (phase 3) and once a month during months 9 to13 (phase 4). The focus during these

phases was to reinforce strategies for weight loss maintenance, healthy eating, and lifestyle physical activities.

3.4 Outcomes and Covariates

The MOVE UP study utilized the CES-D to assess for depressive symptoms. The focus of the current analysis is on mild depressive symptoms (defined as CES-D of 11 or greater). This cutpoint was chosen because of sample size and because previous studies have shown that there may be public health utility in examining older adults with subsyndromal depressive symptomatology (ref).

All physical activity in minutes per week was assessed using the CHAMPS Activities Questionnaire for Older Adults. Minutes of all physical activity, as assessed in this analysis, include activities such as housework, golf, walking, yoga, and stretching, in addition to more vigorous activities. Weight was assessed via a calibrated digital scale with participants wearing light clothing and not wearing shoes.

3.5 Statistical Methods

The general aim and focus was to determine whether depressive symptoms (CES-D) declined from baseline to 5, 9 and 13 months in MOVEUP and to identify factors associated with changes in depressive symptoms. Analyses were conducted that included all MOVEUP

participants as well as sub-analyses restricted to those with mild depressive symptoms (CES-D ≥ 11).

To examine if drop-out rates from the MOVE UP study differed between those with and without mild depressive symptoms at baseline, a chi-square test was used. Those who dropped out at any point in the study were compared to those who completed the study.

To determine if participants with mild depressive symptoms experienced a change in their CES-D score, student's t-tests were used. Change in CES-D score (from baseline to each timepoint) were calculated. Then a t-test was used for each timepoint with the null hypothesis of no change

To determine if change in depressive symptoms in individuals with mild depressive symptoms (n=55) was associated with weight loss or with increased physical activity, a generalized linear model was used. Primary predictors and covariates included change in total minutes of physical activity, change in weight, and baseline characteristics. Change in CES-D was examined from baseline to 5 months, baseline to 9 months, and from baseline to 13 months.

A generalized linear model was also applied to all participants (n=182). In this model, CES-D at baseline was included to examine any associations that remained after accounting for baseline depressive symptoms. This model also included change in physical activity, change in weight, and baseline characteristics. This model aimed to determine if any factors were correlated with change in CES-D score aside from the CES-D score at baseline. All participants included in the both analyses had complete data.

4.0 Results

Table 1 below shows the baseline characteristics of the participants with and without mild depressive symptoms at baseline. The mean CES-D score among participants in the analytic sample at baseline was 7.92, and 30% of the participants met the criteria for minor depressive symptoms (CES-D or 11+). No statistically significant baseline sociodemographic or weight differences were found between those with and without MDS. Overall, the participants were mostly female and approximately one-quarter African American. About half of the participants attained a 4-year college degree or higher, and nearly all participants graduated from high school.

Table 1 Baseline characteristics for those with and without mild depressive symptoms: the MOVE UP study

		Participants with MDS (CES-D >10)* n=55 N (%)	Participants without MDS (CES-D ≤ 10) n=127 N (%)	p
Sex	Male	6 (10.9)	15 (11.8)	0.86
	Female	49 (89.1)	112 (88.2)	
Race/ Ethnicity	White	43 (78.2)	90 (70.9)	0.27
	Black	12 (21.8)	32 (25.2)	
	Other or Two or More Races	0 (0)	5 (3.9)	
Education	Less than High School	0 (0)	4 (3.2)	0.69
	High School Graduate or GED	12 (21.8)	22 (17.3)	
	Some College or Technical School	13 (23.6)	31 (24.4)	
	Associate or Bachelor Degree	19 (34.6)	42 (33.1)	
	Post-College or Professional Degree	11 (20.0)	28 (22.0)	
Age (std)		68.8 ± 13.2	67.8 ± 4.24	0.58
CES-D Score (std)		16.9 ± 6.0	4.0 ± 4.2	<0.001
Weight in lbs (std)		203.2 ± 35.6	202.3 ± 30.8	0.88
* CES-D= Center for Epidemiological Studies Depression Scale MDS= mild depressive symptoms (CES-D score of 11 or more)				

Table 2 below shows the drop-out rate in participants with and without MDS at baseline. There was no statistically significant difference in loss to follow-up between individuals with and without mild depressive symptoms at baseline. Although there is a nominal difference of 7.0% loss to follow-up between these groups, this did not reach the threshold of statistical significance, as the p-value for the chi-square test was 0.11.

Table 2 Retention rate in those with and without mild depressive symptoms at baseline: the MOVE UP study

	Without MDS*	With MDS	Total
Completed intervention	171	71	242
	88.6%	81.6%	86.4%
Lost to Follow-up	22	16	38
	11.4%	18.4%	13.6%
Total	193	87	280
p-value for chi-square =0.11			
* MDS= mild depressive symptoms (score of 11 or more on the Center for Epidemiological Studies Depression Scale (CES-D))			

Figure 1 shows the point estimate and 95% confidence intervals for mean CES-D scores of participants with and without MDS at baseline and each of the three follow up time points. The largest decrease in CES-D score occurred between baseline and five months, after which point the scores leveled off. Table 3 below shows the change in CES-D score between baseline and each of the three follow-up visits. For those with MDS at baseline, there was a statistically significant decrease between the CES-D score at baseline and the CES-D score at 5 months, 9 months, and 13 months of 3.91, 3.87, and 3.13, respectively. However, those without MDS at baseline showed a statistically significant increase in CES-D scores. The increase in mean CES-D score in these participants was 0.98, 1.03, and 1.27 at 3 months, 9 months, and 13 months, respectively.
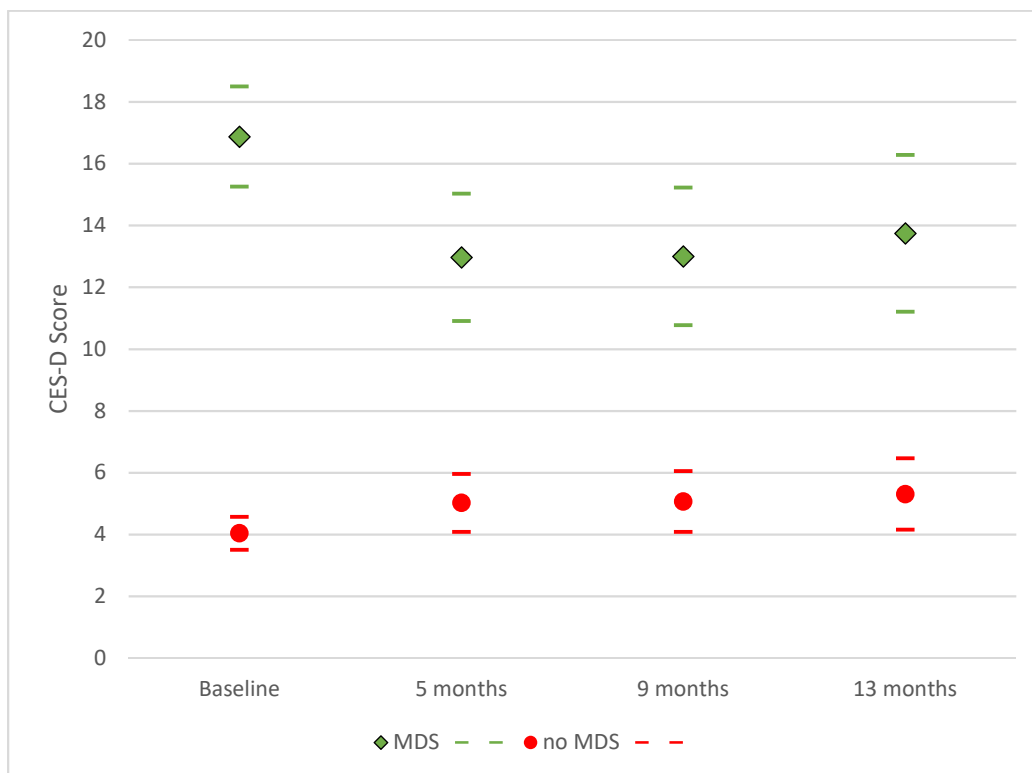
Figure 1 Scores on the Center for Epidemiological Studies- Depression (CES-D) rating scale for participants with and without mild depressive symptoms (MDS) at baseline: the MOVE UP study

Table 3 Change in score on the Center for Epidemiological Studies- Depression (CES-D) rating scale for participants with and without mild depressive symptoms (MDS) at baseline: the MOVE UP study

	5 Months		9 Months		13 Months	
	beta	p-value	beta	p-value	beta	p-value
Participants with MDS (n=55)	-3.91	<0.001	-3.87	<0.001	-3.13	0.004
Participants without MDS (n=127)	0.98	0.023	1.03	0.026	1.27	0.014

Figure 2 shows the point estimate and confidence intervals for change in weight at each of the follow-up assessments. In those with MDS, mean weight loss at 13 months was 14.3 (10.0,

18.6) pounds, and for those without MDS, it was 14.5 (12.3, 16.6) pounds as shown in Table 4. The difference between groups was not significant. Participants lost the most weight between baseline and 5 months regardless of baseline depressive symptom status. They continued to lose some weight between 5 and 9 months, after which point weight was maintained through the 13-month mark.
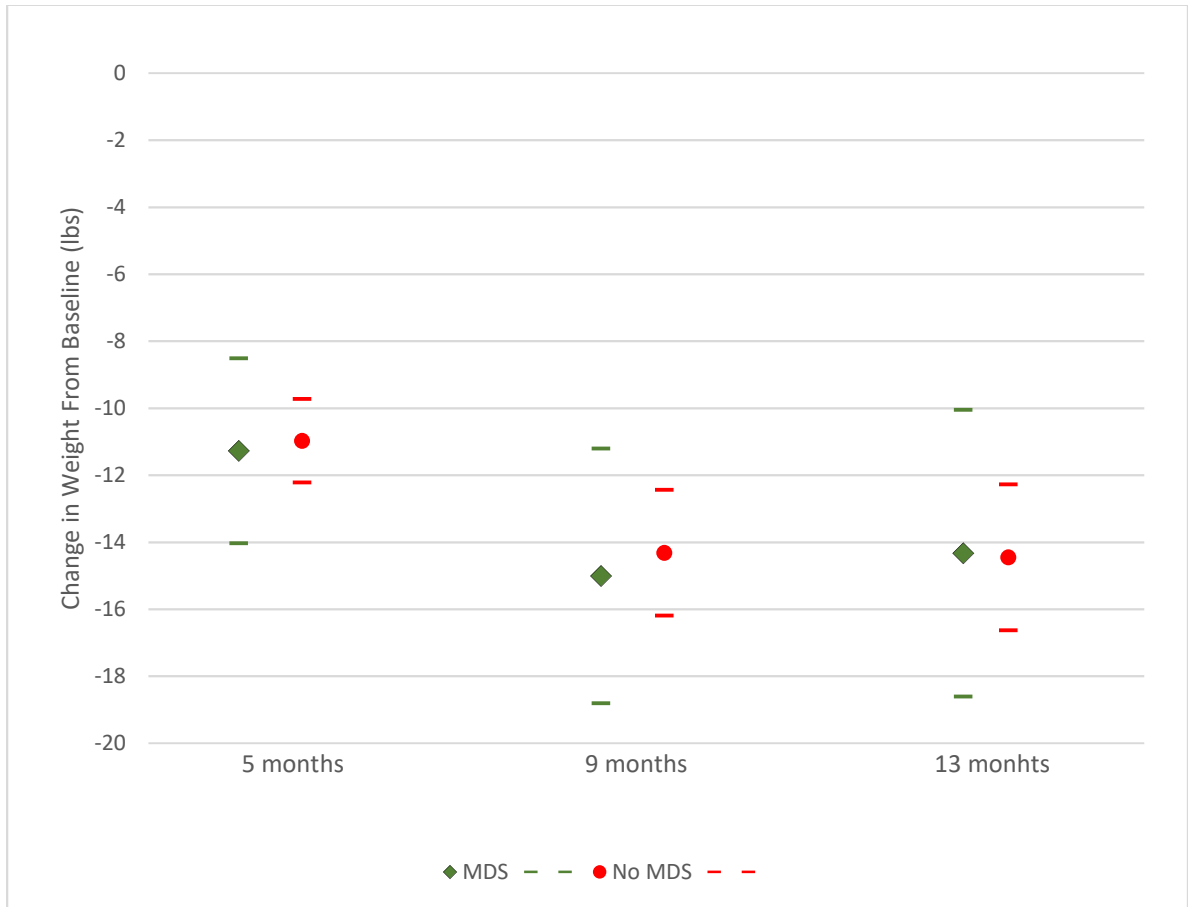
Figure 2 Weight change (lbs) from baseline in participants with and without mild depressive symptoms (MDS): the MOVE UP STUDY

Table 4 Weight change (lbs) from baseline in participants with and without mild depressive symptoms

(MDS): the MOVE UP STUDY

	Participants with MDS	Participants without MDS
5 months	-11.3 (-14.0, -8.5)	-11.0 (-12.2, -9.7)
9 months	-15.0 (-18.8, -11.2)	-14.3 (-16.2, -12.4)
13 months	-14.3 (-18.6, -10.0)	-14.5 (-16.6, -12.3)

Table 5 shows the results of a generalized linear model (GLM) for participants with mild depressive symptoms at baseline (n=55). A threshold for mild depressive symptoms (11+) was used as described in Section 3.4. The GLM examines whether changes in weight or activity predict or are associated with a drop in CES-D. In this model, there was no statistically significant association between change in depressive symptoms and change in weight, change in activity, or baseline characteristics at any point in the study.

Table 5 Change in the Center for Epidemiological Studies- Depression (CES-D) rating scale from baseline for participants with mild depressive symptoms (MDS) (n=55), adjusted for change in minues of activity, change in weight, and baseline characteristics: the MOVE UP study

Model Variables		5 Months		9 Months		13 Months	
		beta	p-value	beta	p-value	beta	p-value
Change in Weight from Baseline		0.187	0.127	0.124	0.167	-0.075	0.373
Change in Minutes of Activity		0.0002	0.930	-0.002	0.530	-0.004	0.098
Age		0.358	0.245	0.367	0.208	-0.008	0.977
Race/ Ethnicity	Black (12)	-1.549	0.593	-1.200	0.661	-0.796	0.771
	Other (0)	N/A	N/A	N/A	N/A	N/A	N/A
	White (43)	ref	.	ref	.	ref	.
Sex	Female (49)	-0.648	0.871	-3.401	0.402	4.901	0.228
	Male (6)	ref	.	ref	.	ref	.
Education	Less than High School (0)	N/A	N/A	N/A	N/A	N/A	N/A
	High School (12)	0.167	0.964	2.935	0.401	2.202	0.529
	Some College (13)	-2.661	0.458	-0.484	0.885	-0.823	0.803
	Associate or Bachelor's (19)	1.630	0.639	3.001	0.390	5.029	0.119
	Post College or Professional (11)	ref	.	ref	.	ref	.

Table 6 shows the results for a generalized linear model of the change in CES-D score from baseline to each of the three follow-up timepoints for all participants (n =182). There was no association between change in minutes of physical activity per week and change in CES-D over the course of the intervention. At 5 months, there was a statistically significant association between change in weight from baseline and change in CES-D score. For each pound lost, the CES-D score was 0.14 points lower. This association was not found at 9 months or 13 months. For minutes of physical activity, there was no association between change in minutes of physical activity and change in CES-D over the course of the intervention. For the baseline characteristics,

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there was no statistically significant association with age, race/ethnicity, or sex and change in depressive symptoms. There was some association between education and change in CES-D. Those with a bachelor's degree received less benefit from the intervention than did those with postgraduate education. There was no difference found in change in CES-D between those with high school, less than high school, or some college and those with a postgraduate education. Those with a bachelor's degree had 2.6 less of a decrease in CES-D at 5 months and 13 months when compared to those with a postgraduate education. This association was not significant at 9 months.

Table 6 Change in the Center for Epidemiological Studies- Depression (CES-D) rating scale from baseline for all participants (n=182),
adjusted for change in minues of activity, change in weight, and baseline characteristics:
the MOVE UP study

Model Variables		5 Months		9 Months		13 Months	
		beta	p-value	beta	p-value	beta	p-value
CES-D at Baseline		**-0.406**	**<.0001**	**-0.378**	**<.0001**	**-0.256**	**<0.001**
Change in Weight from Baseline		**0.141**	**0.010**	0.073	0.063	0.023	0.555
Change in Minutes of Activity		-0.001	0.280	0.000	0.579	0.000	0.971
Age		0.144	0.167	0.220	0.045	0.019	0.874
Race/ Ethnicity	Black	-1.501	0.150	-1.581	0.147	-0.777	0.523
	Other	-3.611	0.167	-2.114	0.441	-1.344	0.663
	White	ref	.	ref	.	ref	.
Sex	Female	-1.405	0.294	-2.019	0.150	-1.188	0.448
	Male	ref	.	ref	.	ref	.
Education	Less than High School	0.504	0.865	0.255	0.934	-1.226	0.724
	High School	1.098	0.413	1.425	0.308	0.345	0.826
	Some College	1.049	0.401	1.513	0.245	2.034	0.165
	Associate or Bachelor's	**2.603**	**0.027**	1.924	0.116	**2.636**	**0.056**
	Post College or Professional	ref	.	ref	.	ref	.

5.0 Discussion

In a one-year lifestyle intervention study of older adults with overweight and obesity, we first found that participants with mild depressive symptoms were as likely to complete the intervention as those without symptoms. While the drop-out rate in the former group was nominally higher at 18.4% compared to 11.4% in the latter, this difference was not statistically significant. Our observation that 4 out of 5 of participants with elevated symptoms completed the intervention is considered clinically meaningful. The second finding was that participants with mild depressive symptoms showed an average decrease of 3.9 points in their CES-D score from baseline to 5 months. This difference was maintained throughout the study and remained 3.1 points lower at the 13-month mark, which is also considered clinically important. Although some of this effect may be due to regression to the mean, the magnitude of the change suggests a true decrease in depressive symptoms during the course of the intervention.

The main findings of this study are supported by the study by Stahl et al, which compared dietary coaching with a more traditional problem-solving therapy (Stahl et al., 2014). This study had several differences from MOVE UP, particularly in the study population, outcome assessment, and type of lifestyle change intervention. The mean CES-D score at baseline in the Stahl et al study was 21.2, while in MOVE UP participants with minor depressive symptoms, it was 16.9. Outcome assessment in the study by Stahl et al used the Beck Depression instead of the CES-D. The type of lifestyle change intervention also differed between the studies. Despite these differences, both studies showed improvements in the depressive symptoms of participants while receiving a lifestyle improvement intervention.

The lack of association in MOVE UP between weight loss or physical activity and the decrease in depressive symptoms is a notable finding. We found no significant relationship between weight or activity changes and mood changes for either group. This suggests that there may be a benefit for this population in participating in a lifestyle change program that goes beyond the effects of weight loss or physical activity. Under the behavioral activation model, this improvement in depressive symptomatology could be due to the process of self-regulation and self-care that is fostered through this kind of program. The study by Stahl et at also supports this model as a dietary coaching intervention was associated with improvements in depressive symptoms (Stahl et al., 2014).

In the model evaluating all MOVE UP participants, there was an association at 5 months between weight loss and change in depressive symptoms, where more pounds lost was associated with a bigger decrease in depressive symptoms. In looking to this finding further, a check for an interaction between baseline CES-D score and change in weight was not found. Further statistical analysis that goes beyond the scope of this paper is warranted in order to examine this further. All of these analyses were also run using a CES-D cutoff of 16 and above and showed similar results. This supports the relevance of these findings to older adults with differing levels of depressive symptoms.

The population in the MOVE UP study was well-suited for the study of depressive symptoms and lifestyle change in older adults. This sample had a higher prevalence of depressive symptoms than the national average for older adults. In MOVE UP, 24% of participants met the criteria for depressive symptoms using the CES-D, while nationally 10% and 15% of older adults have been shown to have elevated depressive symptoms (Kok & Reynolds, 2017). This difference

might be attributed to the study sample being predominantly female (89%), as well as the inclusion criteria of an elevated BMI between 27 and 45 kg/m^2, as those are risk factors for depression.

Strengths of this study include the length of the study, which is useful in understanding how changes in depressive symptomology are maintained over time. In addition, the use of the CES-D for the evaluation of depressive symptoms is helpful in comparing the results of this study to others because this is a commonly used survey tool. A limitation to this study is the lack of a control group, which limits the interpretation of results and introduces methodological limitations to the data., There is also the potential for regression to the mean which can obscure the true effect of the intervention.

Further analysis using potential indicators of social cohesion and support over the course of the study might help to confirm that the decrease in depressive symptoms is indicative of a true change. If participants with MDS had a true change in depressive symptoms during the course of the intervention, they might be expected to also feel that they have increased social support as a part of their lessening depression. Data from the exit survey and the SF-36 could be useful in this type of analysis. It may also be informative to examine which questions within the CES-D were most likely to improve over the course of the intervention and whether these symptoms were primarily cognitive, affective, or somatic. Further study of the effect of a lifestyle improvement programs in overweight and obese older adults with depressive symptoms is warranted in order to allow possible corroboration with these results. A randomized clinical trial, in particular, would be instrumental in determining the effectiveness of such an intervention on the improvement of depressive symptoms. It is also possible that participants may have experienced an improvement in their depressive symptoms simply by the temporary nature of these symptoms in some individuals.

Overall, this study has great public health significance as depression is a serious concern in older adults and many depressed older adults are overweight or obese. Lifestyle change programs hold great promise in the treatment of depression in older adults and may be useful as an adjunct to pharmacotherapy or as a stand-alone intervention in some cases.

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