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Weight Loss Impact on Change in Depression in Type 2 Diabetes Mellitus: Study to Help Improve Early Evaluation and Management of Risk Factors Leading to Diabetes (SHIELD)

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Abstract

Objectives: This study evaluated the association between weight loss and change in depression among patients with type 2 diabetes mellitus (T2DM). Methods: Weight change from 2008 to 2009 among respondents (with and without T2DM) in the Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes (SHIELD) was calculated. Change in depression was calculated as change from 2008 to 2009 in Patient Health Questionnaire-9 (PHQ-9) scores. Respondents with weight loss (>1%, >3%, >5%) were compared with respondents with weight gain (≥1%). Multivariate regression adjusted for baseline characteristics. Results: Among those with T2DM, more respondents with weight loss (n = 779) improved their depression scores, compared with respondents with weight gain (n = 731): 32.9%, 36.9%, 39.8% for >1%, >3%, and >5% weight loss, respectively, vs. 28.7% for weight gain ($p<0.05$). More respondents with weight loss improved the severity level of depression compared with respondents with weight gain ($p < 0.05$). After adjustment, T2DM respondents with weight loss had significantly greater improvement in depression scores ($p < 0.05$) and had 2 - 3 times higher odds of improving depression severity than T2DM respondents with weight gain (OR: 2.22 for >1%, 2.96 for >3%, and 3.31 for >5% weight loss, $p < 0.01$). Similar improvement in depression scores and severity of depression related to weight loss was observed among all SHIELD respondents (with and without T2DM). Conclusions: Our findings demonstrate an association between weight loss and improvement in depression over a 1-year period in adults with T2DM, and suggest the need for further investigation with respect to causality.

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Keywords

Depression, Type 2 Diabetes Mellitus, Weight Loss

1. Introduction

Body weight is an important factor in the management of type 2 diabetes mellitus (T2DM) and health status. The majority (85%) of patients with T2DM are obese or overweight [1]. To add to this burden, some anti-diabetic medications, such as insulin, thiazolidinediones, and sulfonylureas, lead to an increase in body weight [2] [3]. Newer anti-diabetic therapies, including glucagon-like peptide 1 (GLP-1) receptor agonists and sodium-glucose cotransporter 2 (SGLT2) inhibitors, are associated with weight loss [4] [5]. Previous studies have shown that weight loss significantly improves glycemic control and lowers the risk of progression of T2DM [6] [7]. Other investigations have demonstrated that weight loss was related to better adherence to therapy [8], an effect that was durable for at least 10 years of metformin treatment [9].

However, the impact of weight loss on other health outcomes, including mental health, has not been well studied among patients with T2DM. A survey among patients with T2DM found that self-reported weight loss was associated with improved well-being and better weight management behaviors [10]. Yet, the relationship between weight loss and depression has not been specifically investigated. The present investigation was designed to evaluate the association between weight loss and change in depression level among adults with T2DM and adults with and without T2DM.

2. Methods

A longitudinal analysis of data from the Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes (SHIELD) was conducted to assess the relationship between weight loss and change in depression. SHIELD is a 5-year, survey-based study conducted to better understand patterns of health status, health behavior, and quality of life (QOL) of adults living with diabetes and those with varying levels of cardiometabolic risk.

3. SHIELD Survey

SHIELD included an initial screening phase to identify cases of interest in the general adult population (e.g., diabetes mellitus), a baseline survey to follow identified cases with a questionnaire about health status, health knowledge and attitudes, and current behaviors and treatments, and annual follow-up surveys for 5 years. A detailed description of the SHIELD methodology has been published previously [11] [12]. SHIELD was approved by the Quorum Review Board.

In brief, the screening survey was mailed in April 2004 to a stratified random sample of 200,000 US households, representative of the US population for geographic residence, household size and income, and age of the head of household [13], identified by the Taylor Nelson Sofres National Family Opinion panel (TNS NFO; Greenwich, CT). All TNS NFO surveys were voluntary, and no special incentives were provided. A response rate of 64% (128,000 households with data on 211,097 individuals) was obtained for the screening survey.

A comprehensive baseline survey was mailed in September through October 2004 to a representative sample of adults (n = 22,001) who were identified in the screening survey as having self-reported type 1 diabetes mellitus or T2DM, no diabetes, or being at risk for diabetes. Each respondent group was balanced to be representative of that segment of the population for age, sex, geographic region, household size, and income for the US population, and then a random sample from each group was selected and sent the baseline survey. A response rate of 72% was obtained for the baseline survey. The 2008 follow-up survey collected information from 14,921 individuals (71% response rate), and 2969 respondents reported a diagnosis of T2DM. A total of 13,822 individuals completed the 2009 follow-up survey (70% response rate), and 2172 respondents had T2DM.

4. Study Measures

Respondents were classified as having T2DM based on their self-report of having been told by a doctor, nurse,

or other health care professional that they had T2DM. Weight and height were self-reported at the time of the 2008 and 2009 surveys. Weight change was computed by subtracting the weight reported in the 2008 survey from the weight reported in the 2009 survey. Three weight-loss categories (loss >1%, >3%, and >5%) were evaluated to determine whether a small amount of weight loss (>1%) as well as greater weight loss (>3% and >5%) was associated with change in depression. Weight gain was categorized as gain ≥1% of body weight, as any weight gain is detrimental to health.

The Patient Health Questionnaire 9 (PHQ-9) was used to assess depression at the time of the 2008 and 2009 surveys. The PHQ-9 includes the nine signs and symptoms of depression from the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) [14] and is used to provide a depressive disorder diagnosis as well as a symptom severity score. For a diagnosis of depression, five or more items must be scored as present more than half of the days or nearly every day. Higher scores indicate increasing severity of depression. PHQ-9 scores of 5 - 9 indicate minimal depressive symptoms, scores of 10 - 14 indicate mild depression, scores of 15 - 19 indicate moderately severe depression, and scores ≥ 20 indicate severe major depression [14]. A point change in PHQ-9 scores was calculated by subtracting the 2008 score from the 2009 score, and a decrease of 1 or more points from 2008 to 2009 was classified as improvement in depression, while an increase of 1 or more points was classified as worsening of depression. Change in severity of depression category (minimal, mild, moderate, severe) was also calculated and classified as improvement if a respondent moved at least one category from severe to moderate or lower, from moderate to mild or lower, or from mild to minimal. Worsening of depression severity category was classified as a change of at least one category from minimal to mild or higher, mild to moderate or higher, or moderate to severe.

5. Statistical Analysis

Analyses were conducted for all SHIELD respondents regardless of diabetes status and for those respondents with T2DM. The proportion of respondents with weight loss or weight gain was computed. Change in PHQ-9 scores and change in PHQ-9 severity category were computed for each weight change group (>1%, >3%, >5% weight loss and ≥1% weight gain). Comparisons between respondents with weight loss and those with weight gain were made using chi-square tests for categorical variables and *t*-tests for continuous variables. Multivariate regression modeling was used to adjust for patient baseline characteristics. Linear regression was used for change in PHQ-9 scores, while logistic regression was used for change in PHQ-9 severity category. Both models adjusted for age, gender, education, comorbid conditions, weight at baseline, and 2008 PHQ-9 score.

6. Results

In total, 7278 SHIELD respondents (referred to as "all respondents") completed the PHQ-9 in both the 2008 and 2009 surveys and had either lost (48.2%, n = 3509) or gained (51.8%, n = 3769) weight over the year. Of these 7278 respondents, 1510 had T2DM (referred to as "T2DM respondents") and had either lost (51.6%, n = 779) or gained weight (48.4%, n = 731). In both groups, a similar proportion of respondents with weight loss lost >3% of body weight: 63.9% of all respondents and 63.0% of T2DM respondents (**Table 1**). In both groups, the proportion of respondents with >5% weight loss among respondents with weight loss also was similar: 40.0% for all respondents and 40.9% for T2DM respondents. All respondents who lost weight were slightly older, weighed more at baseline, and had a greater proportion with T2DM, heart disease, and cholesterol problems compared with all respondents who gained weight (**Table 1**). T2DM respondents who lost weight were slightly older and had more chronic pulmonary disease than T2DM respondents who gained weight.

7. Impact of Weight Change on Depression Scores and Severity in T2DM Respondents

A greater proportion of T2DM respondents with weight loss improved their depression scores, compared with T2DM respondents with weight gain ($p < 0.05$) (**Table 2**). For all weight-loss groups (>1%, >3%, >5% loss), more T2DM respondents with weight loss improved their PHQ-9 scores by at least 1 point than T2DM respondents with weight gain. As weight loss increased, the proportion of T2DM respondents who improved their PHQ-9 scores increased; proportion with improvement was 32.9% for >1% weight loss, 36.9% for >3% weight loss, and 39.8% for >5% weight loss.

Table 1. Baseline characteristics of SHIELD respondents.

Characteristics	All respondents		T2DM respondents	
	Weight loss > 1% n = 3509	Weight gain n = 3769	Weight loss > 1% n = 779	Weight gain n = 731
Age (years), mean (SD)	59.8 (14.4)*	57.2 (14.4)	63.9 (11.4)*	61.7 (11.4)
Men, %	37.7	38.7	37.9	40.8
High school diploma or less, %	31.5	29.6	34.6	32.6
Cancer, %	12.1	10.2	15.9	12.6
COPD, %	5.5	4.7	8.2*	5.6
Type 2 diabetes, %	25.1*	21.5	100	100
Heart disease, %	17.4*	15.4	24.3	23.0
Cholesterol problems, %	56.6*	52.8	75.5	76.3
Stroke/TIA, %	4.4	4.2	4.5	5.7
Weight at baseline (lb), mean (SD)	200.8 (54.3)*	192.4 (49.8)	217.3 (54.8)	210.6 (54.0)
Weight loss > 3%, %	63.9	NA	63.0	NA
Weight loss > 5%, %	40.0	NA	40.9	NA
PHQ-9 score at baseline, mean (SD)	3.5 (4.9)	3.5 (4.9)	4.1 (5.3)	4.1 (5.2)

Baseline: 2008 survey data. COPD: chronic obstructive pulmonary disease; NA: not applicable; PHQ-9: Patient Health Questionnaire-9; SD: standard deviation; T2DM: type 2 diabetes mellitus; TIA: transient ischemic attack. *$p < 0.05$.

Table 2. Change in depression (PHQ-9 scores and severity category) by weight change over 1 year for T2DM respondents.

Change in PHQ-9 depression scores	Weight loss	Weight gain of ≥1%	p-value
≥1 point change in depression score:			
>1% weight loss	N = 779	N = 731	0.037
Improved[a] depression score, %	32.9	28.7	
Stayed the same, %	30.7	28.5	
Worsened[b] depression score, %	36.5	42.8	
>3% weight loss	N = 491	N = 731	0.002
Improved depression score, %	36.9	28.7	
Stayed the same, %	29.5	28.5	
Worsened depression score, %	33.6	42.8	
>5% weight loss	N = 319	N = 731	0.001
Improved depression score, %	39.8	28.7	
Stayed the same, %	28.2	28.5	
Worsened depression score, %	32.0	42.8	
Change in depression severity category:			
>1% weight loss	N = 779	N = 731	0.031
Improved[c] depression category, %	13.2	13.3	
Stayed the same, %	73.7	68.8	
Worsened[d] depression category, %	13.1	17.9	
>3% weight loss	N = 491	N = 731	0.037
Improved depression category, %	16.5	13.3	
Stayed the same, %	70.5	68.8	
Worsened depression category, %	13.0	17.9	
>5% weight loss	N = 319	N = 731	0.002
Improved depression category, %	18.2	13.3	
Stayed the same, %	71.8	68.8	
Worsened depression category, %	10.0	17.9	

[a]improved score = decrease of ≥1 point in PHQ-9 score from 2008 to 2009; [b]worsened score = increase of ≥1 point in PHQ-9 score from 2008 to 2009; [c]improved category = decrease of 1 or more severity categories (severe to moderate or lower, moderate to mild or lower, mild to minimal) from 2008 to 2009; [d]worsened category = increase of 1 or more severity categories (minimal to mild or higher, mild to moderate or higher, moderate to severe). PHQ-9: Patient Health Questionnaire-9; T2DM: type 2 diabetes mellitus.

For change in depression severity category, more T2DM respondents with weight loss improved their depression severity than T2DM respondents with weight gain, and fewer T2DM respondents with weight loss experienced a worsening of depression severity than T2DM respondents with weight gain ($p < 0.05$) (**Table 2**). As weight loss increased, the proportion of T2DM respondents who improved their depression severity increased, from 13.2% for >1% weight loss, 16.5% for >3% weight loss, to 18.2% for >5% weight loss.

After adjusting for patient demographics, comorbid conditions, baseline weight, and baseline PHQ-9 score, T2DM respondents with weight loss (all 3 weight-loss groups) had significantly greater improvement (decrease in PHQ-9 score) in depression scores than T2DM respondents with weight gain ($p < 0.05$). The adjusted mean PHQ-9 score was 0.397 points lower for the >1% weight-loss group, 0.564 points lower for the >3% weight-loss group, and 0.753 points lower for the >5% weight-loss group, compared with the weight-gain group.

For change in depression severity category, T2DM respondents with weight loss had 2 - 3 times greater odds of improving depression severity (decreasing at least 1 category) than worsening depression severity compared with T2DM respondents with weight gain, after adjusting for patient baseline characteristics ($p < 0.01$) (**Table 3**). The greater odds of improving depression severity increased as weight loss increased, from 2.2 for >1% weight loss, 2.96 for >3% weight loss, to 3.31 for >5% weight loss.

8. Impact of Weight Change on Depression Scores and Severity in All SHIELD Respondents

A similar pattern of improvement in depression scores and depression severity as observed among T2DM respondents was also observed among all SHIELD respondents, regardless of diabetes status. For all 3 weight-loss groups, more respondents with weight loss improved their depression scores by at least 1 point ($p < 0.01$) and their depression severity category by a decrease of at least 1 category ($p < 0.01$) than respondents with weight gain (**Table 4**). A total of 31.0% of respondents with >1% weight loss, 32.6% with >3% weight loss, and 34.2% with >5% weight loss improved their PHQ-9 scores over 1 year, compared with 28.2% of respondents with weight gain. Overall, 11.7% of respondents with >1% weight loss, 13.1% with >3% weight loss, and 14.3% with >5% weight loss improved their depression severity category over 1 year, compared with 11.2% of respondents with weight gain.

All respondents with weight loss (all 3 weight-loss groups) had significantly greater improvement in PHQ-9 scores (decrease of at least 1 point) over 1 year than respondents with weight gain after adjusting for patient baseline characteristics ($p < 0.0001$). The adjusted mean PHQ-9 score was 0.376 points lower for the >1%

Table 3. Logistic regression odds ratio for improvement vs. worsened depression severity category adjusted for patient characteristics among the T2DM respondents.

Variables	>1% weight loss N = 779 loss, 731 gain		>3% weight loss N = 491 loss, 731 gain		>5% weight loss N = 319 loss, 731 gain	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Weight loss vs. gain	2.22 (1.32, 3.73)	0.003	2.96 (1.65, 5.31)	<0.0001	3.31 (1.69, 6.47)	<0.0001
Age	1.01 (0.98, 1.03)	0.58	1.01 (0.98, 1.04)	0.58	1.01 (0.98, 1.04)	0.49
Male vs. female	0.88 (0.49, 1.57)	0.66	0.83 (0.44, 1.58)	0.57	0.87 (0.44, 1.71)	0.68
Education: college vs. high school	1.52 (0.88, 2.64)	0.13	1.66 (0.91, 3.03)	0.10	1.59 (0.84, 3.02)	0.15
Education: graduate vs. high school	1.02 (0.42, 2.52)	0.96	1.16 (0.43, 3.12)	0.77	1.06 (0.34, 3.28)	0.92
Cancer	0.64 (0.32, 1.28)	0.21	0.40 (0.18, 0.90)	0.026	0.62 (0.26, 1.48)	0.28
Cholesterol problems	1.04 (0.56, 1.92)	0.90	0.79 (0.40, 1.54)	0.49	0.84 (0.42, 1.66)	0.61
COPD	1.40 (0.55, 3.54)	0.48	2.31 (0.77, 6.87)	0.13	1.69 (0.55, 5.18)	0.36
Heart disease/heart attack	0.92 (0.50, 1.69)	0.78	0.71 (0.35, 1.43)	0.34	0.92 (0.44, 1.96)	0.84
Stroke/TIA	0.70 (0.22, 2.17)	0.53	0.43 (0.12, 1.57)	0.20	0.53 (0.14, 2.02)	0.35
Weight at baseline	0.992 (0.987, 0.997)	0.003	0.991 (0.986, 0.997)	0.003	0.99 (0.986, 0.998)	0.011
PHQ-9 at baseline	1.30 (1.22, 1.40)	<0.0001	1.28 (1.19, 1.38)	<0.0001	1.26 (1.16, 1.35)	<0.0001

Baseline: 2008 survey data. CI: confidence interval; COPD: chronic obstructive pulmonary disease; PHQ-9: Patient Health Questionnaire-9; T2DM: type 2 diabetes mellitus; TIA: transient ischemic attack.

Table 4. Change in depression (PHQ-9 scores and severity category) by weight change over 1 year for all SHIELD respondents.

Change in PHQ-9 depression scores	Weight loss	Weight gain of ≥1%	p-value
≥1 point change in depression score:			
>1% weight loss	N = 3509	N = 3769	0.003
Improved[a] depression score, %	31.0	28.2	
Stayed the same, %	34.3	33.5	
Worsened[b] depression score, %	34.7	38.3	
>3% weight loss	N = 2242	N = 3769	0.001
Improved depression score, %	32.6	28.2	
Stayed the same, %	32.6	33.5	
Worsened depression score, %	34.8	38.3	
>5% weight loss	N = 1403	N = 3769	<0.0001
Improved depression score, %	34.2	28.2	
Stayed the same, %	31.9	33.5	
Worsened depression score, %	33.9	38.3	
Change in depression category:			
>1% weight loss	N = 3509	N = 3769	<0.0001
Improved[c] depression category, %	11.7	11.2	
Stayed the same, %	76.1	73.4	
Worsened[d] depression category, %	12.2	15.4	
>3% weight loss	N = 2242	N = 3769	0.003
Improved depression category, %	13.1	11.2	
Stayed the same, %	74.1	73.4	
Worsened depression category, %	12.8	15.4	
>5% weight loss	N = 1403	N = 3769	<0.0001
Improved depression category, %	14.3	11.2	
Stayed the same, %	73.5	73.4	
Worsened depression category, %	12.3	15.4	

[a]improved score = decrease of ≥1 point in PHQ-9 score from 2008 to 2009; [b]worsened score = increase of ≥1 point in PHQ-9 score from 2008 to 2009; [c]improved category = decrease of 1 or more severity categories (severe to moderate or lower, moderate to mild or lower, mild to minimal) from 2008 to 2009; [d]worsened category = increase of 1 or more severity categories (minimal to mild or higher, mild to moderate or higher, moderate to severe). PHQ-9: Patient Health Questionnaire-9; SHIELD: Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes.

weight-loss group, 0.369 points lower for the >3% weight-loss groups, and 0.481 points lower for the >5% weight-loss group, compared with the weight-gain group. For change in depression severity category, respondents with weight loss had significantly greater odds of improvement vs. worsening in depression severity than respondents with weight gain after adjusting for baseline characteristics ($p < 0.01$) (**Table 5**). The greater odds of improving depression severity increased as weight loss increased, from 1.49 for >1% weight loss, 1.63 for >3% weight loss, to 1.64 for >5% weight loss.

9. Discussion

This study provides evidence of an additional benefit of weight loss that has not been explored previously among adults with T2DM. The study findings show an association between weight loss and improvement in depression over a 1-year period in adults with and without T2DM. Significantly more respondents, both T2DM and all respondents who lost weight improved their depression scores compared with respondents who gained weight. Furthermore, respondents with weight loss had significantly greater odds of improving depression severity compared with respondents with weight gain: greater odds of 222% - 331% for T2DM respondents and 49% - 64% for all respondents. Improvement in depression scores and improvement in severity of depression increased as weight loss increased.

With the association of weight loss and improvement in depression established in the present study, it is

Table 5. Logistic regression odds ratio for improvement vs. worsened depression severity category adjusted for patient characteristics among all SHIELD respondents.

Variables	>1% weight loss N = 3509 loss, 3769 gain		>3% weight loss N = 2242 loss, 3769 gain		>5% weight loss N = 1403 loss, 3769 gain	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Weight loss vs. gain	1.49 (1.17, 1.90)	0.001	1.63 (1.24, 2.13)	<0.0001	1.64 (1.20, 2.24)	0.002
Age	1.00 (0.99, 1.01)	0.60	1.00 (0.99, 1.01)	0.46	1.00 (0.99, 1.01)	0.91
Male vs. female	1.08 (0.82, 1.42)	0.60	1.13 (0.84, 1.52)	0.43	1.18 (0.86, 1.62)	0.31
Education: college vs. high school	0.97 (0.75, 1.27)	0.84	1.09 (0.82, 1.45)	0.56	1.05 (0.78, 1.43)	0.74
Education: graduate vs. high school	1.02 (0.69, 1.51)	0.92	1.03 (0.67, 1.58)	0.88	0.91 (0.57, 1.46)	0.71
Cancer	0.92 (0.64, 1.33)	0.66	0.76 (0.50, 1.14)	0.18	0.77 (0.49, 1.20)	0.24
Cholesterol problems	0.83 (0.64, 1.08)	0.17	0.78 (0.58, 1.04)	0.09	0.83 (0.61, 1.12)	0.21
COPD	1.19 (0.72, 1.97)	0.49	1.18 (0.68, 2.04)	0.56	1.11 (0.62, 1.97)	0.73
Diabetes	1.01 (0.78, 1.31)	0.92	1.09 (0.82, 1.44)	0.56	1.09 (0.81, 1.47)	0.57
Heart disease/heart attack	0.94 (0.68, 1.32)	0.73	0.91 (0.63, 1.31)	0.60	1.10 (0.68, 1.49)	0.96
Stroke/TIA	0.76 (0.44, 1.33)	0.34	0.72 (0.39, 1.31)	0.28	0.65 (0.34, 1.24)	0.19
Weight at baseline	0.996 (0.994, 0.998)	0.001	0.996 (0.994, 0.999)	0.003	0.997 (0.994, 1.000)	0.025
PHQ-9 at baseline	1.31 (1.26, 1.35)	<0.0001	1.29 (1.25, 1.34)	<0.0001	1.27 (1.23, 1.32)	<0.0001

Baseline: 2008 survey data. CI: confidence interval; COPD: chronic obstructive pulmonary disease; PHQ-9: Patient Health Questionnaire-9; SHIELD: Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes; TIA: transient ischemic attack.

possible to hypothesize that anti-diabetic therapy that provides a weight-loss effect may have an indirect effect of improvement of depression. Weight loss may also lead to better adherence with anti-diabetic therapy, which may lead to better glycemic control and slowing the rate of diabetes progression. Several studies have demonstrated that weight loss was related to better adherence with therapy [8] [9]. Additionally, a previous SHIELD investigation found that weight loss was associated with improved QOL [10]. In the study by Grandy *et al.* [10], the domains of QOL, including emotional health, self-esteem, and overall QOL, showed that more respondents who lost weight had improvement in these domains than respondents who gained weight. Similarly, other studies have shown that weight loss was associated with improvement in QOL [15] [16]. The present study strengthens the support for the association between weight loss and improved mental health, specifically depression.

However, it remains to be proved that these associations are causal. Further research is needed to determine whether weight loss caused the respondents' depression to improve rather than both occurring simultaneously. Furthermore, it is important to determine if improved depression along with weight loss will assist adults with T2DM to better manage their diabetes and control their glucose levels. For adults without T2DM, it would be important to understand if improved depression along with weight loss will assist them with maintaining good health and preventing the onset of chronic conditions like diabetes.

The present study used a large, population-based sample of T2DM respondents and respondents without T2DM to assess weight change and change in depression. There are limitations to the study that should be considered. The diagnosis of T2DM, weight, and depression symptoms were self-reported and could not be validated with laboratory tests or medical records review. However, this determination was made consistently for all respondent groups (e.g., weight loss and weight gain) evaluated in this study, so it should not have affected the comparison across groups. Household panels, like the TNS NFO, tend to under represent the very wealthy and very poor segments of the population and do not include military or institutionalized individuals. These limitations are true for most random sampling and clinically based methodologies. Self-selection bias may be present because respondents were those who could read and comprehend the survey. Information about glycemic control in the T2DM respondents was not collected in the SHIELD survey, so the impact of improved depression with weight loss on glycemic control could not be investigated.

In conclusion, there is an association between weight loss and improvement in depression over a 1-year period in adults with and without T2DM. Respondents with and without T2DM and weight loss had higher odds of improving depression scores and severity. Improvement in depression increased as weight loss increased.

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