



Published in final edited form as:

Obesity (Silver Spring). 2014 December ; 22(12): 2532–2538. doi:10.1002/oby.20916.

Depression, Stress and Weight Loss in Individuals with Metabolic Syndrome in SHINE, a DPP Translation Study

Paula M. Trief, PhD^{1,2}, Donald Cibula, PhD³, Linda M. Delahanty, MS, RD⁴, and Ruth S. Weinstock, MD, PhD²

¹Dept. of Psychiatry & Behavioral Sciences, SUNY Upstate Medical University

²Dept. of Medicine, SUNY Upstate Medical University

³Dept. of Public Health & Preventive Medicine, SUNY Upstate Medical University

⁴Diabetes Research Center, Massachusetts General Hospital, and Dept. of Medicine, Harvard University

Abstract

OBJECTIVE—To examine the relationships between elevated depression symptoms (EDS) or stress and weight loss in SHINE, a telephonic, primary-care based, translation of the Diabetes Prevention Program.

DESIGN AND METHODS—N=257 adults with metabolic syndrome were randomized to individual (IC) or group (CC) phone participation. We assessed weight, depression, anti-depressant use (ADMs), and stress (baseline, 6 months, 1 and 2 years). Univariate analyses used linear and logistic regression, t-tests for continuous variables and exact tests for categorical variables. Stratified analyses assessed modifiers of effects of depression/stress on weight loss.

RESULTS—Approximately 35% reported EDS, with no change over time. Approximately 28% of all participants used ADMs. Participants with EDS had lower mean % weight loss and a smaller % who achieved 5% weight loss. Participants with EDS were less likely to be “completers” (40.1 % vs. 61.5%, p=.002), coached (48.0% vs. 60.7%, p=.049), or log diet/activity (19.4% vs. 42.7%, p<.001), behaviors related to weight loss. Results were similar for high stress. ADM use had no independent effect on weight loss.

CONCLUSIONS—Individuals with metabolic syndrome and EDS and/or high stress were less likely to lose significant weight. Pre-intervention depression and stress screening to intervene may improve weight loss.

Keywords

depression; stress; metabolic syndrome; weight loss; behavioral strategies

Users may view, print, copy, and download text and data-mine the content in such documents, for the purposes of academic research, subject always to the full Conditions of use:http://www.nature.com/authors/editorial_policies/license.html#terms

Corresponding Author: Paula M. Trief, PhD, Dept. of Psychiatry & Behavioral Sciences, SUNY Upstate Medical University, 750 E. Adams St., Syracuse, NY 13210. Phone: 315-464-3120; Fax: 315-464-3163; triefp@upstate.edu.

Authors have no relevant competing interests to disclose.

Introduction

Approximately 34% of US adults have metabolic syndrome (central obesity and at least two of: dyslipidemia, elevated blood pressure, elevated fasting glucose). Persons with metabolic syndrome are at increased risk for morbidity and mortality (e.g., cardiovascular disease, type 2 diabetes) (1). In the Diabetes Prevention Program (DPP), patients at-risk for diabetes who lost weight decreased their risk by 58% (2, 3). The program has become a gold standard weight loss intervention, with multiple adaptations reported (4, 5). To tailor interventions one must identify the psychological and behavioral characteristics of those who achieve significant weight loss. Race, higher initial weight and older age are reported as independent predictors of weight loss (6). Delahanty examined psychological (e.g., diet self-efficacy) and behavioral (e.g., activity) predictors in DPP lifestyle intervention participants (7) and reported that improvements in low-fat-diet self-efficacy and dietary restraint skills predicted weight loss.

Depression and stress are two factors shown to relate to weight loss, although some report no relationship (7–10), while others report a positive relationship (11, 12). In the DPP, neither depression nor anxiety/stress predicted weight loss (7). However, scores were low with little variability. The use of anti-depressants, also used to define depression, was linked to increased diabetes risk (13, 14). Studies with different samples (e.g., obese patients, weight loss achievers), interventions (e.g., DPP, other behavioral programs), measures, and time to follow-up, are difficult to compare. Here we examine the relationship between depression, stress and weight loss in the context of a randomized trial of an effective DPP translation.

We reported results of SHINE (Support, Health Information, Nutrition and Exercise), a randomized trial of a telephonic DPP, comparing individual call (IC) to group (conference call, CC) interventions (15). To summarize, both intervention arms lost significant weight after 1 year (IC: -4.6 ± 17.6 kg; CC: -4.9 ± 17.7 kg). After 2 intervention years, IC began to regain (-2.2 ± 14.2 kg), while CC continued to lose (-6.2 ± 14.3 kg). Also, completers (i.e., completed 9 of 16 core sessions) lost significantly more weight than non-completers (completers: -6.2 ± 11.8 kg; non-completers: -1.2 ± 20.5 kg). For these planned secondary analyses, participants completed measures of depression, stress, and use of anti-depressant medications, at baseline and follow-ups. We assessed the predictive value of these variables on weight loss, and the effect of the interventions on these variables.

Methods

Participants

Study approved by the Institutional Review Board for Protection of Human Subjects, SUNY Upstate Medical University. Methods have been described (15). Briefly, eligible participants at five diverse primary care practice (PCP) sites were recruited by letter. Inclusion criteria: >18 years old, BMI ≥ 30 kg/m², metabolic syndrome (International Diabetes Federation criteria (16). Exclusion criteria: diagnosed diabetes, severe medical problems that could interfere with participation. See Table 1 for demographic characteristics (N=257).

Interventions

Participants were randomized to individual or group involvement. DPP materials were adapted for telephonic delivery by educators (trained PCP staff, mostly LPNs) who followed DPP scripts. Contact was weekly for the first 5 weeks, then monthly for yr-1, monthly in yr-2. Dietitian coaches provided additional problem-solving support monthly during yr-1. Participants used “keeping track logs” of activity and diet behaviors, and self-weighed. Their goal was to lose 5% of baseline weight through dietary change and increased physical activity.

Assessments

A blinded research nurse performed standardized height/weight assessments at PCP sites and administered questionnaires, i.e., demographics, depression, stress, use of antidepressant medications. Educators logged attendance.

Depression and Stress Measures

1. *Center for Epidemiologic Studies-Depression Scale*, 20-items, measure of depressive symptoms (e.g., poor appetite, feeling lonely) experienced over the past week (17). Respondents report how often they experienced each symptom (0= rarely – 3= most/all of the time). Scores range from 0–60. Higher scores indicate more, and more severe, depressive symptoms. It has good internal consistency, sensitivity and specificity in identifying those at-risk for clinical depression (18); it is a depression screening tool, not used to diagnose clinical depression. We calculated the mean of the four CES-D scores and defined elevated depression symptoms (EDS) as a mean ≥ 16 , commonly used to define clinically significant depressive symptoms. We chose this method because individual variation over time was random and non-directional, this may be due to the short (past week) recall period in the measure. A mean score is likely to be more representative of depressive symptoms during the two intervention years.
2. *Anti-depressant use*, self-report. Participants listed their medications. SSRIs (e.g., paroxetine), SNRIs (e.g., venlafaxine) and TCAs (e.g., elavil) were coded as ADM (anti-depressant medication).
3. *Perceived Stress Scale* (19), 14-items, measure of how much stress the individual perceived over the past month. For ex., “In the last month, how often have you felt that you were unable to control the important things in your life?” (0= never – 4= often). Scores range from 0–56; higher scores describe higher levels of perceived stress. The PSS has demonstrated acceptable reliability and validity (19). We defined high stress as a PSS score ≥ 23 , a median split.

Statistical Analyses

Mixed linear model procedures (SPSS Ver. 22) were used to identify factors associated with variation in repeated measures of CES-D, PSS and weight over time. Generalized mixed linear model procedures (SPSS Ver. 22) with the logit link function were used to model dichotomized CES-D and PSS scores. Variables associated with outcomes of interest in

univariate analyses were simultaneously entered in multivariate regression models. Univariate analyses were conducted using linear and logistic regression, independent t-tests for continuous variables (with bias-corrected and accelerated confidence intervals produced by resampling procedures, when indicated) and exact tests for categorical variables. Stratified analyses of categorical analysis using Breslow-Day and Mantel-Haenszel statistics were used to assess modifiers of effects of EDS and PSS on achievement of 5% weight loss. All significance testing and confidence intervals were two-tailed and used a prior $\alpha=.05$. Sidak adjustment for multiple comparisons was used when indicated.

Results

Incidence of EDS

Approximately 35% of participants had EDS: baseline: 39.5%; 6 mos.: 37.6%; yr-1: 33.5%; yr-2: 36.4%. The percentage reporting ADM use showed little variation over time (27.4% – 30.3%). At baseline, about 43% with EDS reported ADM use, vs. 17.3% without EDS.

Participant characteristics and EDS/PSS

See Table 1, comparing those with baseline EDS (CES-D ≥ 16) and those below threshold, and those with high stress (PSS ≥ 23) and those below threshold, using univariate analyses. Those with EDS were more likely to be ≥ 45 years old (42.9% vs. 26.0%, $p=0.006$), with a lower mean age (48.0 vs. 54.2 yrs, $p<0.001$). They were more likely female (82.7% vs. 70.0%, $p=0.024$), single (39.8% vs. 19.3%, $p<0.001$), with annual incomes $\leq \$20K$ (28.6% vs. 13.3%, $p=0.003$), and without a high school diploma (19.4% vs. 3.3%, $p<0.001$). Those with EDS had higher mean weight (112.93 vs. 104.85 kg, $p=0.013$) and BMI (41.54 vs. 38.00 kg/m², $p=0.001$). Similarly, high stress individuals were more likely to be ≥ 45 years, female, white, single/divorced/separated, unemployed, with low education, and low income.

Independent predictors of EDS

Multiple linear regression of CES-D scores on factors associated with CES-D in univariate analysis (above) reveals that only employment status [$F(1,245)=24.89$, $p<.001$] and PSS score category (<23 vs. ≥ 23) [$F(1,245)=241.23$, $p<.001$] were significant predictors of mean CES-D ($aR^2 = .529$).

Change in EDS

Individual changes in CES-D scores from baseline were not significant at any follow-up [$F(3, 375) = 0.771$, $p=.511$] and did not differ between arms [$F(1,259) = 0.009$, $p=.926$]. Of those without baseline EDS, 25% progressed to EDS at follow-up; of those with baseline EDS, 41.3% remitted, a significant difference ($p=.032$). Progression to EDS was independent of ADM use (ADMs: 38.1% vs. no-ADMs: 21.1%, $p=.115$), as was remission (ADMs: 35.7% vs. no-ADMs: 45.7%, $p=.423$). Progression to EDS was also independent of group vs. individual intervention (IC: 27.1% vs. CC: 22.7%, $p=.630$), as was remission (IC: 37.0% vs. CC: 44.4%, $p=.554$). Therefore, for the following analyses we combined participants from both arms.

Association between EDS and weight loss

See Table 2. The EDS group had lower mean percent weight loss than those without EDS, at 6 months (-2.87 vs. -5.32 %, $p=.010$), yr-1 (-3.31 vs. -6.24 %, $p=0.028$) and yr-2 (-3.09 vs. -5.88 %, $p=0.066$). Those with EDS were less likely to achieve 5% weight loss than those without EDS at all assessments, i.e., EDS vs. not EDS: 6 months: 26.9% vs. 45.9%, $p=.011$; yr-1: 28.8% vs. 46.6%, $p=.034$; yr-2: 29.2% vs. 47.6%, $p=.038$. We examined the relationships between continuous mean CES-D and percent weight loss at yr-2, controlling for employment status, and found the same relationships as with the dichotomized groups (data not shown).

Association between ADM use and weight loss

ADM use had no independent effect on percent weight loss. At 6 months, the ADM-user group achieved a mean of 3.6% ($\pm 6.3\%$) weight loss vs. 4.4% ($\pm 7.0\%$) for the no-ADM group ($p=0.48$). At yr-1 and yr-2 the numbers were 3.6% ($\pm 7.8\%$) vs. 5.5% ($\pm 9.6\%$), $p=0.18$ and 3.7% ($\pm 8.5\%$) vs. 4.4% ($\pm 9.6\%$), $p=0.64$. Percentages of participants who achieved 5% weight loss did not differ at any assessment comparing those using/not using ADMs.

Association between perceived stress and weight loss

See Table 2. The high stress group had lower percent weight loss than lower stress group at 6 months (-3.17 vs. -5.61 %, $p=.009$), yr-1 (-3.40 vs. -6.77 %, $p=0.007$) and yr-2 (-2.94 vs. -6.56 %, $p=0.013$). The high stress group was less likely to lose 5% weight than low stress (yr-1:29.0% vs. 50.0%, $p=.008$, yr-2:28.8% vs. 50.7%, $p=.011$). We examined the relationship between continuous mean PSS and percent weight loss at yr-2 and found the same relationships as with the dichotomized groups (data not shown).

EDS and stress co-morbidity

Participants with EDS were more likely to have high PSS scores (90.8% vs. 20.0%, $p<0.001$). The mean PSS score for those with EDS was also significantly higher (28.70 vs. 17.40, $p<0.001$).

Relationship of EDS/stress to adherence behaviors

We defined completers ($N=117$) as participants who attended 9 of 16 core sessions (mean and median number of sessions=9; 9 is the threshold chosen by the Centers for Disease Control in awarding diabetes prevention program recognition) (20). As previously reported, completers lost more (6.2 ± 11.2 kg vs. 1.2 ± 20.5 kg), and a greater percentage of, weight (yr-2: $5.7 \pm 11.8\%$ vs. $1.3 \pm 20.9\%$). A higher percentage of participants who lost 5% weight were completers (yr-1:50.0% vs. 18.2%, $p<0.001$; yr-2:45.9% vs. 26.5%, $p=0.047$). Given these benefits of program completion, it is noteworthy that participants with EDS were less likely to be completers (Table 2). Of all participants, 40.1% of those with EDS were completers vs. 61.5% of those without EDS ($p=.002$). Individuals with EDS attended fewer education sessions (mean: 7.40 vs. 8.79 $p=.045$). However, at yr-1, EDS modified the relationship between completion and weight loss (Figure 1). Thus, for those without EDS, 57.5% of completers and 12.5% of non-completers lost 5% of weight ($p<0.001$), but for

those with EDS the difference was not significant (completers: 31.3% vs. non-completers: 25.0% lost 5% weight; $p=0.625$).

We defined being “coached” as attending 3 dietitian coaching sessions (median split) in yr-1. A greater percentage of those who lost 5% weight were coached vs. not coached (45.8% vs. 22.9%, $p=0.02$). When stratified by depression symptoms, those with EDS were less likely to be coached (48.0% vs. 60.7%, $p=.049$), and attended fewer coaching sessions (mean: 3.94 vs. 4.14, $p=.045$) than those without EDS (Table 2). Again, EDS modified the relationship between coaching and weight loss in yr-1 in that the positive link was found only for those without EDS, not for those with EDS (Figure 2).

Logging more (defined as 17 weeks, median split) was associated with weight loss at yr-1 and yr-2. A greater percentage of those who achieved 5% weight loss logged more (42.7% vs. 19.4%, $p<.002$), and 67.6% of those who logged more achieved that goal, vs. 16.0% of those who logged less ($p<.001$). The EDS group logged fewer weeks than non-EDS (9.59 vs. 17.82, $p<.001$) (Table 2). When stratified by EDS (yr-1), those with EDS who logged more were more likely to achieve goal (60.0% vs. 16.2%, $p=.002$), also true for those without EDS (69.5% vs. 15.9%, $p<.001$, Figure 3). At yr-2, for those with EDS there was no significant difference based on logging (42.9% of those who logged more lost 5% weight vs. 23.5% of those who logged less, $p=.18$), while for those without EDS the difference remained significant (60.8% of those who logged more lost 5% weight vs. 27.3% for those who logged less, $p=.003$).

Looking at the relationship of perceived stress to these behaviors results were similar, i.e., high stressed subjects were less likely to be completers (39.3% vs. 62.0%, $p<.001$), to be coached (46.7% vs. 63.6%, $p=.007$), and to log (18.3% vs. 47.3%, $p=.001$) than low stressed subjects (Table 2). Also, similar to EDS, stress modified the relationship between program completion and weight loss at yr-1, i.e., program completion predicted 5% weight loss for the low stress group ($p=.01$) but not for high stress participants (Figure 4). Similarly, stress modified the relationship between coaching and weight loss, i.e., coaching mattered for low stress participants ($p=.05$), but not for high stress (Figure 5). Stress did not modify the relationship between logging and per-cent weight loss at yr-1. Thus, for low stress participants, those who logged more were more likely to achieve their weight loss goal (67.8%) than those who logged less (19.9%, $p=.00$), this was also true for high stress subjects (65.0% vs. 14.3%, $p=.00$). Differences by stress group were not sustained at yr-2.

Possible additive effects of EDS and stress on successful weight loss

Depression and stress are tightly correlated: 90.8% of those with EDS had high PSS scores, and 80% of those without EDS had low PSS scores ($p<.001$). Of those without EDS, there was no significant difference between high and low stress groups in the percent who achieved 5% weight loss at yr-1 (35.0% vs. 49.4%, $p=.247$) or yr-2 (38.5% vs. 49.3%, $p=.472$). The small number of individuals with EDS but low stress with weight measurements negated statistical comparisons. Looking at percentages who met the 5% weight loss goal at yr-2, the numbers are: non EDS/low stress: 49.3%; non EDS/ high stress: 38.5%, EDS/high stress: 26.1%. While there may be an additive, negative effect of stress plus depression on weight loss, small numbers limit inferences.

Discussion

In this sample of adults with metabolic syndrome who participated in SHINE interventions, elevated depression symptoms, and high perceived stress, predicted less weight loss over the two intervention years. This was true at each assessment and whether weight loss was defined by kgs. lost or by having achieved the pre-planned goal of losing 5% of weight.

Also, elevated depression symptoms or stress appeared to have a negative impact on program participation. High depression and stress each predicted poorer educator and coach session attendance, as well as logging, all behaviors shown to predict positive weight loss in this study and others (21, 22).

The literature on the relationship between depression and weight loss yields mixed results. A recent review concludes that evidence does not support the assumption that pre-existing psychopathology precludes weight loss (8). In the DPP, baseline depression did not predict achievement of the 7% weight loss, or 150-minute physical activity, goals (21). Similarly, in a subset of DPP lifestyle intervention participants, baseline depression did not predict weight loss (7). Svetky studied people who achieved significant weight loss in maintenance programs, and also found no relationship of depression to weight loss (9). However, Elder reports that, while baseline depression did not predict weight loss after a 6-month behavioral program, change in depression over the course of the program was linearly associated with change in weight (23). And, in a study of DPP participants who lost 3% weight, anti-depressant use (but not depressive symptoms) predicted weight regain (12).

For stress, results are also mixed. Kim found no relationship between baseline stress and weight loss in women with diabetes not on insulin (10), nor did Svetky in his study of weight loss maintenance (9), while Elder found a positive and linear relationship between stress and weight loss (23).

Stubbs argues that one might expect a relationship between depression and weight loss if the intervention leads to decreased depressive symptoms, so that persistent depression might hinder weight loss (8). As noted above, most studies that examined depression following behavioral weight loss interventions found no change. In the DPP there was no change in depression over time (13). In the recent report from the LookAhead trial (diabetes patients), lifestyle intervention subjects without depression at baseline, compared to controls, were less likely to progress to likely depression (8 year follow-up), but they did not report the relationship of depression to weight loss (24). In this study we found no effect of the interventions on depressive symptoms, although a larger percentage improved than worsened. However, data from different studies are difficult to compare because measures of depression, subject groups and timeframes differ. The DPP is closest to SHINE, both involved patients at-risk for diabetes, and used DPP materials. However, the groups differed in several ways (e.g., SES, education), including in incidence of likely depression. In the DPP, 10.3% of participants were above the “mild depression” cut-off, and 5.7% took ADMs. In LookAhead, 18.2% were above cut-off and 17.1% used ADMs. In SHINE, 39% were above a comparable depression cut-off and about 29% used ADMs. Similarly, our

stress scores were higher than in Kim's study (21.6 vs. 19.4) (other PSS studies use different scales).

Stubbs also argues that, if the intervention results in weight loss, depression might play a role if it has a negative effect on intervention adherence. Depression may relate to higher program attrition, but findings are mixed (25). We found no difference in attrition for those with EDS and those without. In terms of other behaviors, Delahanty reported that higher baseline depression correlated with less physical activity, which related to weight loss, for male participants (7). In SHINE, adherence to three behaviors related to significant weight loss: participation in educator sessions (i.e., "completion"), in coach sessions, and logging. EDS and high stress were negatively related to each of these behaviors, suggesting that depression and stress may limit weight loss by negatively impacting behaviors that promote it. However, EDS modified the relationship between completion/coaching and weight loss in yr-1 and between logging and weight loss in yr-2. Similarly, stress modified the relationship between logging and weight loss in yr-2. This suggests that, for patients with EDS or high stress, even if they are actively involved in key behaviors, they are still less likely to lose weight.

Since 43% of those with EDS were taking ADMs, they may represent a depressed group whose depression treatment has not been fully effective. If true, more effective depression treatment (with ADMs and/or psychotherapy) might improve outcomes. Also, noting the significant overlap of CES-D and PSS scores raises the question of whether our results relate to depression as a psychiatric diagnosis or to general emotional distress. Finally, we don't know if high EDS/PSS individuals are less likely to lose weight due to biological and/or other behavioral factors. Clearly, further research is needed to tease out these complex relationships.

Limitations

Our sample had high rates of depression symptoms and stress, and was poorer, less educated, and predominantly white, which could limit generalizability. EDS was defined by questionnaire; results may have differed if EDS was defined through structured psychiatric interview, or clinical depression diagnosis.

Conclusion

Individuals with metabolic syndrome and elevated depressive symptoms and/or high stress were significantly less likely to lose weight after an effective behavioral weight loss intervention. This may relate to observed negative effects of depression and stress on behaviors known to promote weight loss, i.e., attendance and logging, though unmeasured factors may play a role. Therefore, one might screen for depression and stress to identify those less likely to lose weight. Certainly they should not be excluded, as almost 30% of EDS and high stress groups did lose significant weight. Nor should we assume that program involvement alone will ameliorate these symptoms. Instead, we should consider referral to behavioral health treatment, and develop innovative, tailored interventions to help them achieve their weight loss goals. This might involve a performance readiness task. In the DPP run-in phase, participants completed food/activity logs, and those who kept more detailed

logs lost more weight at yr-1 (22). It may be beneficial to use similar tasks to prepare at-risk participants, given the importance of logging. Other innovative strategies must be developed and tested.

ACKNOWLEDGMENTS

We thank participants, PCPs, educators, and Julie J. Stone, RN, Jane D. Bulger, MS, CCRC and Michael J. Wade, MS for data collection. PMT, RW and DC researched data; DC performed analyses; PMT, RW and DC wrote, LMD reviewed/edited, the manuscript. Study supported by grant R18-DK078553, National Institutes of Health. clinicaltrials.gov identifier: NCT 00749606.

References

1. Mozumdar A, Liguori G. Persistent increase of prevalence of metabolic syndrome among U.S. adults: NHANES III to NHANES 1999–2006. *Diabetes Care*. 2011 Jan; 34(1):216–219. [PubMed: 20889854]
2. Knowler WC, Fowler SE, Hamman RF. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss. *Lancet*. 2009; 374:1677–1686. [PubMed: 19878986]
3. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, Nathan DM. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002 Feb 7; 346(6):393–403. [PubMed: 11832527]
4. Ali MK, Echouffo-Tcheugui J, Williamson DF. How effective were lifestyle interventions in real-world settings that were modeled on the diabetes prevention program? *Health Aff (Millwood)*. 2012 Jan; 31(1):67–75. [PubMed: 22232096]
5. Boltri JM, Davis-Smith M, Okosun IS, Seale JP, Foster B. Translation of the national institutes of health diabetes prevention program in african american churches. *J Natl Med Assoc*. 2011 Mar; 103(3):194–202. [PubMed: 21671523]
6. West DS, Elaine Prewitt T, Bursac Z, Felix HC. Weight loss of black, white, and hispanic men and women in the diabetes prevention program. *Obesity (Silver Spring)*. 2008 Jun; 16(6):1413–1420. [PubMed: 18421273]
7. Delahanty LM, Peyrot M, Shrader PJ, Williamson DA, Meigs JB, Nathan DM. DPP Research Group. Pretreatment, psychological, and behavioral predictors of weight outcomes among lifestyle intervention participants in the diabetes prevention program (DPP). *Diabetes Care*. 2013 Jan; 36(1): 34–40. [PubMed: 23129133]
8. Stubbs J, Whybrow S, Teixeira P, Blundell J, Lawton C, Westenhoefer J, Engel D, Shepherd R, McConnon A, Gilbert P, Raats M. Problems in identifying predictors and correlates of weight loss and maintenance: Implications for weight control therapies based on behaviour change. *Obes Rev*. 2011 Sep; 12(9):688–708. [PubMed: 21535362]
9. Svetkey LP, Ard JD, Stevens VJ, Loria CM, Young DY, Hollis JF, Appel LJ, Brantley PJ, Kennedy BM, Kumanyika SK, Batch BC, Corsino L, Lien LF, Vollmer WM. Weight Loss Maintenance Collaborative Research Group. Predictors of long-term weight loss in adults with modest initial weight loss, by sex and race. *Obesity (Silver Spring)*. 2012 Sep; 20(9):1820–1828. [PubMed: 21527896]
10. Kim KH, Bursac Z, DiLillo V, White DB, West DS. Stress, race, and body weight. *Health Psychol*. 2009 Jan; 28(1):131–135. [PubMed: 19210027]
11. Aikens JE. Prospective associations between emotional distress and poor outcomes in type 2 diabetes. *Diabetes Care*. 2012 Dec; 35(12):2472–2478. [PubMed: 23033244]
12. Price DW, Ma Y, Rubin RR, Perreault L, Bray GA, Marrero D, Knowler WC, Barrett-Connor E, Lacoursiere DY. Diabetes Prevention Program Research Group. Depression as a predictor of weight regain among successful weight losers in the diabetes prevention program. *Diabetes Care*. 2013 Feb; 36(2):216–221. [PubMed: 23002085]

13. The Diabetes Prevention Program Research Group. Depression symptoms and antidepressant medicine use in diabetes prevention program participants. *Diabetes Care*. 2005; 28:830–837. [PubMed: 15793181]
14. Rubin RR, Ma Y, Marrero DG, Peyrot M, Barrett-Connor EL, Kahn SE, Haffner SM, Price DW, Knowler WC. Diabetes Prevention Program Research Group. Elevated depression symptoms, antidepressant medicine use, and risk of developing diabetes during the diabetes prevention program. *Diabetes Care*. 2008 Mar; 31(3):420–426. [PubMed: 18071002]
15. Weinstock RS, Trief PM, Cibula D, Morin PC, Delahanty LM. Weight loss success in metabolic syndrome by telephone interventions: results from the SHINE study. *J Gen Intern Med*. 2013; 12:1620–1628. [PubMed: 23843020]
16. Alberti KG, Zimmet P, Shaw J. IDF Epidemiology Task Force Consensus Group. The metabolic syndrome—a new worldwide definition. *Lancet*. 2005 Sep 24–30; 366(9491):1059–1062. [PubMed: 16182882]
17. Radloff LS. The CES-D scale: A self report depression scale for research in the general population. *Applied Psychological Measurements*. 1977; 1(3):385–401.
18. Lewinsohn PM, Seeley JR, Roberts RE, Allen NB. Center for epidemiologic studies depression scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging*. 1997 Jun; 12(2):277–287. [PubMed: 9189988]
19. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983 Dec; 24(4):385–396. [PubMed: 6668417]
20. Williamson, DF.; Marrero, DG. Scaling up type 2 diabetes prevention programs for high risk persons: progress and challenges in the united states. In: Schwartz, P.; Reedy, P.; Greaves, C.; Dunbar, J.; Schwarz, J., editors. *Diabetes prevention in practice, world progress on prevention of diabetes*. Dresden: Tumani Institute for Prevention Management; 2010. p. 69-81.
21. The Diabetes Prevention Program Research Group. Achieving weight and activity goals among diabetes prevention program lifestyle participants. *Obesity Research*. 2004; 12:1426–1434. [PubMed: 15483207]
22. Tsai AG, Fabricatore AN, Wadden TA, Higginbotham AJ, Anderson A, Foreyt J, Hill JO, Jeffery RW, Gluck ME, Lipkin EW, Reeves RS, Van Dorsten B. Readiness redefined: A behavioral task during screening predicted 1-year weight loss in the look AHEAD study. *Obesity (Silver Spring)*. 2014 Apr; 22(4):1016–1023. [PubMed: 24151217]
23. Elder CR, Gullion CM, Funk KL, Debar LL, Lindberg NM, Stevens VJ. Impact of sleep, screen time, depression and stress on weight change in the intensive weight loss phase of the LIFE study. *Int J Obes (Lond)*. 2012 Jan; 36(1):86–92. [PubMed: 21448129]
24. The Look Ahead Research Group. Impact of intensive lifestyle intervention on depression and health-related quality of life in type 2 diabetes: The Look AHEAD trial. *Diabetes Care*. 2014; 37:1544–1553. [PubMed: 24855155]
25. Moroshko I, Brennan L, O'Brien P. Predictors of dropout in weight loss interventions: A systematic review of the literature. *Obes Rev*. 2011 Nov; 12(11):912–934. [PubMed: 21815990]

What is already known about this subject?

- Depression may relate to poor weight loss outcomes.
- Stress may relate to poor weight loss outcomes.
- Results are mixed and studies are difficult to compare.

What does this study add?

- Depressive symptoms predicted poor weight loss outcomes within the context of a randomized clinical trial of a translation of the DPP weight loss intervention.
- Stress also predicted poor weight loss outcomes within this context.
- Both depressive symptoms and stress related to poorer adherence behaviors found to predict greater weight loss, i.e., participation and logging.

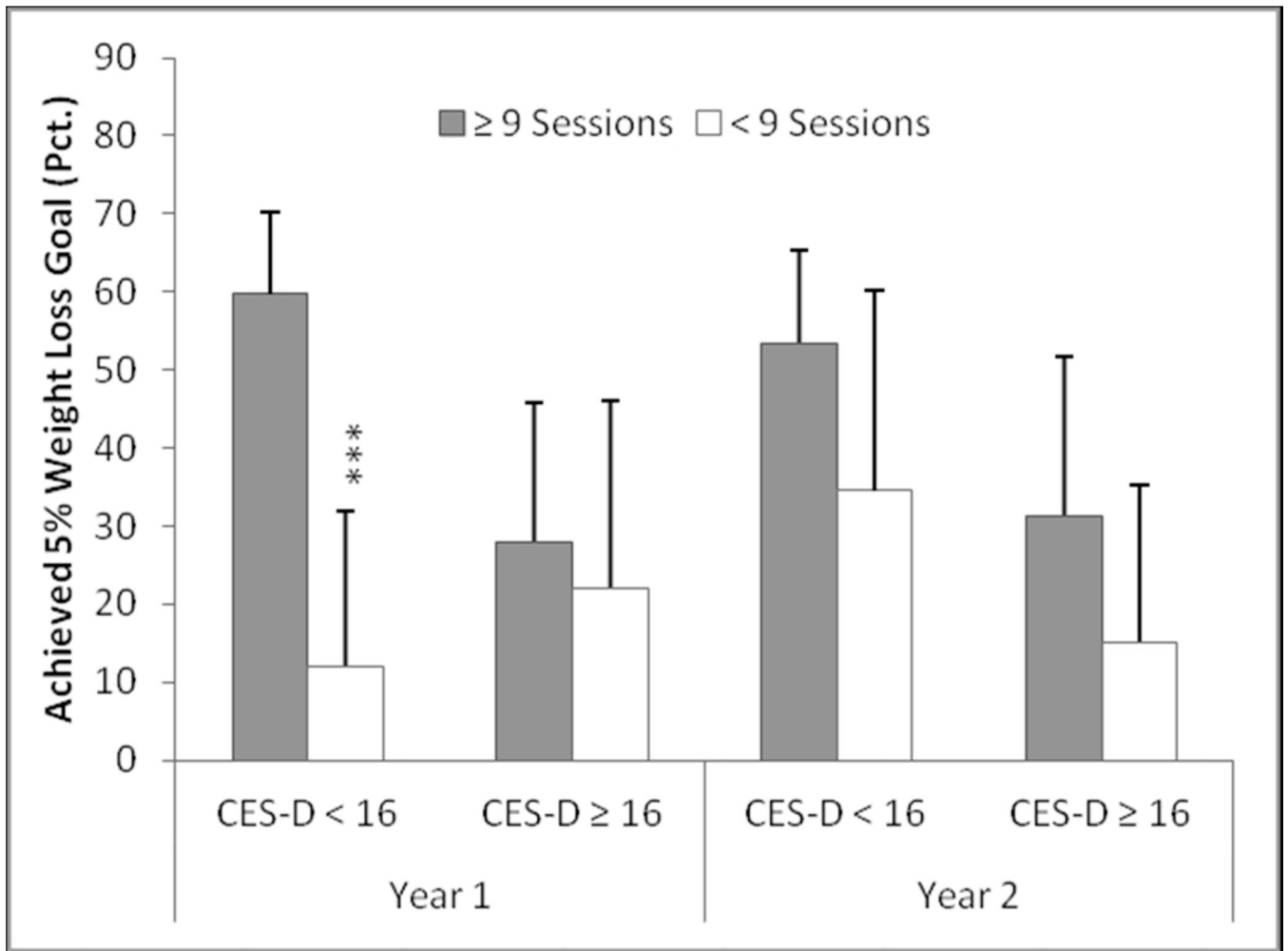


Figure 1. Percent of subjects achieving 5% weight loss stratified by CES-D category who were “completers” (completed ≥ 9 educator sessions) vs. not completers, years 1 and 2. *** P < .001

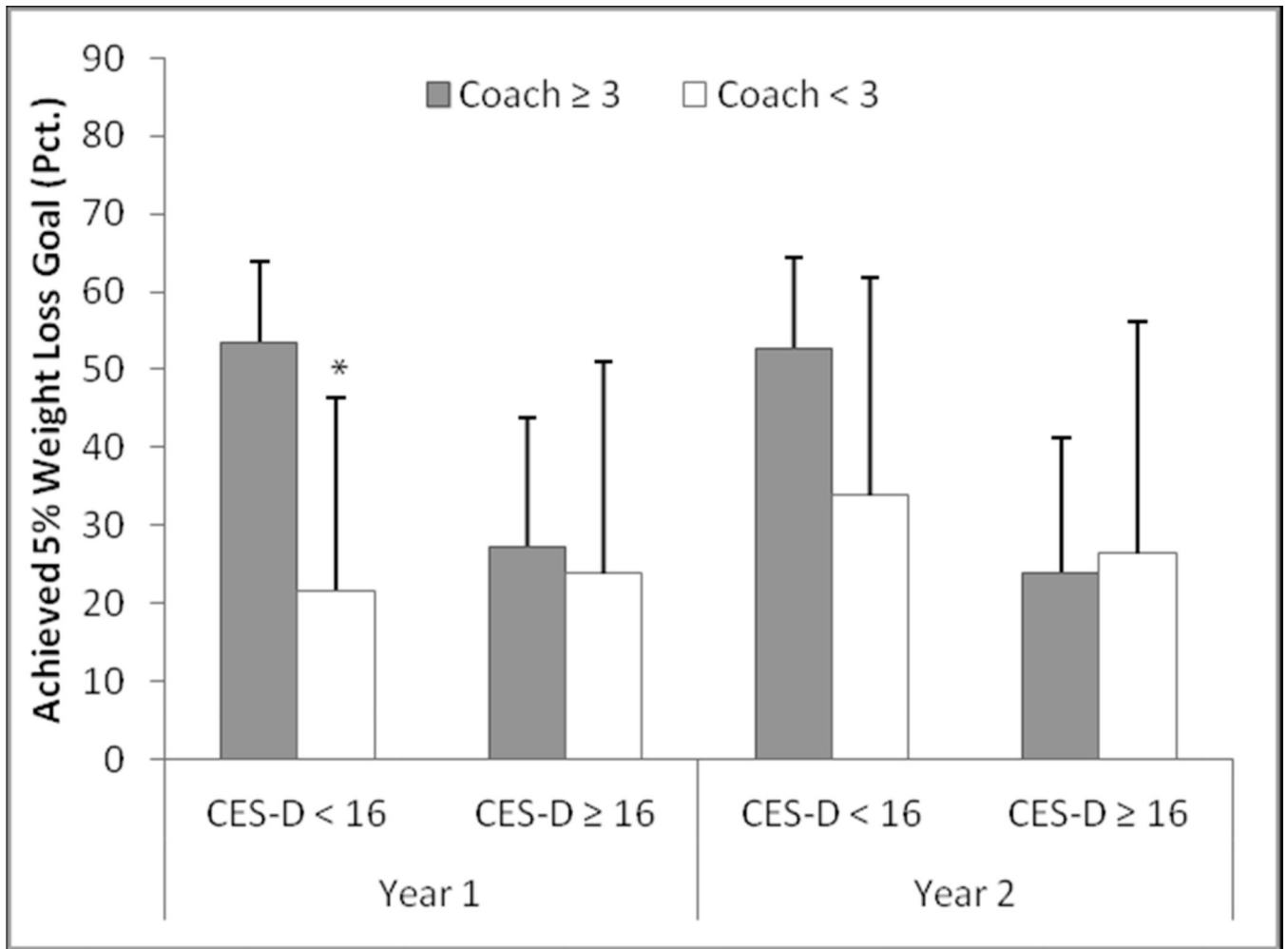


Figure 2. Percent of subjects achieving 5% weight loss stratified by CES-D category who were “coached” (completed 3 coaching sessions) vs. not coached, years 1 and 2.
*P < .05

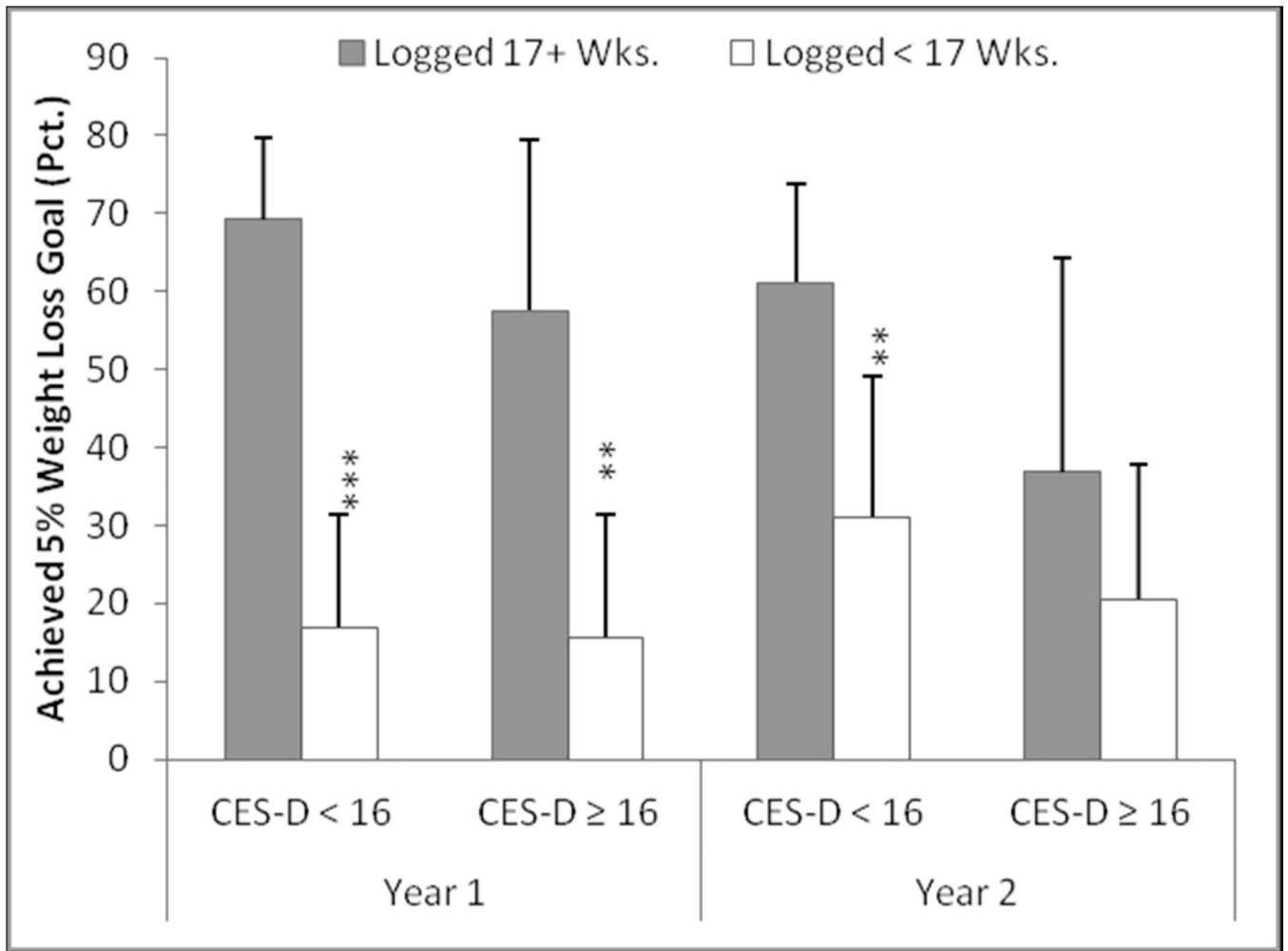


Figure 3. Percent of subjects achieving 5% weight loss stratified by CES-D category who logged more (logged diet/activity ≥ 17 weeks) vs. logged less, years 1 and 2.
 ** P < .01 *** P < .001

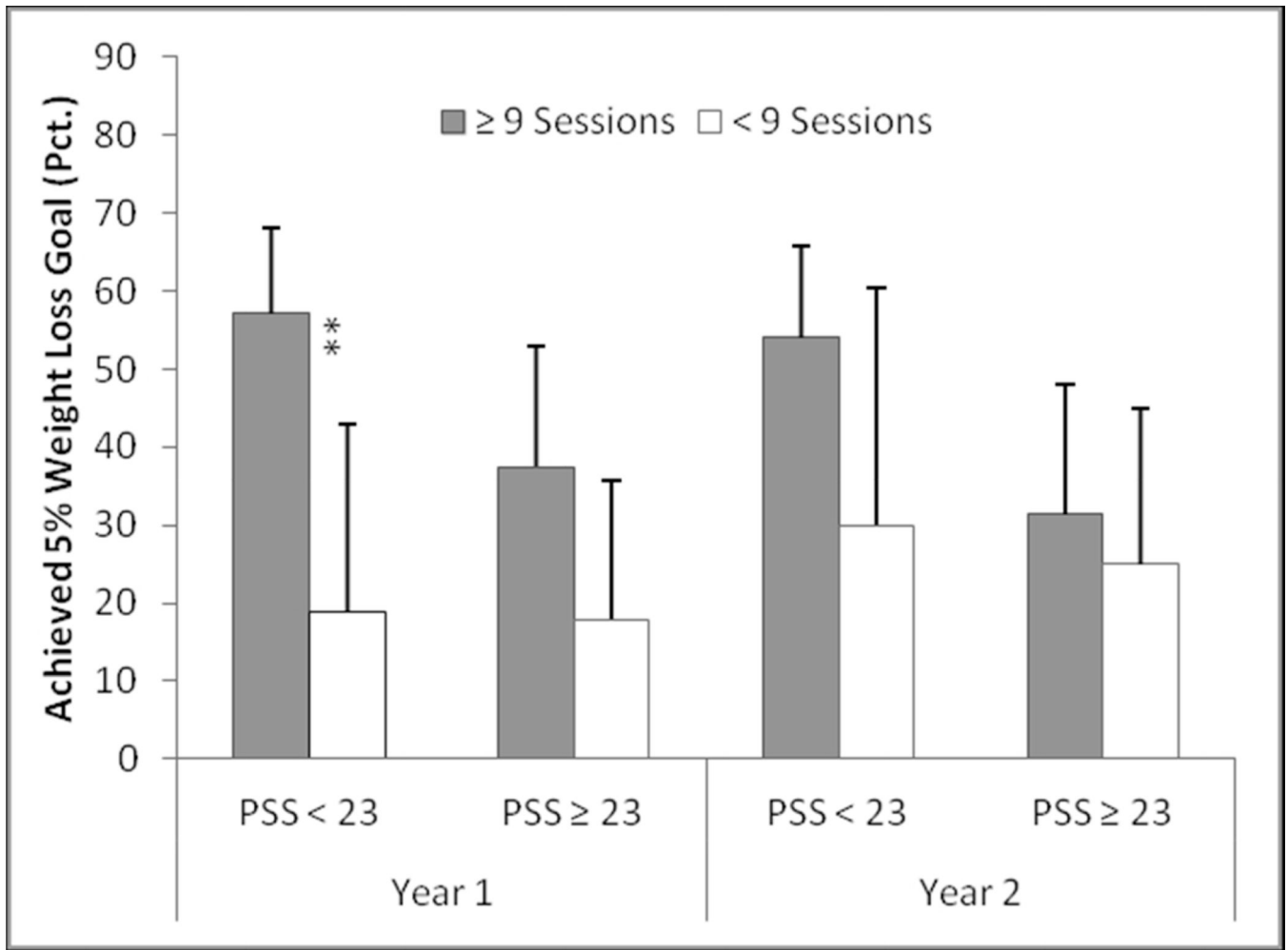


Figure 4. Percent of subjects achieving 5% weight loss stratified by PSS category who were “completers” (completion of 9 educator sessions) vs. not completers, years 1 and 2. ** P < .01

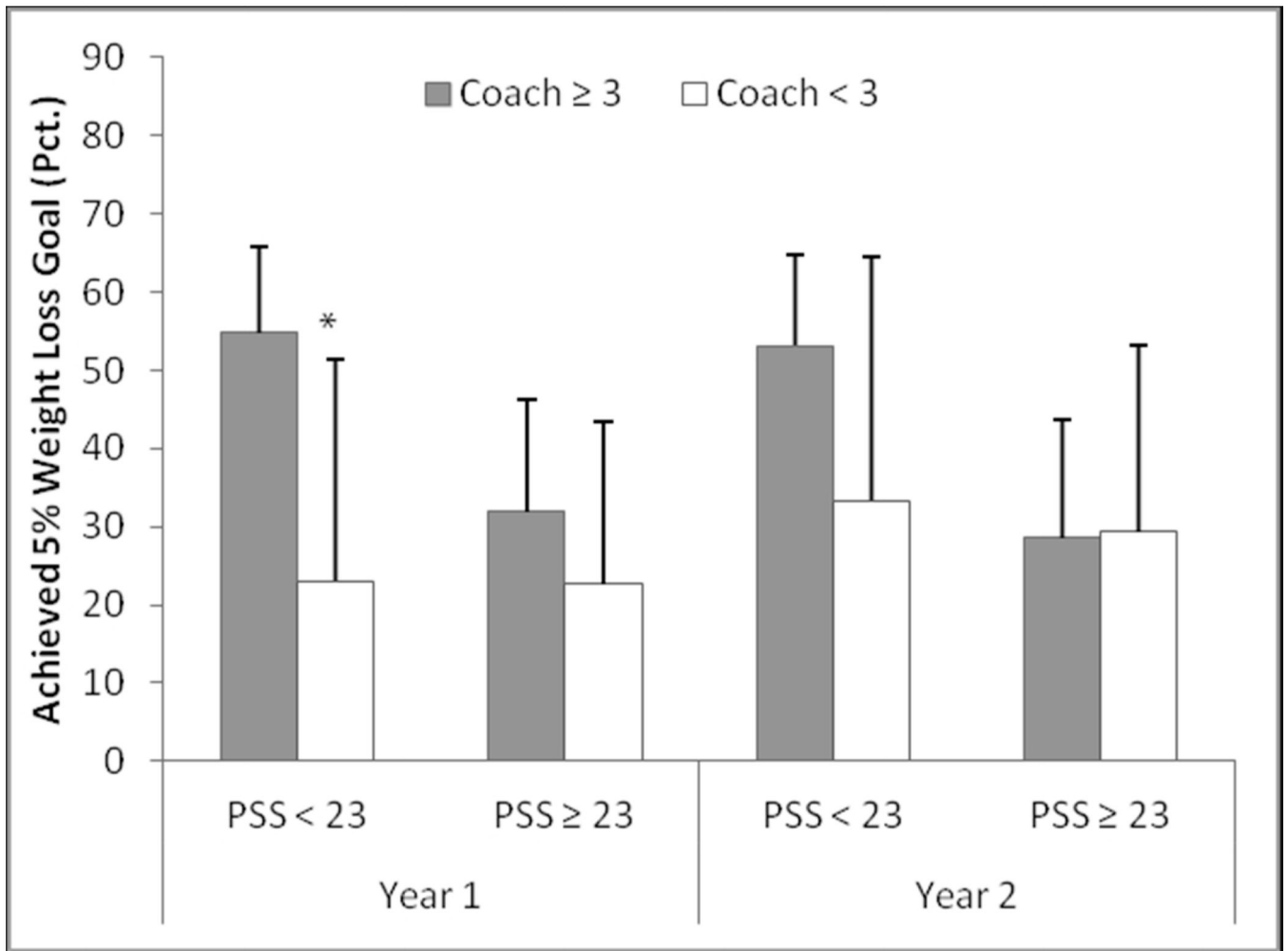


Figure 5.

Percent of subjects achieving 5% weight loss stratified by PSS category who were “coached” (completed 3 coaching sessions) vs. not coached, years 1 and 2.

*P < .05

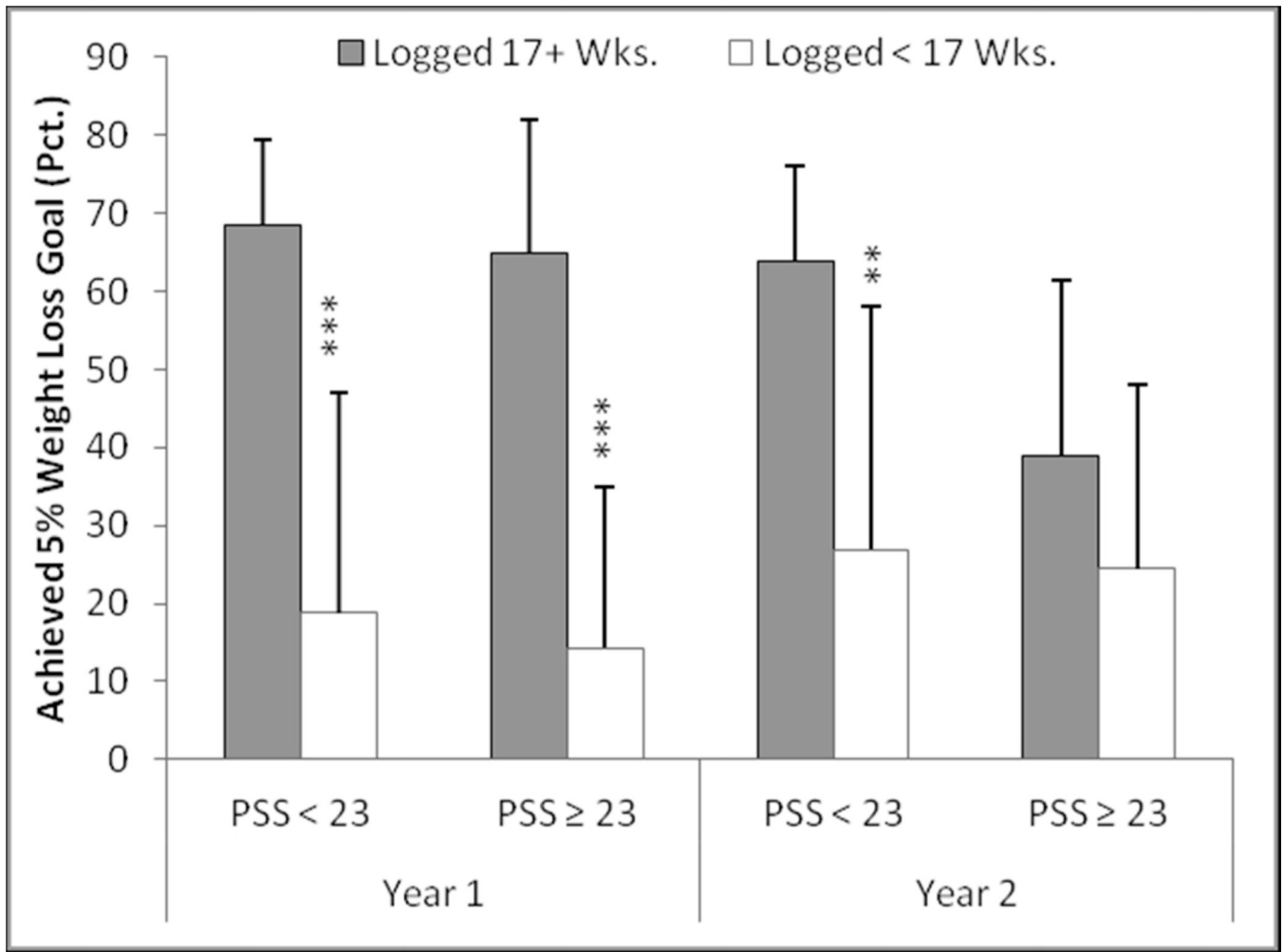


Figure 6. Percent of subjects achieving 5% weight loss stratified by PSS category who logged more (logged diet/activity ≥ 17 weeks) vs. logged less, years 1 and 2.
 ** P < .01 *** P < .001

Table 1

Baseline and demographic characteristics by CES-D and PSS categories

	CES-D <16 (n=150)	CES-D 16 (n=98)	PSS < 23 (n=129)	PSS 23 (n=120)	P
Gender: Female (%)	70.0	82.7	66.7	83.3	.003
Age Tertiles (Years, %)					
45	26.0	42.9	23.3	42.5	.001
46 – 59	36.7	38.8	37.2	37.5	.962
60	37.3	18.4	39.5	20.0	.001
Age (years, mean ± SD)	54.2 ±12.7	48.0 ±12.2	54.8±12.4	48.5±12.4	<.001
Race (%)					
White	87.2	83.7	90.6	80.8	.042
Black/ Other	12.8	16.3	9.4	19.2	.042
Education (%)					
No HS Diploma	3.3	19.4	6.2	13.3	.057
HS/ GED/ Tech Diploma	54.0	49.0	49.6	55.0	.395
AA Degree	14.7	16.3	15.5	15.0	.912
Bachelor's Degree	18.0	8.2	17.1	10.8	.158
Masters or Higher	10.0	7.1	11.6	5.8	.107
Employed (yes, %)	43.3	68.4	49.6	57.5	.212
Annual Income (%)					
\$20,000	13.3	28.6	13.2	25.8	.011
\$20,001 – 39,999	25.3	30.6	24.8	30.0	.358
\$40,000	51.3	26.5	51.9	30.8	<.001
Not reported	10.0	14.3	10.1	13.3	.699
Marital Status (%)					
Single	19.3	39.8	21.7	33.3	.040 ^f
Married	59.3	42.9	59.7	45.0	.020 ^f
Divorced or separated	13.3	12.2	10.9	15.8	.247
Widowed	8.0	5.1	7.8	5.8	.548
Weight (kg, mean ± SD)	104.8±21.6	112.9±29.0	106.3±22.4	109.8±27.5	.260
BMI (Mean ± SD)	38.±6.7	41.5±9.3	38.3±7.1	40.5±8.8	.030

	CES-D <16 (n=150)	CES-D 16 (n=98)	p	PSS < 23 (n=129)	PSS 23 (n=120)	p
Intervention arm (%)						
Individual calls (IC)	51.3	49.0	.717	51.9	49.2	.662
Conference calls (CC)	48.7	51.0	.717	48.1	50.8	.662
CES-D Score (mean ±SD)	7.9±5.7	25.5±8.9	<.001	7.6 ±5.9	22.7±10.3	<.001
PSS Score (mean ± SD)	17.4±7.1	28.7±5.2	<.001	15.5±5.9	28.8±4.6	<.001
Taking ADMs (%)	17.3	43.0	<.001	20.2	35.0	.009

[†] Sidak-adjusted α is smaller than p-value; difference is not statistically significant

Table 2

Behavioral and weight loss outcomes by CES-D and PSS categories

	CES-D <16 (n=150)	CES-D 16 (n=98)	PSS <23 (n=129)	PSS 23 (n=120)	p	
Completed 9 ed. sessions (%)	59.9	38.5	.002	62.0	39.3	.001
Kept journal 17 weeks (%)	42.7	19.4	<.001	47.3	18.3	<.001
Mean # educ. sessions attended	8.8	7.4	.045	9.2	7.1	.003
Mean # coaching sessions	4.8	3.6	.026	5.0	3.5	.004
Mean # weeks logging	17.8	9.6	<.001	19.3	9.4	<.001
5% weight loss (%) ^a						
at 6 months	45.9	26.9	.011	46.4	29.6	.022
at yr-1	46.6	28.8	.013	50.0	29.0	.008
at yr-2	47.6	29.2	.007	50.7	28.8	.011
% weight loss from baseline ^a						
at 6 months	-5.4	-2.7	.008	-5.5	-3.0	.006
at yr-1	-6.3	-2.9	.012	-7.2	-2.9	<.001
at yr-2	-6.0	-2.1	.001	-6.8	-2.4	.003

^a adjusted for employment status