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PTSD Symptom Decrease and Use of Weight Loss Programs

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Abstract

Objective—Posttraumatic stress disorder (PTSD) is associated with poor health behaviors, including low utilization of Veteran Health Affairs (VHA) weight loss programs. It is not known if clinically meaningful PTSD improvement is associated with increased use of weight loss programs.

Methods—Medical record data was obtained from VHA patients who received PTSD specialty care between Fiscal Year (FY) 2008 to FY2012. Clinically meaningful PTSD improvement was defined as ≥20 point PTSD Checklist (PCL) decrease between the first PCL ≥ 50 and a second

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PCL at least 8 weeks later and within 12 months of the first PCL. Eligible patients, n=993, were followed through FY2015. Propensity scores and inverse probability of exposure weighting controlled confounding. Cox proportional hazard models estimated the association between clinically meaningful PCL decrease and weight loss clinic utilization. Supplemental analysis compared both PTSD groups vs. no PTSD.

Results—Patients were 44.8 (SD ±14) years of age, 88.9% male and 66.8% white. Patients with vs. without a clinically meaningful PCL decrease were more likely to use a weight loss clinic (HR=1.37; 95%CI:1.02–1.85). Among those with a weight loss encounter, PCL decrease was not associated with the number of encounters (RR=1.13; 95%CI:0.70–1.81). Compared to no PTSD, patients with PTSD improvement had more weight loss encounters.

Conclusions—Large improvements in PTSD are associated with increased utilization of weight loss programs, and PTSD is not a barrier to seeking weight loss counseling. Research to understand why improvement in PTSD is not related to better weight loss outcomes is needed.

Keywords

cohort; epidemiology; health services; nutrition; posttraumatic stress disorder; veteran; weight

INTRODUCTION

Patients with PTSD are more likely to be overweight and obese compared to patients without PTSD.[1–3] A meta-analysis found patients with PTSD are 1.4 to 2 times more likely to be obese, compared to those without PTSD.[1,3]

Persistent obesity in patients with PTSD may be due to barriers these patients face in seeking health behavior change. A recent study found that compared to patients free of psychiatric disorders, those with PTSD reported more pain, stress and depression as barriers to improving diet.[4] Compared to veterans with no mental health diagnosis, patients with PTSD had a significantly lower probability of receiving an adequate number of visits to the Veterans Health Administration (VHA) weight loss program called “MOVE!”.[5]

Completing PTSD treatment has been associated with improved self-reported health, improved sleep[6,7], lower blood pressure[8], improved depression[9–11] decreased risk for type 2 diabetes[12], less mental health services use[13] and increased self-efficacy.[14] We recently found patients with vs. without a large clinically meaningful improvement in PTSD over a year did not experience a parallel improvement in BMI over the same time frame.[15] This suggests improvements in PTSD may not lead to rapid weight loss. However, to our knowledge, there are no studies that have determined if clinically meaningful PTSD improvement is associated with increased likelihood of seeking weight loss treatment. Thus, it is not known if participation in weight and nutrition programs is more likely among patients who experience clinically meaningful PTSD improvement, compared to those who experience none or less than clinically meaningful improvement.

The current study was designed to determine if clinically meaningful PTSD symptom decrease was 1) associated with using any type of weight loss clinic or nutrition counseling

(henceforth called weight loss programs) and 2) associated with the number of weight loss program encounters.

METHODS

All study procedures were approved by the Institutional Review Boards of participating institutions. In a retrospective cohort design, we obtained medical record data from VHA patients. Medical record data included information from ICD-9 diagnosis codes, vital signs, laboratory results, demographic data and type of clinic encounters (e.g. primary care clinic, PTSD specialty mental health clinics). Mental health domain data supplemented with chart abstraction were obtained to measure change in PTSD Checklist (PCL) scores. PCL scores were abstracted because VHA administrative medical record data do not capture all PCL scores. Abt Associates' (www.abtassociates.com) trained medical chart abstractors conducted chart abstraction. Details of chart abstraction have been previously reported.[15]

Eligible patients had ≥2 visits to a PTSD specialty clinic between fiscal years (FY) 2008 to FY2012 (10/1/2007 to 9/30/2012) at one of five VHA medical centers geographically dispersed across the United States. Follow-up continued until the end of FY2015 (9/30/2015). Patients were 18–70 years of age and had a PTSD diagnosis (n=5,916). After selecting patients with a PCL score ≥50 in FY2008 to FY2012, a value indicating a current PTSD diagnosis, we sampled those who had at least one subsequent PCL score within the following 12 months. The last PCL value in the 12 months must have been at least 8 weeks after the first PCL≥50 (n=1,814). The index date was 12 months after the first PCL≥50, and this 12 months was called the 'exposure year'. The exposure years occurred from FY2008 to FY2013 (10/1/2007 to 9/30/2013); thus, index dates could occur from the start of FY2009 to the end of FY2013 (10/1/2008 to 9/30/2013). Follow-up began at index date and continued through the end of available data (FY2015), which gave a follow-up time period to search for outcomes of 2 to 7 years for each patient.

Patients who had a history of bariatric surgery (n=10) were not eligible. We required patients to be obese (BMI≥30) or overweight (BMI 25 to <30) with an obesity/weight related disorder (n=1,260). Following Del Re and colleagues[18], obesity-related disorders included diabetes, hypertension, hyperlipidemia, coronary/ischemic heart disease, congestive heart failure, cholelithiasis, osteoarthritis, low back pain, gastroesophageal reflux and obstructive sleep apnea. We removed those who had used weight loss programs in the year prior to index (n=999). Lastly, patients must have had a VHA clinic encounter after index date (n=993). See Figure 1 for detailed cohort selection and Appendix A for detailed variable definitions.

Variable Definitions

PTSD was defined by the presence of ICD-9 code 309.81 on at least 2 separate outpatient visits within a 12-month period or one inpatient stay. This diagnostic algorithm has an 82% positive predictive value when compared to a gold standard PCLscore ≥50,[19] and 79.4% agreement with the Structured Clinical Interview for DSM-IV lifetime PTSD diagnosis.[20]

Exposure

Clinically meaningful PCL decrease was defined as ≥20 point decrease from first PCL≥50 and the last PCL in the exposure year. Those with < 20 point decrease or an increase were classified as not having a clinically meaningful decrease. While 10 points has been suggested as indicating clinically meaningful improvement,[21] we selected an a priori threshold shown to be associated with lower risk for type 2 diabetes.[15] Specifically, we used a 20 point threshold to increase the ability to detect an association between PTSD improvement and use of weight loss programs. Post-hoc analysis evaluated whether a 3-level PCL decrease defined as 1) no decrease, 2) PCL decrease 10–19 and 3) PCL decrease ≥20 point was associated with increasing likelihood of weight loss program use and number of weight loss encounters.

Outcomes

We used VHA clinic stop codes which indicate the type of care received during an encounter. Weight loss program use was defined by use of weight counseling, nutrition counseling or use of the VHA MOVE! program. MOVE! is an “evidence based, multidisciplinary, comprehensive” weight management program based on National Institutes of Health guidelines, implemented in 2005 and adopted nationally by 2008.[22] The number of unique weight loss program encounters were counted from first session through FY2015, among those with any program utilization.

Follow-up time

Follow-up time for outcomes associated with any utilization was measured as days since index date to either the start of any weight loss program or censor date, which was the last clinical encounter in FY2008 to FY2015. Index dates ranged from FY2009 to FY2013, giving a possible 2 to 7 years to search for outcomes to occur for each patient. For the number of unique weight loss encounters outcome, patients who started a weight loss program were followed from first weight loss program visit after index through the end of FY2015.

Covariates

Detailed covariate definitions are shown in Appendix A. Covariates included sociodemographic, comorbid conditions, antidepressant treatment and PTSD psychotherapy. Sociodemographic variables were age, race, gender, marital status, access to VHA insurance and volume of primary care utilization. The latter two variables control for detection bias because patients with private insurance may use non-VHA healthcare and high volume of healthcare use is associated with greater likelihood of diagnosis and treatment.

Comorbid conditions were measured prior to index date and included severe PTSD defined by initial PCL≥70, depression, anxiety disorders, substance use disorders, smoking and baseline BMI categories (overweight, class 1 obese, class 2 obese and class 3 obese). We controlled for 0, 1 or ≥2 obesity-related comorbidities. Minimally adequate antidepressant treatment was receipt of an antidepressant for ≥12 weeks and minimally adequate PTSD psychotherapy duration, measured in the exposure year, was defined as 9 or more visits in any 15-week period.

Propensity Score and Inverse Probability of Exposure Weighting

Our study was designed to measure the total association between clinically meaningful PCL decrease and use of weight loss programs. Therefore, we sought to remove differences in the distribution of covariates between patients who did vs. did not experience a clinically meaningful PCL decrease by computing propensity scores (PS) and inverse probability of exposure weighting (IPEW). The PS is a binary logistic regression model which estimates the probability of clinically meaningful PCL decrease vs. less than a clinically meaningful decrease given covariates.[23] Stabilized weights are computed using the PS and marginal probability of exposure group membership.[24,25] Effective PS modeling and weighting are indicated when weights have a mean close to 1 and a maximum < 10; therefore, weights ≥ 10 were trimmed.[25] Covariate balance between patients with and without a clinically meaningful PCL decreases after applying IPEW is indicated by standardized mean differences (SMD%)<10%) between exposure groups.[25–27]

Analytic approach

All analyses were performed using SAS v9.4 (SAS Institute, Cary, NC) at an alpha=0.05. The relationship of each covariate with PCL decrease groups was assessed with either a chi-square test for categorical variables or an independent samples t-test for continuous variables. SMD% assessed imbalance between PCL groups in weighted and unweighted data. In crude, unweighted data, Poisson regression models were used to calculate and assess differences in incidence rate per 1000 person-years (PY) for any weight loss encounter in each PCL decrease group.

All outcome models were calculated in unweighted (crude) and weighted by IPEW data. Robust, sandwich-type variance estimators were used to calculate confidence intervals and p-values in weighted data. Cox proportional hazard models were used to calculate hazard ratios and 95% confidence intervals for the relationship of PCL group and starting any weight loss program. The proportional hazard assumption was tested by examining the time-dependent interaction term of log follow-up time and PCL decrease ≥20 vs < 20 exposure variable, where a significant interaction term would indicate non-proportionality. Proportional hazard assumptions were met for all models (p's>.40). Differences in the average number of weight loss program encounters among the patients starting a weight loss program were assessed with rate ratios and 95% confidence intervals calculated with negative binomial regression models. Negative binomial models were used in place of Poisson count models to account for over-dispersed data.

Supplemental analysis

To determine if patients with PTSD who experience a clinically meaningful improvement differ in likelihood of using a weight loss program, as compared to patients without PTSD, we computed a supplementary analysis by sampling from 5,940 patients with ≥2 visits to a VHA PTSD specialty clinic but without PTSD in FY2008 to FY2012. From these patients, the eligible sample were those without any indication of PTSD (no diagnosis and/or PCL >35) from FY2008 to FY2015 (n=5,513). The non-PTSD exposure year was defined by the first visit to a PTSD specialty clinic, where index date is the end of the exposure year (one year after the first visit). The last visit in the exposure year must have been at least 8 weeks

from first (n=4,573). We excluded 13 patients with a history of bariatric surgery and those without a visit after the exposure year (n=4,238). Patients must have been obese, or overweight with a weight related condition, at the last visit in the exposure year (n=2,728). There were 2,411 non-PTSD patients eligible for analysis after removing patients who used weight loss programs in the year prior to index.

Because non-PTSD patients differ substantially from those with PTSD, controlling for confounding using PS and IPEW methods was not successful. Therefore, we computed Cox proportional hazard models to measure the hazard of using any weight loss program before and after controlling for age, gender, race, marital, VHA insurance, primary health care utilization, BMI category, depression, anxiety, substance use, smoking and number of obesity-related comorbidities. We did not control for first PCL, adequate antidepressant treatment and adequate PTSD psychotherapy when comparing clinically meaningful improvement to no PTSD.

Because use of weight loss clinics typically requires a primary care referral, we computed a sensitivity analysis limiting the cohort of non-PTSD patients and PTSD patients to those in the top 25th percentile of primary care clinic utilization. The measures and analytic approach were the same as that described in the previous paragraph.

RESULTS

On average, patients were 44.8 (SD±14) years of age, 88.9% male, 66.8% white and 21.6% black. Nearly 31% had severe PTSD (i.e. PCL ≥70) and 45.8% were overweight, 35.3% had class 1 obesity, 14.2% class 2 obesity and 4.7% class 3 obesity (Table 1). Follow-up time, or days since index to a weight loss encounter or censor date, ranged from 2 days to 2,555 days (7 years). Median follow-up time was 1,148 days (3.14 years), with an interquartile range of 735 days (2.01 years) to 1,581 days (4.33 years).

Table 1 shows the distribution of potential confounders by clinically meaningful PCL symptom decrease. Patients with severe PTSD were significantly (p=0.007) more prevalent among those who experienced clinically meaningful PCL decrease. In patients with a clinically meaningful PCL decrease, we observed the average first PCL was significantly (p<.001) greater and the average last PCL significantly (p<.001) less compared to those who did not have a clinically meaningful decrease. Minimally adequate duration of PTSD psychotherapy was significantly (p p<0.01) more prevalent among those with a clinically meaningful PCL decrease while adequate antidepressant treatment was significantly (p=.01) more common among patients who did not have a clinically meaningful PCL decrease. There were no other significant differences in the distribution of potential confounders by clinically meaningful PCL decrease.

PS and IPEW performed well with the maximum weight=3.29 and a mean weight of 1.0 (±0.22). No weights were trimmed. As shown in Table 2, PS and IPEW effectively balanced the distribution of potential confounding variables between patients with and without a clinically meaningful PCL decrease. This is indicated by all SMD < 10% in the weighted sample.

As shown in Table 3, prior to controlling for confounding with PS and IPEW, we observed no difference in the percent of patients who used any weight loss program in those who did and did not experience clinically meaningful PCL decrease. We observed the incidence rate for using any weight loss program was not significantly greater in those who had vs. did not have a clinically meaningful PCL decrease (111.7/1000PY vs. 86.5/1000PY, p=0.08). The average number of encounters for weight loss programs among those starting a program was nearly the same in both groups.

Results of all outcome models are shown in Table 4. After weighting data, patients with vs. without a clinically meaningful PCL decrease were significantly more likely to use any weight loss program (HR=1.37; 95%CI:1.02–1.85). There was little evidence for an association between clinically meaningful PCL decrease and number of weight loss clinic visits (RR=1.13; 95%CI:0.70–1.81).

Results from a supplementary analysis are shown in e-table 5. The incidence of any weight loss clinic use was lowest in non-PTSD controls (62.4/1000PY), followed by patients with PTSD who did not have a clinically meaningful PTSD symptom decrease (86.5/1000PY), followed by patients with a clinically meaningful symptom decrease (111.7/1000PY). Results from fully adjusted survival models indicated that compared to non-PTSD patients, those with a clinically meaningful PCL decrease were significantly more likely to use a weight loss program (HR=1.35; 95%CI:1.01–1.81). Patients with less than a clinically meaningful improvement did not significantly differ from non-PTSD controls in use of any weight loss program. In a fully adjusted model, both patients who did and did not experience a clinically meaningful PTSD decrease were significantly more likely to have more weight loss clinic use as compared to non-PTSD controls.

Sensitivity analysis, in a subset of patients who were in the top 25th percentile of primary care use, revealed similar results. In fully adjusted models (see e-table 6), as compared to non-PTSD patients, those who had a clinically meaningful PCL decrease were significantly more likely to use any weight loss program (HR=1.60; 95%CI:1.01–2.55). However, those without a clinically meaningful PCL decrease were not significantly more likely to use weight loss programs (HR=1.01; 95%CI:0.71–1.44). Patients with, but not those without, a clinically meaningful symptom decrease had more weight loss encounters compared to non-PTSD patients (RR=1.78; 95%CI:1.09–2.89).

Results of post-hoc analyses, measuring the association between a 3-level PCL decrease and any use of weight loss programs and number of weight loss program encounters did not support a dose-response relationship. As compared to no PCL decrease, a 10–19 point PCL decrease was unrelated to using any weight loss program (OR=0.92;95%CI:0.66–1.28), but a ≥20 point decrease was related to increased odds of weight loss program utilization (1.34; 95%CI:1.01–1.82). Increasing magnitude of PCL decrease was found to be unrelated to number of weight loss visits in those with any visits.

DISCUSSION

In VHA patients diagnosed with PTSD, we observed that a clinically meaningful decrease in PTSD symptoms was associated with a greater likelihood of using a weight loss program, although not with amount of program utilization. This association was independent of demographics, PTSD severity, BMI class, comorbid psychiatric disorders, number of obesity related comorbidities and receipt of adequate antidepressants and minimally adequate PTSD psychotherapy. Thus, meaningful improvement in PTSD appears to have a direct association with increased use of any form of VHA weight loss programs or nutrition counseling.

Results of a supplemental analysis pointed to evidence that patients with clinically meaningful PTSD improvement were more likely than non-PTSD patients to use any weight loss program. More visits to weight loss clinics occurred in patients with vs. without PTSD, regardless of symptom decrease. Our results are consistent with the majority of research on psychiatric disorders and use of weight loss or nutrition counseling. This prior research supports the conclusion that patients with psychiatric diagnoses are 13% to 58% more likely to use weight loss programs.[18,28–31] In contrast, research suggesting psychiatric disorders are associated with less MOVE! use have sampled from a MOVE! data base in which all patients had at least one MOVE! visit.[5,32] Therefore, these studies are not able to measure the association between psychiatric disorders and use vs. no use of weight loss programs. Most importantly, the present study expands this literature by demonstrating an association between PTSD symptom reduction and use of any weight loss program.

Patients with PTSD who experience large, clinically meaningful improvement may engage in weight and nutrition care because of increased self-efficacy following PTSD psychotherapy.[14] Persons with higher self-efficacy, i.e. confidence in their ability to change, are more likely to progress through stages of change leading to adoption of smoking cessation, exercise and a healthy diet.[33]

Nearly 75% of our sample had depression. Because depression may be a barrier to using weight loss programs in patients with PTSD,[4] we conducted post-hoc analysis in a sub-sample of 208 patients with two or more PHQ-9 scores in the exposure year to measure. Analysis compared change in PHQ-9 scores during the exposure year in patients with and without a clinically meaningful PTSD improvement. As we have previously found patients without PTSD improvement had similar PHQ-9 scores at the beginning and end of the exposure year (mean= 16.9±5.6 and mean =16.0±5.6, respectively).[15] Patients with a clinically meaningful PTSD improvement had a significant decrease in PHQ-9 scores from the beginning to the end of the exposure year (mean=14.5±7.4 and mean=8.4±5.3, respectively) which was significantly greater than those without PTSD improvement ($p<.001$). Patients with comorbid PTSD and depression may be more likely to use any weight loss program if both PTSD and depression symptoms decrease.

Because patients who have engaged PTSD specialty care have more VHA encounters than patients without PTSD, they may be more aware of available health promotion programs and have had more time to adjust day-to-day priorities to participate. Longitudinal studies of PTSD treatment outcomes are needed to measure if improved self-efficacy follows large

reductions in PTSD symptoms and leads to improvement in other health behaviors such as smoking cessation.

Unfortunately, even if PTSD improves and leads to more use of weight loss programs, existing evidence suggests these patients may not lose weight.[32] Despite patients with PTSD reporting a similar readiness for change, compared to those with no mental health disorders, patients with PTSD in one study identified more barriers (e.g. depression, stress, pain, arthritis) to changing diet and exercise habits.[4] Emotional eating among patients with PTSD may be another barrier to benefiting from participation in weight loss programs.[34] Independent of participating in weight and nutrition programs, the likelihood of losing 5% of baseline weight does not differ between patients who do vs. do not experience clinically meaningful PTSD symptom decrease.[15] This is particularly concerning because obesity is a risk factor for many chronic conditions and is central to the association between PTSD and incident diabetes.[35]

Using a similar design as the present study, we recently reported that patients with vs. without clinically meaningful PTSD improvement were 49% less likely to develop type 2 diabetes over a 2 to 7 year follow-up.[15] Surprisingly, at both the start and end of the year in which PTSD symptom decrease was measured, body mass index was very similar in patients with and without clinically meaningful symptom improvement. Obesity may explain the risk for incident type 2 diabetes in patients with PTSD compared to those without[35] but within persons who have PTSD, large symptom decrease does not appear to influence weight loss. Further research is needed to identify novel treatments for obesity that are effective for patients with PTSD.

Limitations

The results were from a VHA patient sample and may not generalize to non-veterans. However, studies of chronic opioid use and new onset depression and the association between metformin and incident dementia conducted with VHA patient data have been replicated in several civilian patients samples.[36,37] ICD-9 codes are not ideal for diagnosing PTSD but we used diagnostic algorithms, which have good agreement with gold standard diagnoses. It is possible that unmeasured confounding influenced our results. For instance, patients may have used weight and nutrition care prior to our observation period and if treatment did not help, it is unlikely they would seek out the same programs to lose weight. Lastly, although we balanced PTSD severity between exposure groups, we did not have measures of individual PTSD symptoms or qualifying traumatic events which may have different relationships with use of weight loss programs.

Conclusions

While our results indicate PTSD improvement is associated with increased use of weight loss programs, symptom decrease is not sufficient for weight loss given evidence that those with PTSD do not benefit as much as others when completing evidence based weight loss programs[32] and clinically meaningful PTSD improvement is not associated with weight loss (Scherrer et al. in review). Additional research is needed to understand why patients with PTSD have difficulty losing weight when engaged in evidence based weight loss programs

and future studies should identify factors behind persistent overweight and obesity even in those who experience large improvements in PTSD symptoms. Novel care delivery models should be developed to enable those with PTSD adopt healthy diets, increase exercise and lose and maintain weight loss.

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Appendix A. Variable definitions table

Any weight loss encounter – Clinic stop codes = 123, 124 (Nutrition/dietetics) or 372, 373 (MOVE!)
Number of weight loss encounters – *Only among those with a weight loss encounter.* Count unique clinic stops from first weight loss encounter to 9/30/2015
PCL checklist score difference (range of scores for PCL is 17–85) First PCL and last PCL in exposure year must be at least 8 weeks apart. A significant PCL decrease is defined as ≥ 20 point decrease (yes or no)
First PCL severity Severe – 70–85 Moderate – 50–69
End of follow-up = a. Any weight loss encounter = first stop code date or last visit date if no encounter b. Number of weight loss encounters = 9/30/2015
Baseline sociodemographics: Age, Gender, Race, marital status, VA only insurance
Primary healthcare utilization - number of unique primary care clinic stops per total months in entire VA system. Total months is calculated from first visit date to any VA facility in FY08 to FY15 to the index date. Stop codes from first VA visit to index date: 170, 172, 301, 322, 323, 348, 350
Depression –Presence of a single inpatient code or ≥2 outpatient codes within a 12 month period. Measured prior to index date. (296.2x, 296.3x, 311)
Other anxiety – Presence of a single inpatient code or ≥2 outpatient codes within a 12 month period. Measured prior to index date. Composite of panic disorder, ocd, social phobia, gad, anxiety nos (300.00, 300.01, 300.02, 300.23, 300.3)
Substance abuse/dependence –Presence in record of at least a single code for any alcohol or drug/abuse dependence before index date. Composite of alcohol (303.9x, 305.0x), sedative (304.1x, 305.4x), cocaine (304.2x, 305.6x), cannabis (304.3x, 305.2x), amphetamine (304.4x, 305.7x), hallucinogens (304.5x, 305.3x), 'other' (304.6x, 305.9x), opioid (304.0x, 305.5x), opioid with other SUD (304.7x), other SUD excluding opioid (304.8x), unspecified drug abuse/ dependence (304.9x).
Smoking/nicotine dependence – Any smoking = "current smoker" in health factors or ICD9 code for nicotine dependence (V15.82, 305.1) before index date.
Adequate ADM treatment – any continuous period of ≥12 weeks ADM fills prior to index date. ADMs are: selective serotonin re-uptake inhibitors (SSRIs: citalopram, escitalopram, fluvoxamine, fluoxetine, paroxetine, sertraline, and vilazodone); serotonin and norepinephrine reuptake inhibitors (SNRIs: venlafaxine, duloxetine, milnacipran, and desvenlafaxine); tricyclic antidepressants (TCAs: amitriptyline, desipramine, doxepine, imipramine, nortriptyline, trimipramine, clomipramine, maprotiline, protriptyline, amoxapine); non-classified antidepressants (bupropion, nefazodone, trazodone, and mirtazapine); and monamine oxidase inhibitors (MAOIs: selegiline, phenelzine, tranylcypromine, and isocarboxazid).
PTSD Psychotherapy = from the first PCL date to index date. Clinic stop codes include 516, 540, 541, 561, 562 at 'gold standard clinics' (STA6A=534, 539, 662, 664, 664BY). Classified as adequate treatment (in any 15 week period, had 9+ visits) – yes vs. no
Baseline BMI = last BMI in the year prior to index date. Classified as: Overweight (25 to < 30), Class 1 Obese (30 to < 35), Class 2 Obese (35 to < 40), Class 3 Obese (≥ 40)

# of obesity-related comorbidities – Sum total of number of comorbidities out of 10 up to index date, classified as 0 vs. 1 vs. ≥ 2
Obesity-related comorbidities – Occur anytime up to index date Diabetes (250.x, 357.2, 362.0x, 366.41) – 134 (13.5%) Hypertension (401.x, 402.x, 403.x, 404.x, 405.x) – 459 (46.2%) Hyperlipidemia (272.x) – 455 (45.8%) Coronary/Ischemic Heart Disease (429.0, 429.1, 429.2, 429.9, 410.x, 411.x, 412.x, 413.x, 414.x, 440.x) – 114 (11.5%) Congestive Heart Failure (402.x, 404.0x, 414.19, 425.4, 428.x, 429.1, 429.4, 997.1) – 30 (3.0%) Cholelithiasis (574.x) – 8 (0.8%) Osteoarthritis (715.x) – 234 (23.6%) Low Back Pain (722.x, 724.x, 846.x, 847.x) – 626 (63.0%) Gastroesophageal Reflux (530.11, 530.81, 530.2x787.1) – 284 (28.6%) Obstructive Sleep Apnea (780.57, 786.03, 327.20, 327.21, 327.23, 327.29) – 283 (28.5%)
History of Gastric bypass – Any occurrence from FY2008-FY2015 ICD9 = V45.86, V53.51 ICD9 procedure = 44.31, 44.38, 44.39, 44.68, 44.95, 44.96, 44.97, 44.98 CPT = 43770 to 43775, 43644, 43645, 43842, 43843, 43845, 43846, 43847, 43848, 43850, 43855, 43860, 43865, 43886, 43887, 43888

References

1. Bartoli F, Crocamo C, Alamia A, et al. Posttraumatic Stress Disorder and Risk of Obesity: Systematic Review and Meta-Analysis. Journal of Clinical Psychiatry. 2015;76(10):E1253–+. [PubMed: 26528647]
2. Suliman S, Anthonissen L, Carr J, et al. Posttraumatic Stress Disorder, Overweight, and Obesity: A Systematic Review and Meta-analysis. Harv Rev Psychiatry. 2016;24(4):271–293. [PubMed: 27384397]
3. van den Berk-Clark C, Secrest S, Walls J, et al. Association between posttraumatic stress disorder and lack of exercise, poor diet, obesity, and co-occuring smoking: A systematic review and meta-analysis. Health psychology : official journal of the Division of Health Psychology, American Psychological Association. 2018;37(5):407–416.
4. Klingaman EA, Hoerster KD, Aakre JM, Viverito KM, Medoff DR, Goldberg RW. Veterans with PTSD report more weight loss barriers than Veterans with no mental health disorders. General hospital psychiatry. 2016;39:1–7. [PubMed: 26719103]
5. Maguen S, Hoerster KD, Littman AJ, et al. Iraq and Afghanistan veterans with PTSD participate less in VA's weight loss program than those without PTSD. Journal of affective disorders. 2016;193:289–294. [PubMed: 26774516]
6. Gutner CA, Casement MD, Stavitsky Gilbert K, Resick PA. Change in sleep symptoms across Cognitive Processing Therapy and Prolonged Exposure: a longitudinal perspective. Behaviour research and therapy. 2013;51(12):817–822. [PubMed: 24184428]
7. Galovski TE, Monson C, Bruce SE, Resick PA. Does cognitive-behavioral therapy for PTSD improve perceived health and sleep impairment? Journal of traumatic stress. 2009;22(3):197–204. [PubMed: 19466746]
8. Schubert CF, Schreckenbach M, Kirmeier T, et al. PTSD psychotherapy improves blood pressure but leaves HPA axis feedback sensitivity stable and unaffected: First evidence from a pre-post treatment study. Psychoneuroendocrinology. 2019;100:254–263. [PubMed: 30391833]
9. Resick PA, Williams LF, Suvak MK, Monson CM, Gradus JL. Long-term outcomes of cognitive-behavioral treatments for posttraumatic stress disorder among female rape survivors. Journal of consulting and clinical psychology. 2012;80(2):201–210. [PubMed: 22182261]
10. Asukai N, Saito A, Tsuruta N, Kishimoto J, Nishikawa T. Efficacy of exposure therapy for Japanese patients with posttraumatic stress disorder due to mixed traumatic events: A randomized controlled study. Journal of traumatic stress. 2010;23(6):744–750. [PubMed: 21171135]
11. Resick PA, Wachen JS, Dondanville KA, et al. Effect of Group vs Individual Cognitive Processing Therapy in Active-Duty Military Seeking Treatment for Posttraumatic Stress Disorder: A Randomized Clinical Trial. JAMA psychiatry. 2017;74(1):28–36. [PubMed: 27893032]

12. Scherrer JF, Salas J, Norman SB, et al. Clinically meaningful PTSD improvement and risk for type 2 diabetes. JAMA psychiatry. In Press.
13. Tuerk PW, Wangelin B, Rauch SA, et al. Health service utilization before and after evidence-based treatment for PTSD. Psychological services. 2013;10(4):401–409. [PubMed: 23148769]
14. Cusack SE, Coleman JA, Rappaport LM, Sheerin C. Moderation of improvement in self-efficacy following group psychotherapy for PTSD. Psychological services. 2018.
15. Scherrer JF, Salas J, Norman SB, et al. Association Between Clinically Meaningful Posttraumatic Stress Disorder Improvement and Risk of Type 2 Diabetes. JAMA psychiatry. 2019.
16. Scherrer JF, Salas J, Friedman MJ, et al. Clinically Meaningful PTSD Improvement and Incident Hypertension, Hyperlipidemia and Weight Gain Health psychology : official journal of the Division of Health Psychology, American Psychological Association. In Review.
17. Van den Berk Clark C, Salas J, Gebauer S, et al. Society of Teachers of Family Medicine Annual Spring Conference, 2019, Toronto CA https://www.stfm.org/conferences/49/sessions/24005.
18. Del Re AC, Maciejewski ML, Harris AH. MOVE: weight management program across the Veterans Health Administration: patient- and facility-level predictors of utilization. BMC Health Serv Res. 2013;13:511. [PubMed: 24325730]
19. Gravely AA, Cutting A, Nugent S, Grill J, Carlson K, Spoont M. Validity of PTSD diagnoses in VA administrative data: comparison of VA administrative PTSD diagnoses to self-reported PTSD Checklist scores. Journal of rehabilitation research and development. 2011;48(1):21–30. [PubMed: 21328160]
20. Holowka DW, Marx BP, Gates MA, et al. PTSD diagnostic validity in Veterans Affairs electronic records of Iraq and Afghanistan veterans. Journal of consulting and clinical psychology. 2014;82(4):569–579. [PubMed: 24731235]
21. Monson CM, Gradus JL, Young-Xu Y, Schnurr PP, Price JL, Schumm JA. Change in posttraumatic stress disorder symptoms: do clinicians and patients agree? Psychological assessment. 2008;20(2):131–138. [PubMed: 18557690]
22. Kinsinger LS, Jones KR, Kahwati L, et al. Design and Dissemination of the MOVE! Weight-Management Program for Veterans. Preventing Chronic Disease. 2009;6(3).
23. Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika Trust. 1983;70:41–55.
24. Curtis LH, Hammill BG, Eisenstein EL, Kramer JM, Anstrom KJ. Using inverse probability-weighted estimators in comparative effectiveness analysis with observational databases.. Medical care. 2007;45:S103–S107. [PubMed: 17909367]
25. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. Statistics in medicine. 2015;34(28):3661–3679. [PubMed: 26238958]
26. Cole SR, Hernan MA. Constructing inverse probability weights for marginal structural models. American journal of epidemiology. 2008;168(6):656–664. [PubMed: 18682488]
27. Sturmer T, Wyss R, Glynn RJ, Brookhart MA. Propensity scores for confounder adjustment when assessing the effects of medical interventions using nonexperimental study designs. Journal of internal medicine. 2014;275(6):570–580. [PubMed: 24520806]
28. Desai MM, Rosenheck RA, Druss BG, Perlin JB. Receipt of nutrition and exercise counseling among medical outpatients with psychiatric and substance use disorders. Journal of general internal medicine. 2002;17(7):556–560. [PubMed: 12133146]
29. Noel PH, Copeland LA, Pugh MJ, et al. Obesity diagnosis and care practices in the Veterans Health Administration. Journal of general internal medicine. 2010;25(6):510–516. [PubMed: 20180155]
30. Copeland LA, Pugh MJ, Hicks PB, Noel PH. Use of obesity-related care by psychiatric patients. Psychiatric services (Washington, DC). 2012;63(3):230–236.
31. Littman AJ, Damschroder LJ, Verchinina L, et al. National evaluation of obesity screening and treatment among veterans with and without mental health disorders. General hospital psychiatry. 2015;37(1):7–13. [PubMed: 25500194]
32. Hoerster KD, Lai Z, Goodrich DE, et al. Weight loss after participation in a national VA weight management program among veterans with or without PTSD. Psychiatric services (Washington, DC). 2014;65(11):1385–1388.

33. O'Hea EL, Boudreaux ED, Jeffries SK, Carmack Taylor CL, Scarinci IC, Brantley PJ. Stage of change movement across three health behaviors: the role of self-efficacy. Am J Health Promot. 2004;19(2):94–102. [PubMed: 15559709]

34. Dorflinger LM, Masheb RM. PTSD is associated with emotional eating among veterans seeking treatment for overweight/obesity. Eat Behav. 2018;31:8–11. [PubMed: 30048898]

35. Scherrer JF, Salas J, Lustman PJ, et al. The Role of Obesity in the Association Between Posttraumatic Stress Disorder and Incident Diabetes. JAMA psychiatry. 2018;75(11):1189–1198. [PubMed: 30090920]

36. Scherrer JF, Salas J, Copeland LA, et al. Prescription Opioid Duration, Dose, and Increased Risk of Depression in 3 Large Patient Populations. Annals of family medicine. 2016;14(1):54–62. [PubMed: 26755784]

37. Scherrer JF, Salas J, Floyd JS, Farr SA, Morley JE, Dublin S. Metformin and Sulfonylurea Use and Risk of Incident Dementia Mayo Clinic Proceedings. In Press.

Highlights

- Posttraumatic stress disorder (PTSD) is linked to obesity
- PTSD associated with barriers to weight loss
- PTSD treatment is associated with improved self-efficacy
- Improvements in PTSD associated with use of weight loss program
- PTSD improvement not associated with adequate weight loss sessions

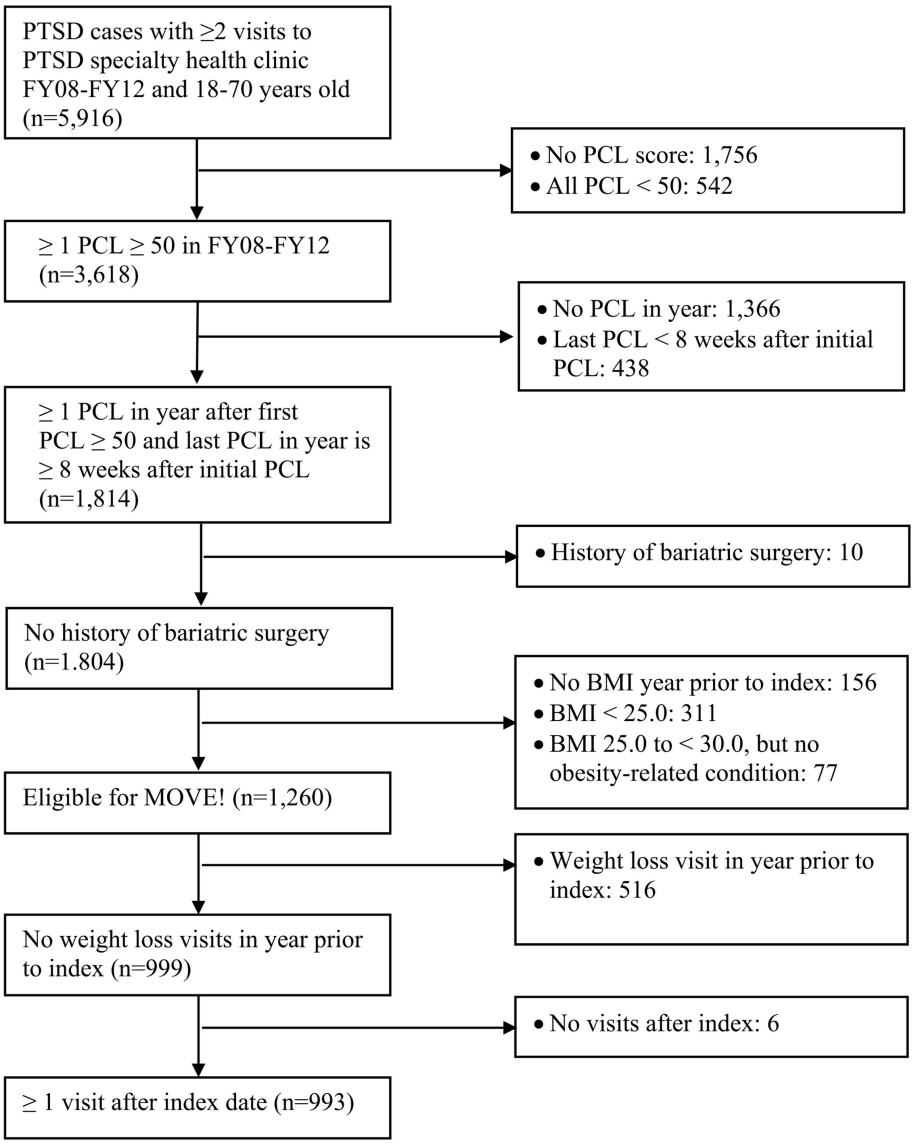

Figure 1.
Sample selection process

Table 1.

Sample characteristics in unweighted data, overall and by PCL decrease in veterans age 18–70 years and obese or overweight with a weight related comorbidity (n=993)

Variable, n(%) or mean (±sd)	Overall (n=993)	PCL dec < 20 (n=798)	PCL dec ≥ 20 (n=195)	p-value
Age (years), mean (±sd)	44.8 (±14.0)	44.5 (±13.9)	46.1 (±14.3)	.16
Male gender, n(%)	883 (88.9)	714 (89.5)	169 (86.7)	.26
Race, n(%)				
White	663 (66.8)	521 (65.3)	142 (72.8)	
Black	215 (21.6)	177 (22.2)	38 (19.5)	
Other	74 (7.5)	64 (8.0)	10 (5.1)	.17
Missing	41 (4.1)	36 (4.5)	5 (2.6)	
Married, n(%)	535 (53.9)	428 (53.6)	107 (54.9)	.76
VHA only insurance, n(%)	577 (58.1)	462 (57.9)	115 (59.0)	.78
High primary HCU, n(%)	249 (25.1)	205 (25.7)	44 (22.6)	.37
First PCL severe (≥70), n(%)	307 (30.9)	231 (28.9)	76 (39.0)	.01
First PCL, mean (±sd)	64.6 (±8.9)	64.1 (±8.9)	66.6 (±8.5)	<.001
Last PCL, mean (±sd)	56.5 (±15.9)	61.9 (±11.9)	34.6 (±10.3)	<.001
BMI, mean (±sd)	31.3 (±4.5)	31.3 (±4.5)	31.1 (±4.3)	.46
BMI category				
Overweight (25– < 30)	455 (45.8)	364 (45.6)	91 (46.7)	
Class 1 Obese (30 – < 35)	350 (35.3)	284 (35.6)	66 (33.9)	.97
Class 2 Obese (35 – < 40)	141 (14.2)	112 (14.0)	29 (14.9)	
Class 3 Obese (≥40)	47 (4.7)	38 (4.8)	9 (4.6)	
Comorbidities and treatments[a]				
Depression, n(%)	726 (73.1)	587 (73.6)	139 (71.3)	.52
Other anxiety, n(%)[b]	252 (25.4)	205 (25.7)	47 (24.1)	.65
Substance abuse/dependence, n(%)	393 (39.6)	316 (39.6)	77 (39.5)	.98
Any Smoking, n(%)[c]	459 (46.2)	364 (45.6)	95 (48.7)	.44
Adequate PTSD psychotherapy, n(%)[d]	448 (45.1)	341 (42.7)	107 (54.9)	.<0.01
Adequate ADM treatment, n(%)[e]	752 (75.7)	619 (77.6)	133 (68.2)	.01
# obesity-related comorbidities				
0	53 (5.3)	45 (5.6)	8 (4.1)	
1	258 (26.0)	202 (25.3)	56 (28.7)	.48
≥ 2	682 (68.7)	551 (69.1)	131 (67.2)	

PTSD=posttraumatic stress disorder; PCL=PTSD checklist (range: 17–85); FY=fiscal year; DEC=decrease; HCU=healthcare utilization; ADM=antidepressant

[a]Comorbidities occur from start of FY2008 to index date

[b]Composite of panic disorder, obsessive compulsive disorder, social phobia, generalized anxiety disorder, anxiety not otherwise specified.

[c]Health factors or ICD-9-CM code

[d]Measured in exposure year. Presence of at least 9 psychotherapy visits in any 15 week period.

[e] At least 12 weeks of continuous ADM fills prior to index date

Table 2.

SMD unweighted and weighted for potential confounders

Variable	Unweighted	Weighted
Age (years)	11.3%	0.1%
Male gender	−8.7%	1.5%
Race		
White	16.4%	−2.1%
Black	−6.6%	1.0%
Other	−11.7%	7.1%
Missing	−10.6%	−7.7%
Married	2.5%	0.1%
VHA only insurance	2.2%	0.6%
High primary HCU	−7.3%	0.02%
First PCL severe (≥70)	21.3%	−1.1%
BMI category		
Overweight (25– < 30)	2.1%	0.0%
Class 1 Obese (30 – < 35)	−3.7%	3.2%
Class 2 Obese (35 – < 40)	2.4%	−2.7%
Class 3 Obese (≥40)	−0.7%	−2.8%
Depression	−5.1%	1.8%
Other anxiety	−3.7%	−1.8%
Substance abuse/dependence	−0.2%	3.3%
Any Smoking	6.2%	3.2%
Adequate PTSD psychotherapy	24.5%	−6.5%
Adequate ADM treatment	−21.2%	−2.1%
# obesity-related comorbidities		
0	−7.1%	−0.9%
1	7.7%	1.3%
≥ 2	−4.0%	−0.8%

Table 3.

Crude comparisons - nutrition and weight loss program utilization

	Overall (n=993)	PCL dec < 20 (n=798)	PCL dec ≥ 20 (n=195)	p-value
Any weight loss program, n(%)	282 (28.4%)	220 (27.6%)	62 (31.8%)	.24
Any weight loss program, incident rate (1000PY)	91.0/1000PY	86.5/1000PY	111.7/1000PY	.08
# weight loss encounters, mean (±sd) [1]	5.2 (±8.3)	5.1 (±8.4)	5.2 (±8.3)	.94

[1]Among 282 the patients that had a weight loss encounter

Table 4.

Results from outcome models estimating the association of PCL decrease and weight loss encounter utilization outcomes.

	Model 1 – Crude	Model 2–Weighted
Any weight loss program	HR (95% CI)	HR (95% CI)
PCL dec ≥ 20	1.26 (0.95–1.67)	1.37 (1.02–1.85)
# weight loss encounters[1]	RR (95% CI)	RR (95% CI)
PCL dec ≥ 20	1.01 (0.74–1.39)	1.13 (0.70–1.81)

PCL=PTSD checklist; PTSD=posttraumatic stress disorder; HR=hazard ratio; RR=rate ratio; OR=odds ratio

[1]Among 282 the patients that had a weight loss encounter. Negative binomial model

e-Table 5.

Results from models estimating the association of non-PTSD vs. PCL decrease < 20 vs. PCL decrease ≥ 20 weight loss encounter utilization outcomes (n=3404) [1].

	n(%) or mean ±sd	Incidence rate (1000PY)	Model 1 – Crude	Model 2–Fully adjusted [3]
Any weight loss program			HR (95% CI)	HR (95% CI)
Non-PTSD	644 (26.7%)	62.4/1000PY	1.00	1.00
PCL dec < 20	220 (27.6%)	86.5/1000PY	1.30 (1.11–1.51)	1.05 (0.85–1.29)
PCL dec ≥ 20	62 (31.8%)	111.7/1000PY	1.64 (1.26–2.14)	1.35 (1.01–1.81)
	p=.30	*p<.001*		
# weight loss encounters[2]			RR (95% CI)	RR (95% CI)
Non-PTSD	4.1 (±7.3)	na	1.00	1.00
PCL dec < 20	5.1 (±8.4)	na	1.25 (1.06–1.48)	1.47 (1.17–1.86)
PCL dec ≥ 20	5.2 (±8.3)	na	1.27 (0.95–1.69)	1.69 (1.23–2.32)
	P=.02			

PCL=PTSD checklist; PTSD=posttraumatic stress disorder; HR=hazard ratio; RR=rate ratio; OR=odds ratio

[1] Group sample sizes: non-PTSD (n=2,411); PCL dec < 20 (n=798); PCL dec ≥20 (n=195)

[2] Among 926 the patients that had a weight loss encounter. Negative binomial model

[3] PS and IPEW not used in this analysis because could not balance between 3-groups. Thus, used fully-adjusted regression models. Models do not include PTSD specific variables: initial PCL score, adequate ADM, and adequate PTSD therapy. Thus, fully adjusted models included: age, gender, race, marital, VHA insurance, primary HCU, BMI category, depression, anxiety, substance use, smoking and obesity-related comorbidities.

e-Table 6.

Results from models estimating the association of non-PTSD vs. PCL decrease < 20 vs. PCL decrease ≥ 20 weight loss encounter utilization outcomes, among patients with high primary healthcare utilization (n=840) [1].

	n(%) or mean ±sd	Incidence rate (1000PY)	Model 1 – Crude	Model 2–Fully adjusted [3]
Any weight loss program			HR (95% CI)	HR (95% CI)
Non-PTSD	186 (34.8%)	91.8/1000PY	1.00	1.00
PCL dec < 20	88 (35.3%)	115.1/1000PY	1.18 (0.91–1.53)	1.01 (0.71–1.44)
PCL dec ≥ 20	30 (53.6%)	209.5/1000PY	2.05 (1.39–3.03)	1.60 (1.01–2.55)
	p=.02	*P<.001*		
# weight loss encounters [2]			RR (95% CI)	RR (95% CI)
Non-PTSD	4.3 (±7.2)	na	1.00	1.00
PCL dec < 20	5.3 (±8.1)	na	1.25 (0.95–1.65)	1.48 (0.98–2.24)
PCL dec ≥ 20	6.6 (±10.6)	na	1.55 (1.03–2.35)	1.78 (1.09–2.89)
	p=.05			

PCL=PTSD checklist; PTSD=posttraumatic stress disorder; HR=hazard ratio; RR=rate ratio; OR=odds ratio

[1] Group sample sizes: non-PTSD (n=535); PCL dec < 20 (n=249); PCL dec ≥20 (n=56)

[2] Among the 304 patients that had a weight loss encounter. Negative binomial model

[3] PS and IPEW not used in this analysis because could not balance between 3-groups. Thus, used fully-adjusted regression models. Models do not include PTSD specific variables: initial PCL score, adequate ADM, and adequate PTSD therapy. Thus, fully adjusted models included: age, gender, race, marital, VHA insurance, BMI category, depression, anxiety, substance use, smoking and obesity-related comorbidities.