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The Weight of Traumatic Stress: A Prospective Study of Posttraumatic Stress Disorder Symptoms and Weight Status in Women

Laura D. Kubzansky, PhD, **Paula Bordelois, MPH**, **Hee Jin Jun, DrPH**, **Andrea L. Roberts, PhD**, **Magdalena Cerda, DrPH**, **Noah Bluestone, BA**, and **Karestan C. Koenen, PhD**
Harvard School of Public Health (L.K., A.R.) and Channing Laboratory (H.J.J), Department of Medicine, Brigham & Women's Hospital, and Harvard Medical School, Boston; Boston University (N.B.), Boston; Columbia Mailman School of Public Health (P.B., M.C., K.K.), New York City

Abstract

Importance—Posttraumatic stress disorder (PTSD) indicates a chronic stress reaction in response to trauma, and is a prevalent condition that has been identified as a possible risk factor for obesity.

Objective—To determine if women who develop PTSD symptoms are subsequently more likely to gain weight and become obese relative to either trauma exposed women who do not develop PTSD symptoms or women with no trauma and no PTSD symptoms, and if effects are independent of depression.

Design and Setting—The Nurses' Health Study II (NHS II), a prospective observational study initiated in 1989 with follow-up to 2005, using a PTSD screener to measure PTSD symptoms and when they onset.

Participants—The sub-sample of the NHSII (n= 54,224; ages 24–44 years in 1989) in whom trauma and PTSD symptoms were measured.

Main Outcome Measure(s)—Development of overweight and obesity using BMI cut-points 25.0 and 30.0kg/m^2 respectively. Change in BMI during follow-up among women reporting PTSD symptom onset prior to 1989. BMI trajectory before and after PTSD symptom onset among women who developed PTSD symptoms during follow-up.

Results—Among women with ≥ 4 PTSD symptoms prior to 1989 (cohort initiation) BMI increased more steeply (b = 0.05, SE = 0.01, p< 0.001) over the follow-up. Among women who developed PTSD symptoms after 1989, BMI trajectory did not differ by PTSD status before PTSD onset. After PTSD symptom onset, women with ≥ 4 symptoms had a faster rise in BMI (b = 0.07, SE = 0.02, p< 0.000). The onset of ≥ 4 PTSD symptoms after 1989 was also associated with increased risk of becoming overweight or obese (OR = 1.36, 95% CI: 1.19–1.56) among women who were normal weight in 1989. Effects were maintained after adjusting for depression.

Correspondence and reprint requests to: Dr. L. Kubzansky, Department of Society, Human Development, and Health, Harvard School of Public Health, 677 Huntington Ave., Boston, MA 02115; phone: 617-432-3589; fax: 617-432-3123; Lkubzans@hsph.harvard.edu.

Conflict of interest
The authors declare no conflict of interest.

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Conclusions and Relevance—Experiencing PTSD symptoms is associated with increased risk of becoming overweight or obese, and PTSD symptom onset alters BMI trajectories over time. The presence of PTSD symptoms should raise clinician concerns about physical health problems that may develop and prompt closer attention to weight status.

Keywords

body weight changes; weight status; obesity; PTSD; stress; women

Obesity is a significant public health problem in the developed world, associated with increased likelihood of premature mortality and higher rates of morbidity.[1,2] Among women, effects of obesity may be apparent at each stage of life (e.g., affecting reproductive health and outcomes, aging, life expectancy) and may have far-reaching effects in future generations.[3,4] Numerous studies have documented associations between obesity and various forms of psychological distress.[5,6] While some studies have failed to find a relationship,[7,8] the preponderance of evidence suggests that severe forms of distress adversely influence weight status. Recent work has identified posttraumatic stress disorder (PTSD), a marker of extreme distress occurring in response to a traumatic event and indicative of a chronic stress reaction,[9] as a possible risk factor for weight gain and ultimately obesity.[10–16] PTSD is prevalent especially among women; one in nine women will meet criteria for the diagnosis over their lifetime.[17] Understanding the role of PTSD is important for interventions aimed at curbing weight gain and obesity treatment. However, whether PTSD is causally related to weight gain and obesity or is simply a co-morbid condition due to shared risk factors has not been established.

Most studies on PTSD and obesity are cross-sectional,[14] and while they generally find positive associations, they cannot determine whether PTSD symptoms preceded development of obesity. In the only prospective study to date, among young women who were not overweight when PTSD was assessed, those with PTSD were at increased risk of becoming obese over six years of follow up.[11] However, this study could not determine whether changes in PTSD status lead to changes in weight status over time. Demonstrating that PTSD symptom onset is associated with altered trajectory of weight gain would provide stronger evidence that PTSD is a risk factor for overweight and obesity.

The current study sought to determine if PTSD symptoms alter the trajectory of weight gain in a well-characterized sample of women. Using information on age of onset of PTSD symptoms, we considered weight status as measured by body mass index (BMI) both prior to and after onset of symptoms and examined whether women who develop symptoms are subsequently more likely to gain weight and become overweight or obese. Because there is debate on the relative role of trauma versus PTSD in pathophysiological processes, we considered effects of PTSD symptoms separately from effects of experiencing trauma, and hypothesized that women who develop PTSD symptoms will gain more weight than women who experience trauma but do not develop symptoms. Depression and PTSD are commonly comorbid, and other work has suggested that depression is also associated with weight gain.[18] To address concerns about potential confounding, we also considered the primary associations after taking account of depressive status. Additional potential confounders were

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selected based on prior work[15] suggesting demographic characteristics (e.g., age, marital status) and behaviors (e.g., cigarette smoking, alcohol consumption) may be related to both PTSD and weight status.

METHODS

Source and Study Population

The Nurses' Health Study II (NHSII) is an ongoing prospective cohort study of 116,671 female registered nurses that began in 1989. Participants are followed up via biennial questionnaires that gather information on health-related behaviors and medical events. For the present study, outcomes were assessed at 8 waves, with 87% of initially enrolled participants completing the 2005 questionnaire. The institutional review board at Brigham and Women's Hospital reviewed and approved this study, and participants provided consent.

Data are from a subsample of the NHSII who participated in a supplemental study in 2008 (only participants responding to the longer form of the most recent biennial questionnaire = were asked to participate). The Trauma and PTSD Screening Questionnaire[19,20] was mailed to 60,804 participants. The response rate was 84% (N = 54,224). Analysis was limited to 50,504 of these respondents after excluding women who provided no information on trauma (n=719), PTSD symptoms (n = 2,964) or at least one measure of BMI (n=37). Differences between included versus excluded women were minimal with regard to baseline age, childhood socioeconomic position (SEP) and regional distribution. The proportion of non-Hispanic whites was higher in the analytic versus original sample (95.7% vs. 93.8%), and the proportion of current smokers was lower (11.4% vs. 13.5%). These 50,504 women were divided into two separate groups for analysis depending on when trauma/PTSD occurred. Analytic sample 1 included women who reported having PTSD symptoms before or at the start of the cohort and women without PTSD or trauma through 2005 (N=35,702); analytic sample 2 included only women who reported either PTSD symptoms or worst trauma between 1989 and 2005 (N=14,839). Among women whose trauma/PTSD onset during the study follow-up period (Sample 2) assessments of BMI before and after onset of trauma/PTSD are available, facilitating direct evaluation of changes in BMI related to trauma/PTSD. See Figure 1.

Assessment of Trauma and PTSD

A modified version of the Brief Trauma Questionnaire (BTQ),[21,22] included as part of the Trauma and PTSD Screening Questionnaire, was used to determine whether a woman met Criterion A1 for traumatic exposure according to the DSM-IV PTSD diagnosis.[19] Breslau et al.'s 7-item screening scale for DSM-IV PTSD[23] was used to identify PTSD symptomatology among women who met Criterion A1 for trauma exposure according to the BTQ. Endorsing 4 or more symptoms in relation to the worst trauma classifies PTSD cases with a sensitivity of 85%, specificity of 93%, positive predictive value of 68%, and negative predictive value of 98%.[23] Participants were asked to identify their worst event on the BTQ as this is a sensitive method for screening PTSD.[24]. Women reported the age at which the worst event occurred, and whether they experienced PTSD symptoms in relation to that

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trauma. They also reported the age they most recently had symptoms, from which remission status was determined for specific analyses.

Women were categorized according to whether they had no trauma, trauma but no PTSD symptoms, trauma with 1–3 PTSD symptoms (subclinical levels of PTSD), or trauma with 4 or more PTSD symptoms, the validated diagnostic cut-off. Date of onset of trauma and/or PTSD was the age at which the worst event was reported.

Assessment of Weight Status

Data on weight and height were collected with the 1989 questionnaire, and weight was further reported biennially. Self-reported weight was highly reliable (r = 0.97) among a subset of regionally residing participants who underwent direct measurement of their weight.[25] We calculated BMI as weight in kilograms divided by the square of height in meters (kg/m^2). To define normal weight, overweight and obesity, we used BMI cut-points 25.0 and 30.0kg/m^2 respectively.[26] Most participants had data on BMI at all follow-up periods (74%) with some women missing one (19%), two (5%) or 3 or more (2%) follow-up measurements.

Assessment of Covariates

In 1989, age and race was obtained. Region of residence at age 15 was assessed in 1993. Childhood SEP was assessed using a proxy of parental educational attainment, maximum of mother's and father's education at birth, reported in 2005. Participants self-classified their race, and for analytic purposes were categorized as white, black, Hispanic, other. Age, marital status (married, not married), alcohol consumption (0 g/day, 0.1–4.9 g/day, 5.0–14.9 g/day, 15+ g/day), and smoking status (never, former, current) were also updated with each questionnaire cycle. Lifetime history of depression (ever, never) was ascertained on the 2005 questionnaire.[27]

Statistical Analyses

Trauma/PTSD symptoms as a predictor of weight status was considered with several separate analyses. Initial analyses considered whether active or remitted PTSD symptoms versus no trauma or PTSD confer similar risk relative to the combined outcome of becoming either overweight or obese in 1989, using the full sample (N=50,290, excluding 251 without information on BMI in 1989). Logistic regression models were used to compare women with no trauma or PTSD symptoms to women with either current PTSD symptoms in 1989 or remitted PTSD symptoms in 1989. Additionally, using a subsample of Sample 2, we assessed the likelihood of being overweight/obese after experiencing trauma/PTSD symptoms, considering only women who experienced trauma/PTSD symptoms after 1989 and who reported normal weight on the questionnaire closest in time to when trauma occurred (n = 7,116). Models were adjusted for demographics and other covariates using PROC LOGISTIC in SAS 9.2.

To examine the timing of PTSD relative to weight gain, we conducted 1) hierarchical linear modeling (HLM) using repeated measures analysis (MPlus, version 5.1, Muthén & Muthén, Los Angeles, CA) among women with PTSD symptom onset prior to or in 1989; 2) linear

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spline models to consider whether BMI rises more sharply after versus before PTSD symptom onset among only women who experienced trauma after 1989.

HLM analyses were conducted with Sample 1, women whose trauma/PTSD symptoms onset before 1989 or with no trauma/no symptoms. Women with no trauma or PTSD symptoms were compared with women who had trauma/no symptoms or trauma with 1–3 PTSD symptoms, or trauma with 4+ PTSD symptoms whose onset was reported prior to or occurring in1989 The spline analysis was conducted with Sample 2, women whose trauma/PTSD symptoms onset after 1989. Those with trauma/no PTSD served as the reference group compared with women with trauma and 1–3 PTSD symptoms or trauma and 4+ symptoms that onset after 1989. Each analysis involved three sets of models: a) trauma/PTSD only; b) a + age, race/ethnicity, region of residence at age 15, childhood SEP; c) b + lifetime history of depression, marital status + alcohol consumption + smoking status. Longitudinal multilevel models facilitate examination of how weight status changes over time within persons, and how that change is related to PTSD symptoms and their onset. Continuous BMI was modeled, and missing values of BMI do not pose a problem.[28] Intercepts of the outcome at the 8 evenly spaced time points (2-year intervals) were fixed at zero. Means and variances of the growth factors were estimated with maximum likelihood, and an unstructured covariance model was used.

RESULTS

Table 1 summarizes demographic characteristics of participants by PTSD symptom status, including Samples 1 and 2. Through 2008, 18.6% of women experienced neither trauma nor PTSD symptoms, 30.3% experienced trauma but no symptoms, 30.6% experienced 1–3 symptoms and 20.5% experienced 4 or more symptoms. Compared with participants without PTSD symptoms, those with symptoms were more likely to be living in the South or West of the U.S. at age 15 and less likely to be living in the Northeast, were slightly older, had parents slightly more educated, had higher baseline BMI, were more likely to report lifetime depression, and were more likely to smoke.

PTSD Symptoms and Risk of Overweight or Obesity

Among all women (samples 1 and 2) we evaluated the likelihood of being obese or overweight in 1989, after adjusting for demographics, considering trauma/PTSD status prior to 1989. Compared to women with no trauma or PTSD symptoms, neither women with trauma only (odds ratio [OR]=0.99, 95% CI=0.95–1.04), nor women with remitted symptoms (OR=1.03, 95% CI=0.96–1.09), demonstrated excess odds of overweight or obesity. Women with trauma and ongoing symptoms had significantly excess odds (1–3 symptoms: OR=1.15, 95% CI=1.08–1.23; 4+ symptoms: OR=1.26, 95% CI=1.18–1.35).

We then examined the odds of becoming overweight or obese among women who were normal weight at baseline and experienced trauma/ PTSD symptoms between 1989 and 2005. Women with 1 to 3 and 4+ PTSD symptoms had 18% (OR = 1.18, 95% CI: 1.04–1.33) and 36% (OR = 1.36, 95% CI: 1.19–1.56), respectively, increased odds of becoming overweight or obese in adjusted models compared to women with trauma-only. Results

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remained significant albeit slightly attenuated after adjusting for other covariates including depression.

PTSD Symptoms and Weight Gain

Unadjusted BMI trajectories over time indicate a faster rate of weight gain among women who experienced trauma or symptoms prior to study entry relative to women who never experienced trauma or PTSD (Figure 2). At every follow-up year women who initially reported trauma and symptoms had higher BMI even after controlling for all covariates including depression (intercept parameters, Table 2). Furthermore, a dose-response relation was evident. Higher PTSD symptoms were associated with greater BMI increases over time (slope parameters, Table 2). We also compared the steepness of BMI increase among women with trauma compared to those with and without PTSD symptoms. In fully adjusted models, compared with women with trauma and no symptoms, women with 1 to 3 symptoms ($b = 0.03$, SE = 0.01, $p < 0.000$), and with 4+ symptoms ($b = 0.05$, SE = 0.01, $p < 0.000$) demonstrated faster rates of BMI increase over the follow up period.

PTSD Symptoms and BMI Trajectory

By considering only women with PTSD symptom onset after entry into the study, we can evaluate whether PTSD symptoms alter BMI trajectories. Spline models that impose an inflection at the time PTSD symptoms onset indicate that BMI trajectory *prior* to symptom onset did not significantly differ from those with trauma who never develop symptoms. However, *after* PTSD symptom onset, women with 1 to 3 symptoms ($b = 0.05$, SE = 0.01, $p = 0.002$) and with 4+ symptoms had a faster rise in BMI ($b = 0.08$, SE = 0.02, $p< 0.001$) over time compared with women with trauma and no PTSD. This effect was maintained after adjusting for all covariates including depression (Table 3).

DISCUSSION

PTSD symptoms were associated with faster weight gain and increased risk of obesity in women. Moreover, these are the first findings to demonstrate that PTSD symptom onset is associated with altered BMI trajectories over time. Relative to women who did not experience trauma or PTSD symptoms at any time, women with PTSD symptom onset prior to 1989 had higher BMI at every follow-up assessment and their BMI increased at a faster rate. Among women whose trauma occurred after 1989 an altered BMI trajectory was evident: prior to symptom onset, BMI trajectories were comparable to women who did not subsequently develop PTSD symptoms, however after symptom onset, BMI increased at a faster rate. Previous studies have largely focused on the association of PTSD symptoms with weight status in combat veterans.[13,14,29–33] This is the first study to examine the prospective relation of PTSD symptoms to BMI trajectories and obesity in women exposed to a wide range of traumatic events occurring in civilian settings.

Rigorous epidemiologic studies are increasingly showing that PTSD has significant implications for physical health.[34–36] Moreover, it appears that effects of PTSD are not simply due to co-morbid depression, and even sub-clinical threshold PTSD levels should be considered as potentially increasing risk of subsequent health problems. The link between

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PTSD and obesity is of particular interest given that PTSD has been identified as a potential risk factor for cardiometabolic diseases,[37–39] and obesity is a candidate mechanism by which these effects occur.

PTSD may influence weight gain by behavioral and biological mechanisms, and both may operate simultaneously. Recent studies have suggested PTSD is associated with physical inactivity,[14] increased consumption of unhealthy foods and beverages,[40] or generally dysregulated food intake related to dependence on activation of the brain reward system.[41] In addition, dysregulated neuroendocrine function including enhanced negative feedback sensitivity of glucocorticoid receptors, blunted cortisol levels, and exaggerated catecholamine responses to trauma-related stimuli have all been found in adults diagnosed with PTSD[39]. Recent work has suggested that neuropeptide Y (NPY) is a likely mediator between PTSD and metabolic imbalances due to high exposure to sympathetic activation.[11] Animal studies suggest that stress upregulates NPY which plays an important role in adipose tissue remodeling and development of abdominal obesity.[42]. Thus, high levels of distress may directly alter fat production and its distribution.

Strengths and Limitations

This investigation has numerous strengths including prospective data, a large study population, extensive data on potential confounding factors, and information on BMI prior to and after onset of PTSD symptoms. However, PTSD was assessed only in relation to the worst event which can result in some misclassification of timing of onset of PTSD; and trauma exposure, PTSD symptoms, and age of onset were assessed retrospectively, which can result in underestimating lifetime prevalence or psychopathology.[43] In our sample, the prevalence of trauma exposure is comparable to other samples using DSM-IV diagnostic criteria[44] but the prevalence of women reporting 4+ PTSD symptoms (20.5%) is somewhat higher[17] possibly due to our use of a screen versus a diagnostic interview. Also, to limit concerns about potential confounding we adjusted for lifetime depressive status; however, a more refined assessment of confounding was not possible because we lacked information on timing of depression relative to PTSD symptom onset. Another limitation is generalizability, given our population of predominately White, female nurses. Finally, it is possible that confounding by some unmeasured variable could explain findings. However, this seems less likely given that observed associations were unchanged in analyses that considered BMI pre- and post-onset of PTSD symptoms whereby each woman served as her own comparison.

Conclusions

Studies have suggested that once obesity develops, it is difficult to treat.[45] Thus, while PTSD is a significant concern for its effects on mental health, our findings also suggest that the presence of PTSD symptoms should raise clinician concerns about potential physical health problems that may develop. Thus, primary care settings that treat populations at high risk for trauma exposure may want to screen for PTSD and monitor patients for other sequelae. Findings from this study suggest that trauma will be most strongly associated with increased risk of weight gain if trauma leads to the development of PTSD symptoms,

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although future work may also want to consider type of trauma in this relationship more deeply.

Physicians may be more effective if they can recognize and manage this type of emotional distress. Our work may also suggest that women with PTSD should be monitored or screened for development of adverse cardiometabolic outcomes. In fact, our work highlights the importance of expanding PTSD treatments to attend to behavioral alterations – like changes in diet or exercise - that lead to obesity. Health behaviors are currently completely outside the scope of PTSD treatments. Moreover, our data provide initial evidence that if PTSD remits, adverse impacts on weight gain may be attenuated. With improved prevention, the potential for earlier intervention, and more effective treatment strategies, we may significantly improve patient outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Drs. Kubzansky and Koenen had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis."

Abbreviations

PTSD	posttraumatic stress disorder
NHSII	Nurses' Health Study II
BMI	body mass index
SE	standard error
OR	odds ratio
CI	confidence interval

References

1. Adams KF, Schatzkin A, Harris TB, et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. N. Engl. J. Med. 2006 Aug 24; 355(8):763–778. [PubMed: 16926275]
2. National Task Force on the Prevention and Treatment of Obesity. Overweight, obesity, and health risk. Arch. Intern. Med. 2000 Apr 10; 160(7):898–904. [PubMed: 10761953]
3. Kulie T, Slattengren A, Redmer J, Counts H, Eglash A, Schrager S. Obesity and women's health: an evidence-based review. J Am Board Fam Med. 2011 Jan-Feb;24(1):75–85. [PubMed: 21209347]
4. Ryan D. Obesity in women: a life cycle of medical risk. Int J Obes (Lond). 2007 Nov; 31(Suppl 2):S3–S7. discussion S31–32. [PubMed: 17968435]

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5. Luppino FS, de Wit LM, Bouvy PF, et al. Overweight, Obesity, and Depression: A Systematic Review and Meta-analysis of Longitudinal Studies. Arch. Gen. Psychiatry. 2010 Mar; 67(3):220–229. [PubMed: 20194822]
6. Simon GE, Von Korff M, Saunders K, et al. Association between obesity and psychiatric disorders in the US adult population. Arch. Gen. Psychiatry. 2006 Jul; 63(7):824–830. [PubMed: 16818872]
7. Hach I, Ruhl UE, Klotsche J, Klose M, Jacobi F. Associations between waist circumference and depressive disorders. J. Affect. Disord. 2006 Jun; 92(2–3):305–308. [PubMed: 16503357]
8. Roberts RE, Deleger S, Strawbridge WJ, Kaplan GA. Prospective association between obesity and depression: evidence from the Alameda County Study. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity. 2003 Apr; 27(4):514–521.
9. Breslau N, Reboussin BA, Anthony JC, Storr CL. The structure of posttraumatic stress disorder: latent class analysis in 2 community samples. Arch. Gen. Psychiatry. 2005 Dec; 62(12):1343–1351. [PubMed: 16330722]
10. Dobie DJ, Kivlahan DR, Maynard C, Bush KR, Davis TM, Bradley KA. Posttraumatic stress disorder in female veterans: association with self-reported health problems and functional impairment. Arch. Intern. Med. 2004 Feb 23; 164(4):394–400. [PubMed: 14980990]
11. Perkonigg A, Owashi T, Stein MB, Kirschbaum C, Wittchen HU. Posttraumatic stress disorder and obesity: evidence for a risk association. Am. J. Prev. Med. 2009 Jan; 36(1):1–8. [PubMed: 18976880]
12. Scott KM, McGee MA, Wells JE, Oakley Browne MA. Obesity and mental disorders in the adult general population. J. Psychosom. Res. 2008 Jan; 64(1):97–105. [PubMed: 18158005]
13. Barber J, Bayer L, Pietrzak RH, Sanders KA. Assessment of rates of overweight and obesity and symptoms of posttraumatic stress disorder and depression in a sample of Operation Enduring Freedom/Operation Iraqi Freedom veterans. Mil. Med. 2011 Feb; 176(2):151–155. [PubMed: 21366076]
14. Chwastiak LA, Rosenheck RA, Kazis LE. Association of psychiatric illness and obesity, physical inactivity, and smoking among a national sample of veterans. Psychosomatics. 2011 May-Jun; 52(3):230–236. [PubMed: 21565594]
15. Pagoto SL, Schneider KL, Bodenlos JS, et al. Association of post-traumatic stress disorder and obesity in a nationally representative sample. Obesity (Silver Spring). 2012 Jan; 20(1):200–205. [PubMed: 22016096]
16. Roenholt S, Beck NN, Karsberg SH, Elklit A. Post-traumatic stress symptoms and childhood abuse categories in a national representative sample for a specific age group: associations to body mass index. Eur J Psychotraumatol. 2012; 3
17. Kessler RC, Sonnega A, Bromet E, Hughes M, Nelson CB. Posttraumatic stress disorder in the National Comorbidity Survey. Arch. Gen. Psychiatr. 1995; 52:1048–1060. [PubMed: 7492257]
18. Pan A, Sun Q, Czernichow S, et al. Bidirectional association between depression and obesity in middle-aged and older women. Int. J. Obes. 2012 Apr; 36(4):595–602.
19. Morgan CA 3rd, Hazlett G, Wang S, Richardson EG Jr, Schnurr P, Southwick SM. Symptoms of dissociation in humans experiencing acute, uncontrollable stress: a prospective investigation. A. J. Psychiatry. 2001 Aug; 158(8):1239–1247.
20. Schnurr P, Vielhauer M, Weathers FW. Brief Trauma Interview. 1995
21. Schnurr PP, Lunney CA, Sengupta A, Spiro A 3rd. A longitudinal study of retirement in older male veterans. J. Consult. Clin. Psychol. 2005 Jun; 73(3):561–566. [PubMed: 15982154]
22. Schnurr PP, Spiro AI, Velhauer MJ, Findler MN, Hamblen JL. Trauma in the lives of older men: Findings from the Normative Aging Study. Journal of Clinical Geropsychology. 2002; 8:175–187.
23. Breslau N, Peterson EL, Kessler RC, Schultz LR. Short screening scale for DSM-IV posttraumatic stress disorder. A. J. Psychiatry. 1999 Jun; 156(6):908–911.
24. Breslau N, Peterson EL, Poisson LM, Schultz LR, Lucia VC. Estimating post-traumatic stress disorder in the community: lifetime perspective and the impact of typical traumatic events. Psychol. Med. 2004 Jul; 34(5):889–898. [PubMed: 15500309]

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25. Rimm EB, Stampfer MJ, Colditz GA, Chute CG, Litin LB, Willett WC. Validity of self-reported waist and hip circumferences in men and women. Epidemiology. 1990 Nov; 1(6):466–473. [PubMed: 2090285]
26. WHO. Physical status: the use and interpretation of anthropometry; Report of a WHO Expert Committee. 1995. p. 854
27. O'Reilly EJ, Mirzaei F, Forman MR, Ascherio A. Diethylstilbestrol exposure in utero and depression in women. Am. J. Epidemiol. 2010 Apr 15; 171(8):876–882. [PubMed: 20332145]
28. Fitzmaurice, GM.; Laird, NM.; Ware, JE. Applied longitudinal analysis. New York: John Wiley and Sons; 2004.
29. Chwastiak LA, Rosenheck RA, Desai R, Kazis LE. Association of psychiatric illness and all-cause mortality in the National Department of Veterans Affairs Health Care System. Psychosom. Med. 2010 Oct; 72(8):817–822. [PubMed: 20639387]
30. Coughlin SS. Post-traumatic Stress Disorder and Cardiovascular Disease. The open cardiovascular medicine journal. 2011; 5:164–170. [PubMed: 21792377]
31. Coughlin SS, Kang HK, Mahan CM. Selected Health Conditions Among Overweight, Obese, and Non-Obese Veterans of the 1991 Gulf War: Results from a Survey Conducted in 2003-2005. The open epidemiology journal. 2011; 4:140–146. [PubMed: 21731594]
32. Haskell SG, Gordon KS, Mattocks K, et al. Gender differences in rates of depression, PTSD, pain, obesity, and military sexual trauma among Connecticut War Veterans of Iraq and Afghanistan. J. Women's Health. 2010 Feb; 19(2):267–271.
33. McFarlane AC. The long-term costs of traumatic stress: intertwined physical and psychological consequences. World psychiatry: official journal of the World Psychiatric Association. 2010 Feb; 9(1):3–10.
34. Boscarino JA. Posttraumatic stress disorder and physical illness: results from clinical and epidemiologic studies. Ann. N. Y. Acad. Sci. 2004 Dec.1032:141–153. [PubMed: 15677401]
35. Boscarino JA. A prospective study of PTSD and early-age heart disease mortality among Vietnam veterans: implications for surveillance and prevention. Psychosom. Med. 2008 Jul; 70(6):668–676. [PubMed: 18596248]
36. Kubzansky LD, Koenen KC. Is posttraumatic stress disorder related to development of heart disease? An update. Cleve. Clin. J. Med. 2009 Apr; 76(Suppl 2):S60–S65. [PubMed: 19376986]
37. Kubzansky LD, Koenen KC, Jones C, Eaton WW. Post-traumatic stress disorder symptoms and coronary heart disease in women. Health Psychol. 2009; 28(3):364–372. [PubMed: 19450043]
38. Kubzansky LD, Koenen KC, Spiro A 3rd, Vokonas PS, Sparrow D. Prospective study of posttraumatic stress disorder symptoms and coronary heart disease in the Normative Aging Study. Arch. Gen. Psychiatry. 2007 Jan; 64(1):109–116. [PubMed: 17199060]
39. Vanitallie TB. Stress: a risk factor for serious illness. Metabolism. 2002; 51 Suppl 1(6):40–45. [PubMed: 12040540]
40. Hirth JM, Rahman M, Berenson AB. The association of posttraumatic stress disorder with fast food and soda consumption and unhealthy weight loss behaviors among young women. J. Women's Health. 2011 Aug; 20(8):1141–1149.
41. Adam TC, Epel ES. Stress, eating and the reward system. Physiol. Behav. 2007 Jul 24; 91(4):449–458. [PubMed: 17543357]
42. Kuo LE, Kitlinska JB, Tilan JU, et al. Neuropeptide Y acts directly in the periphery on fat tissue and mediates stress-induced obesity and metabolic syndrome. Nat. Med. 2007 Jul; 13(7):803–811. [PubMed: 17603492]
43. Moffitt TE, Caspi A, Taylor A, et al. How common are common mental disorders? Evidence that lifetime prevalence rates are doubled by prospective versus retrospective ascertainment. Psychol. Med. 2010 Jun; 40(6):899–909. [PubMed: 19719899]
44. Roberts AL, Gilman SE, Breslau J, Breslau N, Koenen KC. Race/ethnic differences in exposure to traumatic events, development of post-traumatic stress disorder, and treatment-seeking for post-traumatic stress disorder in the United States. Psychol. Med. 2011 Jan; 41(1):71–83. [PubMed: 20346193]
45. National Institutes of Health. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report. 1998:98–4083.

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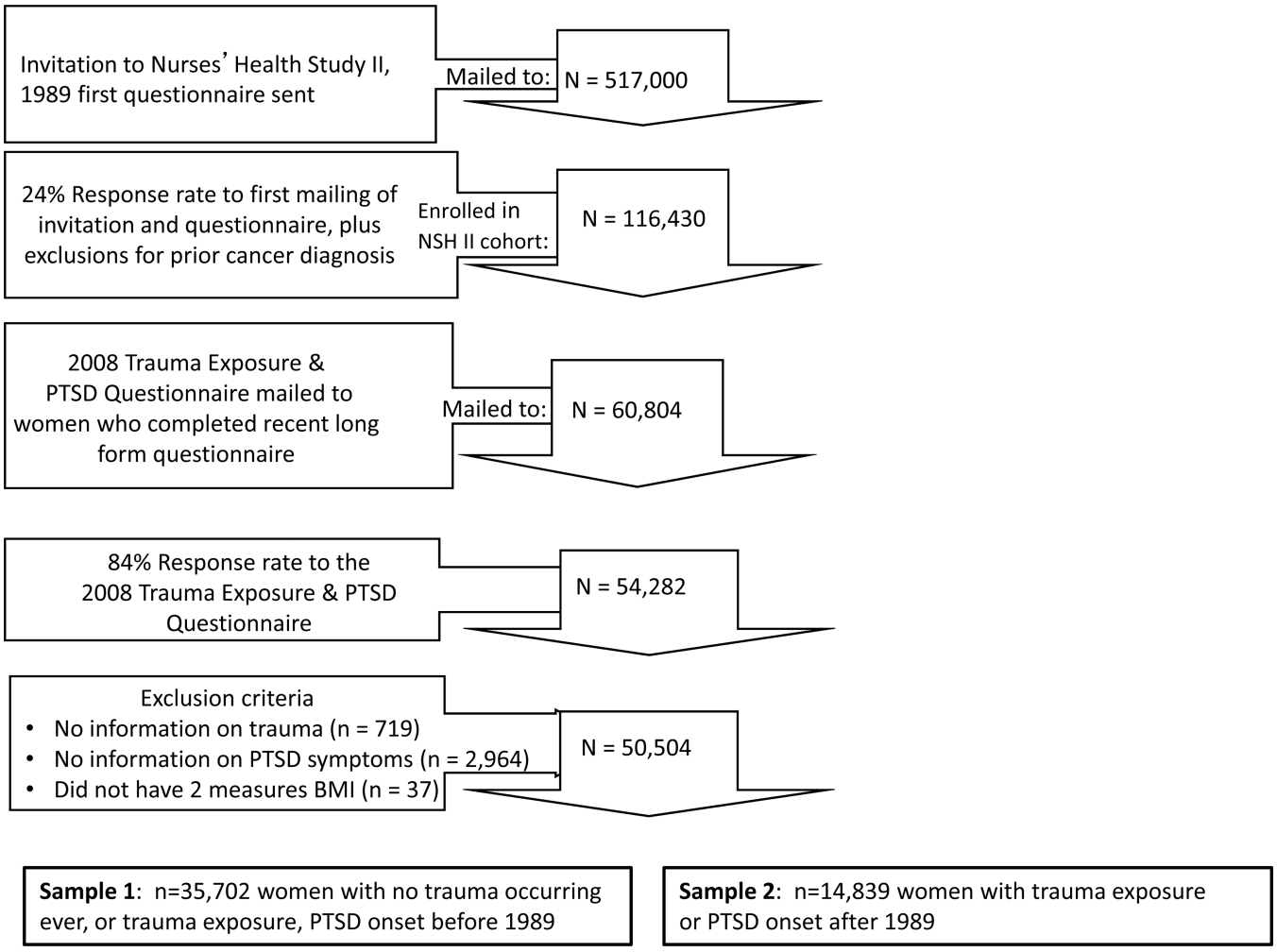

Figure 1.

Overall Design for NHSII Study of PTSD and BMI. Modified from Roberts AL, Galea S, Austin SB, Cerda M, Wright RJ, Rich-Edwards JW, Koenen KC. Posttraumatic stress disorder across two generations: concordance and mechanisms in a population-based sample Biol Psychiatry. 2012 Sep 15;72(6):505–11.

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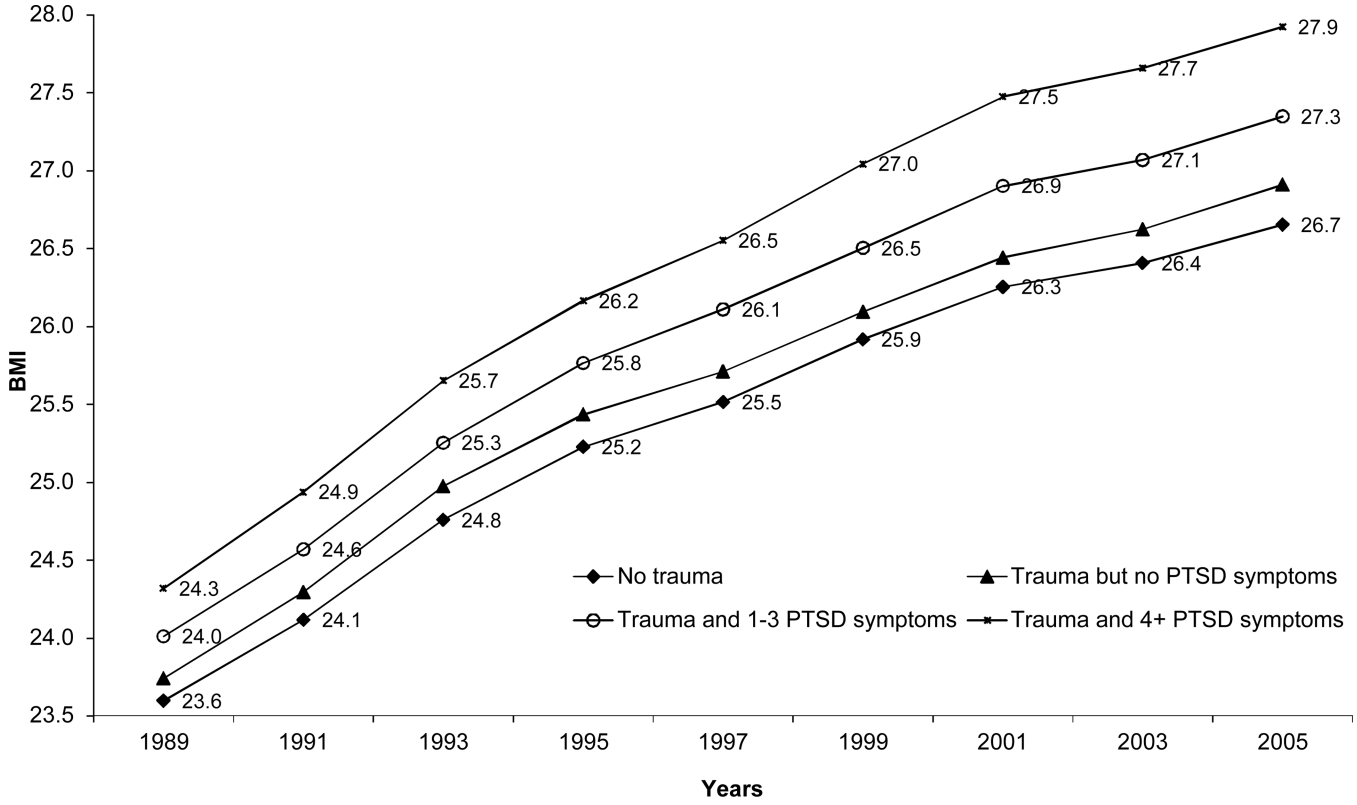

Figure 2.

Unadjusted mean BMI over time according to trauma/PTSD group (including women with trauma/PTSD prior to or in 1989 or who have no trauma/PTSD through 2005, n = 41,976)

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Table 1

Sample Characteristics (characterizing according to participants who reported PTSD symptoms before or on 1989, N=50504)

	No trauma and no PTSD Sx		**Trauma but no PTSD Sx**		**Trauma and 1–3 PTSD Sx**		**Trauma and 4+ PTSD Sx**		
Total (n, %)	**9392**	**18.6**	**15288**	**30.3**	**15447**	**30.6**	**10377**	**20.5**	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F
Age at study entry	34.6	4.7	34.8	4.7	34.9	4.6	34.9	4.5	8.54***
BMI at study entry	23.6	4.6	23.7	4.7	23.9	4.9	24.1	5.1	21.88***
	N	%	N	%	N	%	N	%	X^2
Race/ethnicity									1.69
White	9038	96.2	14624	95.7	14734	95.4	9942	95.8	
Black	69	0.7	174	1.1	184	1.2	80	0.8	
Hispanic	109	1.2	237	1.6	277	1.8	170	1.6	
Asian et al	176	1.9	253	1.7	252	1.6	185	1.8	
Region of residence at age 15									154.9***
Northeast	3476	37.0	5541	36.2	5146	33.3	3413	32.9	
Midwest	3455	36.8	5317	34.8	5415	35.1	3572	34.4	
South	955	10.2	1764	11.5	1918	12.4	1345	13.0	
West	801	8.5	1473	9.6	1844	11.9	1244	12.0	
Missing	705	7.5	1193	7.8	1124	7.3	803	7.7	
Parental education									17.6***
Less than HS	856	9.1	1614	10.6	1532	9.9	1092	10.5	
HS	3874	41.3	6160	40.3	6009	38.9	3844	37.0	
Some college	2136	22.7	3541	23.2	3692	23.9	2438	23.5	
College	2132	22.7	3309	21.6	3560	23.1	2438	23.5	
Missing	394	4.2	664	4.3	654	4.2	565	5.4	
BMI categories									53.5***
Normal weight BMI<25	6883	73.2	10998	71.9	10967	71	7173	69	
Overweight, 25≤BMI<30	1617	17.2	2718	17.8	2716	17.6	1968	19	

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	No trauma and no PTSD Sx		Trauma but no PTSD Sx		Trauma and 1–3 PTSD Sx		Trauma and 4+ PTSD Sx		
Total (n, %)	**9392**	**18.6**	**15288**	**30.3**	**15447**	**30.6**	**10377**	**20.5**	
Obesity, BMI ≥30	858	9.1	1506	9.8	1697	11	189	11	
Missing	40	0.5	77	0.5	78	0.5	56	1	
Lifetime depression									2303.6***
Yes	1097	11.7	1682	11	2856	18.5	3692	35.6	
Missing	369	3.9	576	3.8	562	3.6	525	5.1	
Smoking status									259.9***
Never smoked	6754	71.9	10448	68.3	10123	65.5	6316	60.9	
Past smoker	1720	18.3	3172	20.8	3524	22.8	2624	25.3	
Current smoker	903	9.6	1648	10.8	1787	11.6	1425	13.7	
Missing	15	0.2	20	0.1	13	0.1	12	0.1	

Abbreviations: Sx – symptoms; SD – standard deviation; HS – high school

X^2 (for categorical variables) and ANOVA (for continuous variables) were conducted to assess differences across trauma/PTSD groups

P-values: *<.05,

** <.01,

*** <.001.

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Table 2

Relationship between trauma/PTSD and BMI trajectory among participants who reported first PTSD symptom before or as occurring in 1989 (Nurses Health Study II, N=35,702)

	Model 1[a]			Model 2[b]			Model 3[c]		
	b	**S.E.**	**p-value**	***b***	**S.E.**	**p-value**	***b***	**S.E.**	**p-value**
Intercept									
Trauma and PTSD[d]									
Trauma, no PTSD	0.23	0.07	0.002	0.09	0.07	0.226	0.11	0.07	0.089
PTSD 1–3 Sx	0.39	0.07	<0.000	0.28	0.07	<0.000	0.24	0.07	0.001
PTSD 4 plus Sx	0.69	0.08	<0.000	0.60	0.08	<0.000	0.31	0.08	<0.000
Slope									
Trauma and PTSD[d]									
Trauma, no PTSD	0.01	0.01	0.051	0.01	0.01	0.027	0.01	0.01	0.050
PTSD 1–3 Sx	0.04	0.01	<0.000	0.04	0.01	<0.000	0.03	0.01	<0.000
PTSD 4 plus Sx	0.08	0.01	<0.000	0.09	0.01	<0.000	0.05	0.01	<0.000

Abbreviations: Sx - symptoms

[a]Model 1: PTSD and/or trauma only

[b]Model 2: Model 1 + age at baseline (centered at 34 years old), race/ethnicity, region at age 15, childhood SEP

[c]Model 3: Model 2 + depression status, smoking status, alcohol status, and marital status

[d]Reference: No trauma and no PTSD

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Table 3

Spline models of the relation between trauma/PTSD and BMI trajectory including only participants who reported first PTSD symptom/worst event between 1989 and 2005 surveys. Inflection is set at trauma/PTSD onset (Nurses Health Study II, N=14,839).

	Model 1[a]			Model 2[b]			Model 3[c]		
	b	**S.E.**	**p-value**	***b***	**S.E.**	**p-value**	***b***	**S.E.**	**p-value**
Intercept[d]									
PTSD 1–3 Sx	0.42	0.11	0.000	0.33	0.11	0.003	0.42	0.11	0.000
PTSD 4 plus Sx	0.39	0.12	0.002	0.28	0.12	0.022	0.39	0.12	0.002
Slope before PTSD onset[d]									
PTSD 1–3 Sx	0.01	0.01	0.322	0.01	0.01	0.291	0.01	0.01	0.322
PTSD 4 plus Sx	0.01	0.01	0.512	0.01	0.01	0.543	0.01	0.01	0.512
Slope after PTSD onset[d]									
PTSD 1–3 Sx	0.04	0.01	0.002	0.05	0.01	0.000	0.04	0.01	0.002
PTSD 4 plus Sx	0.07	0.02	0.000	0.08	0.02	0.000	0.07	0.02	0.000

[a] Model 1: PTSD and/or trauma only; reference group is trauma, no PTSD

[b] Model 2: Model 1 + age at baseline (centered at 34 years old), race/ethnicity, region at age 15, childhood SEP

[c] Model 3: Model 2 + depression status, smoking status, alcohol status, and marital status

[d] Reference: Trauma but no PTSD