



The Relationship Between Body Mass Index and Mental Health Among Iraq and Afghanistan Veterans

Shira Maguen, Ph.D.

San Francisco VA Medical Center

University of California, San Francisco

In Women's Veteran Health Special Supplement:

- Maguen S, Madden E, Cohen B, Bertenthal D, Neylan T, Talbot L, Grunfeld C, Seal K. **The relationship between body mass index and mental health among Iraq and Afghanistan veterans.** *J Gen Intern Med.* 2013;28(2):S563-70.



Poll Question

- What is your primary role in VA?
 - Clinician
 - Researcher
 - Student, trainee, or fellow
 - Manager or policy-maker
 - Peer support specialist
 - Other



Background

- Obesity is becoming epidemic among Veterans in the post-deployment period and as they age
 - Burst of weight gain after military discharge
 - May be tied to vulnerability and eating patterns post-deployment
- Being overweight and having high body mass index (BMI) is becoming problematic for Iraq and Afghanistan (OIF/OEF) Veterans



Background



- Over half of OEF/OIF Veterans in VA care have ≥ 1 mental health diagnoses
 - Posttraumatic stress disorder (PTSD) most common
- Mixed results in studies exploring PTSD and obesity markers (e.g., BMI)
 - Majority have found no association between BMI and PTSD *or* were conducted with older, predominantly male veterans
 - One study supported relationship between obesity and PTSD for women only

The Current Study

- Goal: explore the relationship between BMI and PTSD in a large cohort of Iraq and Afghanistan Veterans
 - Attend to gender differences
 - Evaluate trajectories of change in BMI over time



Methods



- Retrospective, longitudinal cohort study
- VA national level administrative data sets
 - OEF/OIF/OND Roster
 - Demographics and Vital Signs
 - National Data Extract of pharmacy data
 - National Patient Care Database of outpatient clinical encounters, associated clinical diagnoses

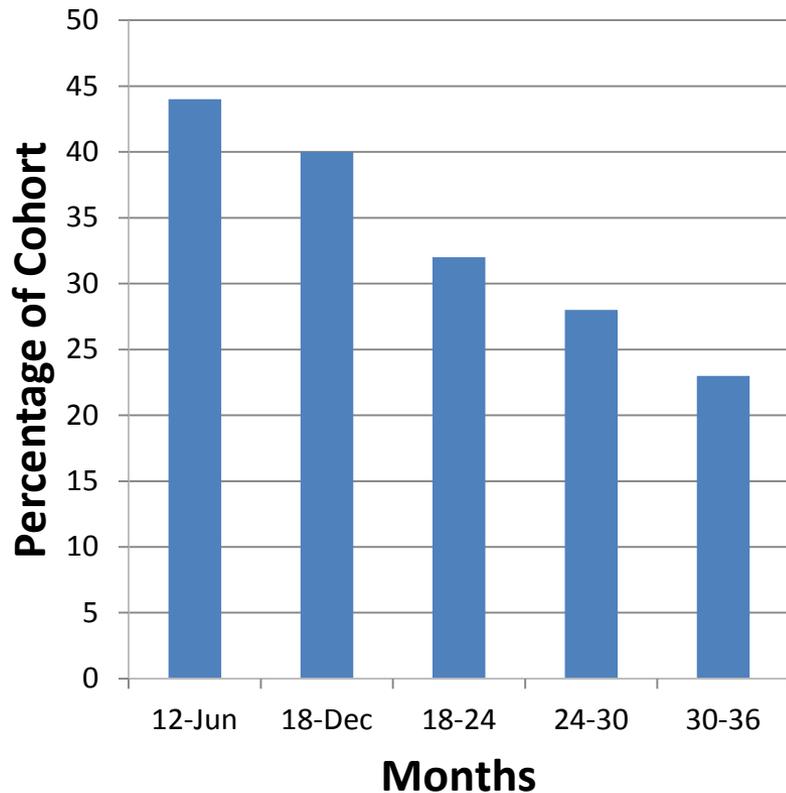
Participants

- Veterans who served in Afghanistan (OEF) and Iraq (OIF and OND)
- Used the VA healthcare system for clinical visit 10/07/01-12/31/11
- Height and weight recorded at the VA at least once after end of last deployment
- First post-deployment outpatient encounter at VA was ≥ 1 year prior to end of the study period
- Excluded pregnant women



Measures

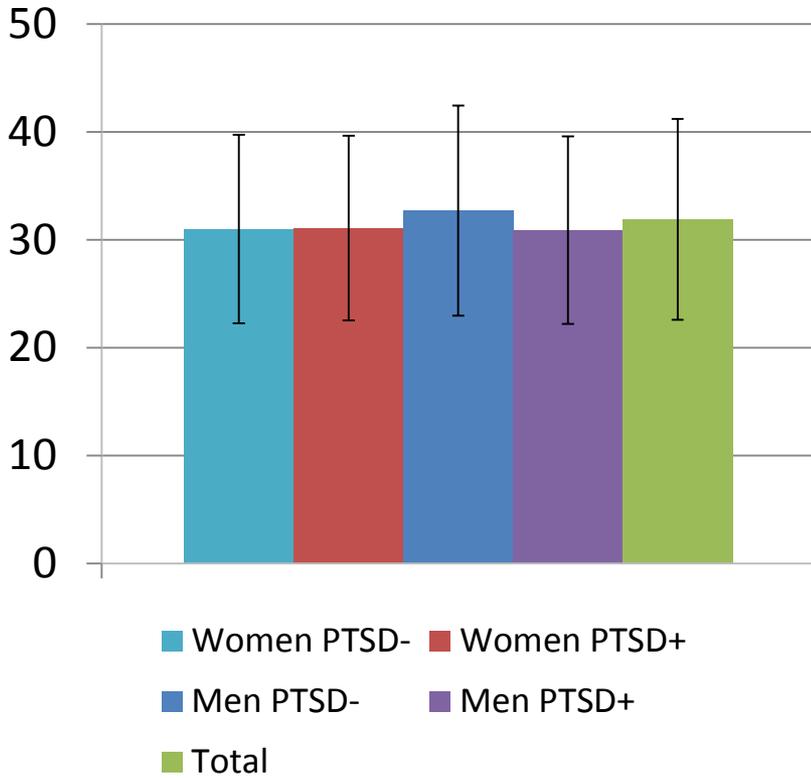
BMI Data Available



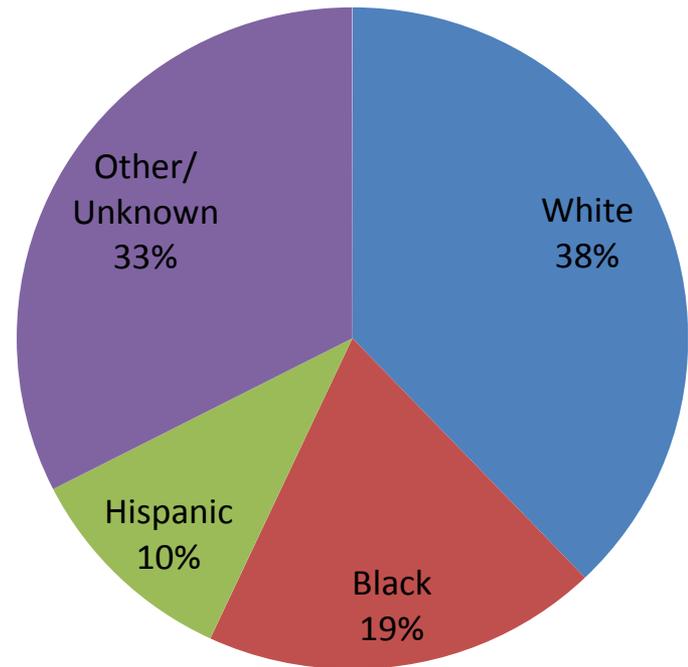
- **BMI:** weight (median of all clinical visits during study period) in kilograms \div height in meters squared
 - Used BMI measurements up to 3 years following index weight measurement (after last deployment)
 - Average patient-level BMI calculated for each 6 month interval

Demographics

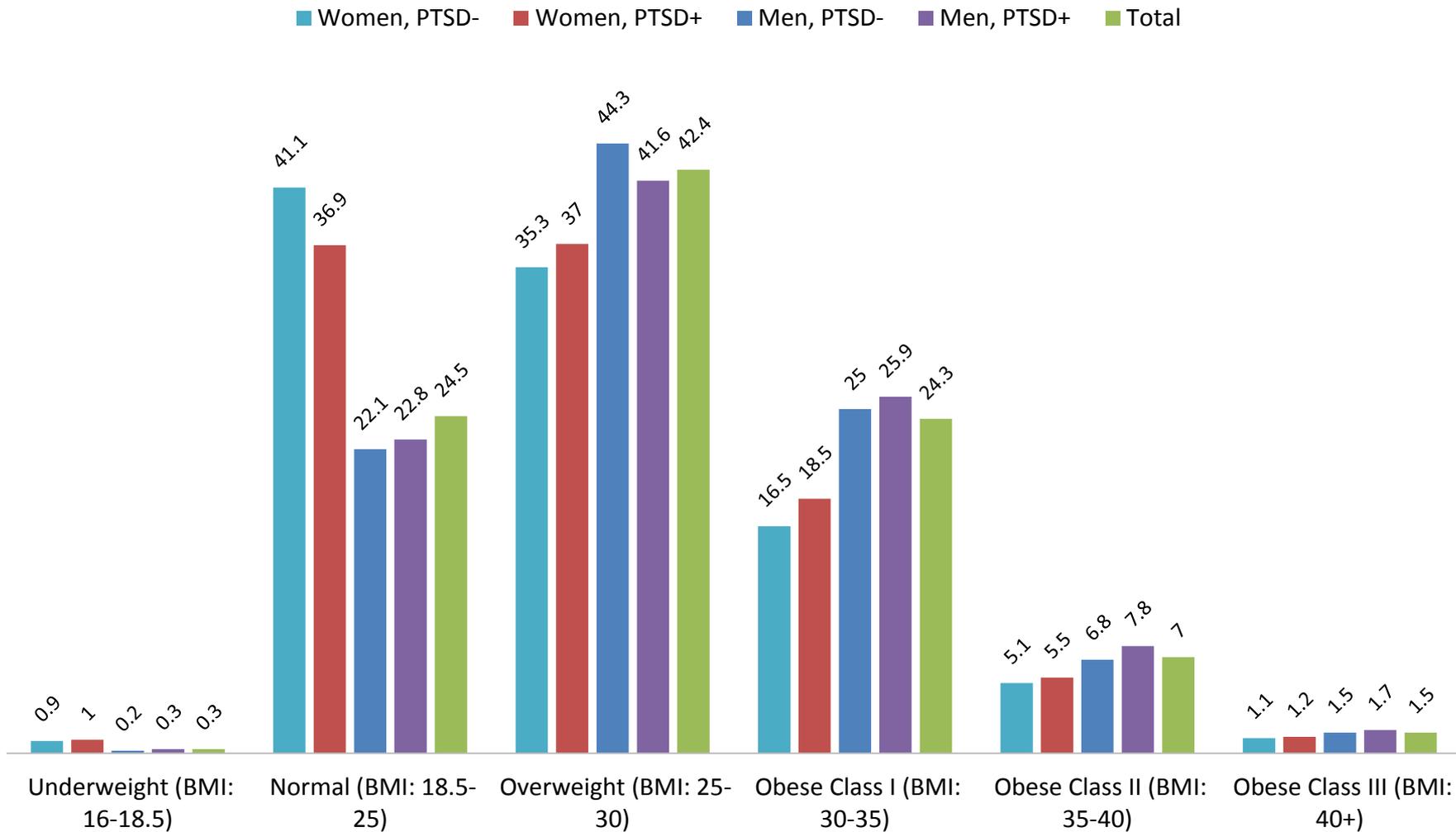
Age at index BMI measurement



Race

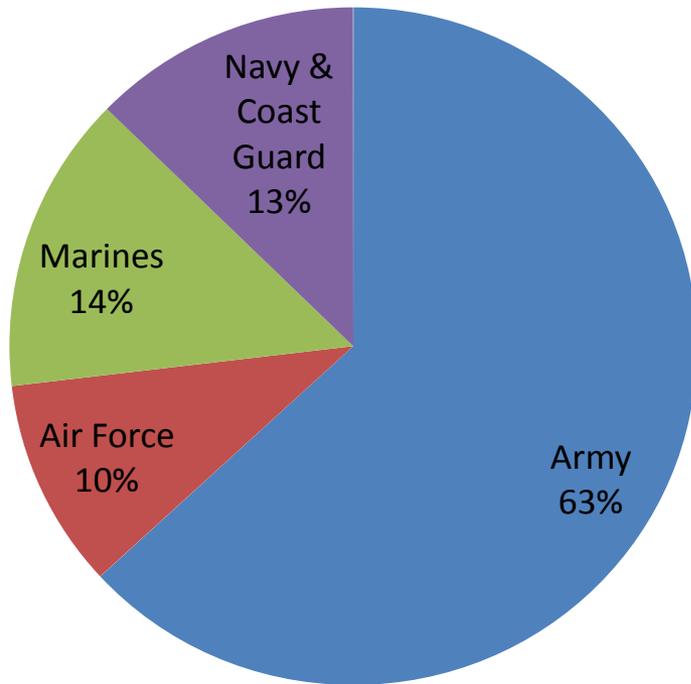


BMI category at baseline

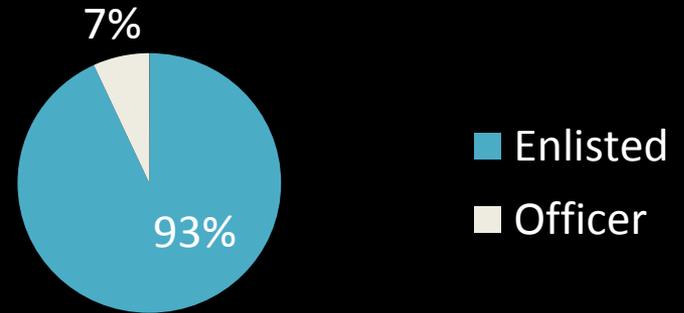


Military Service

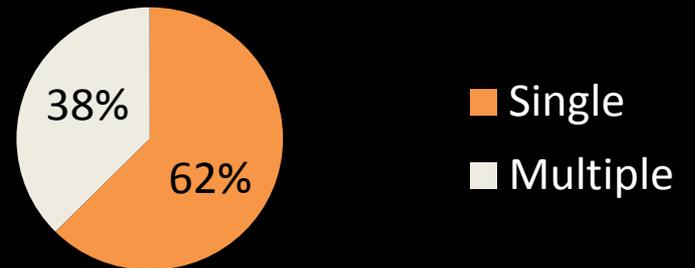
Branch of Service



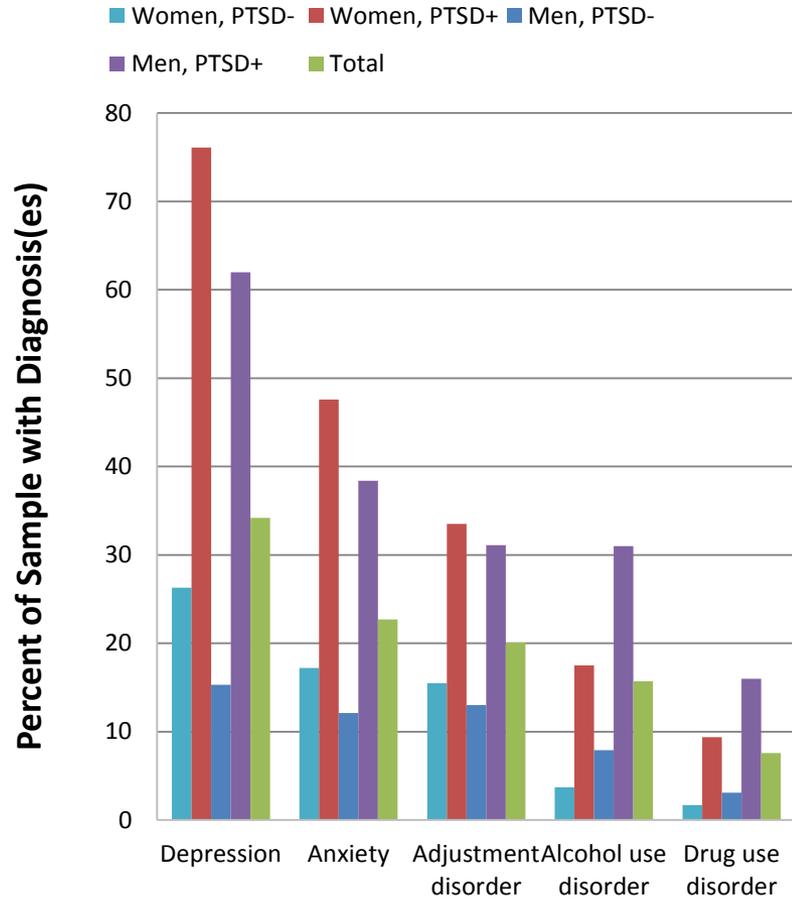
Rank



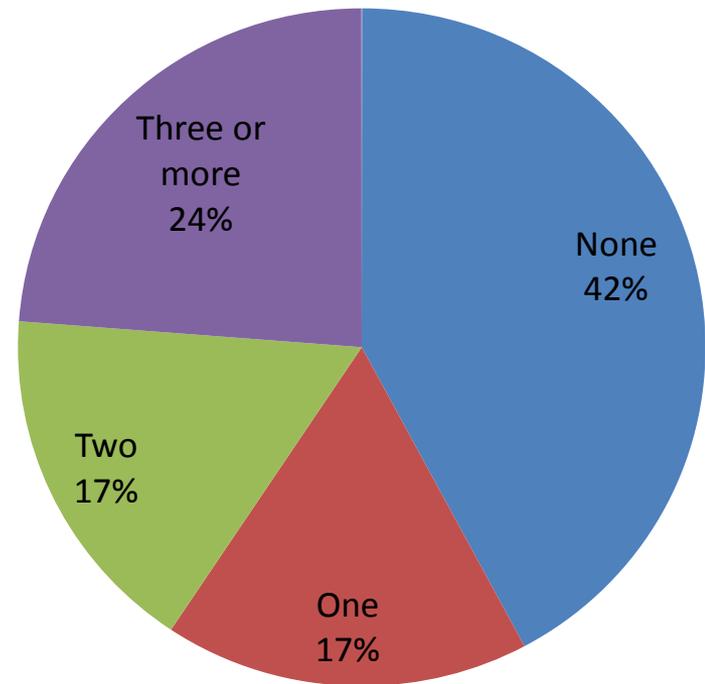
Number of Deployments



Mental Health Diagnoses



Number of Diagnoses



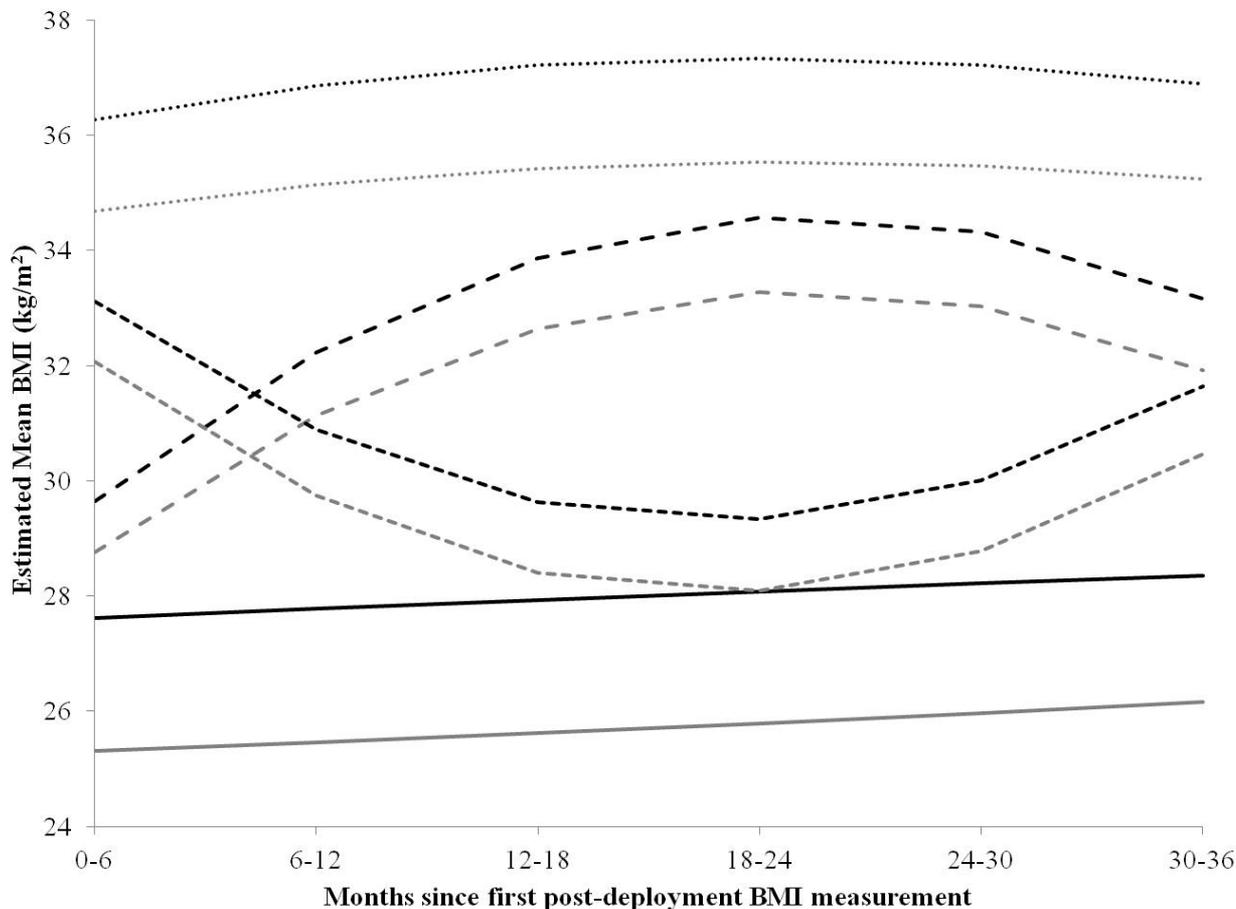
Statistical Analyses

- Growth Mixture Modeling (GMM) used to model longitudinal trajectories, with age race/ethnicity as covariates
- Women and men were modeled separately
- Multinomial logistic regressions were used to examine association between trajectories and each MH condition separately
- First model adjusted for age and race/ethnicity
- Second models further adjusted for other demographics, military characteristics, and antipsychotic medication use.

Results

- Four latent BMI trajectories emerged:
 - Stable overweight
 - Stable obese
 - Overweight/obese gaining
 - Obese losing
- Trajectories similar in females and males, although proportion in each class differed slightly by gender.

Trajectories of body mass index since first BMI measurement post-deployment among women & men OEF/OIF/OND Veterans



Women

- stable obese (11.4%)
- obese losing (3.6%)
- overweight/obese gaining (6.2%)
- stable overweight (78.9%)

Men

- stable obese (8.2%)
- obese losing (2.9%)
- overweight/obese gaining (3.9%)
- stable overweight (85%)

Probability of belonging to latent BMI trajectory class by mental health condition (column percents within gender)

Latent Class	Gender	PTSD		Depression		Anxiety		Adjustment	
		No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)	No n (%)	Yes n (%)
Stable overweight	Women	35083 (84.8)	14813 (80.4)	30130 (86.3)	19766 (79.4)	36993 (84.3)	12903 (81.2)	39539 (83.8)	10357 (82.3)
	Men	245644 (91.3)	146708 (87.4)	265920 (91.1)	126432 (87.1)	306744 (90.3)	85608 (88.2)	315284 (90.1)	77068 (88.4)
Overweight/ obese gaining	Women	1116 (2.7)	1019 (5.5)	796 (2.3)	1339 (5.4)	1298 (3.0)	837 (5.3)	1481 (3.1)	654 (5.2)
	Men	3642 (1.4)	5336 (3.2)	4001 (1.4)	4977 (3.4)	5740 (1.7)	3238 (3.3)	6345 (1.8)	2633 (3.0)
Obese losing	Women	800 (1.9)	541 (2.9)	595 (1.7)	746 (3.0)	865 (2.0)	476 (3.0)	1017 (2.2)	324 (2.6)
	Men	3216 (1.2)	3625 (2.2)	3590 (1.2)	3251 (2.2)	4759 (1.4)	2082 (2.1)	5118 (1.5)	1723 (2.0)
Stable obese	Women	4364 (10.6)	2054 (11.1)	3372 (9.7)	3046 (12.2)	4746 (10.8)	1672 (10.5)	5162 (10.9)	1256 (10.0)
	Men	16493 (6.1)	12268 (7.3)	18250 (6.3)	10511 (7.2)	22611 (6.7)	6150 (6.3)	23046 (6.6)	5715 (6.6)

*Latent trajectory classes were determined from gender-specific latent growth mixture models of BMI that included age and race as covariates. Individuals were assigned to the latent BMI trajectory class for which they had the highest posterior probability of belonging.

Probability of belonging to latent BMI trajectory class by mental health condition (column percents within gender)

Latent Class	Gender	Alcohol Use		Drug Use		Number MH conditions			
		No n (%)	Yes n (%)	No n (%)	Yes n (%)	None n (%)	One n (%)	Two n (%)	Three+ n (%)
Stable overweight	Women	46045 (83.6)	3851 (81.2)	47926 (83.6)	1970 (80.5)	21678 (86.8)	8885 (82.9)	8763 (80.4)	10570 (80.2)
	Men	327323 (90.0)	65029 (88.7)	361233 (89.9)	31119 (88.3)	169620 (92.0)	66946 (89.7)	63985 (87.8)	91801 (87.4)
Overweight/ obese gaining	Women	1841 (3.3)	294 (6.2)	1966 (3.4)	169 (6.9)	459 (1.8)	365 (3.4)	491 (4.5)	820 (6.2)
	Men	6431 (1.8)	2547 (3.5)	7510 (1.9)	1468 (4.2)	1795 (1.0)	1364 (1.8)	1881 (2.6)	3938 (3.8)
Obese losing	Women	1183 (2.1)	158 (3.3)	1226 (2.1)	115 (4.7)	385 (1.5)	223 (2.1)	315 (2.9)	418 (3.2)
	Men	5132 (1.4)	1709 (2.3)	5675 (1.4)	1166 (3.3)	1808 (1.0)	1070 (1.4)	1405 (1.9)	2558 (2.4)
Stable obese	Women	5979 (10.9)	439 (9.3)	6224 (10.9)	194 (7.9)	2457 (9.8)	1249 (11.6)	1337 (12.3)	1375 (10.4)
	Men	24763 (6.8)	3998 (5.5)	27265 (6.8)	1496 (4.2)	11235 (6.1)	5250 (7.0)	5565 (7.6)	6711 (6.4)

*Latent trajectory classes were determined from gender-specific latent growth mixture models of BMI that included age and race as covariates. Individuals were assigned to the latent BMI trajectory class for which they had the highest posterior probability of belonging.

Associations between BMI trajectory classes and mental health conditions among women veterans (N=59,790)

MH Condition	Overweight/obese gaining vs. Stable overweight		Obese losing vs. Stable overweight		Stable obese vs. Stable overweight	
	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)
PTSD	1.44 (1.32,1.56)‡	1.29 (1.17,1.41)‡	1.23 (1.1,1.38)‡	1.21 (1.07,1.36)	1.11 (1.04,1.19)	1.13 (1.05,1.21)
Depression	1.53 (1.4,1.66)‡	1.39 (1.27,1.52)‡	1.34 (1.21,1.49)‡	1.3 (1.16,1.45)‡	1.36 (1.28,1.44)‡	1.33 (1.25,1.42)‡
Anxiety	1.28 (1.17,1.39)‡	1.15 (1.05,1.27)	1.19 (1.07,1.33)	1.12 (1,1.26)	1.02 (0.95,1.09)	0.99 (0.92,1.06)
Adjustment	1.24 (1.13,1.37)‡	1.19 (1.08,1.32)	0.99 (0.86,1.13)	1.03 (0.9,1.18)	0.96 (0.89,1.04)	1.03 (0.96,1.12)
Alcohol use	1.39 (1.21,1.6)‡	1.16 (1.01,1.35)	1.26 (1.06,1.51)	1.18 (0.99,1.41)	0.91 (0.81,1.02)	0.87 (0.76,0.99)
Drug use	1.47 (1.24,1.75)‡	1.12 (0.93,1.35)	1.69 (1.38,2.07)‡	1.48 (1.19,1.85)‡	0.8 (0.68,0.95)	0.71 (0.6,0.85)‡
1 MH condition	1.23 (1.08,1.4)	1.19 (1.04,1.36)	1.13 (0.97,1.32)	1.13 (0.96,1.33)	1.23 (1.12,1.34)‡	1.21 (1.1,1.32)‡
2 MH conditions	1.43 (1.27,1.62)‡	1.34 (1.18,1.51)‡	1.34 (1.15,1.55)‡	1.29 (1.11,1.51)	1.35 (1.24,1.48)‡	1.34 (1.22,1.46)‡
3+ MH conditions	1.71 (1.53,1.9)‡	1.47 (1.31,1.65)‡	1.38 (1.21,1.58)‡	1.34 (1.16,1.55)‡	1.17 (1.07,1.27)‡	1.17 (1.07,1.28)

*Odds ratios adjusted for age at first post-deployment BMI measurement and race.

†Odds ratios further adjusted for marital status, rank, branch of service, component, multiple vs. single deployments, time since end of last deployment, type and distance of nearest VA facility, and time on antipsychotic medication(s).

‡ p<.001

Associations between BMI trajectory classes and mental health conditions among men veterans (N=436,932)

MH Condition	Overweight/obese gaining vs. Stable overweight		Obese losing vs. Stable overweight		Stable obese vs. Stable overweight	
	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)	Age and Race AOR* (95% CI)	Fully AOR† (95% CI)
PTSD	1.42 (1.37,1.48)‡	1.2 (1.15,1.25)‡	1.25 (1.19,1.31)‡	1.15 (1.1,1.21)‡	1.22 (1.18,1.25)‡	1.15 (1.11,1.18)‡
Depression	1.44 (1.38,1.5)‡	1.26 (1.21,1.31)‡	1.24 (1.19,1.3)‡	1.18 (1.13,1.24)‡	1.18 (1.15,1.21)‡	1.12 (1.09,1.16)‡
Anxiety	1.31 (1.25,1.37)‡	1.15 (1.1,1.2)‡	1.13 (1.08,1.19)‡	1.07 (1.02,1.13)	0.98 (0.95,1.01)	0.95 (0.92,0.98)
Adjustment	1.21 (1.16,1.27)‡	1.13 (1.08,1.19)‡	1.07 (1.02,1.13)	1.09 (1.03,1.15)	1.02 (0.99,1.06)	1.04 (1,1.07)
Alcohol use	1.37 (1.31,1.44)‡	1.12 (1.07,1.18)‡	1.22 (1.15,1.29)‡	1.11 (1.04,1.17)	0.86 (0.83,0.89)‡	0.81 (0.77,0.84)‡
Drug use	1.46 (1.37,1.55)‡	1.1 (1.03,1.17)	1.54 (1.45,1.65)‡	1.34 (1.25,1.43)‡	0.67 (0.63,0.71)‡	0.6 (0.57,0.64)‡
1 MH condition	1.2 (1.13,1.27)‡	1.12 (1.05,1.19)‡	1.15 (1.08,1.23)‡	1.1 (1.02,1.17)	1.16 (1.12,1.21)‡	1.11 (1.07,1.15)‡
2 MH conditions	1.37 (1.3,1.45)‡	1.22 (1.15,1.29)‡	1.26 (1.19,1.35)‡	1.19 (1.11,1.27)‡	1.27 (1.23,1.32)‡	1.19 (1.14,1.24)‡
3+ MH conditions	1.65 (1.57,1.73)‡	1.32 (1.25,1.4)‡	1.36 (1.29,1.44)‡	1.24 (1.17,1.32)‡	1.1 (1.06,1.14)‡	1.02 (0.98,1.06)

*Odds ratios adjusted for age at baseline and race.

†Odds ratios further adjusted for marital status, rank, branch of service, component, multiple vs. single deployments, time since end of last deployment, type and distance of nearest VA facility, and time on antipsychotic medication(s).

‡p<.001

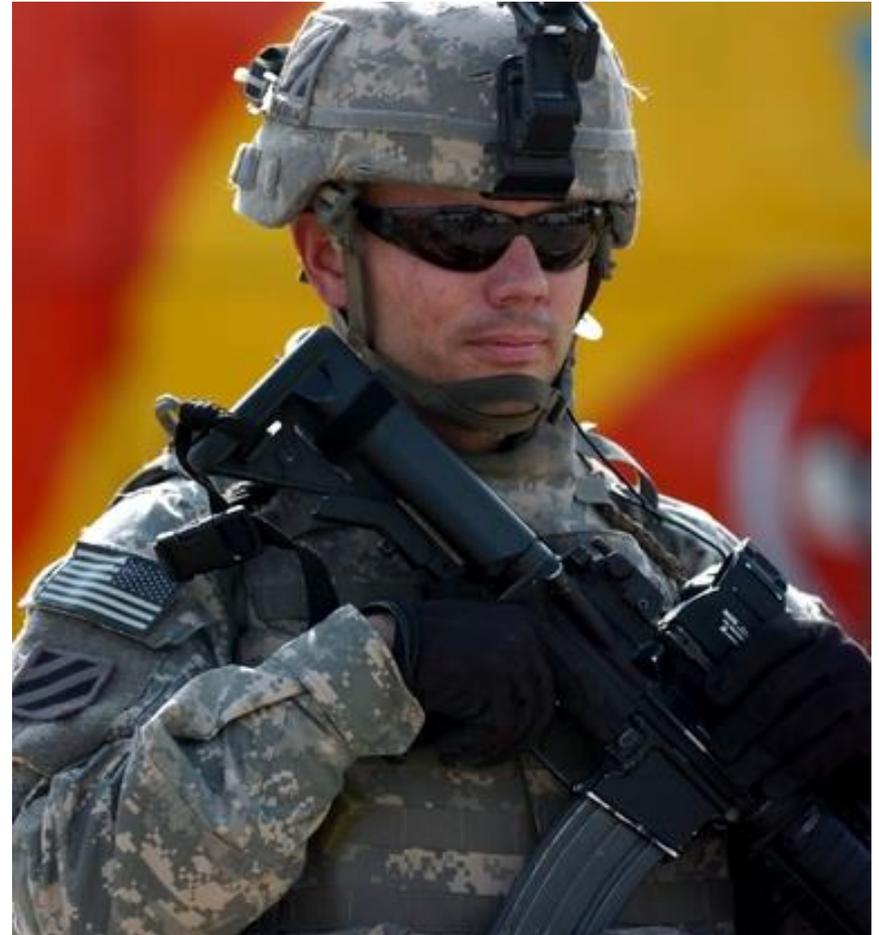
General BMI Findings



- 75% of sample of OEF/OIF veterans were either overweight or obese at baseline
 - Demonstrated continued weight gain over time
 - 12-18% in highest risk groups
- Those in larger two BMI trajectories classes demonstrated gradual increases over time

BMI and MH Diagnoses

- Those with MH diagnoses more likely to be in overweight or obese groups, with some exceptions.
 - Those with PTSD and depression, as well as with multiple other MH diagnoses, had greatest likelihood of being in the highest-risk groups (“stable obese” and “overweight/obese gaining”)
- Two smaller classes (“overweight/obese gaining” and “obese losing”) reversed direction around 18-24 months
 - May coincide with engagement in minimally adequate MH treatment → weight loss facilitator or temporary barrier



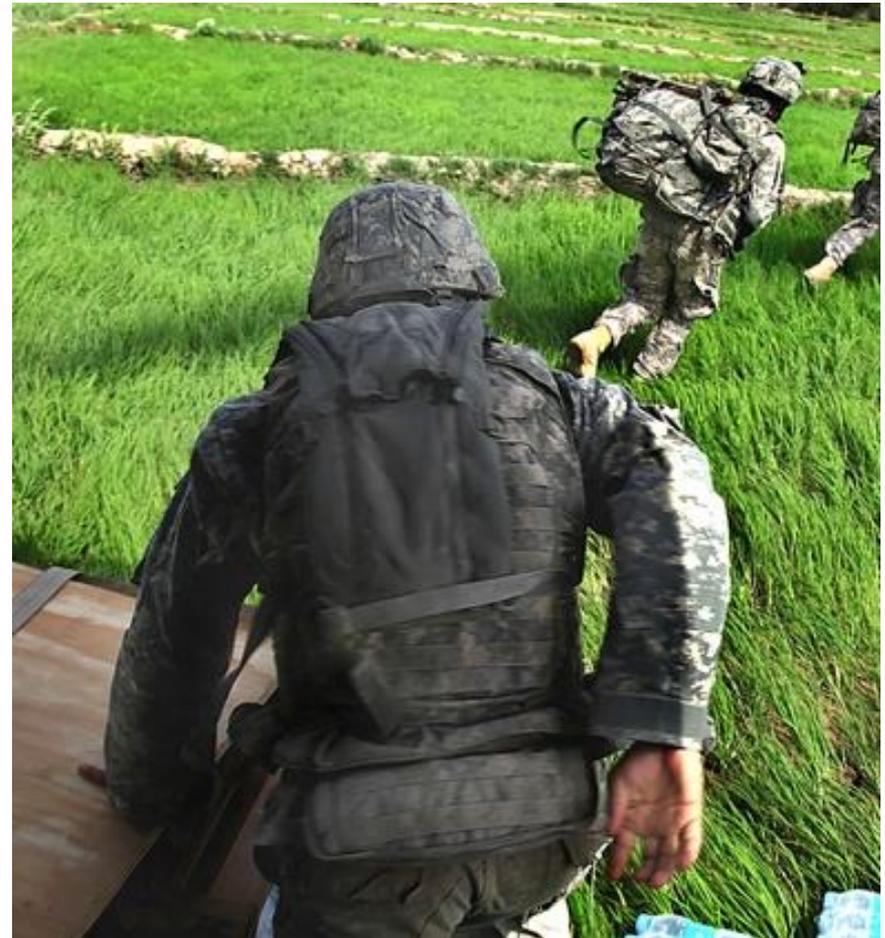
Gender Differences



- Some gender differences in risk profile
- Gender differences in MH condition that predicted belonging to the stable obese class: depression in women, PTSD in men
 - Important treatment implications, given growing number of women in military
 - Depression most common diagnosis among returning female veterans

Discussion

- Treating underlying MH issues may facilitate weight loss
 - Those with MH diagnoses may engage in unhealthy eating in response to stress or to assist with emotional regulation
- Unfortunately, a large number of returning veterans do not engage in adequate MH care



Limitations



- Unable to include measurements of body fat or more specific indicators of obesity
 - Returning veterans may have higher BMI due to muscle mass
- Number of BMI measures differed across subjects
- Rates of PTSD may be greater in cohort
- MH conditions were assessed by diagnostic codes rather than clinical interviews
- Analyses measured associations (rather than causal relationships) between MH and BMI

Implications

- Findings highlight the need to:
 - Refer patients with MH and weight issues for specialty MH care
 - Screen for overeating and emotion-based eating within MH clinics
 - Expand weight management interventions within MH clinics (including barriers to engagement)
 - Collaborative care between primary care and MH clinicians



Implications

- Continue to conduct research focusing on weight loss among veterans with MH diagnoses:
 - National Evaluation of *MOVE!* Outcomes for Veterans with and without MH disorders (NEMO) workgroup
 - Research to better understand unique mental health barriers



References

- Koepsell, TD, Littman AJ, Forsberg CW. Obesity, overweight, and their life course trajectories in veterans and non-veterans. *Obesity* 2012;2:434-439.
- Rosenberger PH, Ning Y, Brandt C, Allore H, Haskell S. BMI trajectory groups in veterans of the Iraq and Afghanistan wars. *Prev Med*. 2011;3:149-154.
- Hoge, CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med*. 2004;1:13-22.
- Vieweg WV, Julius DA, Benesek J, et al. Posttraumatic stress disorder and body mass index in military veterans. Preliminary findings. *Prog Neuropsychopharmacol Biol Psychiatry*. 2006;6:1150-1154.
- Vieweg WV, Julius DA, Bates J, et al. Posttraumatic stress disorder as a risk factor for obesity among male military veterans. *Acta Psychiatr Scand*. 2007;6:483-487.
- Perkonigg A, Owashii T, Stein MB, Kirschbaum C, Wittchen HU. Posttraumatic stress disorder and obesity: evidence for a risk association. *Am J Prev Med*. 2009;1:1-8.

Thank You

Co-Authors

- Erin Madden, MPH
- Beth Cohen, MD, MAS
- Daniel Bertenthal, MPH
- Thomas Neylan, MD
- Lisa Talbot, PhD
- Carl Grunfeld, MD
- Karen Seal, MD, MPH

Acknowledgements

- Julie Dinh, BA

Questions? Comments?

Can also email:

Shira.Maguen@va.gov



Funding • Department of Defense Concept Award Grant (Maguen) • VA Health Sciences Research and Development (HSR&D) Career Development Award (Maguen)
• National Institutes of Health grant K23 HL 094765-01 (Cohen) • Mental Illness Research and Education Clinical Center of the US Veterans Health Administration