Metabolic Syndrome Among People with PTSD: Epidemiological Overview

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Abstract

Previous reports highlighted that traumatic stress exposure may have a key role on both mental and physical health. People suffering from post-traumatic stress disorder (PTSD) may have a shorter life expectancy than general population, mainly due to a higher risk of cardiovascular diseases. Several factors may

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explain this association, but, in recent years, there has been a growing concern on the relationship between metabolic syndrome and PTSD. According to previous reports on both community and special populations' samples, e.g., war veterans, PTSD is associated with a higher risk of suffering from metabolic syndrome as well as obesity, diabetes, hypertension, and dyslipidemia. Clinicians and mental health professionals should regularly assess and screen metabolic alterations among people with PTSD. The potential role of factors and mediators that might explain the nature of the co-occurrence of PTSD and metabolic syndrome – as well as specific interventions addressed to prevent and treat this comorbid condition – need further research.

List of Abbreviations

95%CI	95 % confidence interval
OR	Odds ratio
PTSD	Post-traumatic stress disorder
RR	Relative risk

Introduction

Current medical management of post-traumatic stress disorder (PTSD) is focused on its clinical and psychosocial consequences with little emphasis on comorbid conditions that may impair overall long-term health outcomes (Levine et al. 2014). Indeed, traumatic stress may have a key role also on physical health (McFarlane 2010). People with PTSD have a shorter life expectancy than general population (Boscarino 2006). Epidemiologic research found that traumatic stress exposure and PTSD are associated with several physical illnesses, e.g., autoimmune diseases, diabetes, obesity, gastrointestinal diseases, fibromyalgia, and chronic fatigue syndrome (Boscarino 2004; Coughlin 2011). Furthermore, other studies showed that individuals suffering from PTSD have a higher risk of cardiovascular disease and mortality (Boscarino 2008; Ahmadi et al. 2011). It has been hypothesized that several factors might explain this association, with recent, growing concern on the association between metabolic syndrome and PTSD (Bartoli et al. 2013). Regardless of differences in clinical features, PTSD might share health risk behaviors with other mental illnesses (Bartoli et al. 2013). Several reports have pointed out that metabolic risky behaviors, such as lack of physical activity, unhealthy diet, and smoking, are highly frequent among people suffering from PTSD (Chwastiak et al. 2011; Hirth et al. 2011). Therefore, people with PTSD may have an increased prevalence of metabolic syndrome. The objective of this chapter is to analyze available scientific literature on the association between metabolic syndrome – and its subcomponents – and PTSD.

Metabolic Syndrome: Definition and Prevalence

Metabolic syndrome, also known as insulin resistance syndrome or metabolic syndrome X (Reaven 1993), is characterized by a cluster of cardiovascular risk factors, including abdominal obesity, high blood pressure, dyslipidemia, and high levels of fasting blood glucose.

Several diagnostic classifications for metabolic syndrome have been proposed (NCEP ATP III 2002; Grundy et al. 2005; Alberti et al. 2005; Alberti and Zimmet 1998) (see Table 1). The National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults – Adult Treatment Panel III (NCEP ATP III 2002) defined metabolic syndrome as the presence of three out of the five following criteria:

- Waist circumference $\geq$102 cm in men and $\geq$88 cm in women
- Serum triglycerides $\geq$150 mg/dl
- High density lipoprotein (HDL) cholesterol level $<$40 mg/dl in men and $<$50 mg/dl in women
- Blood pressure $\geq$130/85 mmHg
- Serum glucose level $\geq$110 mg/dl

Metabolic syndrome is a pandemic phenomenon, involving, in most countries, from 20 % to 30 % of the adult population (Grundy 2008). National data on US adults from the 2003–2006 National Health and Nutrition Examination Survey, highlighted that the age-adjusted prevalence of metabolic syndrome was 34 % among all adults, 36 % among men, and 32 % among women, with increasing rates using the International Diabetes Federation ethnic-specific criteria for waist circumference (Ford et al. 2010). In Europe, according to World Health Organization definition, the prevalence of metabolic syndrome seems slightly lower, with rates varying between 7 % and 36 % among 40–55-year-old men and between 5 % and 22 % among women with same age range (Balkau et al. 2002). Based on 11 prospective European cohort studies involving 6,156 men and 5,356 women without diabetes and aged from 30 to 89 years, the age-standardized prevalence of metabolic syndrome was slightly higher in men (16 %) than in women (14 %) (Hu et al. 2004).

Metabolic syndrome has been associated with an increased likelihood of cardiovascular disease and represents an important risk factor for all-cause mortality. People suffering from metabolic syndrome have a threefold higher risk of coronary heart disease and stroke (Isomaa et al. 2001). According to the Kuopio Ischaemic Heart Disease Risk Factor Study (Lakka et al. 2002) – a population-based, prospective cohort study on 1,209 Finnish middle-aged men – metabolic syndrome was associated with 2.6 (1.4–5.1) to 3.0 (1.5–5.7) times higher cardiovascular diseases mortality and 1.9 (1.2–3.0) to 2.1 (1.3–3.3) times higher all-cause mortality, respectively.

Table 1 Definitions of metabolic syndrome

	NCEP ATP III	AHA NHLBI	IDF	WHO
	Any three of the following five criteria:	Any three of the following five criteria:	Criterion #1 plus any two of the other criteria:	Criterion #2 plus any two of the other criteria:
#1	*Waist circumference* >102 cm (men) >88 cm (women)	*Waist circumference* >102 cm (men) >88 cm (women)	*Waist circumference*[a] ≥94 cm (men) ≥80 cm (women)	*BMI* ≥30 kg/m2 and/or *waist/hip ratio* ≥0.90 (men) ≥0.85 (women)
#2	*Fasting glucose* ≥110 mg/dL	*Fasting glucose* ≥100 mg/dL or on drug treatment for elevated glucose	*Fasting glucose* ≥100 mg/dL and/or previously diagnosed type 2 diabetes	*Insulin resistance* Type 2 diabetes or impaired fasting glucose or impaired glucose tolerance
#3	*Blood pressure* Systolic ≥130 mmHg Diastolic ≥85 mmHg	*Blood pressure* Systolic ≥130 mmHg Diastolic ≥85 mmHg or on antihypertensive drug treatment in a patient with a history of hypertension	*Blood pressure* Systolic ≥130 mmHg Diastolic ≥85 mmHg and/or treatment of previously diagnosed hypertension	*Blood pressure* Systolic ≥140 mmHg Diastolic ≥90 mmHg and/or antihypertensive medication
#4	*HDL cholesterol* ≤40 mg/dL (men) ≤50 mg/dL (women)	*HDL cholesterol* ≤40 mg/dL (men) ≤50 mg/dL (women) or on drug treatment for reduced HDL cholesterol	*HDL cholesterol* ≤40 mg/dL (men) ≤50 mg/dL (women)	*HDL cholesterol* ≤35 mg/dL (men) ≤39 mg/dL (women)
#5	*Triglycerides* ≥150 mg/dL	*Triglycerides* ≥150 mg/dL or on drug treatment for elevated triglycerides	*Triglycerides* ≥150 mg/dL and/or specific treatment for this lipid abnormality	*Triglycerides* ≥150 mg/dL
#6				*Urinary albumin excretion rate* ≥20 μg/min or *albumin/creatinine ratio* ≥30 mg/g

[a]Ethnic-specific values include the following: Europids male ≥ 94 cm and female ≥ 80 cm; South Asian male ≥ 90 cm and female ≥ 80 cm; Chinese male ≥ 90 cm and female ≥ 80 cm; Japanese male ≥ 90 cm and female ≥ 80 cm

NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; AHA NHLBI = American Heart Association/National Heart, Lung, and Blood Institute; IDF = International Diabetes Federation; WHO = World Health Organization

Table 2 Key facts of metabolic syndrome

Metabolic syndrome is also known as insulin resistance syndrome or metabolic syndrome X
Metabolic syndrome includes a cluster of alterations, such as central obesity, high blood pressure, dyslipidemia, and hyperglycemia
Metabolic syndrome is a worldwide phenomenon with a prevalence varying between 20 % and 30 % in the adult population
Metabolic syndrome is associated with increased rates of cardiovascular disease
Metabolic syndrome represents an important risk factor for all-cause mortality

Key facts on metabolic syndrome, including its basic definition, frequency, and related risk for early mortality

A 2007 meta-analysis (Gami et al. 2007) on 37 studies including 43 different cohorts and an overall number of 172,573 individuals showed that metabolic syndrome had a relative risk (RR, 95%CI) of cardiovascular events and death of 1.8 (1.6–2.0). A more recent meta-analysis on 21 studies including 372,411 participants (Wu et al. 2010) confirmed these findings, pointing out that individuals affected by metabolic syndrome, as compared to those without, had a pooled RR for all-causes mortality of 1.5 (1.4–1.6).

Table 2 summarizes the key facts on metabolic syndrome.

The Association Between PTSD and Metabolic Syndrome

Though an extensive literature on high vulnerability for metabolic syndrome in people with mental disorders – such as schizophrenia (Mitchell et al. 2013) and affective disorders (Pan et al. 2012; Vancampfort et al. 2013) – does exist, there are few relevant studies involving PTSD. Studies published on this field are detailed in Table 3, with rates of metabolic syndrome among people suffering from PTSD ranging between 17 and 72 %. Comparative studies on the association between PTSD and metabolic syndrome are mainly conducted on war veterans' samples (e.g., Jakovljevic et al. 2008; Maslov et al. 2008; Heppner et al. 2009; Linnville et al. 2011; Ahmadi et al. 2013; Babic et al. 2013), whereas less data are available from nonveterans' samples such as police officers (Violanti et al. 2006) and urban populations (Weiss et al. 2011). Prevalence differences on metabolic syndrome between PTSD and control groups are detailed in Fig. 1.

Comprehensive medical and mental health examinations from 253 male (92 %) and female (8 %) veterans entering Gulf War screening and PTSD programs at the Cincinnati Veterans Affairs showed that more severe PTSDs were associated with metabolic syndrome after controlling for relevant potential confounders (Heppner et al. 2009). Specifically, it was pointed out that Clinician-Administered PTSD Scale total score was a significant predictor of metabolic syndrome. According to diagnostic classification, metabolic syndrome involved 29 % of those with major depressive disorder, 34 % of those with PTSD, and 46 % of those with both PTSD and major depressive disorder. Similarly, a retrospective study highlighted that rates of

Table 3 Studies exploring metabolic syndrome in people with PTSD

Study	Population	PTSD sample size	PTSD diagnosis	MetS diagnosis	MetS prevalence
Ahmadi et al. 2013	Veterans	N = 11,420	N/A	NCEP ATP III	52.5 %
Babic et al. 2013	Veterans	N = 60	HTQ	NCEP ATP III	48.3 %
Heppner et al. 2009	Veterans	N = 139	CAPS	Mixed NCEP and WHO criteria	43.2 %
Jakovljevic et al. 2008	Veterans	N = 100	Clinical diagnosis according to DSM-IV	NCEP ATP III	35 %
Jin et al. 2009	Outpatients needing antipsychotic treatment	N = 33	Clinical diagnosis according to DSM-IV	AHA NHLBI	72 %
Linnville et al. 2011	Veterans	N = 90	IES-R and DSM-IV criteria	Modified NCEP ATP III	30 %
Maslov et al. 2008	Veterans	N = 105	Clinical diagnosis according to ICD-10	NCEP ATP III	38.1 %
Violanti et al. 2006	Police officers	N = 48	IES	AHA NHLBI	16.7 % (50 % in severe PTSD)
Weiss et al. 2011	Individuals from primary care clinics	N = 46	CAPS	NCEP ATP III	47.8 %

Data sources: Ahmadi et al. (2013), Babic et al. (2013), Heppner et al. (2009), Jakovljevic et al. (2008), Jin et al. (2009), Linnville et al. (2011), Maslov et al. (2008), Violanti et al. (2006), Weiss et al. (2011)

Abbreviations: *N/A* not available, *NCEP ATP III* National Cholesterol Education Program Adult Treatment Panel III, *HTQ* Harvard Trauma Questionnaire, *CAPS* Clinician-Administered PTSD Scale, *WHO* World Health Organization, *DSM-IV* Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, *AHA NHLBI* American Heart Association/National Heart, Lung, and Blood Institute, *IES-R* Impact of Event Scale-Revised, *IES* Impact of Event Scale, *ICD* International Classification of Disease

metabolic syndrome were 30 % and 24 % among US veterans with and without PTSD, respectively (Linnville et al. 2011). According to a recent study on more than 200,000 mainly male (93 %) US veterans (Ahmadi et al. 2013), metabolic syndrome was significantly higher in PTSD group (52.5 %) as compared to their non-comorbid counterpart (37.3 %), with metabolic syndrome risk attributable to PTSD of 41 %. However, mixed results on the association between PTSD and metabolic syndrome come from European studies on veterans. A comparative study on consecutively

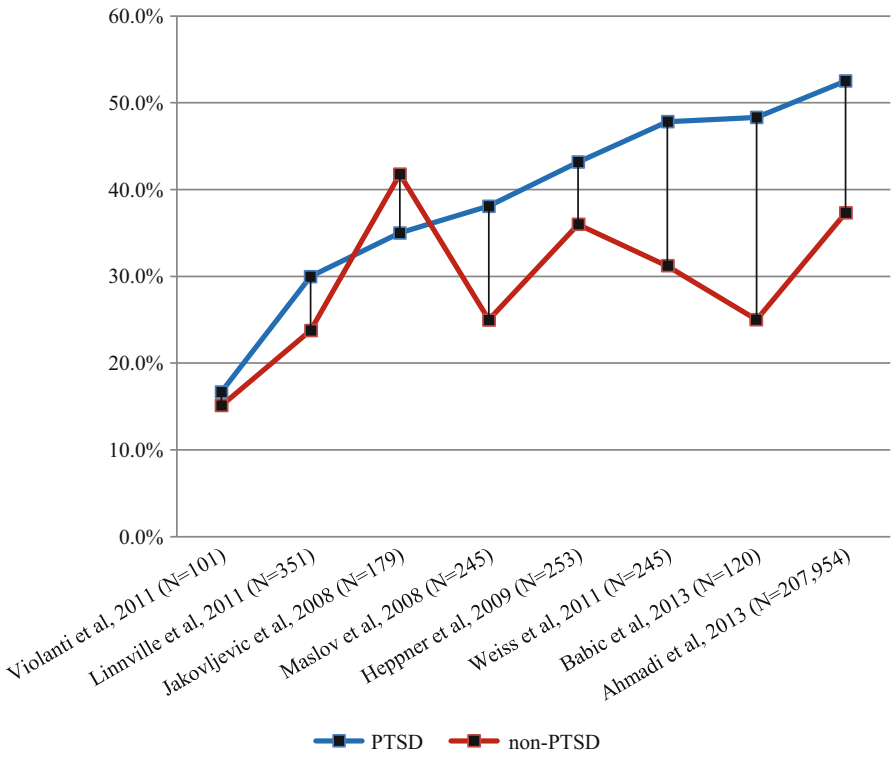

Fig. 1 Comparative rates of metabolic syndrome: PTSD vs. non-PTSD (Data sources: Ahmadi et al. 2013; Babic et al. 2013; Heppner et al. 2009; Jakovljevic et al. 2008; Jin et al. 2009; Linnville et al. 2011; Maslov et al. 2008; Violanti et al. 2006; Weiss et al. 2011)

recruited veterans with war-related PTSD (Jakovljevic et al. 2008) showed a metabolic syndrome prevalence of 35 %, slightly lower than a healthy control group (42 %), though it was higher in PTSD people with additional major depression (48 %). Another comparative study (Maslov et al. 2008) highlighted higher rates of metabolic syndrome among individuals suffering from war-related PTSD (38 %) as compared to a healthy control group (25 %).

Some data are available also from samples based on PTSD unrelated to war experiences. A study on 245 low socioeconomic status, primarily African American, subjects from general medical clinics in an inner-city hospital (Weiss et al. 2011) confirmed that people with current PTSD had a higher risk of metabolic syndrome (48 % vs. 32 %). Logistic regression controlling for other predictor variables, including age, gender, ethnicity, smoking history, antipsychotic medications, trauma exposure, and a diagnosis of major depression, showed that only current PTSD remained a statistically significant predictor of metabolic syndrome ($p < 0.01$).

Mixed results are available from studies comparing the risk of metabolic syndrome between PTSD and other mental disorders. A study enrolling 203 outpatients

older than 40 years and treated with antipsychotic drugs (Jin et al. 2009) found that people with PTSD had higher adjusted rates of metabolic syndrome as compared to those with schizophrenia (73 % vs. 61 %) or a mood disorder (58 %). On the other hand, another study highlighted similar rates of metabolic syndrome among 205 patients with schizophrenia (45.9 %) and a control group of 105 individuals with PTSD (38.1 %) (Maslov et al. 2009).

A recent systematic review and meta-analysis (Bartoli et al. 2013) pooled available data from published scientific reports on both veterans and nonveterans' samples. The analyses – involving an overall size of 528 individuals suffering from PTSD and 846 controls – showed a significant association between PTSD and metabolic syndrome ($p = 0.03$), with low statistical heterogeneity between the included studies ($I^2 = 22$ %). The finding was confirmed by the sensitivity analysis based on the quality assessment.

However, several unanswered questions on the role of PTSD on the risk of metabolic syndrome remain (Schwenke and Siegel 2013). The first concerns whether the relationship between PTSD and metabolic syndrome is independent from other factors that have been related to metabolic syndrome or its components, e.g., lower socioeconomic status, unhealthy diet, lack of physical activity, and insomnia (Schwenke and Siegel 2013). Second, it should be investigated if the PTSD-metabolic syndrome association is independent from medical treatments, such as antipsychotic and antidepressant drugs as well as self-medication with licit or illicit substances, e.g., alcohol, tobacco, cannabis, and cocaine. Third, it remains unexplored if the rates of metabolic syndrome differ according to the nature of trauma and setting where the trauma is experienced (Schwenke and Siegel 2013).

PTSD and Metabolic Syndrome Components

As previously highlighted, metabolic syndrome is a disorder characterized by a cluster of modifications, such as central obesity, high blood pressure, hyperglycemia, low HDL cholesterol, and high levels of triglycerides. In this paragraph, main epidemiological published reports analyzing data on the relationships between PTSD and obesity, hypertension, diabetes, and dyslipidemia, respectively, are summarized in order to test which component may have the greatest weight in determining the high prevalence of metabolic syndrome among individuals suffering from PTSD.

PTSD and Obesity

Data on PTSD from the 1999 Large Health Survey on 501,161 veterans showed a significant, though small, association between PTSD and obesity, with an odds ratio of 1.10 (95%CI: 1.08–1.13) (Chwastiak et al. 2011).

A similar study on national data from 303,223 veterans of Operation Enduring Freedom/Operation Iraqi Freedom who sought care at Veterans Affairs facilities (Cohen et al. 2009) found obesity rates of 13 % and 17 % among men and women suffering from PTSD, respectively, and PTSD was associated with a 1.5-fold higher likelihood of obesity. Furthermore, as Maguen and colleagues showed (Maguen et al. 2013), during a 3-year ascertainment period, those with PTSD and depression were particularly at risk of being either obese without weight loss, overweight or obese, and continuing to gain weight.

A good number of studies confirmed the association between PTSD and obesity also in community studies analyzing trauma unrelated to war. For example, a nationally representative face-to-face household survey conducted in New Zealand, involving 12,992 participants aged 16 years and over (Scott et al. 2008), showed an OR of 2.6 ($p < 0.01$) for a body mass index (BMI) >30 among individuals suffering from PTSD. Collaborative Psychiatric Epidemiology Surveys (Pagoto et al. 2012), including three nationally representative cross-sectional studies conducted between 2001 and 2003, pointed out that rates of obesity were 24.1 % for subjects without a lifetime history of PTSD and 32.6 % for those with past-year PTSD. Adjusting for potential several confounders, such as sociodemographic characteristics, depression, substance and alcohol abuse/dependence, and psychotropic medication status, past-year PTSD was associated with higher risk of obesity, with no differences by gender and an OR (95%CI) of 1.5 (1.2–2.0).

PTSD and Hypertension

In a study on World War II prisoners (Kang et al. 2006), those with PTSD (n = 3,254) had an OR (95%CI) of 1.25 (1.16–1.35) for hypertension as compared to those without PTSD (n = 16,188).

Similar findings were found in a study investigating the association between PTSD and hypertension in male Australian Gulf War veterans (n = 1,381) (Abouzeid et al. 2012). Adjusted ORs (95%CIs) of hypertension were 2.90 (1.19–7.09) and 2.27 (1.01–5.10) among veterans with past-year and lifetime PTSD, respectively.

Studies based on general population data from both the USA and Europe confirmed the association between PTSD and hypertension. In the US National Comorbidity Survey (Kibler et al. 2009), PTSDs both with and without depression, but not depression without PTSD, were significantly associated with the risk of hypertension, after controlling for age, gender, and smoking history. A German population-based study (Glaesmer et al. 2011) examining the relationship of traumatic experiences and PTSD in a representative sample of 1,456 individuals, though aged between 60 and 85 years, highlighted an OR (95%CI) of 3.5 (1.9–6.9) for hypertension among people with PTSD and of 1.4 (1.1–1.8) among those with a lifetime trauma exposure.

PTSD and Diabetes

In a large sample of 2,970 subjects aged 32–81 years drawn from a Southern Germany population-based cross-sectional study (Lukaschek et al. 2013), the model adjusted for sociodemographic characteristics and metabolic risk factors figured out that full PTSD was significantly associated with type 2 diabetes mellitus, with an OR (95%CI) of 3.9 (1.6–9.5), as compared to subjects without an history of traumatic event. Statistic significance of the association was confirmed by the additional adjustment for other psychopathological conditions, with an OR (95% CI) of 3.6 (1.4–8.9). These findings are partially confirmed by a previous study evaluating the relationship between PTSD and diabetes among vulnerable migrant populations (Agyemang et al. 2012). Asylum seekers with PTSD had a higher prevalence of type 2 diabetes as compared with those without PTSD, with age-adjusted prevalence ratios (95%CI) of 1.4 (1.1–1.8) among men and 1.2 (0.9–1.6) among women, respectively.

A longitudinal study on US service members participating in the Millennium Cohort Study probably provided the most interesting and robust findings in this field (Boyko et al. 2010). Individuals reporting diabetes after three years of follow-up were significantly older, had greater baseline BMI, and were less likely to be Caucasian. However, after adjustment for age, gender, BMI, education, race/ethnicity, military service characteristics, and mental health conditions, only baseline PTSD remained significantly associated with diabetes, with an OR (95%CI) of 2.1 (1.3–3.3).

PTSD and Dyslipidemia

According to a cross-sectional survey on 157 active duty male police officers of an elite unit of the Police Force of the State of Goiás, Brazil, participants with full PTSD had significantly higher serum total cholesterol, LDL-C, and triglycerides levels than those without PTSD (Maia et al. 2008). Findings based on multivariate linear regression models showed that PTSD was significantly associated with higher triglycerides levels ($p < 0.01$) even after controlling for age, BMI, and tobacco use. A recent study on 60 male patients with chronic war-related PTSD, compared to 60 patients males who needed medical attention in the dispensary of family medicine in Mostar, Bosnia Herzegovina, highlighted higher, but not statistically significant, rates of both hypertriglyceridemia (40 % vs. 28 %) and low HDL cholesterol (32 % vs. 27 %) among individuals suffering from PTSD (Babic et al. 2013). No significant difference on triglycerides and HDL cholesterol levels could be found in a further cross-sectional study comparing PTSD and non-PTSD male veterans participating in the war in Croatia (Jendricko et al. 2009). However, HDL cholesterol appeared to have a key role among subjects developing PTSD after a myocardial infarction. A previous report on patients assessed with the Clinician-Administered PTSD Scale interview after a myocardial infarction (average follow-up of 33 months) showed that patients with full PTSD had lower HDL cholesterol than those with

subsyndromal PTSD and those without PTSD ($p < 0.05$), even after controlling for gender, BMI, and statin equivalent dosage (Von Känel et al. 2010). Interestingly, HDL cholesterol levels appeared negatively associated with PTSD total symptoms, reexperiencing and avoidance, but not with hyperarousal symptoms.

PTSD and Metabolic Syndrome Co-occurrence: Potential Explanations

The nature of the PTSD and metabolic syndrome co-occurrence remains unknown, and multiple factors may be hypothesized as having a role in contributing to this association. A relatively recent systematic review (Dedert et al. 2010) pointed out that several unhealthy behaviors related to metabolic syndrome, such as excessive alcohol use, smoking, low physical exercise, low self-care, and great caloric intake, may contribute to the increased risk of cardiovascular and metabolic disorders among individuals with PTSD. The 1999 Large Health Survey of Veterans involving more than 500,000 participants found that individuals with PTSD are significantly more likely to smoke and to report physical inactivity (Chwastiak et al. 2011). Furthermore, cross-sectional data gathered from 3,181 young women attending five publicly funded clinics in Texas showed that PTSD symptoms were associated with an increased frequency of consumption of fast food and soda as well as unhealthy eating behaviors (Hirth et al. 2011). However, there may be several other factors potentially explaining or mediating the association between PTSD and metabolic syndrome. First, PTSD symptoms severity may play an important role. Some studies have shown that PTSD people with a comorbid depressive disorder and/or more severe PTSD symptoms may have a higher risk of metabolic syndrome than PTSD people without these specific features (Jakovljevic et al. 2008; Heppner et al. 2009).

Second, the increased off-label use of antipsychotics agents for the treatment of subjects with PTSD (Leslie et al. 2009) as well as other pharmacological treatments, such as antidepressant drugs (McIntyre et al. 2010), may play a major role in explaining high rates of metabolic syndrome. Specifically, metabolic side effects of second-generation antipsychotics are related to a greater likelihood of several metabolic abnormalities, such as weight gain, hyperglycemia, and dyslipidemia (Newcomer 2005). According to an analysis of the Veterans Affairs health-care system on 279,778 individuals (Leslie et al. 2009), PTSD represented the most common mental illness among patients with off-label prescribed antipsychotics. Although a previous study revealed that the association between current PTSD and metabolic syndrome was not explainable by a treatment with atypical antipsychotic drugs (Weiss et al. 2011), the burden of these pharmacological agents on metabolic syndrome risk among people with PTSD should be further investigated.

Third, the association between PTSD and metabolic syndrome may be mediated by the burden of stress on metabolic alterations (Rosmond 2005). Stressful life events are associated with obesity, insulin resistance, hypertriglyceridemia, and poor metabolic health (Pyykkonen et al. 2010). These associations may be mediated

Table 4 Key facts on PTSD and metabolic syndrome comorbidity

Data on the risk of metabolic syndrome among individuals with PTSD are mainly from samples of veterans
Pooled findings showed a significant association between PTSD and metabolic syndrome
PTSD has also high rates of metabolic syndrome components
The nature of this association remains unknown
Unhealthy behaviors, comorbid depression, pharmacological treatments, and neuroendocrinal alterations may mediate this association

Key facts on comorbidity between PTSD and metabolic syndrome (and metabolic syndrome components), including its significant association and potential explanations

by alterations in the hypothalamic-pituitary-adrenal (HPA) axis and changes in glucocorticoid system (Rosmond 2005; Pasquali et al. 2006). Therefore, metabolic syndrome among people with PTSD may be a consequence of neuroendocrinal adaptations to extreme stress (Rasmusson et al. 2010). Table 4 summarizes key facts of metabolic syndrome and comorbid PTSD.

PTSD and Metabolic Syndrome: Practices and Procedures

Findings on the strength of the association between PTSD and metabolic syndrome emphasize the need of an ongoing cardiometabolic assessment in this clinical population raising awareness of physical health issues similarly to people suffering from other severe mental illnesses (De Hert et al. 2011). Metabolic syndrome may explain at least partially the high rates of cardiovascular load and early mortality among these individuals. Clinicians should regularly assess risk for metabolic syndrome, and its components as well as relevant lifestyle habits, weight/waist circumference, and blood pressure measures with fasting blood glucose and lipid profile should become a key element in long-term routine monitoring. More specifically, as regards people taking off-label antipsychotic medications, according to the consensus conference of the American Diabetes Association, the American Psychiatric Association, the American Association of Clinical Endocrinologists, and the North American Association for the Study of Obesity (2004), the main recommendations are *i*) promoting patient, family, and caregiver education; (*ii*) regularly screening and monitoring cardiometabolic alterations; and (*iii*) referring to specialized services, when appropriate.

All individuals suffering from PTSD should be frequently monitored, regularly assessing BMI 1, 2, and 3 months after initiation of any new drug treatment. Fasting plasma glucose, lipid levels, and blood pressure should be assessed at baseline and 3 months after the initiation of an antipsychotic medication. Thereafter, lipid profile should be evaluated every five years or more frequently, if clinical alterations are likely, whereas blood pressure and plasma glucose values should be obtained annually or more frequently in those who have a higher baseline clinical risk of developing hypertension or diabetes. A summary of the panel recommendations for baseline and follow-up screening measures after the introduction of any antipsychotic medication is shown in Table 5.

Table 5 Summary of recommendations for the early monitoring of patients receiving second-generation antipsychotic drugs

Temporal steps	Recommendations
Early monitoring	
t0	Collecting information on personal and family history of obesity, diabetes, dyslipidemia, hypertension, or cardiovascular disease Measuring height and weight to assess BMI Measuring waist circumference to assess central obesity Measuring systolic and diastolic blood pressure Taking a fasting blood sample to check for glycemia and lipid profile
t1	Measuring BMI to check for weight gain
t2	Measuring BMI to check for weight gain
t3	Measuring BMI to check for weight gain Measuring systolic and diastolic blood pressure Taking a fasting blood sample to check for glycemia and lipid profile
Long-term monitoring	
Quarterly	Measuring BMI to check for weight gain
Annually	Collecting information on personal and family history of obesity, diabetes, dyslipidemia, hypertension, or cardiovascular disease Measuring waist circumference to assess central obesity Measuring systolic and diastolic blood pressure Taking a fasting blood sample to check for glycemia
Every 5 years	Taking a fasting blood sample to check for lipid profile

t0 = start of treatment with a second-generation antipsychotic drug; t1 = one month after the start of treatment; t2 = two months after the start of treatment; t3 = three months after the start of treatment

Conclusions

Individuals suffering from PTSD have a greater risk of metabolic syndrome. PTSD should be considered a vulnerable condition for physical and cardiometabolic disorders. The potential role of unknown factors or mediators explaining the nature of this association needs additional research. Furthermore, there is a lack of studies longitudinally investigating the impact of screening, prevention, or treatment measures for people with PTSD in terms of improvement of health status and life expectancy.

Summary Points

- The traumatic stress has a key role on mental and physical health.
- People suffering from PTSD show a high risk of cardiovascular diseases and early mortality.
- There is a growing concern on the association between PTSD and metabolic syndrome.
- Metabolic syndrome may explain at least partially high rates of cardiovascular diseases and early mortality among people with PTSD.

- Individuals with PTSD have a higher risk of suffering from metabolic syndrome, as well as its subcomponents, including obesity, diabetes, hypertension, and dyslipidemia.
- Clinicians and mental health professionals should regularly assess and screen metabolic modifications in these patients.
- Although several hypotheses have been made, the nature of the association between PTSD and metabolic syndrome remains unknown, and it is probably multifactorial.
- Future research is needed to investigate the impact of screening, prevention, and treatment measures in terms of improvement of health outcomes and life expectancy.

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