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ORIGINAL PAPER

Post-traumatic stress disorder (PTSD) in mid-age and older adults differs by immigrant status and ethnicity, nutrition, and other determinants of health in the Canadian Longitudinal Study on Aging (CLSA)

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Abstract

Purpose This study aimed to address knowledge gaps about post-traumatic stress disorder (PTSD) in mid-age and older adults, with particular attention to the relationship of PTSD with nutrition and with ethnicity and immigrant status.

Methods Binary logistic regression analysis of weighted comprehensive cohort data from the baseline Canadian Longitudinal Study on Aging (CLSA; $n = 27{,}211$) was conducted using the four-item Primary Care-PTSD tool (outcome) and immigrant status by ethnicity (Canadian-born white, Canadian-born minority, immigrant white, immigrant minority). Covariates included various social, economic, nutrition and health-related variables.

Results After controlling for socioeconomic and health variables, immigrants from minority groups had significantly higher odds of PTSD compared to their Canadian-born counterparts, whereas white immigrants had lower odds of PTSD. These relationships were significantly robust across seven cluster-based regression models. After adjusting for ethnicity/immigrant status, the odds of PTSD were higher among those earning lower household incomes, widowed, divorced, or separated respondents, ever smokers, and those who had multi-morbidities, chronic pain, high nutritional risk, or who reported daily consumptions of pastries, pulses and nuts, or chocolate. Conversely, those 55 years and over, who had high waist-to-height ratio, or who consumed 2–3 fiber sources daily had significantly lower odds of PTSD.

Conclusion Interventions aimed at managing PTSD in mid-age and older adults should consider ethnicity, immigrant status, as well as socioeconomic, health, and nutrition status.

Keywords Older adults · Immigration · Ethnicity · Determinants of health · Nutrition · CLSA · Post-traumatic stress disorder · PTSD

Abbreviations

aOR	Adjusted odds ratio
BMI	Body mass index
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition

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DSM-5	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition
OR	Odds ratio
PC-PTSD	Primary Care Post-Traumatic Stress Disorder (scale)
SPSS	Statistical Package for the Social Sciences
T-score	Bone density test score
WHR	Waist-to-hip ratio
CLSA	Canadian Longitudinal Study on Aging
PTSD	Post-traumatic stress disorder

Introduction

Post-traumatic stress disorder (PTSD) is a syndrome that develops after exposure to traumatic event(s) such as threatened or actual death, serious injury, and/or sexual violence [1]. PTSD can develop from direct experience, witnessing of a traumatic event, learning of a traumatic event that happened to someone close, or from extreme exposure(s) to the details of a traumatic incident [2]. A wide range of experiences can result in PTSD including childhood maltreatment, accidents, exposure to war, violence, and conflict. PTSD results in clinically significant distress and/or impairment of daily functioning (i.e., capacity to work, social interaction). The lifetime prevalence estimates of PTSD have been estimated as 6.1% in the United States [3] and 9.2% in Canada [4]. Among groups that have had high exposure to violence and conflict, such as refugees, the prevalence of PTSD can be much higher with estimates close to 30% [5]. Other groups, particularly those who have endured exposure to combat and/or sexual abuse, are also more likely to experience PTSD ($\geq$25–50%) than the general public [6]. PTSD can result in a wide range of negative outcomes including insomnia, greater difficulties in progressing in education and career [7, 8], increased risk for unemployment and homelessness [9], and problematic relationships [8]. PTSD is associated with substantial indirect costs to the economy due to lost work and health care-related needs [7]. For instance, in Canada there is an estimated $21 billion per year loss in productivity directly associated to PTSD [8].

Vulnerability to PTSD has been shown to differ by various social determinants of health. The lifetime prevalence of PTSD in women is twice that of men [6, 10–12]. Women are believed to be more prone to PTSD due to their heightened risk of exposure to sexual abuse. The age at which the peak prevalence of PTSD occurs varies by gender, with the prevalence of PTSD being highest among men in their early 40s and women in their early 50s [11]. The prevalence of PTSD is lower among individuals who are married [13, 14], those who are more educated [15, 16] and those who have higher socio-economic status [17]. Individuals with greater social support are less likely to develop PTSD after experiencing trauma [18]. Studies have shown a strong association between PTSD and comorbid conditions, including depression, anxiety, and substance use disorders (such as alcoholism) [6, 19–23]. Recovery from PTSD is more rapid among those who experience a non-intentional injury vs those who have had an intentional injury inflicted upon them during the traumatic event [24, 25].

PTSD has been reported to be associated with a wide range of health issues including neurological (e.g., epileptic seizures), gastrointestinal (e.g., ulcers), autoimmune, metabolic and/or joint/bone conditions [22, 26]. PTSD may also elevate the risk of subsequent suicidal ideation, suicidal attempt, and death by suicide [8, 27]. The prevalence of chronic pain is higher among those with PTSD than among those who do not have a diagnosis of PTSD [28, 29]. Chronic pain, particularly when it is a consequence of a traumatic event, exacerbates PTSD [30]. These reported relationships may be due to alterations in the gut microbiome, hypothalamic–pituitary–adrenal (HPA) axis, and sympathetic nervous system, as well as processes of inflammation and oxidative stress [31].

PTSD, and its associated health outcomes, may also be moderated or mediated by a wide range of health behaviors. PTSD and the use of substances, such as cigarettes [32] and alcohol [33], have been reported to be highly comorbid as individuals use these as mechanisms to self-medicate [34]. Some cross-sectional studies have found that PTSD is associated with obesity [35] and one prospective study reported that those with PTSD gained more weight than their peers who did not have PTSD [36]. The effects of trauma, such as sensory issues, hyperarousal, being easily startled, and feelings of numbness, have been shown to influence appetite and eating [37]. Potential mechanisms that may contribute to the relationship between PTSD and obesity include using food as a negative coping behavior [38], gut dysbiosis [39], HPA disruption [35, 40], cortisol stimulation [41], and inflammation [42]. Some of these associations may be influenced by PTSD-induced changes in sleep and metabolism; both are factors that are associated with obesity [38]. Specific studies examining the relationship between nutrition and PTSD are limited. Preliminary studies suggest that certain nutrients such as B vitamins (i.e., vitamin B_{12} and folic acid), antioxidants (i.e., vitamin C), essential fatty acids (i.e., omega-3 fatty acids), zinc, magnesium, curcumin, and probiotics have therapeutic potential in modulating various physiological alterations associated with PTSD [43–46].

The relationship between immigrant status, ethnicity, and PTSD warrants greater research attention. Immigrants include refugees, displaced persons, uprooted people, and economic migrants [47]. From 2000 to 2017, the number of international migrants has increased by 85 million (49%) [48]. Regardless of the reason for migration, stressful life events often precede or co-occur with the process, such

as pre-immigration exposure to stressful and traumatizing experiences [49, 50]. Migrant status is often associated with acculturative stress, discrimination, geographic segregation, reduced social networks and supports, urban violence, abuse by law enforcement officers, separation from families, food insecurity, poor mental health, and changes in diet quality [51–53]. Refugees have a much higher prevalence of developing PTSD compared to the general population [54–56]. Several studies indicate that the incidence of mental health outcomes such as psychological distress [57] and PTSD [58] among a diversity of ethnic immigrant groups has increased worldwide [59].

To better understand the mental health of immigrants, research is needed about PTSD and factors which contribute to its manifestation, particularly among racial/ethnic groups to develop an evidence base which can better contribute to health practice and policies [60, 61]. Using Canadian Longitudinal Study on Aging data, PTSD and its relationships with ethnicity and immigrant status were analyzed while controlling for a number of covariates that included socioeconomic status, physical health (e.g., multi-morbidity), health behaviors (e.g., substance use, physical activity), over-nutrition (e.g., disease risk), poor nutrition status (e.g., handgrip strength, nutrition screen scores, body composition, anemia screen), and dietary intake. Based on current understandings from the literature, the study was directed by three research questions:

1. Does the prevalence of PTSD vary by ethnicity and immigrant status among those aged 45–85 years?
2. Are the associations between ethnicity and immigrant status and PTSD attenuated by a wide range of health determinants?
3. Are there other determinants of health that are significantly associated with PTSD after controlling for ethnicity and immigrant status?

Materials and methods

Participants

Details about the participants have been discussed elsewhere [62–66]. For this investigation, the baseline (2012–2015) comprehensive data of the Canadian Longitudinal Study on Aging (CLSA) was utilized. This dataset includes biological, medical, psychological, social, lifestyle, and economic measures of Canadians aged 45–85 years [66]. The sampling framework for the comprehensive portion of the CLSA included a random selection of households within 50 km of 11 data collections sites [67–69]. The data collection sites were in cities in 7 of Canada's 10 provinces. If the households included an eligible member between the age of 45–85 years, they were asked to participate. It is important to note that the response rate was very low (10%) and predominantly well-educated individuals, and therefore, the CLSA comprehensive sample may not be representative of the Canadian population.

Participants in the comprehensive data set ($n = 30{,}097$) completed in-home interviews and had a wide range of physical assessment measures taken at specific study sites [70]. The final sample size with complete data was 27,211. The study protocol of the CLSA has been approved by 13 research ethics boards across Canada. Details about the study are available at www.clsa-elcv.ca. The secondary analysis of CLSA data conducted in this paper was approved by the University of Toronto's Health Sciences Research Ethics Board.

Measures

Dependent variable

Post-traumatic stress disorder (PTSD): The four-item Primary Care Post-Traumatic Stress Disorder (PC-PTSD) tool was used to screen for PTSD [71]. The PC-PTSD includes 4 questions with yes/no responses about DSM-IV PTSD symptoms and experiences in the last month. The screen begins with an introduction to orient respondents to traumatic events. If participants responded in the affirmative to at least three questions, they are considered to have screened positive for PTSD [72].

Independent variables

Ethnicity/Immigrant Status: A four-level variable was generated to assess differences in the prevalence of PTSD among those born in Canadians and immigrants: (1) Canadian-born white; (2) Canadian-born visible minority member; (3) immigrant white; and (4) immigrant visible minority member.

Covariates

Demographic, social, economic, health, and nutrition-related variables that could potentially attenuate the relationship between PTSD and immigration status were also examined in the analysis and are detailed in Supplementary Table 1.

Statistical analysis

All analyses were completed using SPSS Version 25. As a modification of the model-based approach, an adjusted weight variable was applied to provide estimates that are representative of the total population of Canadians between 45 and 85 years. In keeping with recommended strategies for

complex national surveys [73], the adjusted weight was created by dividing the population-based weight by the average weight for the subsample of 27,211 respondents. Weighted percentages were used to describe the entire sample and unweighted sample sizes were also presented. Descriptions of the sample when stratified by presence and absence of PTSD were based on weighted means. Adjusted odds ratios were derived using binary logistic regression to examine associations between ethnicity and immigrant status and PTSD while adjusting for the covariates. An interaction term of gender by ethnicity/immigrant status was not significant in the regression analyses ($p = 0.849$), and therefore, logistic regression estimates are reported for both sexes together. Seven stepwise models were analyzed by entering seven clusters of factors, respectively, based on the core model with age, sex and ethnicity/immigrant status adjusted (Model 1): demographic and socioeconomic variables (Model 2), health characteristics (Model 3), health behavior variables (Model 4), over-nutrition and poor nutrition status indicators (Model 5), and dietary intake measures (Model 6). The final model was adjusted for all of the aforementioned variables (Model 7). For the final logistic regression model, diagnostics and model fit measures were applied that included the Omnibus Test of Model Coefficients and Nagelkerke's R^2.

Results

Description of sample

The sample mainly consisted of Canadian-born residents ($n = 22,448$; 82.5%), 45–65 years ($n = 16,006$; 58.8%), earning between C$20,000–$99,999/year ($n = 15,977$; 58.7%), in a relationship ($n = 18,877$; 69.4%), and who had earned a post-secondary diploma or degree or above ($n = 21,148$; 77.7%) (Table 1). The proportion of women is slightly higher than men (women: 50.6%; men: 49.4%).

With reference to health-related characteristics, the majority of participants had at least one health condition ($n = 22,302$; 82.0%), a form of hypertension or were taking anti-hypertensive medication ($n = 14,728$; 54.1%), reported having no chronic pain ($n = 20,596$; 75.7%), did not drink excessive amounts of alcohol ($n = 17,598$; 64.7%), and indicated they had never or seldom engaged in light sports or recreational activities in the past 7 days ($n = 23,289$; 85.6%). A slightly higher proportion of participants smoked more than 100 cigarettes in their lifetime compared to those who did not ($n = 14,507$; 53.3%).

Based on the nutrition status prevalence estimates, most respondents tended to carry excess weight (BMI ≥ 25, $n = 18,936$; 69.6%) and, based on BMI and WHR measures, were at risk for developing chronic conditions ($n = 19,239$; 70.7%). Most of the sample did not report indications of poor nutrition status (> 58% across measures for normal/healthy status categories).

With reference to the dietary intake measurements, the majority of respondents tended to consume low amounts of fiber (≤ 2 servings/day; $n = 21,656$; 79.6%), pulses and nuts (< 1 serving/day; $n = 15,048$; 55.3%), fruits and vegetables (≤ 4 servings/day; $n = 20,289$; 74.6%), and calcium containing foods with high vitamin D content (≤ 2 servings/day; 18,376; 67.5%). All demographic, social, economic, health, nutrition status, and dietary intake measurements showed significant associations with PTSD (p's < 0.05); the exception being binge drinking, bone density scores, and anemia screen, as well as intakes of omega-3 eggs, pure fruit juice, salty snack intakes, and calcium sources with low vitamin D content.

Multivariable analysis

Research Question #1: Does the prevalence of PTSD vary by ethnicity and immigrant status among those aged 45–85 years?

The prevalence of PTSD among visible minority immigrants (7.5%) was more than double that of white immigrants (3.6%, $p < 0.001$), and approximately 50% higher than whites born in Canada (5.6%, $p = 0.008$), but did not differ significantly from that of Canadian-born visible minority members (4.9%, $p = 0.19$), possibly due to the small sample size of the latter. Canadian-born whites had significantly higher prevalence of PTSD than white immigrants ($p < 0.001$). There was no significant difference in prevalence of PTSD by visible minority status among those born in Canada ($p = 0.62$), nor between Canadian-born minorities and immigrant whites ($p = 0.233$).

In the final model of the logistic regression (Please see Table 2), in comparison to whites born in Canada, immigrants from visible minority groups (Table 2) had higher odds of PTSD (OR 1.47, 95% CI 1.14–1.90, $p < 0.001$). Conversely, white immigrants had 26% lower odds of PTSD (OR 0.74, 95% CI 0.61–0.90, $p = 0.003$) when compared to whites born in Canada. Canadian-born visible minority respondents did not differ significantly from whites born in Canada. In the base model (Model 1; variables ethnicity and immigrant status, age, sex), compared to Canadian-born whites, immigrant whites had lower odds of PTSD (OR 0.73, $p < 0.05$, 95% CI 0.61–0.88) (see Fig. 1b) while immigrant visible minorities had higher odds of PTSD (OR 1.26, $p = 0.058$, 95% CI 0.99–1.60) but this was not significant (see Fig. 1c). Supplemental analyses, not shown, indicate that compared to white immigrants, both visible minority immigrants (OR 1.72, $p < 0.001$, 95% CI 1.29–2.30) and Canadian-born whites (OR 1.37, $p = 0.001$, 95% CI 1.13–1.65) had higher odds of PTSD. Canadian-born visible

Table 1 Description of sample characteristics by PTSD screen ($n = 27,211$)

Variables	Total Unweighted $n = 27,211$		PTSD positive Unweighted $n = 1,323$		PTSD negative Unweighted $n = 25,888$		χ^2 (*df*) *p* value
	n	%	*n*	% weighted	*n*	% weighted	
Demographic, social, and economic factors							
Ethnicity/immigrant status							
Canadian-born white[a]	22,196	81.6	1123	5.6	21,073	94.4	33.6 (3), < 0.001
Canadian-born visible minority[b]	252	0.9	12	4.9	240	95.1	
Immigrant white[c]	3865	14.2	125	3.6	3740	96.4	
Immigrant visible minority[d]	898	3.3	63	7.5	835	92.5	
Sex							
Men	13,439	49.4	449	3.9	12,990	96.1	124.1 (1), < 0.001
Women	13,772	50.6	874	6.9	12,898	93.1	
Age							
45–55 years	6988	25.7	457	6.4	6531	93.6	70.1 (3), < 0.001
56–65 years	9018	33.1	502	5.5	8516	94.5	
66–75 years	6601	24.3	252	4.0	6349	96.0	
76–85 years	4604	16.9	112	3.1	4492	96.9	
Household income							
< $20,000	1309	4.8	175	14.1	1134	85.9	294.6 (5), < 0.001
$20,000–$49,999	5626	20.7	383	7.6	5243	92.4	
$50,000–$99,999	9042	33.2	388	5.2	8654	94.8	
$100,000–$149,999	5111	18.8	159	3.7	4952	96.3	
≥ $150,000	4478	16.5	127	3.4	4351	96.6	
Not answered	1645	6.0	91	7.2	1554	92.8	
Marital status							
Single	2318	8.5	2148	7.9	170	92.1	161.3 (2), < 0.001
Married/live with a partner/common-law	18,877	69.4	18,166	4.4	711	95.6	
Widowd/divorced/separated	6016	50.6	5574	8.8	442	91.2	
Education level							
Less than secondary school	1457	22.1	110	8.5	1347	91.5	31.3 (3), < 0.001
High school graduate and/or with some post-secondary	4566	5.4	243	5.8	4323	94.2	
Post-secondary degree/diploma	21,148	77.7	966	5.1	20,182	94.9	
Non-response	40	0.1	4	11.4	36	88.6	
Variables	Total		PTSD positive		PTSD negative		χ^2 (*df*)
	n	%	*n*	% weighted	*n*	% weighted	*p* value
Physical health							
Morbidities							
No health conditions	4909	18.0	110	2.5	4799	97.5	546.6 (3), < 0.001
1 health condition	7122	26.2	178	2.9	6944	97.1	
2 health conditions	6252	23.0	255	4.8	5997	95.2	
3 or more health conditions	8928	32.8	780	10.2	8148	89.8	
Hypertension levels							
Normal	9889	36.3	502	5.2	9387	94.8	10.6 (4), 0.032
Elevated	2594	9.5	124	5.1	2470	94.9	
Stage 1 hypertension	4344	16.0	192	4.8	4152	95.2	
Stage 2 hypertension	2884	10.6	149	6.0	2735	94.0	
Takes anti-hypertensive medication	7500	27.6	356	6.0	7144	94.0	

Table 1 (continued)

Variables	Total		PTSD positive		PTSD negative		χ^2 (*df*)
	n	%	*n*	% weighted	*n*	% weighted	*p* value
Chronic pain							
No reported pain	20,596	75.7	740	4.0	19,856	96.0	340.2 (2), < 0.000
Have pain	5383	19.8	492	10.2	4891	89.8	
Refused	1232	4.5	91	8.7	1141	91.3	
Health behaviors							
Smoking (lifetime)							
≥ 100 cigarettes	14,507	53.3	803	6.2	13,704	93.8	41.2 (1), 0.000
< 100 cigarettes	12,704	46.7	520	4.5	12,184	95.5	
Binge drinking							
Non-binge drinking	17,598	64.7	867	5.6	16,731	94.4	4.3 (2), 0.114
Occasional binge drinking[a]	5308	19.5	254	5.0	5054	95.0	
Regular binge drinking[b]	4305	15.8	202	5.1	4103	94.9	
Physical activity							
Never or seldom	23,289	85.6	1101	5.2	22,188	94.8	24.4 (2), < 0.001
Sometimes or often	2781	10.2	137	5.8	2644	94.2	
No answer or refused	1141	4.2	85	8.7	1056	91.3	
Indicators of over-nutrition							
BMI							
Underweight: < 18.5	197	0.7	14	6.3	183	93.7	52.8 (3), < 0.001
Normal weight: 18.5–24.99	8078	29.7	335	4.7	7743	95.3	
Overweight: 25–29.99	11,009	40.5	479	4.8	10,530	95.2	
Obese: 30 or above	7927	29.1	495	7.0	7432	93.0	
Waist-to-hip ratio							
Low risk	9271	34.1	519	6.2	8752	93.8	18.8 (1), < 0.001
High risk	17,940	65.9	804	4.9	17,136	95.1	
Waist-to-height ratio							
Below cut-off	18,158	66.7	799	4.9	17,359	95.1	20.8 (1), < 0.001
Above cut-off	9053	33.3	524	6.3	8529	93.7	
Disease risk							
Least risk	7972	29.3	7636	4.7	7636	95.3	56.1 (3), < 0.001
Increased	7144	26.3	6847	4.7	6847	95.3	
High	4690	17.2	4469	5.2	4469	94.8	
Very high	7405	27.2	6936	7.1	6936	92.9	
Body fat percent							
< 26%	4990	18.3	154	3.2	4836	96.8	170.7 (4), < 0.001
26–31%	5431	20.0	188	4.3	5243	95.7	
31–36%	5497	20.2	246	5.2	5251	94.8	
36–41%	5234	19.2	286	5.9	4948	94.1	
41–59%	6059	22.3	449	8.4	5610	91.6	
Indicators of poor nutrition status							
Grip strength							
No under-nutrition	20,829	76.5	978	5.2	19,851	94.8	10.1 (2), 0.007
Under-nutrition	4510	16.6	226	6.0	4284	94.0	
Not assessed	1872	6.9	119	6.7	1753	93.3	
Nutritional risk							
Low risk	16,778	61.7	546	3.7	16,232	96.3	263.1 (2), < 0.001
High risk	9038	33.2	687	8.4	8351	91.6	
Not assessed	1395	5.1	90	7.8	1305	92.2	

Table 1 (continued)

Variables	Total		PTSD positive		PTSD negative		χ^2 (*df*)
	n	%	*n*	% weighted	*n*	% weighted	*p* value
Skeletal muscle index (SMI)							
No sarcopenia	15,906	58.5	965	6.8	14,941	93.2	134.0 (1), < 0.001
Sarcopenia	11,305	41.5	358	3.6	10,947	96.4	
T-scores							
Normal body density	21,040	77.3	991	5.3	20,049	94.7	3.7 (2), 0.157
Osteopenia	1223	4.5	58	6.2	1165	93.8	
Osteoporosis	4948	18.2	274	5.9	4674	94.1	
Screen for anemia							
Negative	21,797	80.1	1043	5.3	20,754	94.7	5.6 (2), 0.060
Positive	1154	4.2	47	4.7	1107	95.3	
No consent for blood work	4260	15.7	233	6.1	4027	93.9	
Dietary intakes							
Average daily intakes of fiber sources							
< 1	8789	32.3	511	6.3	8278	93.7	29.7 (3), 0.000
1 & < 2	12,867	47.3	556	4.9	12,311	95.1	
2 & < 3	4449	16.4	194	4.6	4255	95.4	
≥ 3	1106	4.1	62	6.7	1044	93.3	
Average daily intakes of pulses and nuts							
< 0.5	8771	32.2	456	5.5	8315	94.5	12.0 (3), 0.007
0.5 & < 1	6277	23.1	272	4.8	6005	95.2	
1 & < 2	10,369	38.1	502	5.4	9867	94.6	
≥ 2	1794	6.6	93	6.8	1701	93.2	
Average daily intakes of fat sources							
< 2.5	3369	12.4	174	5.3	3195	94.7	11.6 (3), 0.009
2.5 & < 5	10,281	37.8	456	4.9	9825	95.1	
4 & < 5	6639	24.4	322	5.5	6317	94.5	
≥ 5	6922	25.4	371	6.0	6551	94.0	
Intakes of fish							
No consumption	2280	8.4	157	7.1	2123	92.9	15.1 (1), < 0.001
Consumes fish	24,931	91.6	1166	5.2	23,765	94.8	
Intakes of omega-3 eggs							
No consumption	20,090	73.8	973	5.5	19,117	94.5	0.9 (1), 0.333
Consumes omega-3 eggs	7121	26.2	350	5.2	6771	94.8	
Average daily intakes of fruits and vegetables							
< 2	3919	14.4	213	5.8	3706	94.2	9.0 (4), 0.061
≥ 2 & < 3	6514	23.9	349	5.8	6165	94.2	
≥ 3 & < 4	6789	24.9	281	4.7	6508	95.3	
≥ 4 & < 6	7381	27.1	345	5.3	7036	94.7	
≥ 6	2608	9.6	135	5.6	2473	94.4	
Average daily intakes of pure fruit juice							
No consumption	8790	32.3	439	5.5	8351	94.5	3.6 (2), 0.162
≤ 1	17,850	65.6	853	5.3	16,997	94.7	
> 1	571	2.1	31	7.0	540	93.0	
Average daily intakes of salty snacks							
No consumption	5153	18.9	254	5.5	4899	94.5	3.0 (2), 0.228
> 0 & ≤ 1	21,999	80.8	1066	5.3	20,933	94.7	
> 1 & ≤ 10	59	0.2	3	10.2	56	89.8	

Table 1 (continued)

Variables	Total		PTSD positive		PTSD negative		χ^2 (*df*)
	n	%	*n*	% weighted	*n*	% weighted	*p* value
Average daily intakes of calcium sources with high vitamin D content							
< 1	6038	22.2	296	5.5	5742	94.5	10.9 (3), 0.012
≥ 1 & < 2	12,338	45.3	559	5.0	11,779	95.0	
≥ 2 & < 4	7860	28.9	409	5.8	7451	94.2	
≥ 4	975	3.6	59	6.9	916	93.1	
Average daily intakes of calcium sources with low vitamin D content							
No consumption	4984	18.3	248	5.5	4736	94.5	0.2 (1), 0.626
> 0	22,227	81.7	1075	5.4	21,152	94.6	
Average daily intakes of pastries							
No consumption	2764	10.2	167	6.5	2597	93.5	12.1 (2), 0.002
> 0 & ≤ 1	23,983	88.1	1125	5.2	22,858	94.8	
> 1	464	1.7	31	7.4	433	92.6	
Average weekly intakes of chocolate bars							
No consumption	9420	34.6	458	5.5	8962	94.5	17.0 (2), < 0.001
> 0 & < 0.6	16,561	60.9	780	5.2	15,781	94.8	
≥ 0.6	1230	4.5	85	8.0	1145	92.0	

[a] > once/month but at least once/past 12 months

[b] Regular binge drinking (i.e., men who had 5 drinks or women who had 4 drinks on one occasion once/month in the past 12 months) (Statistics Canada, 2016)

[c] Immigrant white differed significantly from immigrant minority ($p < 0.001$) and Canadian white ($p < 0.001$)

[d] Immigrant minority differed significantly fromimmigrant white ($p < 0.001$) and Canadian white ($p = 0.008$)

[e] Canadian-born white differed significantly from immigrant white ($p < 0.001$) and immigrant minorities ($p = 0.008$)

[f] Canadian-born minority did not differ significantly from any of the other categories

minority respondents did not differ significantly from any of the other categories. Compared to visible minority immigrants only white immigrants had significantly lower odds of PTSD (OR 0.58, $p < 0.001$, 95% CI 0.43–0.78).

> Research Question #2: Are the associations between ethnicity and immigrant status and PTSD attenuated by a wide range of health determinants?

As shown in Fig. 1b, immigrant whites (ORs 0.73–0.75) had consistently significantly lower odds of PTSD when compared to whites born in Canada after adjusting for each model cluster (Models 1–7). Conversely, in all but the first model, immigrants from visible minority groups had consistently significantly higher odds of PTSD (ORs 1.47–1.56) than whites born in Canada (Fig. 1c: Models 2–7). Visible minority respondents born in Canada did not differ significantly in the odds of PTSD compared to whites born in Canada in any of the models. Research Question #3: Are there other determinants of health that aresignificantly associated with PTSD after controlling for ethnicity and immigrant status

After adjusting for ethnicity and immigrant status, many significant associations were found for demographic, social, and economic variables (Table 2). Compared to those aged 45–55 years, those in older groups had lower odds of PTSD (ORs 0.18–0.58, p's < 0.001). For participant groups earning less than C$100,000 annually, there were higher odds of PTSD (ORs 1.39–2.58, p's < 0.001) when compared to those earning more than C$150,000 annually. Those who were widowed, divorced, or separated had higher odds of PTSD (OR 1.39, 95% CI 1.20–1.60, $p < 0.001$) compared to those who were single.

There were also many significant associations between PTSD and different health determinants such as physical health and health behaviors. Those who reported having at least two health conditions (ORs 1.76–3.34, p's < 0.001), having chronic pain (OR 1.64, $p < 0.001$), or smoking (OR 1.22, $p < 0.001$), had higher odds of reporting PTSD.

Some indicators of over-nutrition and poor nutritional status were also associated with PTSD. Those with a high waist-to-height ratio (OR 0.82, 95% CI 0.69–0.97, $p = 0.018$) had lower odds of PTSD; conversely, those who were assessed to be at high nutritional risk (OR 1.60, 95% CI 1.41–1.80, $p < 0.001$) had higher odds of PTSD.

Finally, some interesting associations were found between PTSD and the consumption of certain food components. For those who on average consumed fiber sources less than three times daily, lower odds of PTSD were

Table 2 Adjusted odds ratios between PTSD and ethnicity and immigrant status, socio-demographic, physical health, health behavior, over- and under-nutrition, and dietary measures

Variable	aOR (95% CI)	*p* value
Demographic, social, and economic characteristics		
Ethnicity/immigrant status (Ref.: Canadian-born white)[a]		
Canadian-born visible minority	0.77 (0.44–1.34)	0.353
Immigrant white	0.74 (0.61–0.90)	0.003
Immigrant visible minority	1.47 (1.14–1.90)	0.003
Age (Ref.: 45–55 years)		
56–65 years	0.58 (0.51–0.67)	< 0.001
66–75 years	0.32 (0.26–0.39)	< 0.001
76–85 years	0.18 (0.14–0.24)	< 0.001
Sex (Ref.: Female)		
Male	1.21 (0.93–1.57)	0.154
Household income (Ref.: C$150.000)		
< $20,000	2.58 (1.95–3.41)	< 0.001
$20,000–49,999	1.99 (1.60–2.46)	< 0.001
$50,000–99,999	1.39 (1.15–1.67)	0.001
$100,000–149,999	1.04 (0.85–1.28)	0.691
Not answered	1.99 (1.52–2.61)	< 0.001
Marital status (Ref.: married/living with a partner/common-law)		
Single	1.03 (0.85–1.25)	0.755
Widowed/divorced/separated	1.39 (1.20–1.62)	< 0.001
Education level (Ref.: high school graduate and/or with some post-secondary)		
Less than secondary school	1.25 (0.97–1.61)	0.081
Post-secondary degree/diploma	1.04 (0.89–1.21)	0.631
Not answered	1.46 (0.43–4.93)	0.541
Physical Health		
Morbidities (Ref.: no health conditions)		
1 health condition	1.12 (0.90–1.40)	0.297
2 health conditions	1.76 (1.43–2.17)	< 0.001
3 or more health conditions	3.34 (2.74–4.06)	< 0.001
Hypertension levels (Ref.: normal blood pressure)		
Elevated	1.05 (0.85–1.31)	0.627
Stage 1 hypertension	0.92 (0.77–1.08)	0.305
Stage 2 hypertension	1.21 (1.00–1.48)	0.053
Taking anti-hypertensive	1.16 (0.99–1.36)	0.071
Chronic pain (Ref.: no pain)		
Pain	1.64 (1.45–1.86)	< 0.001
Refused	1.26 (0.45–3.50)	0.663
Health behaviors		
Smoking ≥ 100 cigarettes (Ref.: < 100)	1.22 (1.09–1.37)	0.001
Binge drinking (no binge drinking)		
Regular binge drinking	0.99 (0.85–1.16)	0.913
Occasional binge drinking	0.98 (0.85–1.13)	0.813
Physical activity (Ref.: sometimes or often)		
Never or seldom	0.85 (0.71–1.02)	0.083
No answer or refused	1.47 (0.43–5.06)	0.539
Indicators of over nutrition		
BMI (Ref.: underweight < 18.5)		
Normal weight: 18.5–24.99	1.36 (0.70–2.62)	0.363
Overweight: 25–29.99	2.08 (0.83–5.20)	0.118

Table 2 (continued)

Variable	aOR (95% CI)	*p* value
Obese: 30 or above	2.09 (0.76–5.74)	0.152
Waist-to-hip categorical (Ref.: below cut-off; low risk)		
Above cut-off; high risk	0.91 (0.78–1.05)	0.192
Waist-to-height ratio (below cut-off; low risk)		
Above cut-off; high risk	0.82 (0.69–0.97)	0.018
Disease risk (Ref.: least risk)		
Increased	0.71 (0.37–1.34)	0.286
High	0.63 (0.32–1.25)	0.190
Very high	0.72 (0.32–1.61)	0.419
Body fat percent (Ref.: < 26%)		
26–31%	1.22 (0.99–1.50)	0.068
31–36%	1.25 (0.98–1.59)	0.077
36–41%	1.21 (0.90–1.62)	0.204
41–59%	1.45 (1.05–2.00)	0.024
Indicators of over nutrition		
Grip strength (Ref.: no under-nutrition)		
Under-nutrition	0.11 (0.95–1.31)	0.201
Not assessed	0.89 (0.72–1.10)	0.274
Nutritional risk (Ref.: low risk)		
High risk	1.60 (1.41–1.80)	< 0.001
Not assessed	0.91 (0.43–1.90)	0.793
Skeletal muscle index (Ref.: no sarcopenia)		
Sarcopenia	0.95 (0.72–1.26)	0.721
T-scores (Ref.: normal bone density)		
Osteoporosis	1.13 (0.83–1.54)	0.439
Osteopenia	0.98 (0.83–1.15)	0.796
Screen for anemia (Ref.: negative screen)		
Positive screen	0.97 (0.69–1.37)	0.859
No consent for blood work	1.09 (0.95–1.26)	0.223
Dietary intakes		
Average daily intakes of fiber sources (Ref.: 0 to < 1)		
1 to < 2	0.86 (0.76–0.98)	0.018
2 to < 3	0.83 (0.69–1.00)	0.049
≥ 3	1.22 (0.92–1.62)	0.167
Average daily intakes of pulses and nuts (Ref.: 0 to < 0.5)		
0.5 to < 1	0.99 (0.85–1.16)	0.902
1 to < 2	1.16 (1.02–1.33)	0.029
≥ 2	1.50 (1.20–1.87)	< 0.001
Average daily intakes of fat sources (Ref.: 0 to < 2.5)		
2.5 to < 4	1.04 (0.86–1.27)	0.669
4 to < 5	1.17 (0.94–1.47)	0.165
≥ 5	1.19 (0.94–1.52)	0.153
Average daily intakes of fish (Ref.: no fish consumption)		
Consumes fish	0.96 (0.80–1.15)	0.667
Average daily intakes of omega-3 eggs (Ref.: no omega-3 eggs)		
Consumes omega-3 eggs	0.92 (0.81–1.05)	0.202
Average daily intakes of fruits and vegetables (Ref.: ≥ 6)		
0 to < 2	0.89 (0.70–1.13)	0.351
2 to < 3	1.15 (0.93–1.41)	0.188
3 to < 4	0.96 (0.79–1.18)	0.712

Table 2 (continued)

Variable	aOR (95% CI)	*p* value
4 to < 6	1.06 (0.88–1.29)	0.531
Average daily intakes of pure fruit juice (Ref.: no consumption)		
≤ 1 per day	1.04 (0.92–1.18)	0.505
> 1 per day	1.31 (0.91–1.88)	0.154
Average daily intakes of salty snacks (Ref.: no consumption)		
0 to ≤ 1	0.95 (0.81–1.11)	0.483
> 1 day	1.28 (0.52–3.16)	0.590
Average daily intakes of calcium sources with high vitamin D content (Ref.: 4)		
0 to < 1	0.94 (0.67–1.30)	0.698
1 to < 2	0.89 (0.66–1.20)	0.444
2 to < 4	0.98 (0.73–1.31)	0.872
Average daily intakes of calcium sources with low vitamin D content (Ref.: > 0)		
No consumption	1.08 (0.92–1.26)	0.362
Average daily intakes of pastries (Ref.: no consumption)		
> 0 to ≤ 1	0.97 (0.81–1.16)	0.133
> 1	1.37 (0.91–2.06)	0.025
Average weekly intakes of chocolate bars (Ref.: no consumption)		
> 0 to ≤ 0.6	0.98 (0.86–1.10)	0.692
> 0.6	1.35 (1.06–1.73)	0.016

[a] Statistics using Canadian minority, immigrant white, immigrant visible minority as the reference group are presented in the text

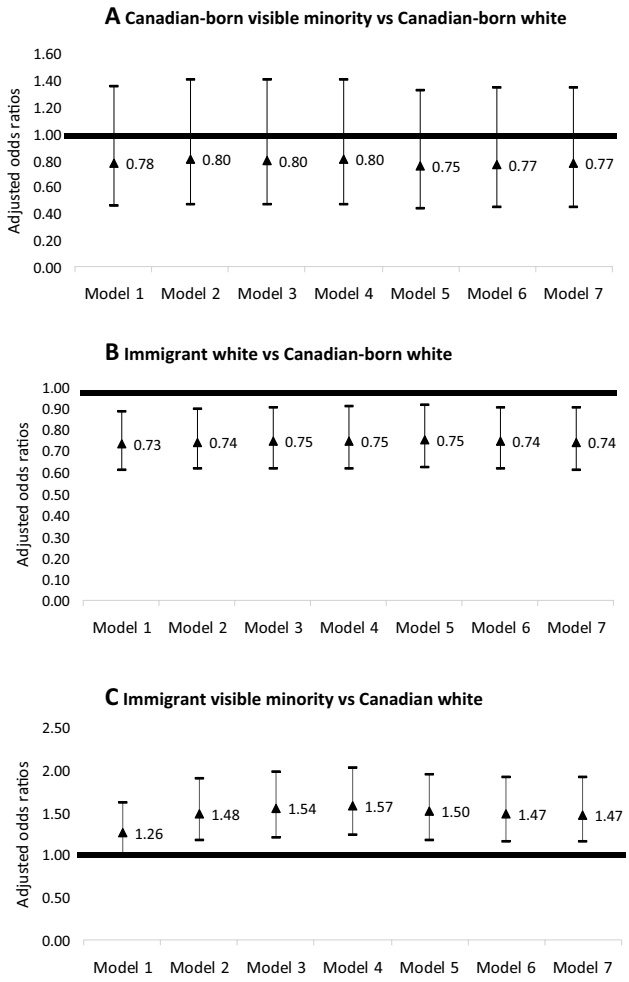
indicated (ORs 0.83–0.86, *p*'s 0.018–0.049) compared to those consuming fewer than one source daily. Conversely, those who consumed on average one or more sources of pulses and nuts had higher odds of PTSD (ORs 1.50–1.16, *p*'s 0.029 to < 0.001) compared to those who consumed half or less daily. Those who consumed on average one or more pastries or at least two-thirds of a chocolate bar or more daily had higher odds of PTSD (ORs 1.35–1.37, *p*'s 0.016–0.025) compared to those who reported no consumption of these types of foods.

Assessment of model fit

The results of the Omnibus Test of Model Coefficients were highly significant (χ^2 (79) = 1316.9, $p < 0.001$) indicating the final model is significantly better than the baseline model. The Nagelkerke's R^2 suggests that the model explains about 13.8% of the variation in PTSD outcome.

Discussion

This study which examined PTSD in a national sample of mid-age and older adults found that compared to white Canadians, those who were immigrant and of visible minority groups had higher odds of PTSD, whereas Canadians who were from visible minority groups were less likely to have PTSD. Furthermore, these associations were robust to adjustments for a number of demographic, social, economic, health status, health behaviors, nutrition status, and dietary intake indicators. After adjusting for ethnicity and immigrant status, those in older groups (> 55 years) had lower odds of PTSD relative to those between 45 and 55 years, whereas lower income earners had higher odds of PTSD when compared to high income earners (≥ C$150,000 annually). Participants who were widowed, divorced, or separated had higher odds of PTSD compared to those who were single. When assessing health status indicators, those who reported having at least two health conditions, having chronic pain, or ever smoking, had higher odds of reporting PTSD. An indicator of over-nutrition, high waist-to-height ratio, was associated with lower odds of PTSD, whereas an indicator of poor nutrition status, high nutrition risk, was associated with increased odds of PTSD. In comparison to low levels of consumption, those with moderate intakes of fiber sources (average two to three times daily) had lower odds of PTSD, while consumption of one or more sources of pulses and nuts on average was associated with higher odds of PTSD compared to those who did not consume pulses or nuts daily. The intake of pastries and chocolate bars was associated with higher odds of PTSD.



Model 1: Demographic, social, and economic characteristics: Immigrant status, sex, age, education, income
Model 2: Model 1 + Physical Health: Co-morbidities, hypertension, chronic pain
Model 3: Model 2 + Health Behaviours: smoking, binge drinking, physical activity
Model 4: Model 3 + Over-nutrition: Disease risk, percent body fat, waist to hip ratio, waist to height ratio
Model 5: Model 4 + Poor nutrition: Grip strength, nutrition risk (SCREEN™), skeletal muscle index, t-scores, anemia screen
Model 6: Model 5 + Dietary Intakes: Fiber, pulses/nuts, fat sources, fish sources, omega 3 eggs, fruits and vegetables, pure fruit juice, salty snacks, calcium sources with high vitamin D content, calcium sources with low vitamin D content, pastries, chocolate bars
Model 7: Full Model: All variables in models 1 to 7

Fig. 1 Adjusted odds ratios for PTSD by ethnicity and immigrant status **a** Canadian-born visible minority vs Canadian-born white. **b** Immigrant white vs Canadian-born white. **c** Immigrant visible minority vs Canadian white. Model 1: Demographic, social, and economic characteristics: Immigrant status, sex, age, education, household income. Model 2: Model 1 + Physical Health: Co-morbidities, hypertension, chronic pain. Model 3: Model 2 + Health Behaviours: smoking, binge drinking, physical activity. Model 4: Model 3 + Over-nutrition: Disease risk, percent body fat, waist-to-hip ratio, waist-to-height ratio. Model 5: Model 4 + Poor nutrition: Grip strength, nutrition risk (SCREEN™), skeletal muscle index, T-scores, anemia screen, Model 6: Model 5 + Dietary Intakes: Fiber, pulses/nuts, fat sources, fish sources, omega-3 eggs, fruits and vegetables, pure fruit juice, salty snacks, calcium sources with high vitamin D content, calcium sources with low vitamin D content, pastries, chocolate bars. Model 7: Full Model: All variables in models 1–7

Research Question #1: Does the prevalence of PTSD vary by ethnicity and immigrantstatus among those aged 45–85 years? and
Research Question #2: Are the associations between ethnicity and immigrant status and PTSD attenuated by a wide range of health determinants?

Interestingly, associations with PTSD varied according to ethnicity and immigrant status which, to the best of our knowledge, has not been reported elsewhere. While higher incidence of mental health outcomes, such as PTSD, among immigrants have been previously reported, this study concluded that this was only true among visible minority immigrants, with the unexpected finding that white immigrants had significantly lower odds of PTSD compared to Canadian-born whites. Despite controlling for a broad range of demographic, social, economic, health, and nutrition related factors, the associations between PTSD by ethnicity and immigrant status remained consistent. These findings suggest that the lower odds of PTSD among white immigrants and the higher odds of PTSD among visible minority immigrants is not due to the various factors investigated in the fully adjusted model. This suggests that the relationship may be driven by other factors not examined in this study.

A study that examined the psychological effects of trauma exposure among Asian Americans and European American survivors of the 1994 Northridge, California earthquake found Asian American participants reported more psychiatric distress based on the Brief Symptom Inventory [74]. Ethnic differences remained after accounting for age,

immigrant status, and exposure to the earthquake. Furthermore, moderator analyses showed that ethnic differences were explained by the interaction of ethnicity and having a foreign-born parent. These findings may be due to heterogeneity of those reporting immigrant status, which can include refugees, displaced persons, uprooted people, and economic migrants [47]. Regardless, they challenge beliefs about immigration and PTSD and suggest there is a heightened need for greater mental health resources for visible minority immigrant groups.

Previous research suggests that first-generation immigrants are physically healthier than individuals of the same ethnic background who are born in the receiving country [75]; a phenomenon referred to as the 'healthy immigrant effect'. The evidence for the healthy immigrant effect is particularly robust in a 15-year follow-up study based upon the 1991 Census [75]. This analysis included a representative sample of more than 500,000 immigrants aged 25 to 74 and 2 million adults born in Canada, In comparison to those born in Canada, immigrants to Canada had more than a 30% lower risk of death from preventable causes and approximately 20% lower risk of death from treatable causes [76]. However, the physical and mental health of immigrants are known to decline over time [77]. Visible minority immigrants in Canada are largely from South Asia, China and the Middle East source regions, where groups of individuals have experienced political conflict and/or disruption during the previous 60 years [78, 79]. Immigrants from these regions are also more likely to have experienced traumatic incidents such as natural disasters and are at greater risk of PTSD as a result [80–82]. Post-migratory challenges such as difficulties with applications, employment, discrimination, and social isolation are also known as contributing factors to the onset or worsening of PTSD [80].

> Research Question #3: Are there other determinants of health that are significantly associated with PTSD after controlling for ethnicity and immigrant status?

The lower odds of PTSD among those over 55 years, compared to younger respondents, is consistent with other findings which have shown that PTSD tends to be highest among men in their early 40s and women in their early 50s [11]. Our findings that widowed, divorced, and/or separated individuals and those with low household incomes had higher odds of PTSD than married respondents and those with higher incomes, respectively, are similar to the findings of a study of survivors of an earthquake [83]. The association between PTSD and multiple morbidities is of little surprise based on prior findings showing increased risks of cardiovascular, metabolic, and musculoskeletal disorders among individuals with PTSD; these associations may be due to alterations in the HPA axis, sympathetic nervous system, inflammation, and/or health behaviors that could increase the risk of illness [31].

The association between PTSD and chronic pain is also consistent with prior findings [28, 29]. Previous research has shown that both smoking and binge drinking are associated with higher levels of PTSD [84]. In our study, the former, but not the latter, relationship was significant. The current study found that those with higher waist-to-height ratio had lower odds of PTSD. This association has not been extensively studied in the extant literature, although one study indicated higher waist-to-height ratio is associated with anxiety in middle-aged Latin American women [85]. Another investigation suggests that high waist-to-height ratio is positively associated with somatic but not the cognitive-affective symptoms of depression [86, 87]. Finally, based on longitudinal research [38], individuals with new onset, persistent, or resolved PTSD had higher odds of at least 10% body weight gain compared to those without PTSD. In addition, it was indicated that those with new onset or persistent PTSD had a higher incidence of at least 3% body weight loss. Evidently, more work is needed that explores the relationships between PTSD and body anthropometrics.

To our knowledge, the relationship we report between nutritional risk and PTSD is novel. Nutritional risk is measured in the CLSA using the AB SCREEN™ II (Abbreviated Seniors in the Community Risk Evaluation for Eating and Nutrition II) which consisted of eight questions related to appetite, frequency of eating, motivation to cook, ability to shop and prepare food, weight changes, isolation and loneliness, chewing and swallowing, digestion, and food restrictions, to assess eating habits on a typical day. There are many pathways which may explain the relationship between nutritional risk and PTSD. First, oxidative stress and high homocysteine levels are associated with PTSD and with increased mitochondrial damage and neurotransmitter signaling dysfunction in the brain [45, 86, 87]. Oxidative stress occurs when there is an imbalance between the amount of free radicals produced by the body and the body's antioxidant defenses [8]. A source of oxidative stress includes exposure to certain nutrition-related components (e.g., high fat, high sugar, and salt) [87–89]. A second explanatory pathway is that of the gut microbiome which may be altered due to nutritional status. The microbiota of the gut communicates with the brain through the 'microbiota-gut-brain axis'; a pathway involved in the pathophysiology of mental health conditions such as PTSD [90]. Finally, some of the manifestations of PTSD, such as severe anxiety or depression, may interfere with food skills and eating behaviors [91] and lead to heightened nutrition risk.

Based on a review of the dietary intake results and PTSD, it was not a surprise that fiber intakes were associated with lower odds of PTSD; however, this benefit was not significant beyond average intakes of three or

more fiber sources daily. Because high fiber foods contain phytates which bind with trace minerals such as iron, zinc, and manganese and reduce their bioavailability [92], higher intakes may not impart the same mental health benefits. The findings that indicated higher odds of PTSD with increased intakes of pulses and nuts were surprising. The food frequency questions included sources such as peanut butter and also did not distinguish if the sources of pulses and nuts included less healthy components such as salt (e.g., salted nuts), fat (e.g., sauces with legumes such as pork and beans), and sugar (e.g., candied nuts) which may have impacted these findings. PTSD has been associated with overeating [91], which may suggest consumption of high amounts of these food items may be indicative of self-soothing behavior. The association of PTSD with intake of pastries and chocolate is not surprising as consumptions of these foods may be due to heightened appetite and eating psychopathologies associated with PTSD [91].

Limitations

The results of this study must be interpreted with caution due to several important limitations. Firstly, our sample was restricted to those aged 55 and older. Consequently, our findings cannot be generalized to younger populations. The use of cross-sectional data makes it impossible to infer causality. PTSD is a multi-factorial condition and many of the factors that may contribute to it, such as the nature and frequency of traumatic experience(s), were not available in the CLSA data set. We also did not have information on any therapy that the respondents had undergone. The measure of PTSD was based upon the DSM-IV, not the more current DSM-5. The latter reflects more up-to-date knowledge about the PTSD diagnosis. The use of self-report measures for many of the variables made misreporting and misclassification possible. We also did not control for other mental health conditions such as bipolar disorder [93], eating disorders [94], and personality disorders [95] which have been associated with PTSD but do not have prior traumatic experience as part of their diagnostic profiles. Lastly, the very low response rate and disproportionate number of participants with a university degree in the CLSA sample limits generalizability of the findings.

Despite the investigative limitations noted here, this study had a very large sample size that enabled a comprehensive assessment of associations between PTSD and various factors, including immigration status, ethnicity, and nutritional intake. Suggestions for future investigations include oversampling different ethnic groups to allow for ethnic-specific analyses, examining longitudinal data to explore relationship trajectories between PTSD and health determinants post-settlement, and conducting qualitative work to gain important insights into the experience of PTSD among visible minority immigrants.

Conclusion

PTSD contributes to significant morbidity and is associated with substantial indirect costs to the economy due to lost work and extensive health care-related needs [7]. The current study found important differences by immigrant and visible minority status, with those who were immigrants from visible minority groups having a higher prevalence of PTSD than both white immigrants and white and visible minority respondents born in Canada. This association was robust across various analyses that accounted for various demographic, social, economic, health status, health behaviors, nutrition status, and dietary intake indicators. This suggests that immigrant groups may differ in their experience of and/or responses and susceptibility to traumatic events. This investigation provides important insights for policy and program development to mitigate PTSD among mid-age and older adults, particularly for marginalized groups such as visible minority immigrants. Future investigations that use estimate models such as these as well as longitudinal analyses may better inform mental health practice and policies to both prevent and treat PTSD.

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References

1. Nielsen MB, Tangen T, Idsoe T, Matthiesen SB, Magerøy N (2015) Post-traumatic stress disorder as a consequence of bullying at work and at school. A literature review and meta-analysis. Aggress Violent Behav 21:17–24. https://doi.org/10.1016/j.avb.2015.01.001

2. Bottche M, Kuwert P, Knaevelsrud C (2012) Posttraumatic stress disorder in older adults: an overview of characteristics and treatment approaches. Int J Geriatr Psychiatry 27(3):230–239. https://doi.org/10.1002/gps.2725
3. Goldstein RB, Smith SM, Chou SP, Saha TD, Jung J, Zhang H, Pickering RP, Ruan WJ, Huang B, Grant BF (2016) The epidemiology of DSM-5 posttraumatic stress disorder in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions-III. Soc Psychiatry Psychiatr Epidemiol 51(8):1137–1148. https://doi.org/10.1007/s00127-016-1208-5
4. Van Ameringen M, Mancini C, Patterson B, Boyle MH (2008) Post-traumatic stress disorder in Canada. CNS Neurosci Ther 14(3):171–181. https://doi.org/10.1111/j.1755-5949.2008.00049.x
5. Steel Z, Chey T, Silove D, Marnane C, Bryant RA, van Ommeren M (2009) Association of torture and other potentially traumatic events with mental health outcomes among populations exposed to mass conflict and displacement: a systematic review and meta-analysis. JAMA 302(5):537–549. https://doi.org/10.1001/jama.2009.1132
6. Yehuda R, Hoge CW, McFarlane AC, Vermetten E, Lanius RA, Nievergelt CM, Hobfoll SE, Koenen KC, Neylan TC, Hyman SE (2015) Post-traumatic stress disorder. Nat Rev Dis Primers 1(1):15058. https://doi.org/10.1038/nrdp.2015.58
7. Schnurr PP, Lunney CA, Bovin MJ, Marx BP (2009) Posttraumatic stress disorder and quality of life: extension of findings to veterans of the wars in Iraq and Afghanistan. Clin Psychol Rev 29(8):727–735. https://doi.org/10.1016/j.cpr.2009.08.006
8. Wilson S, Guliani H, Boichev G (2016) On the economics of post-traumatic stress disorder among first responders in Canada. J Community Saf Well-Being 1(2):26. https://doi.org/10.35502/jcswb.6
9. O'Connell MJ, Kasprow W, Rosenheck RA (2008) Rates and risk factors for homelessness after successful housing in a sample of formerly homeless veterans. Psychiatr Serv 59(3):268–275. https://doi.org/10.1176/appi.ps.59.3.268
10. Aronson BD, Palombi LC, Walls ML (2016) Rates and consequences of posttraumatic distress among American Indian adults with type 2 diabetes. J Behav Med 39(4):694–703. https://doi.org/10.1007/s10865-016-9733-y
11. Ditlevsen DN, Elklit A (2010) The combined effect of gender and age on post traumatic stress disorder: do men and women show differences in the lifespan distribution of the disorder? Ann Gen Psychiatry 9(1):32. https://doi.org/10.1186/1744-859X-9-32
12. Freedy JR, Steenkamp MM, Magruder KM, Yeager DE, Zoller JS, Hueston WJ, Carek PJ (2010) Post-traumatic stress disorder screening test performance in civilian primary care. Fam Pract 27(6):615–624. https://doi.org/10.1093/fampra/cmq049
13. Solomon Z, Debby-Aharon S, Zerach G, Horesh D (2010) Marital adjustment, parental functioning, and emotional sharing in war veterans. J Fam Issues 32(1):127–147. https://doi.org/10.1177/0192513x10379203
14. Stuber ML, Meeske KA, Krull KR, Leisenring W, Stratton K, Kazak AE, Huber M, Zebrack B, Uijtdehaage SH, Mertens AC, Robison LL, Zeltzer LK (2010) Prevalence and predictors of posttraumatic stress disorder in adult survivors of childhood cancer. Pediatrics 125(5):e1124-1134. https://doi.org/10.1542/peds.2009-2308
15. Brewin CR, Andrews B, Valentine JD (2000) Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. J Consult Clin Psychol 68(5):748–766. https://doi.org/10.1037//0022-006x.68.5.748
16. Darves-Bornoz JM, Alonso J, de Girolamo G, de Graaf R, Haro JM, Kovess-Masfety V, Lepine JP, Nachbaur G, Negre-Pages L, Vilagut G, Gasquet I, ESEMeD/MHEDEA (2000) Investigators (2008) Main traumatic events in Europe: PTSD in the European study of the epidemiology of mental disorders survey. J Trauma Stress 21(5):455–462. https://doi.org/10.1002/jts.20357
17. Koenen KC, Ratanatharathorn A, Bromet EJ, Karam EG, Stein DJ (2018) Population prevalence of posttraumatic stress disorder. Trauma and posttraumatic stress disorder. Cambridge University Press, Cambridge, pp 95–109
18. Morina N, Wicherts JM, Lobbrecht J, Priebe S (2014) Remission from post-traumatic stress disorder in adults: a systematic review and meta-analysis of long term outcome studies. Clin Psychol Rev 34(3):249–255. https://doi.org/10.1016/j.cpr.2014.03.002
19. Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL (2004) Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. N Engl J Med 351(1):13–22. https://doi.org/10.1056/NEJMoa040603
20. Kessler RC (2000) Posttraumatic stress disorder: the burden to the individual and to society. J Clin Psychiatry 61(Suppl 5):4–14 (**PMID: 10761674**)
21. Lohr JB, Palmer BW, Eidt CA, Aailaboyina S, Mausbach BT, Wolkowitz OM, Thorp SR, Jeste DV (2015) Is post-traumatic stress disorder associated with premature senescence? A review of the iterature. Am J Geriatr Psychiatry 23(7):709–725. https://doi.org/10.1016/j.jagp.2015.04.001
22. Michopoulos V, Vester A, Neigh G (2016) Posttraumatic stress disorder: a metabolic disorder in disguise? Exp Neurol 284(Pt B):220–229. https://doi.org/10.1016/j.expneurol.2016.05.038
23. Rosenbaum S, Stubbs B, Ward PB, Steel Z, Lederman O, Vancampfort D (2015) The prevalence and risk of metabolic syndrome and its components among people with posttraumatic stress disorder: a systematic review and meta-analysis. Metabolism 64(8):926–933. https://doi.org/10.1016/j.metabol.2015.04.009
24. Bryant RA, Harvey AG (2002) Delayed-onset posttraumatic stress disorder: a prospective evaluation. Aust N Z J Psychiatry 36(2):205–209. https://doi.org/10.1046/j.1440-1614.2002.01009.x
25. Santiago PN, Ursano RJ, Gray CL, Pynoos RS, Spiegel D, Lewis-Fernandez R, Friedman MJ, Fullerton CS (2013) A systematic review of PTSD prevalence and trajectories in DSM-5 defined trauma exposed populations: intentional and non-intentional traumatic events. PLoS ONE 8(4):e59236. https://doi.org/10.1371/journal.pone.0059236
26. Neigh GN, Ali FF (2016) Co-morbidity of PTSD and immune system dysfunction: opportunities for treatment. Curr Opin Pharmacol 29:104–110. https://doi.org/10.1016/j.coph.2016.07.011
27. Sareen J, Cox BJ, Stein MB, Afifi TO, Fleet C, Asmundson GJ (2007) Physical and mental comorbidity, disability, and suicidal behavior associated with posttraumatic stress disorder in a large community sample. Psychosom Med 69(3):242–248. https://doi.org/10.1097/PSY.0b013e31803146d8
28. Morasco BJ, Lovejoy TI, Lu M, Turk DC, Lewis L, Dobscha SK (2013) The relationship between PTSD and chronic pain: mediating role of coping strategies and depression. Pain 154(4):609–616. https://doi.org/10.1016/j.pain.2013.01.001
29. Sharp TJ (2004) The prevalence of post-traumatic stress disorder in chronic pain patients. Curr Pain Headache Rep 8(2):111–115
30. Otis JD, Keane TM, Kerns RD (2003) An examination of the relationship between chronic pain and post-traumatic stress disorder. J Rehabil Res Dev 40(5):397–405
31. Ryder AL, Azcarate PM, Cohen BE (2018) PTSD and Physical Health. Curr Psychiatry Rep 20(12):116. https://doi.org/10.1007/s11920-018-0977-9
32. van den Berk-Clark C, Secrest S, Walls J, Hallberg E, Lustman PJ, Schneider FD, Scherrer JF (2018) Association between posttraumatic stress disorder and lack of exercise, poor diet, obesity,

and co-occuring smoking: a systematic review and meta-analysis. Health Psychol 37(5):407–416
33. Schaumberg K, Vinci C, Raiker JS, Mota N, Jackson M, Whalen D, Schumacher JA, Coffey SF (2015) PTSD-related alcohol expectancies and impulsivity interact to predict alcohol use severity in a substance dependent sample with PTSD. Addict Behav 41:41–45. https://doi.org/10.1016/j.addbeh.2014.09.022
34. Hruska B, Delahanty DL (2012) Application of the stressor vulnerability model to understanding posttraumatic stress disorder (PTSD) and alcohol-related problems in an undergraduate population. Psychol Addict Behav 26(4):734–746. https://doi.org/10.1037/a0027584
35. Farr OM, Ko BJ, Joung KE, Zaichenko L, Usher N, Tsoukas M, Thakkar B, Davis CR, Crowell JA, Mantzoros CS (2015) Posttraumatic stress disorder, alone or additively with early life adversity, is associated with obesity and cardiometabolic risk. Nutr Metab Cardiovasc Dis 25(5):479–488. https://doi.org/10.1016/j.numecd.2015.01.007
36. Littman AJ, Jacobson IG, Boyko EJ, Powell TM, Smith TC, Millennium Cohort Study (2013) Weight change following US military service. Int J Obes (Lond) 37(2):244–253. https://doi.org/10.1038/ijo.2012.46
37. Kong S, Bernstein K (2009) Childhood trauma as a predictor of eating psychopathology and its mediating variables in patients with eating disorders. J Clin Nurs 18(13):1897–1907. https://doi.org/10.1111/j.1365-2702.2008.02740.x
38. LeardMann CA, Woodall KA, Littman AJ, Jacobson IG, Boyko EJ, Smith B, Wells TS, Crum-Cianflone NF (2015) Post-traumatic stress disorder predicts future weight change in the Millennium Cohort Study. Obesity (Silver Spring) 23(4):886–892. https://doi.org/10.1002/oby.21025
39. Hemmings SMJ, Malan-Müller S, van den Heuvel LL, Demmitt BA, Stanislawski MA, Smith DG, Bohr AD, Stamper CE, Hyde ER, Morton JT, Marotz CA, Siebler PH, Braspenning M, Van Criekinge W, Hoisington AJ, Brenner LA, Postolache TT, McQueen MB, Krauter KS, Knight R, Seedat S, Lowry CA (2017) The microbiome in posttraumatic stress disorder and trauma-exposed controls: an exploratory study. Psychosom Med 79(8):936–946. https://doi.org/10.1097/PSY.0000000000000512
40. Dedert EA, Becker ME, Fuemmeler BF, Braxton LE, Calhoun PS, Beckham JC (2010) Childhood traumatic stress and obesity in women: the intervening effects of PTSD and MDD. J Trauma Stress 23(6):785–763. https://doi.org/10.1002/jts.20584
41. Aaseth J, Roer GE, Lien L, Bjorklund G (2019) Is there a relationship between PTSD and complicated obesity? A review of the literature. Biomed Pharmacother 117:108834. https://doi.org/10.1016/j.biopha.2019.108834
42. Wilson CB, McLaughlin LD, Nair A, Ebenezer PJ, Dange R, Francis J (2013) Inflammation and oxidative stress are elevated in the brain, blood, and adrenal glands during the progression of post-traumatic stress disorder in a predator exposure animal model. PLoS ONE 8(10):e76146. https://doi.org/10.1371/journal.pone.0076146
43. de Souza CP, Gambeta E, Stern CAJ, Zanoveli JM (2019) Posttraumatic stress disorder-type behaviors in streptozotocin-induced diabetic rats can be prevented by prolonged treatment with vitamin E. Behav Brain Res 359:749–754. https://doi.org/10.1016/j.bbr.2018.09.008
44. Ebenezer PJ, Wilson CB, Wilson LD, Nair AR, Francis J (2016) The anti-inflammatory effects of blueberries in an animal model of post-traumatic stress disorder (PTSD). PLoS ONE 11(9):e0160923. https://doi.org/10.1371/journal.pone.0160923
45. Jin H, Lanouette NM, Mudaliar S, Henry R, Folsom DP, Khandrika S, Glorioso DK, Jeste DV (2009) Association of posttraumatic stress disorder with increased prevalence of metabolic syndrome. J Clin Psychopharmacol 29(3):210–215. https://doi.org/10.1097/JCP.0b013e3181a45ed0
46. Solanki N, Alkadhi I, Atrooz F, Patki G, Salim S (2015) Grape powder prevents cognitive, behavioral, and biochemical impairments in a rat model of posttraumatic stress disorder. Nutr Res 35(1):65–75. https://doi.org/10.1016/j.nutres.2014.11.008
47. Perruchoud R (2004) International migration law: glossary on migration. International Organization for Migration (IOM), Geneva
48. United Nations Population Division Department of Economic and Social Affairs (2017) Trends in International Migrant Stock: The 2017 Revision. United Nations Database. POP/DB/MIG/Stock/Rev.2017. https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates17.asp. Accessed 16 July 2019
49. Shiroma PR, Alarcon RD (2011) Time for healing: somatization among chronically mentally ill immigrants. J Cult Divers 18(1):3 (**PMID:21526581**)
50. Rohlof HG, Knipscheer JW, Kleber RJ (2014) Somatization in refugees: a review. Soc Psychiatry Psychiatr Epidemiol 49(11):1793–1804. https://doi.org/10.1007/s00127-014-0877-1
51. Bermejo I, Mayninger E, Kriston L, Harter M (2010) Mental disorders in people with migration background compared with German general population. Psychiatr Prax 37(5):225–232. https://doi.org/10.1055/s-0029-1223513
52. Bragazzi NL, Puente GD, Natta WM (2014) Somatic perception, cultural differences and immigration: results from administration of the Modified Somatic Perception Questionnaire (MSPQ) to a sample of immigrants. Psychol Res Behav Manag 7:161–166. https://doi.org/10.2147/PRBM.S55393
53. Torres L, Driscoll MW, Voell M (2012) Discrimination, acculturation, acculturative stress, and Latino psychological distress: a moderated mediational model. Cult Divers Ethnic Minor Psychol 18(1):17–25. https://doi.org/10.1037/a0026710
54. Jamil H, Hakim-Larson J, Farrag M, Kafaji T, Duqum I, Jamil LH (2002) A retrospective study of Arab American mental health clients: trauma and the Iraqi refugees. Am J Orthopsychiatry 72(3):355–361. https://doi.org/10.1037//0002-9432.72.3.355
55. Davison KM, Gondara L (2019) A comparison of mental health, food insecurity and diet quality indicators between foreign-born immigrants of Canada and Native-born Canadians. J Hunger Environ Nutr. https://doi.org/10.1080/19320248.2019.1672601 (**ahead of print**)
56. Jen KL, Zhou K, Arnetz B, Jamil H (2015) Pre- and post-displacement stressors and body weight development in Iraqi refugees in Michigan. J Immigr Minor Health 17(5):1468–1475. https://doi.org/10.1007/s10903-014-0127-3
57. Carta MG, Bernal M, Hardoy MC, Haro-Abad JM, the "Report on the Mental Health in Europe" working group (2005) Migration and mental health in Europe (the state of the mental health in Europe working group: appendix 1). Clin Pract Epidemiol Ment Health 1:13. https://doi.org/10.1186/1745-0179-1-13
58. Silove D, Steel Z, McGorry P, Mohan P (1998) Trauma exposure, postmigration stressors, and symptoms of anxiety, depression and post-traumatic stress in Tamil asylum-seekers: comparison with refugees and immigrants. Acta Psychiatr Scand 97(3):175–181. https://doi.org/10.1111/j.1600-0447.1998.tb09984.x
59. Haller H, Cramer H, Lauche R, Dobos G (2015) Somatoform disorders and medically unexplained symptoms in primary care. Dtsch Arztebl Int 112(16):279–287. https://doi.org/10.3238/arztebl.2015.0279
60. Baum F, Lawless A, Williams C (2013) Health in all policies from international ideas to local implementation: policies, systems and organizations. In: Clavier C, de Leeuw E (eds) Health promotion and the policy process. Oxford: Oxford University Press, pp 188–217

61. Davison KM, D'Andreamatteo C, Mitchell S, Vanderkooy P (2017) The development of a national nutrition and mental health research agenda with comparison of priorities among diverse stakeholders. Public Health Nutr 20(4):712–725. https://doi.org/10.1017/S1368980016002056
62. Fuller-Thomson E, Saab Z, Davison KM, Lin S, Taler K, Kobayashi K, Tong H (2020) Nutrition, immigration and health determinants are linked to verbal fluency among Anglophone adults in the Canadian Longitudinal Study on Aging (CLSA). J Nutr Health Aging 24(6):672–680
63. Lin S, Kobayashi K, Tong H, Davison KM, Arora SRA, Fuller-Thomson E (2020) Close relations matter: The association between depression and refugee status in the Canadian Longitudinal Study on Aging (CLSA). J Immigr Minor Health 22(5):946–956. https://doi.org/10.1007/s10903-020-00980-0
64. Davison K, Lin S, Tong H, Kobayashi K, Mora-Almanza JG, Fuller-Thomson E (2020) Nutritional factors, physical health and immigrant status are associated with anxiety disorders among middle-aged and older adults: findings from the Canadian Longitudinal Study on Aging (CLSA). Int J Environ Res Public Health 17(5):1493. https://doi.org/10.3390/ijerph17051493
65. Davison K, Lung Y, Lin S, Tong H, Kobayashi K, Fuller-Thomson E (2020) Psychological distress in older adults linked to immigrant status, dietary intake, and physical health conditions in the Canadian Longitudinal Study on Aging (CLSA). J Affect Disord 265:526–537. https://doi.org/10.1016/j.jad.2020.01.024
66. Davison KM, Lung Y, Lin S, Tong H, Kobayashi KM, Fuller-Thomson E (2019) Depression in middle and older adulthood: the role of immigration, nutrition, and other determinants of health in the Canadian longitudinal study on aging. BMC Psychiatry 19(1):329. https://doi.org/10.1186/s12888-019-2309-y
67. Raina PS, Wolfson C, Kirkland SA, Griffith LE, Oremus M, Patterson C, Tuokko H, Penning M, Balion CM, Hogan D, Wister A, Payette H, Shannon H, Brazil K (2009) The Canadian longitudinal study on aging (CLSA). Can J Aging 28(3):221–229
68. Raina P, Wolfson C, Kirkland S, Griffith LE, Balion C, Cossette B, Dionne I, Hofer S, Hogan D, van den Heuvel ER, Liu-Ambrose T, Menec V, Mugford G, Patterson C, Payette H, Richards B, Shannon H, Sheets D, Taler V, Thompson M, Tuokko H, Wister A, Wu C, Young L (2019) Cohort profile: the Canadian Longitudinal Study on Aging (CLSA). Int J Epidemiol 48(6):1752–1753j. https://doi.org/10.1093/ije/dyz173
69. Raina P, Wolfson C, Kirkland S, Griffith LE, Balion C, Cossette B, Dionne I, Hofer S, Hogan D, van den Heuvel ER, Liu-Ambrose T, Menec V, Mugford G, Patterson C, Payette H, Richards B, Shannon H, Sheets D, Taler V, Thompson M, Tuokko H, Wister A, Wu C, Young L (2019) Corrigendum to: cohort profile: the Canadian Longitudinal Study on Aging (CLSA). Int J Epidemiol 48(6):2066. https://doi.org/10.1093/ije/dyz221
70. Stinchcombe A, Wilson K, Kortes-Miller K, Chambers L, Weaver B (2018) Physical and mental health inequalities among aging lesbian, gay, and bisexual Canadians: cross-sectional results from the Canadian Longitudinal Study on Aging (CLSA). Can J Public Health 109:833–844
71. Prins A, Ouimette P, Kimerling R, Cameron RP, Hugelshofer DS, Shaw-Hegwer J, Thrailkill A, Gusman FD, Sheikh JI (2004) The primary care PTSD screen (PC–PTSD): development and operating characteristics. Primary Care Psychiatry 9(1):9–14. https://doi.org/10.1185/135525703125002360
72. Prins A, Bovin MJ, Smolenski DJ, Marx BP, Kimerling R, Jenkins-Guarnieri MA, Kaloupek DG, Schnurr PP, Kaiser AP, Leyva YE, Tiet QQ (2016) The Primary Care PTSD Screen for DSM-5 (PC-PTSD-5): Development and evaluation within a veteran primary care sample. J Gen Intern Med 31(10):1206–1211. https://doi.org/10.1007/s11606-016-3703-5
73. Hahs-Vaughn DL (2005) A primer for using and understanding weights with national datasets. J Exp Educ 73(3):221–248
74. Kulkarni M, Pole N (2008) Psychiatric distress among Asian and European American survivors of the 1994 Northridge earthquake. J Nerv Ment Dis 196(8):597–604. https://doi.org/10.1097/NMD.0b013e3181813290
75. Fennelly K (2007) Health and well-being of immigrants: the healthy migrant phenomenon. In: Walker PF, Barnett ED (eds) Immigrant medicine. Saunders Elsevier, St. Louis, pp 19–26
76. Omariba DWR (2015) Immigration, ethnicity, and avoidable mortality in Canada, 1991–2006. Ethn Health 20(4):409–436
77. Breslau J, Aguilar-Gaxiola S, Borges G, Kendler KS, Su M, Kessler RC (2007) Risk for psychiatric disorder among immigrants and their US-born descendants: evidence from the National Comorbidity Survey Replication. J Nerv Ment Dis 195:189–195
78. Jamil H, Hakim-Larson J, Farrag M, Kafaji T, Jamil LH, Hammad A (2005) Medical complaints among Iraqi American refugees with mental disorders. J Immigr Health 7(3):145–152. https://doi.org/10.1007/s10903-005-3671-z
79. Mills EJ, Singh S, Holtz TH, Chase RM, Dolma S, Santa-Barbara J, Dolma S, Orbinski JJ (2005) Prevalence of mental disorders and torture among Tibetan refugees: a systematic review. BMC Int Health Hum Rights 5(1):7. https://doi.org/10.1186/1472-698X-5-7
80. Aragona M, Rovetta E, Pucci D, Spoto J, Villa AM (2012) Somatization in a primary care service for immigrants. Ethn Health 17(5):477–491. https://doi.org/10.1080/13557858.2012.661406
81. Perreira KM, Ornelas I (2013) Painful passages: traumatic experiences and post-traumatic stress among immigrant Latino adolescents and their primary caregivers. Int Migr Rev 47(4):976–1005. https://doi.org/10.1111/imre.12050
82. Sangalang CC, Vang C (2017) Intergenerational trauma in refugee families: a systematic review. J Immigr Minor Health 19(3):745–754. https://doi.org/10.1007/s10903-016-0499-7
83. Kun P, Tong X, Liu Y, Pei X, Luo H (2013) What are the determinants of post-traumatic stress disorder: age, gender, ethnicity or other? Evidence from 2008 Wenchuan earthquake. Public Health 127(7):644–652. https://doi.org/10.1016/j.puhe.2013.04.018
84. Beckham JC, Roodman AA, Shipley RH, Hertzberg MA, Cunha GH, Kudler HS, Levin ED, Rose JE, Fairbank JA (1995) Smoking in Vietnam combat veterans with post-traumatic stress disorder. J Trauma Stress 8(3):461–472
85. Arroyo KJ, Ramos-Torres G, Mezones-Holguin E, Blumel JE, Baron G, Bencosme A, Benítez Z, Bravo LM, Calle A, Flores D, Espinoza MT, Gómez G, Hernández-Bueno JA, Martino M, Lima S, Monterrosa A, Mostajo D, Ojeda E, Onatra W, Sánchez H, Tserotas K, Vallejo MS, Witis S, Zúñiga MC, Chedraui P (2018) Association between waist-to-height ratio and anxiety in middle-aged women: a secondary analysis of a cross-sectional multicenter Latin American study. Menopause 25(8):904–911. https://doi.org/10.1097/GME.0000000000001089
86. Wiltink J, Michal M, Wild PS, Zwiener I, Blettner M, Munzel T, Schulz A, Kirschner Y, Beutel ME (2013) Associations between depression and different measures of obesity (BMI, WC, WHtR, WHR). BMC Psychiatry 13(1):223. https://doi.org/10.1186/1471-244X-13-223
87. Borovac Stefanovic L, Kalinic D, Mimica N, Beer Ljubic B, Aladrović J, Mandelsamen Perica M, Curić M, Grošić PF, Delaš I (2015) Oxidative status and the severity of clinical symptoms in patients with post-traumatic stress disorder. Ann Clin Biochem 52(Pt 1):95–104. https://doi.org/10.1177/0004563214528882
88. Lavie L (2009) Oxidative stress—a unifying paradigm in obstructive sleep apnea and comorbidities. Prog Cardiovasc Dis 51(4):303–312. https://doi.org/10.1016/j.pcad.2008.08.003

89. Bjorklund G, Chirumbolo S (2017) Role of oxidative stress and antioxidants in daily nutrition and human health. Nutrition 33:311–321. https://doi.org/10.1016/j.nut.2016.07.018
90. Bonaz B, Bazin T, Pellissier S (2018) The vagus nerve at the interface of the microbiota-gut-brain axis. Front Neurosci 12:49. https://doi.org/10.3389/fnins.2018.00049
91. Godfrey KM, Lindamer LA, Mostoufi S, Afari N (2013) Post-traumatic stress disorder and health: a preliminary study of group differences in health and health behaviors. Ann Gen Psychiatry 12(1):30. https://doi.org/10.1186/1744-859X-12-30
92. Schlemmer U, Frolich W, Prieto RM, Grases F (2009) Phytate in foods and significance for humans: food sources, intake, processing, bioavailability, protective role and analysis. Mol Nutr Food Res 53(S2):S330–S375. https://doi.org/10.1002/mnfr.200900099
93. Carmassi C, Bertelloni CA, Dell'Oste V, Foghi C, Diadema E, Cordone A, Pedrinelli V, Dell'Osso L (2020) Post-traumatic stress burden in a sample of hospitalized patients with Bipolar Disorder: which impact on clinical correlates and suicidal risk? J Affect Disord 262:267–272
94. Reyes-Rodríguez ML, Von Holle A, Ulman TF, Thornton LM, Klump KL, Brandt H, Crawford S, Fichter MM, Halmi KA, Huber T, Johnson C, Jones I, Kaplan AS, Mitchell JE, Strober M, Treasure J, Woodside DB, Berrettini WH, Kaye WH, Bulik CM (2011) Post traumatic stress disorder in anorexia nervosa. Psychosom Med 73(6):491–497
95. Gómez-Beneyto M, Salazar-Fraile J, Martí-Sanjuan V, Gonzalez-Luján L (2006) Posttraumatic stress disorder in primary care with special reference to personality disorder comorbidity. Br J Gen Pract 56(526):349–354
96. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Dennison CKJ, Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD, Wright JT Jr (2018) ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 71(19):e127–e248. https://doi.org/10.1016/j.jacc.2017.11.006
97. Centers for Disease Control and Prevention. National Health Interview Survey Glossary. https://ww.cdc.gov/nchs/nhis/tobacco/tobacco_glossary.htm. Accessed 11 Jan 2020
98. Statistics Canada. Heavy Drinking. https://www150.statcan.gc.ca//n1//pub//82-625-x//2017001//article//54861-eng.htm. Accessed 9 Dec 2018
99. Douketis JD, Paradis G, Keller H, Martineau C (2005) Canadian guidelines for body weight classification in adults: application in clinical practice to screen for overweight and obesity and to assess disease risk. CMAJ 172(8):995–998
100. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8–11 December 2008. Geneva: WHO, 2011. https://www.who.int/nutrition/publications/obesity/WHO_report_waistcircumference_and_waisthip_ratio/en. Accessed 11 Jan 2020
101. Browning LM, Hsieh SD, Ashwell M (2010) A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. Nutr Res Rev 23(2):247–269. https://doi.org/10.1017/S0954422410000144
102. Guerra R, Fonseca I, Pichel F, Restivo M, Amaral T (2014) Handgrip strength cutoff values for undernutrition screening at hospital admission. Eur J Clin Nutr 68(12):1315
103. Lourenço RA, Pérez-Zepeda M, Gutiérrez-Robledo L, García-García FJ, Rodríguez Mañas L (2014) Performance of the European Working Group on Sarcopenia in Older People algorithm in screening older adults for muscle mass assessment. Age Ageing 44(2):334–338
104. Yoshida D, Suzuki T, Shimada H, Park H, Makizako H, Doi T, Anan Y, Tsutsumimoto K, Uemura K, Ito T (2014) Using two different algorithms to determine the prevalence of sarcopenia. Geriatr Gerontol Int 14:46–51
105. National Osteoporosis Foundation. Bone density exam/testing. https://ww.nof.org/patients/diagnosis-information/bone-density-examtesting. Accessed 11 Jan 2020
106. World Health Organization (2011) Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and mineral nutrition information system. World Health Organization, Geneva (WHO/NMH/NHD/MNM/11.1). https://ww.who.int/vmnis/indicators/haemoglobin.pdf. Accessed 28 Feb 2019
107. Shatenstein B, Payette H (2015) Evaluation of the relative validity of the Short Diet Questionnaire for assessing usual consumption frequencies of selected nutrients and foods. Nutrients 7(8):6362–6374. https://doi.org/10.3390/nu7085282