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Trauma exposure, posttraumatic stress, and preventive health behaviours: a systematic review

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ABSTRACT

Psychological trauma has implications for many aspects of physical health, including preventive health behaviours (PHBs). However, whether trauma exposure additionally contributes to PHBs above and beyond the effects of posttraumatic stress disorder (PTSD) symptoms remains unclear. In this systematic review, 32 studies were analysed to characterise: (1) the relationships between trauma exposure and PHBs, (2) the relationships between PTSD symptoms and PHBs, (3) the unique associations between trauma exposure and PHBs, independent of PTSD symptoms, and (4) the unique associations between PTSD symptoms and PHBs, independent of trauma exposure. Findings were variable across the three examined PHBs (physical activity, diet, medical screening) when only trauma exposure or PTSD symptoms were taken into account. Clearer relationships emerged between trauma exposure and PHBs when PTSD symptoms were taken into account, demonstrating that trauma exposure is related to PHB engagement above and beyond the effects of PTSD symptoms. Additionally, PTSD symptoms shared unique associations with physical activity and screening frequency, which were not explained by trauma exposure. Our review reveals that teasing apart the effects of trauma exposure and PTSD symptoms on PHBs brings greater clarity to the strength and direction of these associations.

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KEYWORDS
Trauma exposure; health behaviour; PTSD; preventive health

The relationship between psychological trauma and physical health is most frequently studied in the context of the development of posttraumatic stress disorder (PTSD) symptoms. Myriad studies have identified PTSD symptoms as a risk factor for chronic health conditions, particularly cardiovascular and metabolic diseases such as hypertension and diabetes (Dedert, Calhoun, Watkins, Sherwood, & Beckham, 2010; Koenen et al., 2017). In addition, having PTSD, as opposed to not, has been linked to adverse health-related outcomes such as increased all-cause mortality (e.g., Boscarino, 2006), increased medical service utilisation (e.g., Dennis et al., 2009), decreased health-related quality of life (Pacella, Hruska, & Delahanty, 2013), increased general health symptoms (Pacella et al., 2013), and decreased physical functioning (Jakupcak, Luterek, Hunt, Conybeare, & McFall, 2008).

However, the link between PTSD symptoms and physical health may be confounded by trauma exposure. Trauma exposure is often measured by dichotomous categorisation (i.e., non-exposed versus trauma-exposed) or dimensions (e.g., severity, proximity, frequency). In particular, cumulative trauma exposure (i.e., the lifetime accumulation of multiple or chronic traumatic events) is one dimension of trauma exposure that is known to covary with PTSD symptoms, in that individuals with greater cumulative trauma exposure tend to have greater PTSD symptoms (Kira et al., 2008). Other dimensions such as the number of trauma types and extent of trauma severity are also

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positively correlated with PTSD symptoms (Gabert-Quillen et al., 2012). Due to this confounding relationship, it is unclear whether trauma exposure contributes to physical health outcomes above and beyond the effects of PTSD symptoms.

Despite its overlap with PTSD symptoms, trauma exposure is a distinct construct that may have its own important implications for physical health. Epidemiologically, trauma exposure affects a greater number of people than do PTSD symptoms. While a majority of adults will encounter at least one traumatic event in their lifetimes, most will be asymptomatic and only 7% will meet criteria for PTSD (Kessler et al., 2005; Schnurr, Spiro, Vielhauer, Findler, & Hamblen, 2002). For those who develop PTSD symptoms, symptoms may wax and wane over time, but the experience of traumatisation still remains with the individual. Consistent with this notion, some recent research has suggested that dimensions of trauma exposure, independent of PTSD development, may contribute to poorer physical health outcomes. Cumulative trauma exposure, absent the development of any PTSD symptoms, is associated with an elevated risk for cardiovascular disease (Sumner et al., 2015). Furthermore, event characteristics of prior traumas (i.e., number of prior traumas, trauma types, age at first trauma) predict later physical health functioning, a relationship that is not mediated by PTSD symptoms (Irish et al., 2013). These findings suggest that trauma exposure is *uniquely related* to physical health outcomes, independent of the effects of PTSD symptoms.

Developing a more nuanced understanding of trauma exposure's unique contributions to physical health has far-reaching implications. PTSD symptoms are widely understood as a risk factor for poorer physical health, but individuals exposed to trauma remain at risk for some markers of poor health regardless of symptomatology. Greater cumulative trauma exposure, but not PTSD status, is linked to increased medical utilisation (Rosenberg et al., 2000), suggesting that trauma history is important to assess in primary care settings even if patients do not endorse PTSD symptoms. Other factors beyond PTSD may play explanatory roles in the connection between trauma exposure and worse physical health, but more empirical work is needed to build and support theories about the multitude of ways in which trauma exposure can affect physical health, independent of PTSD symptom development.

Consistent with this goal, Schnurr and Green (2004) proposed a model relating trauma exposure to physical health outcomes. The model, which has been adapted to reflect recent research, is presented in Figure 1. The model outlines multiple pathways for these relationships, some of which are mediated by PTSD symptoms and others of which bypass the development of PTSD symptoms.

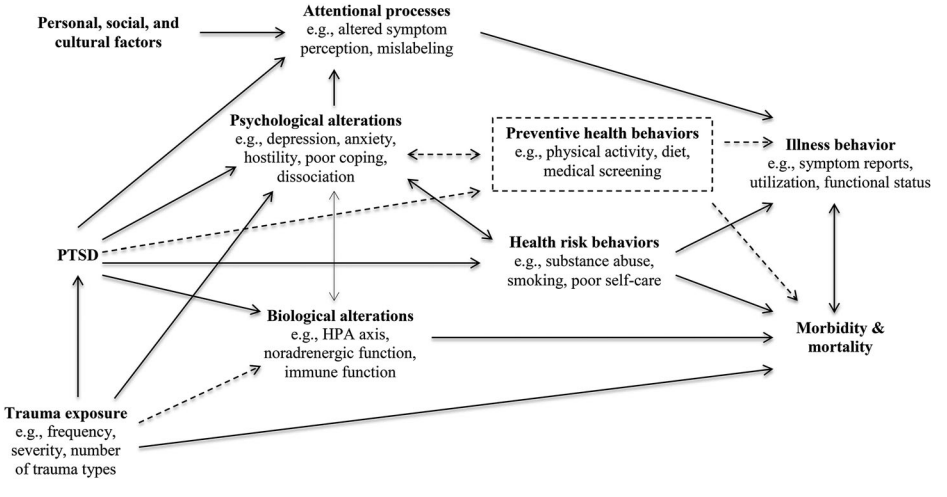

Figure 1. Model relating trauma and physical health (adapted from Schnurr & Green, 2004).

Note: Dashed lines indicate paths and variables not included in the original Schnurr and Green (2004) model, but have been supported by subsequent research.

Independent of PTSD symptoms, trauma exposure can lead to other psychological alterations, which in turn trigger mechanisms that increase risk for morbidity, mortality, and illness behaviour. One mechanism is the alteration of attentional processes that underlie perception and interpretation of physical symptoms. Previous research has demonstrated that trauma exposure, rather than PTSD symptoms, may influence the affective experiences of physical symptoms (Gómez-Pérez & López-Martínez, 2013). Another mechanism by which trauma exposure affects physical health is the dysregulation of bodily systems involved in the stress response. These biological mechanisms include chronic activation of the hypothalamic–pituitary–adrenal axis and sympathetic nervous system, as well as overactivation of the inflammatory response system (Kendall-Tackett, 2009). Supporting research has found that exposure to early life stress may alter these stress response systems, which in turn confers risk for health outcomes in later life (Yehuda et al., 2010).

Trauma exposure and health behaviours

A less-explored mechanism featured in Schnurr and Green's model (2004) of relationships between trauma exposure and physical health is health behaviours. Health behaviours refer to undertaken acts with implications for physical health (Glanz, Rimer, & Viswanath, 2008). Compared to attentional and biological processes, health behaviours are a more readily observable mechanism for studying the effects of trauma on physical health. Health behaviours are typically categorised as risky health behaviours or preventive health behaviours (PHBs). Risky health behaviours, or health risk behaviours, are actions that increase one's susceptibility to disease or illness (Glanz et al., 2008). PHBs, also known as health-promoting behaviours or health-enhancing behaviours, are actions to improve or maintain health, both within and outside a medical care system or authority (Kirscht, 1983). Admittedly, health behaviours can be framed as either preventive or risky, depending on the wording of a measure's items (e.g., physical activity as preventive versus physical inactivity as risky). For the purposes of this review, PHBs refer to behaviours requiring initiative and deliberate effort (e.g., physical activity), rather than the inverse of risky health behaviours (e.g., alcohol abstinence).

Research has been largely mixed regarding the extent to which health behaviours mediate the relationship between trauma exposure and physical health (Schnurr, 2015), with some studies reporting partial mediation (Crawford, Drescher, & Rosen, 2009; Flood, McDevitt-Murphy, Weathers, Eakin, & Benson, 2009) and others finding no mediating effect (Del Gaizo, Elhai, & Weaver, 2011; Schnurr & Spiro, 1999). Consistent findings across studies may be elusive because trauma exposure can affect health behaviour engagement through different mechanisms, depending on the specific health behaviour. For example, the odds of early initiation of smoking and substance use are both higher for individuals with greater childhood trauma (Ramiro, Madrid, & Brown, 2010). However, as two distinct health risk behaviours, smoking and substance use serve different functions: While nicotine use facilitates the release of affect-regulating neurotransmitters (Carmody, 1992), alcohol may be consumed to decrease physiological arousal (McFall, Mackay, & Donovan, 1992). Given the heterogeneity of health behaviours, direct comparisons between different health behaviours may not be helpful (e.g., comparing research on smoking to research on drinking). However, the literature would benefit from a more comprehensive understanding of the role of each health behaviour, particularly PHBs, and a consideration of the factors that explain discrepancies in findings across health behaviours. There are likely multiple pathways that link trauma exposure to health behaviours with different psychological factors accounting for these associations.

One explanation for the relationship between trauma and health behaviours is the mediating effect of PTSD symptoms. However, PTSD symptoms do not fully account for the relationship between trauma and health behaviours. Among a sample of male veterans, Schnurr and Spiro (1999) found that PTSD symptoms mediated only 16% of the effect of combat exposure on smoking (Rheingold, Acierno, & Resnick, 2015), illustrating that PTSD symptoms are *not* the main mechanism by which trauma exposure affects health behaviour. Research has also found that

greater cumulative trauma exposure is related to poorer health behaviours, such as substance abuse, even after controlling for PTSD symptom severity (Del Gaizo et al., 2011). These findings suggest that PTSD symptoms and trauma exposure may have differential effects on the ways in which trauma carries forward to impact health behaviour engagement.

Preventive health behaviours

Much of the work disentangling the effects of trauma exposure from the effects of PTSD symptoms on health behaviours has focused on risky or poor health behaviours such as smoking, alcohol use, and drug use (Rheingold et al., 2015), with little attention given to PHBs. Research efforts to tease out the effects of trauma exposure from the effects of PTSD symptoms on PHBs have been fairly limited for several reasons. First, studies tend to measure trauma exposure *or* PTSD symptoms with few studies measuring both, which does not allow for understanding their potential independent effects on the same PHB. In addition, generalisations about the relationships between trauma exposure and PHBs should be made with caution due to the heterogeneity of PHBs examined across studies. Therefore, efforts to characterise these relationships would benefit from examining PHBs with sufficient literature to warrant review, rather than making inferences from a wider array of PHBs that each has limited research.

Moreover, it is clinically significant to focus on the PHBs that influence risk for and protection against the physical health conditions for which trauma survivors are particularly vulnerable. Prior research has consistently demonstrated that trauma survivors have a higher risk for developing cardiometabolic problems and cancer, compared to non-exposed individuals (e.g., Dong et al., 2004; Felitti et al., 1998). In fact, the odds of developing heart disease and cancer are among the highest of the chronic conditions, when comparing trauma survivors to non-exposed individuals (Sledjeski, Speisman, & Dierker, 2008). Furthermore, among survivors, a graded relationship exists between trauma exposure and risk for these conditions, such that greater cumulative trauma exposure predicts greater risk for heart attack, heart disease, and cancer (Sledjeski et al., 2008). Given that increased physical activity and better diet quality are known predictors of lower cardiometabolic risk (e.g., Goodpaster et al., 2010) and medical screenings are known predictors for reducing mortality from chronic conditions like cancer (Tabar et al., 2003), these PHBs are promising potential mechanisms to study in the context of trauma and health.

The present study

To date, whether trauma exposure has additional effects on PHBs distinct from the effects of PTSD symptoms remains unclear. Therefore, a comprehensive review is needed to evaluate the empirical evidence for the relationships between trauma exposure, posttraumatic stress, and PHBs, and characterise the unique relationships between trauma exposure and PHBs independent of PTSD symptoms. In doing so, we can better understand how to incorporate PHBs in the model of trauma and physical health adapted from Schnurr and Green (2004). The objectives of this systematic review are to investigate the following questions:

(1) How are trauma exposure, posttraumatic stress, and PHBs measured?
(2) What is the nature of the relationships between:
    (a) Trauma exposure and PHBs?
    (b) PTSD symptoms and PHBs?
(3) What happens to the relationships between:
    (a) Trauma exposure and PHBs when PTSD symptoms are accounted for?
    (b) PTSD symptoms and PHBs when trauma exposure is accounted for?

Methods

Search and eligibility criteria

A search of the literature was conducted on 9 January 2017 using the PubMed and PsychInfo databases. The initial search yielded too few results for several PHBs (i.e., sleep hygiene, seatbelt use, contraceptive use, vaccinations), which would have inhibited the ability to broadly characterise meaningful relationships for these PHBs. Therefore, the scope of the search was narrowed to the following PHBs that had a sufficient amount of literature to warrant review: physical activity, diet, and medical screenings. Various keywords, including Medical Subject Headings (MeSH) terms, were used to search titles and abstracts including: trauma exposure, PTSD, preventive health behaviour, diet, physical activity, and medical screening (see Appendix A for a list of all search terms).

Given that research on the topic is fairly limited, we did not restrict year of publication in our search criteria. Reviews were included in the search criteria to allow for handsearching of their references. Only empirical studies that were original, peer-reviewed, and written in English were included for further screening. During the screening process, theoretical articles, qualitative studies, and single-participant case studies were excluded. Intervention studies (e.g., exercise for treating PTSD) were also excluded during the screening process because the present review focuses on how trauma may influence health behaviours. Only studies that assessed exposure to traumatic events, not stressors or adversities (e.g., job loss), were eligible in order to more strictly adhere with the DSM-IV-TR and DSM-5 definitions of a Criterion A event for PTSD (American Psychiatric Association, 2000, 2013). Eligible studies included at least one analysis in which: (a) trauma exposure was or PTSD symptoms were correlated with or predictive of one of the PHBs, (b) group differences for engagement in PHBs were compared based on trauma exposure or PTSD symptoms, (c) group differences for trauma exposure or PTSD symptoms were compared based on engagement in PHBs, or (d) changes in PHB engagement were assessed over time in a sample with trauma exposure or PTSD symptoms.

Results

Study selection

Our database searches yielded a total of 2048 abstracts from both databases: 636 hits on PubMed and 1412 hits on PsychInfo. From these search results, we found three relevant systematic reviews (Hall, Hoerster, & Yancy, 2015; Vancampfort et al., 2016; Whitworth & Ciccolo, 2016), which were used to handsearch references and identify 39 additional records. After 141 duplicates were removed, an additional 1894 abstracts were excluded during the title and abstract screening process. Of the 52 full-text articles assessed, 20 were excluded due to the measurement of other PHBs, use of aggregate scores to measure multiple PHBs, or use of interventions. Overall, 32 studies were eligible for inclusion (see Figure 2 for the PRISMA flow diagram of study selection; Moher et al., 2009).

Information from the eligible articles is presented in Tables 1 (physical activity), 2 (diet), and 3 (medical screening). Although all studies measured the associations that PHBs shared with either trauma exposure or PTSD symptoms, these relationships were not part of the primary research questions in all studies. Studies varied in examining PHBs as a primary outcome, secondary outcome, mediator, or moderator, which is noted in Tables 1–3. The review findings are structured by the four aforementioned objectives of this review. Some studies measured both trauma exposure and PTSD symptoms in relation to PHBs, but did not analyse the relationship between all three variables (i.e., controlling for either trauma exposure or PTSD symptoms). Different results derived from the same study (e.g., multiple analyses or PHBs) are presented separately in their respective sections according to objective and type of PHB.

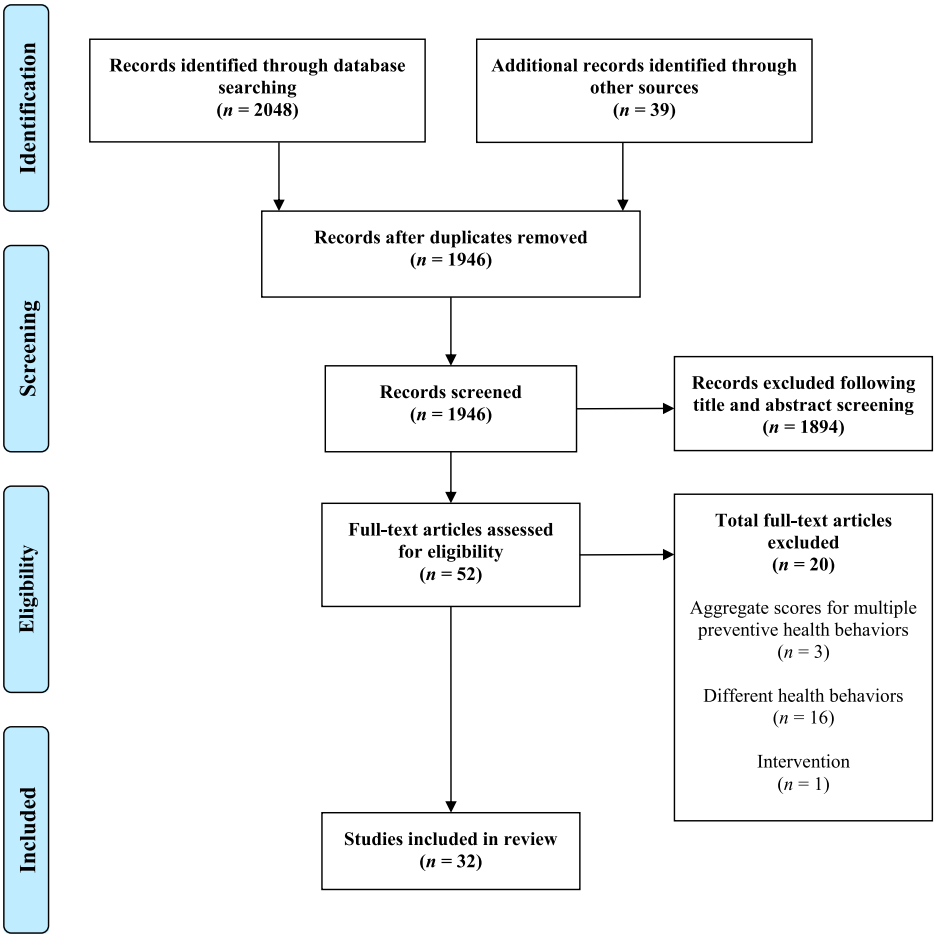

Figure 2. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Moher, Liberati, Tetzlaff, & Altman, 2009).

Measurement of trauma and PHBs (Objective 1)

Trauma exposure

Less than half (13 out of 32) of the identified studies assessed trauma exposure, indicating that most were unable to tease apart the influences of trauma exposure and PTSD on PHBs. Among these studies, approaches to measuring trauma exposure were largely heterogeneous. Different measures were used across studies including the Adult Abuse Screen (McFarlane, Parker, Soeken, & Bullock, 1992), Adult Attachment Interview (George, Kaplan, & Main, 1985), Brief Trauma Questionnaire (Schnurr, Vieilhauer, Weathers, & Findler, 1999), Childhood Trauma Questionnaire (Bernstein & Fink, 1998), Clinician Administered PTSD Scale (Blake et al., 1995), Cumulative Adversity Interview (Turner & Wheaton, 1995), Evaluation of Lifetime Stressors (Krinsley, 1996), Posttraumatic Diagnostic Scale (Foa, Cashman, Jaycox, & Perry, 1997), Structured Clinical Interview for Diagnoses Diagnostic and Statistical Manual (First, Spitzer, Gibbon, & Williams, 1996), Trauma History Questionnaire (Green, 1996), Traumatic Life Events Questionnaire (Kubany et al., 2000), and unvalidated questionnaires. Several studies examined trauma exposure by measuring cumulative trauma exposure, while others further disaggregated cumulative trauma exposure by the frequency of each trauma type using count data (Farley et al., 2001) or qualitative descriptors such as 'very often true' (Rodgers et al., 2004). Another approach to measuring the frequency of trauma exposure was

Table 1. Key findings of articles examining trauma exposure, PTSD, and physical activity.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
Adler, Britt, Castro, McGurk, and Bliese (2011)	Longitudinal	2b	34-item measure of combat experiences (Adler, Bliese, McGurk, Salvi, & Eckford, 2009)[a]	PTSD Checklist (PCL-M)	Secondary (zero-order correlation)	8 items about health behaviours including eating healthy food and exercising (Adler et al., 2009)	Combat-exposed active duty US soldiers (n = 647)	PTSD symptom severity was not correlated with increases or decreases in exercising.
Arnson et al. (2007)	Cross-sectional	2b	N/A	Clinician Administered PTSD Scale (CAPS)	Primary (ANOVA)	1 item about frequency of exercise	Male patients with fibromyalgia and PTSD (n = 55)	No differences in PTSD symptom severity between groups that exercised regularly, infrequently, and not at all.
Chwastiak, Rosenheck, and Kazis (2011)	Cross-sectional	2b	N/A	VA medical records	Primary (logistic regression)	1 item about exercise frequency	Veterans from the 1999 Large Health Survey of Veteran Enrollees (n = 501,161)	Veterans with PTSD had higher odds of no regular exercise compared to veterans without PTSD.
Davidson, Babson, Bonn-Miller, Souter, and Vannoy (2013)	Cross-sectional	2b	N/A	PTSD Checklist (PCL-M)	Secondary (zero-order correlation)	1 item about exercise frequency	Veterans admitted to VA PTSD residential rehabilitation programme (n = 346)	PTSD symptom severity and exercise frequency were not correlated.
de Assis et al. (2008)	Longitudinal case-control	2b	N/A	Clinician Administered PTSD Scale (CAPS)	Primary (prevalence rate)	Item(s) about degree of participation in physical activity	Brazilian patients with PTSD from outpatient clinic (n = 50)	The percentage of individuals participating in physical activity decreased from before to after being diagnosed with PTSD.
Gavrieli, Farr, Davis, Crowell, and Mantzoros (2015)	Cross-sectional & prospective	2a, 2b	Evaluation of Lifetime Stressors interview, Structured Clinical Interview for Diagnoses Diagnostic and Statistical Manual (DSM) IV-R Non-Patient Version Axis I, Adult Attachment Interview	UCLA PTSD Reaction Index	Primary (Spearman correlation and ANCOVA)	Physical activity: Daily and annual physical activity (duration, intensity, type of exercise)	European Americans and African Americans in Boston (n = 151)	Cross-sectional: Early life stress was not correlated with annual physical activity. PTSD symptom severity was negatively correlated with annual physical activity. Individuals with higher symptom severity had less annual physical activity

(*Continued*)

Table 1. Continued.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
								compared to individuals with lower symptom severity; however, there were no differences after adjusting for age and gender. Prospective: Individuals with higher PTSD symptom severity had less annual physical activity compared to individuals with lower symptom severity, after adjusting for age, gender, and race.
Godfrey, Lindamer, Mostoufi, and Afari (2013)	Cross-sectional case-control	2b	N/A	Composite International Diagnostic Interview (CIDI)	Primary (MANOVA)	Physical activity: Short Form of the International Physical Activity Questionnaire (IPAQ-SF)	Veterans and civilians (n = 80)	Those without PTSD reported more vigorous exercise, compared to those without.
Harte, Vujanovic, and Potter (2015)	Cross-sectional	3b	Posttraumatic Diagnostic Scale (PDS)	Posttraumatic Diagnostic Scale (PDS)	Primary (hierarchical linear regression)	Exercise Habits Questionnaire – Revised (EHQ-R)	Community adults (n = 108)	Controlling for gender and lifetime number of trauma types, greater hyperarousal symptoms was negatively associated with vigorous-intensity exercise, but not associated with light- or moderate-intensity exercise.
Hoerster, Jakupcak, McFall, Unützer, and Nelson (2012)	Cross-sectional	2b	N/A	PTSD Checklist (PCL-M)	Primary (t-test)	1 item from Short Form of the International Physical Activity Questionnaires (IPAQ-short) about meeting physical activity recommendations	Iraq and Afghanistan veterans at post-deployment health clinic (n = 266)	No differences in PTSD symptom severity between those who met physical activity recommendations and those who did not.

Kozaric-Kovacic et al. (2009)	Cross-sectional	2b	Combat-exposed vs. non-combat-exposed[a]	ICD-10 criteria	Secondary (χ2 test)	1 item about weekly engagement in physical activity	3 groups of Croatian males: veterans with PTSD, veterans without PTSD, healthy controls (n = 478)	A smaller percentage of veterans with PTSD engaged in weekly physical activity compared to veterans without PTSD.
Kukihara, Yamawaki, Uchiyama, Arai, and Horikawa (2014)	Cross-sectional	2b	N/A	Impact of Events Scale-Revised (IES-R)	Secondary (t-test)	Physical activity: 1 dichotomous item about exercise	Evacuees from the Fukushima disaster (n = 241)	No differences in PTSD symptom severity between those who exercised and those who did not.
Lang et al. (2003)	Cross-sectional	2a	Clinician Administered PTSD Scale (CAPS)	PTSD Checklist (PCL-C)	Primary (χ2 test)	Questions from Walker et al. (1999)	Females who visited VA (n = 221)	No differences between those with and without sexual assault histories on likelihood of engaging in weekly moderate or vigorous exercise.
LeardMann et al. (2011)	Longitudinal	3b	Combat exposure data from Millennium Cohort questionnaires	PTSD Checklist (PCL-C)	Primary (logistic regression)	Questions from Millennium Cohort questionnaires that were adapted from 2001 National Health Interview Survey	Participants from Millennium Cohort Study (n = 38,883)	Controlling for combat exposure, those who had PTSD symptoms at follow-up were proportionately less active in all three categories of physical activity (moderate or light, vigorous, strength training) compared to those with no symptoms. There was one exception: Those with new-onset symptoms were proportionately higher on 'very active' engagement in moderate or light activity and strength training.
May-Ling, Loxton, and McLaughlin (2015)	Longitudinal	2a	1 item dichotomous measure of lifetime exposure to physical, mental, emotional, or	N/A	Mediator (logistic regression)	Questions about frequency and duration of walking briskly, moderate-intensity activities, and	Females from the Australian Longitudinal Study on Women's	Females with trauma exposure were more likely to be physically inactive compared to women without trauma exposure.

(*Continued*)

Table 1. Continued.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
			sexual abuse or violence			vigorous-intensity activities in the past week	Health, ages 45–50 (n = 9276)	After controlling for age, there was no association between trauma exposure and physical activity.
Medina et al. (2011)	Cross-sectional	2b	Posttraumatic Diagnostic Scale (PDS)[a]	Posttraumatic Diagnostic Scale (PDS)	Secondary (zero-order correlation)	Exercise Habits Questionnaire – Revised (EHQ-R)	Community adults exposed to at least one Criterion A traumatic event and endorsed alcohol consumption (n = 114)	PTSD symptom severity was not correlated with vigorous-, moderate-, or light-intensity exercise duration.
Rodgers et al. (2004)	Cross-sectional	2a	Childhood Trauma Questionnaire (CTQ)	N/A	Primary (logistic regression)	Questions about exercise adapted from Walker et al. (1999)	Female veterans seen at VA primary care clinic (n = 221)	Frequency of physical abuse was associated with reduced likelihood of engaging in moderate exercise weekly. Sexual abuse was not associated with exercise. Experiencing multiple types of maltreatment was not associated with odds of moderate exercise or vigorous exercise.
Rosenbaum et al. (2016)	Cross-sectional archival	2b	N/A	PTSD Checklist (PCL-C)	Primary (backward stepwise regression)	Short Form of the International Physical Activity Questionnaire (IPAQ-SF)	Inpatients with PTSD (n = 76)	PTSD symptom severity was negatively associated with total walking time.
Rutter, Weatherill, Krill, Orazem, and Taft (2013)	Cross-sectional	2b	Traumatic Life Events Questionnaire (TLEQ)[a]	PTSD Checklist (PCL-C)	Mediator (Pearson correlation, linear regression)	1 item from the Health Risk Appraisal (HRA)	College undergraduates (n = 200)	PTSD symptom severity was negatively correlated with frequency of exercise. Hyperarousal symptoms negatively predicted frequency of physical exercise.
Spitzer et al. (2010)	Cross-sectional	2b	Structured Clinical Interview for DSM IV[a]	Structured Clinical	Secondary (χ2 test)	1 dichotomous item about performing		No differences in physical activity between those

				Interview for DSM IV		sports less than once per week	Community adults in Germany (n = 3049)	with PTSD and those without PTSD.
Stults-Kolehmainen, Tuit, and Sinha (2014)	Cross-sectional	2a	Life Traumas subscale from Cumulative Adversity Interview (CAI)	N/A	Moderator (Pearson correlation)	2 items modified from Nurses' Health Study about average frequency and duration (mins/week) of moderate or greater exercise (Wolf et al., 1994)	Community adults (n = 395)	Extent of exposure to traumatic life events was not correlated with duration of exercise.
Sumner et al. (2015)[b]	Cross-sectional (same sample as Sumner et al., 2016)	3a	Brief Trauma Questionnaire	Short Screening Scale for DSM-IV	Mediator (prevalence rate)	Physical activity: Questions from Nurses' Health Survey II	US female nurses from Nurses' Health Survey II (n = 49,978)	A greater percentage of those with 4+ PTSD symptoms engaged in greater durations compared to other groups. A greater percentage of those with 1–3 PTSD symptoms engaged in smaller durations compared to other groups. A greater percentage of those with trauma exposure but no PTSD symptoms engaged in moderate durations compared to other groups.
Sumner et al. (2016)[b]	Cross-sectional (same sample as Sumner et al., 2015)	3a	Brief Trauma Questionnaire	Short Screening Scale for DSM-IV	Mediator (mean)	Physical activity: Questions from Nurses' Health Survey II,	US female nurses from Nurses' Health Survey II (n = 47,514)	On average, those with trauma exposure but no PTSD symptoms engaged in the longest durations. On average, those with 1–3 symptoms engaged in the shortest durations.
Talbot, Neylan, Metzler, and Cohen (2014)	Longitudinal case-control	2b	N/A	Clinician Administered PTSD Scale (CAPS)	Primary (t-test, hierarchical linear regression)	1 item about frequency of physical activity	VA patients (n = 746)	Those without PTSD had greater physical activity at baseline and 1-year follow-up compared to those with PTSD. PTSD status predicts physical activity frequency at one-

(*Continued*)

Table 1. Continued.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
								year follow-up. PTSD status does not predict physical activity frequency at one-year follow-up when baseline physical activity is controlled.
Vujanovic, Farris, Harte, Smits, and Zvolensky (2013)	Cross-sectional	2b	Posttraumatic Diagnostic Scale (PDS)[a]	Posttraumatic Diagnostic Scale (PDS)	Secondary (zero-order correlation)	Exercise Habits Questionnaire – Revised (EHQ-R)	Trauma-exposed adults (n = 77)	Duration of exercise was negatively correlated with PTSD hyperarousal symptom severity.
Zen, Whooley, Zhao, and Cohen (2012)	Cross-sectional	2b	N/A	Computerized Diagnostic Interview Schedule (CDIS)	Primary (multivariate logistic regression)	Questions from the Heart and Soul Study	Adults with cardiovascular disease from the Heart and Soul Study (n = 1022)	Among patients with cardiovascular disease, having a PTSD diagnosis was associated with more physical inactivity (in terms of overall, light, and self-rated exercise).

[a]Measure was included, but not part of the analyses discussed in Key Findings.
[b]Only results from Sumner et al., 2016 are reported in-text.

Table 2. Key findings of articles examining trauma exposure, PTSD, and diet.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
Adler et al. (2011)	Longitudinal	2b	34-item measure of combat experiences (Adler et al., 2009)[a]	PTSD Checklist (PCL-M)	Secondary (zero-order correlation)	8 items about health behaviours including eating healthy food and exercising (Adler et al., 2009)	Combat-exposed active duty US soldiers (n = 647)	PTSD symptom severity was not correlated with increases or decreases in eating healthy food.
Gavrieli et al. (2015)	Cross-sectional & prospective	2a, 2b	Evaluation of Lifetime Stressors interview, Structured Clinical Interview for Diagnoses Diagnostic and Statistical Manual (DSM) IV-R Non-Patient Version Axis I, Adult Attachment Interview	UCLA PTSD Reaction Index	Primary (Spearman correlation and ANCOVA)	Diet: alternate Healthy Eating Index-2010 (aHEI-2010), Dietary Approach to Stop Hypertension (DASH)	European Americans and African Americans in Boston (n = 151)	Early life stress was negatively correlated with DASH scores. PTSD symptom severity was negatively correlated with DASH scores. Early life stress was not correlated with aHEI-2010 scores. Symptom severity was not correlated with aHEI-2010 scores. Individuals with higher symptom severity had lower DASH scores compared to individuals with lower symptom severity.
Godfrey et al. (2013)	Cross-sectional case-control	2b	N/A	Composite International Diagnostic Interview (CIDI)	Primary (χ2 test)	Diet: Authors' own questions	Veterans and civilians (n = 80)	Those without PTSD reported more fruit intake and less guilt after overeating, compared to those without.
Kukihara et al. (2014)	Cross-sectional	2b	N/A	Impact of Events Scale-Revised (IES-R)	Secondary (t-test)	Diet: 6 items about eating habits	Evacuees from the Fukushima disaster (n = 241)	No differences in PTSD symptom severity between those who with better and worse eating habits.

(*Continued*)

Table 2. Continued.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
Sumner et al. (2015)[b]	Cross-sectional (same sample as Sumner et al., 2016)	3a	Brief Trauma Questionnaire	Short Screening Scale for DSM-IV	Mediator (prevalence rate)	Diet: Questions based on Alternative Healthy Eating Index	US female nurses from Nurses' Health Survey II (n = 49,978)	A greater percentage of those with no trauma had worse diet quality compared to other groups. A greater percentage of those with 4+ PTSD symptoms had better diet quality compared to other groups.
Sumner et al. (2016)[b]	Cross-sectional (same sample as Sumner et al., 2015)	3a	Brief Trauma Questionnaire	Short Screening Scale for DSM-IV	Mediator (mean)	Diet: Questions based on Alternative Healthy Eating Index	US female nurses from Nurses' Health Survey II (n = 47,514)	A greater percentage of those with no trauma had the worst diet quality compared to other groups.

[a]Measure was included, but not part of the analyses discussed in Key Findings.
[b]Only results from Sumner et al. (2016) are reported in-text.

Table 3. Key findings of articles examining trauma exposure, PTSD, and medical screening.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
Boyer and Cantor (2005)	Cross-sectional	2b	N/A	UCLA PTSD Reaction Index	Primary (Pearson correlation, ANOVA)	4 items about mammography frequency, 1 item about breast self-exam frequency	Daughters who have mothers diagnosed with breast cancer (n = 64 mothers only)	PTSD symptom severity was negatively related to mammography frequency, but not related to breast self-exam frequency.
Farley, Golding, and Minkoff (2002)	Cross-sectional case-control (part of same parent study as Farley, Minkoff, & Barkan, 2001)	3a	Trauma History Questionnaire (THQ), Childhood Trauma Questionnaire (CTQ)	PTSD Checklist (PCL-C)	Primary (logistic regression)	Medical records of Pap Smear in past 2 years	Female patients of HMO clinics, ages 21–64 (n = 737)	Those sexually abused in childhood were less likely to have had a Pap smear in the past 2 years compared to those not abused, controlling for PTSD diagnosis status.
Farley et al. (2001)	Cross-sectional case-control (part of same parent study as Farley et al., 2002)	3a	Traumatic Life Events Questionnaire (TLEQ)	PTSD Checklist (PCL-C)	Primary (multiple logistic regression)	Medical records of mammography in past 2.25 years	Female patients of HMO clinics, ages 52–75 (n = 615)	Those who did not have a mammography within the recommended guidelines had a greater number of total traumatic events. No differences in PTSD symptom severity between the two groups.
Lang et al. (2003)	Cross-sectional	2a, 3b	Clinician Administered PTSD Scale (CAPS)	PTSD Checklist (PCL-C)	Primary (t-test, $\chi 2$ test)	Questions from Walker et al. (1999)	Females who visited VA (n = 221)	Those with a sexual assault history reported more regular Pap smears and more regular breast self-exams, compared to those with a history. Controlling for sexual assault history, those with greater PTSD symptom severity had lower odds of completing breast self-exams, but not Pap smears.
Rodgers et al. (2004)	Cross-sectional	2a	Childhood Trauma Questionnaire (CTQ)	N/A	Primary (logistic regression, multiple	Questions about breast self-exam frequency, and Pap smear	Female veterans seen at VA primary care clinic (n = 221)	Physical and sexual abuse were not associated with breast self-exam or Pap smear frequency. Experiencing

(*Continued*)

Table 3. Continued.

Study	Design	Study objective (2a, 2b, 3a, 3b)	Trauma exposure measure	PTSD measure	PHB outcome type (analysis)	Health behaviour measure	Sample	Key findings
					linear regression)	frequency adapted from Walker et al. (1999)		multiple types of maltreatment was not associated with odds of breast self-exam nor Pap smear frequency in past 5 years.
Silberbogen, Busby, and Ulloa (2014)	Cross-sectional	2b	N/A	PTSD Checklist (PCL-C)	Primary (*t*-test, hierarchical multiple regression)	Questions from other studies of prostate cancer screening (Bloom, Stewart, Oakley-Girvans, Banks, & Chang, 2006; Myers et al., 2000)	Male veterans (n = 350)	Greater PTSD symptom severity was associated with lower rates of past prostate cancer screening (both digital rectal exam and prostate-specific antigen). Greater PTSD symptom severity was associated with greater perceived barriers to prostate cancer screening.
Springs and Friedrich (1992)	Cross-sectional case-control	2a	Questions about sexual abuse history from other studies (Briere & Runtz, 1988; Finkelhor, 1979)	N/A	Primary (multiple linear regression, prevalence rate)	Questions about Pap smear frequency	Females who used rural outpatient family practice clinic (n = 511)	Sexually abused females scheduled Pap smears less frequently compared to non-sexually abused females. Among females for whom the interval between Pap smears exceeded 3 years, 39.1% had prior sexual abuse compared to 22.1% of the entire sample.
Stewart, Gagnon, Merry, and Dennis (2012)	Cross-sectional case-control	2a	Abuse Assessment Screen	Harvard Trauma Questionnaire[a]	Primary ($\chi 2$ test)	Question about ever receiving a Pap smear from the Childbearing Health and Related Service Needs of Newcomers (CHARSNN) study	Pregnant migrant women in Canada (n = 774)	There were no differences in receiving a Pap smear between abused and non-abused groups.

Weitlauf et al. (2013)	Cross-sectional	2b	N/A	Medical records of PTSD diagnosis status	Primary ($\chi 2$ test, logistic regression)	Medical records of receiving Pap smear in past 36 months	Female veterans using VA diagnosed with PTSD, depression, or no psychiatric illness (n = 34,213)	No differences in cervical cancer screening rates between those with PTSD, with depression, and without psychiatric illness. Among low users of primary care services, those with PTSD were more likely to receive a cervical cancer screening than those with no psychiatric illness. Among high users of primary care, those with PTSD were less likely to receive a cervical cancer screening than those with no psychiatric illness.

[a]Measure was included, but not part of the analyses discussed in Key Findings.
[b]Only results from Sumner et al. (2016) are reported in-text.

summing the number of different trauma types (Harte et al., 2015; Rodgers et al., 2004). Studies that dichotomised trauma exposure separated participants who had no traumatic experiences from those with one or more. Several studies dichotomised trauma exposure by comparing those with and without sexual abuse histories (Farley et al., 2002; Lang et al., 2003; Springs & Friedrich, 1992). Similarly, a case–control study about migrant women dichotomised trauma exposure by comparing those who did and did not experience abuse (Stewart et al., 2012). Rather than focus on one type of trauma, one study dichotomised exposure to different types of abuse or violence (May-Ling et al., 2015). Some studies compared multiple groups based on both trauma exposure and another variable such as physical activity or PTSD symptoms (LeardMann et al., 2011; Sumner et al., 2015, 2016).

PTSD symptoms

Most of the identified studies (27 out of 32) assessed PTSD symptoms in relation to PHBs. The majority of these studies used valid and reliable measures, with the PTSD Checklist – Civilian (PCL-C; Weathers, Huska, & Keane, 1991) being the most popular. Among studies using valid and reliable measures, most treated overall symptom severity as a continuous variable. Some studies also examined severity within symptom clusters (Harte et al., 2015; Rutter et al., 2013; Vujanovic et al., 2013). Several studies dichotomised PTSD status by comparing those who did and did not meet criteria for PTSD. Most of these determined whether PTSD status was present or absent based on the use of valid and reliable measures; however, two studies obtained this information via medical records (Chwastiak et al., 2011; Weitlauf et al., 2013). It was unclear across studies whether control groups had no or some symptoms of PTSD. Two of the samples exclusively comprised those who met criteria for PTSD (Arnson et al., 2007; de Assis et al., 2008). The only studies that treated PTSD symptoms as a categorical variable were by Sumner and colleagues, who grouped the trauma-exposed participants by the number of symptoms (i.e., none, one to three, four to five, six to seven) (Sumner et al., 2015, 2016).

Preventive health behaviours

The most commonly measured PHB in the reviewed articles was physical activity (25 out of 32), followed by medical screenings (9 out of 32) and diet (6 out of 32). The majority of articles (20 out of 32) assessed the relationship shared by trauma exposure and/or PTSD symptoms with a PHB as a primary outcome, with the remaining articles assessing PHB as a secondary outcome, mediator, or moderator. Methods for assessing PHBs were variable, with few studies using the same item, set of items, or measure to assess a given PHB. Among studies examining physical activity, many measured only one component of physical activity such as duration, intensity, or frequency. However, guidelines by the American College of Sports Medicine (ACSM) account for all of these components in its recommendation of at least 150 minutes of moderate-intensity exercise per week (Garber et al., 2011).

Studies on diet quality also differed in assessing overall diet quality or assessing eating habits for individual food groups (e.g., vegetables). Aligning these measures with national dietary guidelines is a challenge, considering the vagueness of the guidelines: fruits and vegetables should comprise half of meals, half of grain intake should comprise whole grains, and a variety of proteins is recommended. Recommendations for limiting the following dietary components are more specific: sodium (<2300 mg per day), saturated fat (<10% calories per day), and added sugars (<10% calories per day) (US Department of Health and Human Services & US Department of Agriculture, 2015).

All studies measuring medical screening looked specifically at cancer screenings, with most studies measuring screening frequency rather than screening adherence. This distinction is important when considering that current guidelines by the American Cancer Society (ACS) emphasise greater adherence rather than greater frequency of screening. The ACS recommends mammograms once a year starting at age 45, colon tests once every 3–10 years starting at age 50, and cervical cancer screenings every 3 years between the ages of 21 and 65 (American Cancer Society, 2017). Overall, current methods for assessing PHB engagement in the context of trauma are largely heterogeneous and do not provide information about adherence in relation to recommended guidelines.

Trauma exposure and PHBs (Objective 2a)

Physical activity

Five studies of trauma exposure and physical activity have examined various dimensions of physical activity, including frequency, duration, intensity, and type of exercise. Studies using composite scores of physical activity, based on multiple dimensions, found no relationship between trauma exposure and overall physical activity engagement. One study created composite scores of annual physical activity based on duration, intensity, and type of exercise (Gavrieli et al., 2015). However, composite scores of physical activity were not correlated with composite scores of early childhood trauma created by multiplying frequency, severity, and chronicity. Similarly, no associations were found between lifetime exposure to abuse or violence, and composite scores of weekly physical activity based on frequency, duration, and intensity (May-Ling et al., 2015).

Furthermore, when dimensions of physical activity were examined as separate outcomes by other studies, none were consistently related to trauma exposure. In a study measuring exercise duration in a community sample, cumulative trauma exposure was not correlated with the number of minutes per week spent exercising (Stults-Kolehmainen et al., 2014). Studies that assessed the intensity of exercise yielded similar findings. Among a sample of women, the presence or absence of trauma exposure was not related to the likelihood of engaging in moderate or vigorous exercise (Lang et al., 2003). Furthermore, the lack of association between trauma exposure and exercise intensity remained when different types of trauma were examined. Experiencing more types of childhood maltreatment (e.g., sexual abuse, emotional abuse) was not associated with a change in odds of engaging in moderate exercise or vigorous exercise among female veterans (Rodgers et al., 2004). However, within the same sample, greater frequency of physical abuse was associated with reduced likelihood of engaging in moderate exercise, such that women who experienced more physical abuse were likely to engage in moderate exercise less than once per week (Rodgers et al., 2004). This significant finding may reflect that those who were physically abused may be less likely to exercise at all or that their reduced likelihood is attributable to abuse-related injuries. Despite this lone finding, most studies on trauma exposure and physical activity suggest that trauma exposure is generally unrelated to many dimensions of physical activity.

Diet

Only one study examined the relationship between trauma exposure and diet (Gavrieli et al., 2015). Two measures of diet quality were used, the Dietary Approach to Stop Hypertension (DASH) and the alternate Eating Healthy Index – 2010 (aHEI-2010), with higher scores indicating better diet quality. Scores for the DASH and aHEI-2010 factor in similar food components, except the aHEI-2010 also includes alcohol, polyunsaturated fat, trans fat, and omega-3 fat, and does not include low-fat dairy. Despite high overlap in the two measures, early childhood trauma was negatively correlated with DASH scores, but not with aHEI-2010 scores. One explanation for this discrepancy is that inclusion of more food components for aHEI-2010 scores introduced more noise. Based on these conflicting findings, it is unclear whether trauma exposure is related to diet quality.

Medical screenings

The four studies on trauma exposure and medical screenings, which primarily focused on cervical cancer and breast cancer screenings, present mixed findings. Some studies found no association between the extent of trauma exposure and frequency of medical screenings. Among female primary care patients at a Veterans Affairs (VA) medical centre, experiencing different kinds of childhood maltreatment was not associated with a change in odds for performing monthly breast self-exams and not associated with the frequency of Pap smears in the past five years (Rodgers et al., 2004). Consistent with these findings, no differences were found in frequency of Pap smears between pregnant migrant women who did and did not have abuse histories (Stewart et al., 2012).

Conversely, studies with samples of women who have been sexually assaulted have found associations between trauma exposure and screening frequency, albeit in opposite directions. One study found that women with a sexual abuse history scheduled Pap smears less frequently compared to those without an abuse history (Springs & Friedrich, 1992). Additionally, there was a higher prevalence rate of sexual abuse among women who did not have a Pap smear within the past three years (39.1%) compared to the prevalence rate of sexual abuse in the overall sample (22.1%). In contrast to these negative associations between trauma exposure and screening frequency, Lang et al. (2003) found that trauma exposure was positively associated with greater adherence to regular medical screenings. Interestingly, women with a history of sexual assault reported more regular Pap smears and breast self-exams, which may indicate greater vigilance about one's body as a consequence of previously experiencing bodily harm.

The discrepancies across studies about the association between trauma exposure and medical screenings may be the result of focusing on different types of trauma. Both studies that found no association collapsed different types of trauma into a unitary score, which may have obscured the specific relationship between sexual trauma and medical screening. Among studies of sexual trauma, differences in the directionality of the association may be attributable to differences between samples. Springs and Friedrich (1992) conducted their study with female patients of a family practice clinic in a rural setting, while Lang et al. (2003) studied female veterans who visited a VA medical centre in a city. Given probable differential access to healthcare between the two samples, there may have been greater systemic barriers for the rural women that contributed to the inverse association between trauma exposure and Pap smears. While non-sexual trauma appears to be unrelated to medical screening frequency, sexual trauma is related to screening frequency, but the direction of the association may depend on the specific population.

PTSD symptoms and PHBs (Objective 2b)

Physical activity

A total of 17 studies have been conducted on PTSD symptoms and physical activity, all of which report either an inverse or absence of association. Case–control studies comparing those with and without a PTSD diagnosis largely found that adults with PTSD engaged in less frequent and less vigorous physical activity compared to those without PTSD (Chwastiak et al., 2011; Godfrey et al., 2013; Kozaric-Kovacic et al., 2009; Zen, Whooley, Zhao, & Cohen, 2012). One study found no differences between cases and controls (Spitzer et al., 2010), a finding that may be attributable to the specific measurement of sports engagement rather than overall physical activity.

Although the vast majority of these case–control studies found an association between PTSD status and frequency of physical activity, most studies that measured PTSD symptom severity did not find an association with physical activity engagement. This absence of association was consistent across studies examining different dimensions of physical activity including frequency (Arnson et al., 2007; Davidson, Babson, Bonn-Miller, Souter, & Vannoy, 2013; Kukihara et al., 2014) and duration at varying levels of intensity (Hoerster et al., 2012; Medina et al., 2011). The one exception was a study that found an inverse relationship between PTSD symptom severity and total walking time; however, the sample was restricted to inpatient participants with a PTSD diagnosis (Rosenbaum et al., 2016). While most studies found no relationship between PTSD symptom severity and physical activity engagement, there is evidence that hyperarousal symptoms, in particular, are related to physical activity engagement. One study found an inverse association between PTSD symptom severity and physical activity frequency (Rutter et al., 2013). Upon closer examination, the researchers found that the relationship was largely driven by hyperarousal symptoms, suggesting that certain types of responses to trauma, rather than PTSD itself, may be predictive of reduced physical activity engagement. This potential explanation is consistent with findings from another study, which reported that only hyperarousal symptoms, but not overall PTSD symptom scores, were inversely associated with physical activity duration (Vujanovic et al., 2013). The difference in findings

between studies measuring PTSD dichotomously (i.e., individuals with PTSD have lower physical activity engagement) and continuously (i.e., absence of association between PTSD symptoms and physical activity engagement) indicates that, while there may not be a linear relationship between PTSD symptoms and physical activity, there are likely differences in the average level of physical activity between those with and without PTSD.

Longitudinal studies further elucidate these cross-sectional findings by examining the relationship between PTSD and physical activity with respect to changes in PTSD symptoms or changes in physical activity. Among veterans, PTSD symptom severity was not correlated with retrospective reports of change in exercise engagement during a four-month period (Adler et al., 2011). Similarly, Talbot et al. (2014) found that PTSD status did not predict physical activity levels at one-year follow-up after controlling for baseline levels of physical activity (Talbot et al., 2014). In contrast, other studies with longer follow-up periods have found reductions in physical activity for those with PTSD. In a longitudinal study of participants with PTSD, researchers found reductions in physical activity over a mean follow-up period of 3.6 years (de Assis et al., 2008). Another study found that individuals with greater PTSD symptom severity had less annual physical activity compared to individuals with lower severity over the follow-up period of 2.5 years, even when age, gender, and race were controlled (Gavrieli et al., 2015). These longitudinal findings suggest that PTSD symptoms may have long-term detrimental effects on physical activity engagement that do not show up in studies with cross-sectional designs or shorter follow-up periods.

Diet

Research on the relationship between PTSD symptoms and diet quality is largely inconclusive, with all four of the located studies finding either a negative or an absence of association. One cross-sectional study found no differences in average PTSD symptom severity between those with better or worse eating habits (Kukihara et al., 2014). Another cross-sectional study found that veterans with PTSD consumed fewer servings of fruit per day compared to those without, but found no differences for vegetables, soda, caffeine, or fast food (Godfrey et al., 2013). Longitudinal studies present similarly mixed findings. A study of veterans found that PTSD symptom severity was not correlated with retrospective self-reported changes in healthy eating during a four-month period (Adler et al., 2011). Similar to their own results regarding trauma exposure and diet, Gavrieli et al. (2015) found contradictions within their own study, such that PTSD symptoms were negatively correlated with DASH scores, but uncorrelated with aHEI-2010 scores (Gavrieli et al., 2015). However, follow-up data collected 2.5 years later revealed that individuals who had higher PTSD symptom severity at baseline also had lower DASH scores compared to individuals with lower PTSD symptom severity. Taken together, findings from these four studies suggest PTSD symptoms may have worse implications for some aspects of diet. However, it is not possible to make a wider generalisation, given there were relatively few studies and heterogeneous approaches to measuring diet quality (i.e., aggregate scores, separate food groups), yielding contradictory findings.

Medical screenings

Compared to findings about trauma exposure and medical screenings, research on the relationship between PTSD symptoms and medical screenings is more consistent. The three studies on the relationship between PTSD symptoms and medical screenings found that greater PTSD symptom severity is tied to less frequent medical screenings. Men with greater PTSD symptoms had lower rates of prostate cancer screenings for both digital rectal exams and prostate-specific antigen exams (Silberbogen et al., 2014). Consistent findings across administration styles suggest that avoidance of the invasive nature of some screenings, such as the digital rectal exam, does not explain why those with more PTSD symptoms also engaged in less frequent self-exams.

Other factors may play an influential role in the relationship between PTSD and medical screening frequency when comparing individuals with and without PTSD. One such factor is the frequency of overall primary care utilisation, which plays a moderating role in the relationship between PTSD

status (treated as a dichotomous variable) and medical screening frequency. Weitlauf et al. (2013) found differential odds of screening based on the number of annual primary care visits between those with PTSD and those without PTSD or other psychiatric illnesses. Among low users of primary care services, those with PTSD were more likely to receive a cervical cancer screening compared to those with no psychiatric illness. Among high users, those with PTSD were less likely to receive a cervical cancer screening compared to those with no psychiatric illness. These results are counterintuitive, as one would expect high users to have more opportunities to be screened. However, these findings may reflect that those with PTSD tend to have more chronic health problems (Sareen et al., 2007), thereby increasing their utilisation of services while decreasing their emphasis on preventive care.

Another influential factor in the relationship between PTSD and medical screening frequency is the intergenerational transmission of PTSD symptoms and screening practices. One study examined how PTSD symptoms are related to breast cancer screening practices among a sample of daughters who have mothers diagnosed with breast cancer (Boyer & Cantor, 2005). The researchers assessed PTSD symptoms for daughters with respect to their mothers' breast cancer diagnosis. Daughters with higher PTSD symptoms received less frequent mammograms, but there was no relationship between PTSD symptom severity and the frequency of breast self-exams. The inverse relationship between daughters' PTSD symptoms and mammography frequency suggests that their PTSD symptoms may be driven by symptoms of avoidance.

Overall, research on the relationships between PTSD and medical screenings illustrates that individuals with PTSD or greater PTSD symptoms are less likely to receive frequent cancer screenings compared to those without PTSD or with fewer PTSD symptoms. This relationship holds across sexes (male or female), types of cancer (breast cancer, cervical cancer, prostate cancer), and types of screening (invasive, non-invasive, self-exams), suggesting that common mental processes may underlie these associations.

Unique relationships of PHBs with trauma exposure (Objective 3a)

Physical activity

Although trauma exposure was largely unrelated to various dimensions of physical activity engagement, greater PTSD symptoms was a risk factor for reduced physical activity over time. These discrepant findings are interesting in light of the fact that trauma exposure and PTSD symptom severity tend to be correlated (Gabert-Quillen et al., 2012; Kira et al., 2008). However, studies that consider the effects of trauma exposure separately from the effects of PTSD symptoms present clearer relationships between trauma exposure and physical activity. In two studies using the same sample, Sumner and colleagues found that physical activity duration was associated with the presence or absence of trauma exposure, independent of PTSD symptom severity (Sumner et al., 2015, 2016). Only results from Sumner et al. (2016) are reported in this review, since both Sumner et al. (2016; 2015) articles yielded similar results about associations between trauma exposure, PTSD symptoms, and PHBs using the same sample. Although the original analyses were not originally intended to examine PHBs as primary outcomes, cross-sectional associations between trauma exposure, PTSD symptoms, and PHBs at the baseline assessment of the study were tested.

The average weekly intensity, duration, and frequency of physical activity, measured in metabolic equivalent hours per week (MET h/wk), was compared between groups of women with differences in trauma exposure and PTSD symptom severity as measured by a screening questionnaire: (a) non-exposed, (b) trauma-exposed with no symptoms, (c) trauma-exposed with one to three symptoms, (d) trauma-exposed with four to five symptoms, and (e) trauma-exposed with six to seven symptoms. Comparisons of the non-exposed group and trauma-exposed with no symptoms group revealed that non-exposed women engaged in less physical activity, whereas women with no symptoms engaged in more physical activity (Sumner et al., 2016). In other words, trauma-exposed women engaged in more physical activity compared to non-exposed women, a relationship that was not explained by

PTSD symptoms. For women who experienced trauma, high engagement in physical activity may reflect efforts to cope with stress. While the sample of female nurses may limit the generalizability of these findings, previous research supports the role of physical activity as a potential coping mechanism, such that individuals who are already active tend to exercise more in the face of stress (Stults-Kolehmainen & Sinha, 2014). While studies that only examined the effects of trauma exposure found no association with physical activity, these studies that examined the effects of both trauma exposure and PTSD symptoms revealed associations between trauma exposure and greater physical activity once the effects of PTSD symptoms were controlled.

Diet

The only two studies that simultaneously considered the effects of trauma exposure and PTSD on diet were by Sumner and colleagues (Sumner et al., 2015, 2016), which used aggregate scores from the aHEI to measure diet quality. Among the five groups from the 2016 study (i.e., non-exposed, trauma-exposed with no symptoms, trauma-exposed with one to three symptoms, trauma-exposed with four to five symptoms, trauma-exposed with six to seven symptoms), more participants in the non-exposed group had the worst diet (i.e., first quintile on the aHEI) than those in the trauma-exposed with no symptoms group (Sumner et al., 2016). Moreover, among the trauma-exposed, those with more symptoms had fewer participants in the worst diet category.

These findings are surprising, as they suggest that those with trauma exposure had healthier diets than those without trauma exposure, when PTSD symptom severity was held constant. Additionally, those with greater PTSD symptoms also had healthier diets compared to those without PTSD symptoms among the trauma-exposed. These results are a sharp contrast to the aforementioned studies between trauma exposure and diet, and between PTSD and diet, which found either an inverse or absence of association. Moreover, the findings run counter to a robust body of literature indicating that individuals who are undergoing stress are likely to overeat and engage in unhealthy eating behaviours (Torres & Nowson, 2007). The findings from the Sumner et al. (2016) study may be a function of the unique group categorisation that was intended to compare trauma-exposed and non-exposed groups on cardiovascular disease-relevant outcomes, not PHB outcomes which were used in the present review. Alternatively, the unexpected linkage between trauma exposure and better diet quality may reflect a focus on holistic health following stressful life experiences. After all, increased trauma exposure, independent of PTSD symptoms, has been linked to greater risk for chronic conditions (Dedert et al., 2010), which in turn may foster motivation for better dietary practices. Granted, only a pair of studies by the same group of researchers has examined the effect of trauma exposure on diet, above and beyond the effects of PTSD symptoms. The generalisability of these studies is limited given the sample of predominantly White female nurses. Therefore, further research is necessary before inferring broader conclusions about the positive relationship between trauma exposure and diet quality.

Medical screenings

The two studies accounting for the effects of PTSD symptoms on the relationship between trauma exposure and medical screening frequency provide greater clarity to the mixed findings from studies on medical screening that only examined trauma exposure's effects. Studies revealed that greater trauma exposure was uniquely associated with reduced likelihood of receiving medical screenings within recommended guidelines. Two studies conducted by Farley and colleagues examined these relationships using different samples of female patients at HMO clinics (Farley et al., 2001; Farley et al., 2002). In their study of breast cancer screening, they found that patients who did not receive a mammography within the recommended timeframe had greater cumulative trauma compared to patients who received a mammography, with no difference in PTSD symptom severity between groups (Farley et al., 2001). Similarly, patients who experienced childhood sexual abuse were less likely to receive a cervical cancer screening within the recommended timeframe compared to patients without abuse histories (Farley et al., 2002). This relationship still held when PTSD

symptom severity was controlled. Together, these findings about medical screenings suggest that trauma exposure independently poses a risk for decreased preventive screenings and that this relationship is not entirely explained by PTSD symptoms.

Unique relationships of PHBs with PTSD symptoms (Objective 3b)

Physical activity

Two studies have examined the effects of PTSD symptoms on physical activity engagement, independent of the effects of trauma exposure. LeardMann et al. (2011) longitudinally studied the relationship between combat exposure, PTSD, and physical activity intensity and duration among military members. Controlling for the severity of combat exposure, those who developed new PTSD symptoms were proportionately less active (i.e., had shorter durations) in all three categories of physical activity intensity (moderate or light, vigorous, strength training) compared to those without symptoms. The one exception to this finding was that military members who developed new symptoms were proportionately higher (i.e., had longer durations) on 'very active' engagement in moderate or light activity and strength training, but not vigorous physical activity.

Similarly, another study found that having greater PTSD hyperarousal symptoms was negatively associated with vigorous-intensity exercise, after controlling for gender and lifetime number of trauma types (Harte et al., 2015). Vujanovic and colleagues suggest that this relationship may reflect avoidance of physical activities that recreate similar physiological reactions that were experienced during an individual's traumatic encounters or when reminded of past encounters (e.g., heart racing, sweating) (Vujanovic et al., 2013). Individuals may actively avoid vigorous exercise because experiencing these physiological reactions triggers feelings of distress or an even stronger physiological reaction such as a panic attack. Other features of hyperarousal, such as hypervigilance, may also inhibit individuals with PTSD symptoms from travelling to fitness centres, which require being in close proximity to many people (Rutter et al., 2013).

Together, these studies on physical activity that take into account the effects of both trauma exposure and PTSD symptoms expand upon findings from studies that solely examined either the effects of PTSD symptoms or the effects of trauma exposure. When the effects of trauma exposure are controlled, PTSD symptoms may play a role in inhibiting individuals from engaging in physical activity, particularly those with hyperarousal symptoms, but also mobilise those attempting to cope with new or greater symptoms. The variety of relationships shared by PTSD symptoms and physical activity may be a function of differences between or within samples. For example, individuals with greater PTSD symptoms may have physical trauma or injuries that impede physical activity or, alternatively, necessitate physical activity as a part of rehabilitation. Overall, PTSD symptoms appear to share a negative association with physical activity engagement once trauma exposure is taken into account, with some exceptions. Namely, developing new symptoms was specifically related to longer durations of very active physical activity for moderate or light activity and strength training, but not vigorous activity.

Diet

None of the studies included in this review examined the relationship between PTSD symptoms and diet quality, controlling for trauma exposure.

Medical screenings

Only one study examined the effects of PTSD symptoms on medical screening frequency while controlling for trauma exposure. In the aforementioned study by Lang and colleagues, women with a sexual assault history had higher odds of completing regular breast self-exams and Pap smears compared to women without a history (Lang et al., 2003). However, women with greater PTSD symptoms had lower odds of completing regular breast self-exams and no association with receiving regular Pap smears, controlling for sexual assault history. These findings are seemingly inconsistent with

previously presented findings from the same study, thereby demonstrating that relationships among trauma exposure, PTSD symptoms, and screening frequency can change direction once trauma exposure or PTSD symptoms are taken into account. In sum, PTSD symptoms uniquely contribute to a reduced likelihood of conducting some cancer screenings (i.e., breast self-exams), but not others (i.e., Pap smears). Therefore, measuring the unique effects of trauma exposure and PTSD symptoms is critical for understanding the direction of these shared relationships with PHBs.

Discussion

Summary of evidence

Findings from this review expand on the simple narrative that greater trauma exposure and greater PTSD symptoms are associated with poorer engagement in PHBs. Rather, controlling for PTSD symptoms revealed relationships between trauma exposure and PHBs that were obscured when exclusively examining the effects of trauma exposure or PTSD symptoms. While greater trauma exposure and greater PTSD symptoms each initially appeared to be unrelated or inversely related to engagement in PHBs, controlling for one or the other revealed more complex relationships. Given mixed findings from a limited number of studies, these results should be interpreted as potential themes warranting further study, rather than a conclusive summary of relationships between trauma and PHBs.

A common theme that emerged in several studies was that greater trauma exposure independent of PTSD symptoms and greater PTSD symptoms independent of trauma exposure were related to *higher* engagement in health behaviours. For physical activity, trauma-exposed individuals engaged in longer durations compared to non-exposed individuals. Additionally, having greater PTSD symptoms was related to the longest duration of physical activity and developing new PTSD symptoms was related to the most active engagement in moderate to light exercise and strength training, when trauma exposure was controlled. For diet quality, those with the highest levels of PTSD symptoms had healthier diets compared to those who had fewer symptoms, no symptoms, and no trauma exposure. By accounting for the effects of both trauma exposure and PTSD symptoms, we were able to detect instances when increased trauma exposure or PTSD symptoms were associated with higher PHB engagement.

Studies of medical screenings were the exception, in that greater trauma exposure was still linked to worse outcomes, specifically less frequent medical screenings, even when PTSD symptom severity was controlled. These disparate findings across health behaviours suggest that trauma exposure is differentially related to each PHB, such that trauma exposure may be related to higher engagement for some PHBs, but lower engagement for others. The reasons for these differing relationships across PHBs have not been explored. One potential explanation for finding greater physical activity engagement and better diet quality among those with greater trauma exposure and greater PTSD symptoms is that both of these PHBs may be employed as self-care practices. By comparison, medical screenings do not provide the same immediate benefits and present more practical barriers (e.g., healthcare costs, transportation, availability during business hours), which may dissuade an individual who is already traumatised from seeking preventive screenings. Additionally, trauma exposure may be a stronger predictor for engagement in some PHBs (e.g., medical screening) compared to others (e.g., diet), although this difference also remains unexamined.

Altogether, these findings provide preliminary evidence for the different pathways by which trauma exposure can influence PHBs. These pathways build upon Schnurr and Green's model (2004) by adding PHBs and taking into account the extent of trauma history (e.g., cumulative trauma exposure, number of trauma types). As expected, one pathway is mediated by PTSD symptoms, as evidenced by studies linking greater PTSD symptoms to less physical activity, poorer diet, and less frequent medical screenings. Another pathway is that PTSD symptomatology affects PHBs, independent of the extent of trauma exposure. This second approach revealed that PTSD

symptoms, rather than trauma exposure, drove the highest level of physical activity engagement and diet quality. The third and, arguably, most interesting pathway is when trauma exposure shares an association with PHBs that is independent of PTSD symptoms. This last pathway runs counter to the prevailing notion that the linkage between trauma exposure and preventive health is explained by PTSD symptomatology.

Potential psychological mechanisms

Several potential psychological factors may explain the ways in which trauma exposure affects engagement in PHBs, independent of the development of PTSD. One possible explanation is that depressive symptoms, which are highly comorbid with PTSD (e.g., Campbell et al., 2007), dampen motivation for taking proactive measures for health. Previous research has found that depressive symptoms are associated with poorer engagement in PHBs, including being physically active, eating regular meals, and receiving mammographies within recommended guidelines (Allgöwer, Wardle, & Steptoe, 2001; Azevedo Da Silva et al., 2012; Pirraglia, Sanyal, Singer, & Ferris, 2004). Most of the reviewed studies did not take depressive symptoms into account as an additional factor that may influence engagement in PHBs.

Another mechanism related to depressive symptoms is the kind of cognitive appraisals made by trauma-exposed people. For example, individuals who make appraisals of low self-efficacy may believe they lack the knowledge or resources to take preventive steps toward improving or maintaining their health. Consistent with this potential explanation, the literature consistently identifies self-efficacy beliefs as a predictor of engagement in PHBs such as physical activity and healthy diet (e.g., Anderson, Winett, & Wojcik, 2007; Anderson, Wojcik, Winett, & Williams, 2006).

Other mechanisms may be more specific to the type of PHB. Considering that hyperarousal symptoms are linked to decreased physical activity (Harte et al., 2015), avoidance of bodily arousal may be one explanation for this relationship. Exercise, particularly vigorous types, can induce physiological sensations (e.g., rapid heart rate) that are reminiscent of the body's response during prior traumatic events (Vujanovic et al., 2013). For medical screenings, avoidance of triggering trauma cues may explain differential rates of breast cancer and cervical cancer screening between those with more trauma exposure and those with less. A qualitative analysis by Ackerson (2011) revealed that many trauma-exposed women did not seek routine cervical cancer screenings because they found the experience to be 'retraumatizing'. The physical discomfort during screenings may trigger memories of past traumas, particularly for those who experienced bodily violations (e.g., sexual assault). Consistent with this notion, studies have found that women with a sexual assault history endorse greater distress and pain from cervical cancer exams compared to women without such a history (Weitlauf et al., 2008).

Other pathways may link trauma and PHBs via psychological associations of physical health with mortality. Individuals exposed to trauma may develop a sense of foreshortened future, which was characteristic of the DSM-IV-TR criteria for PTSD (American Psychiatric Association, 2000) but has since been removed. A sense of foreshortened future may make individuals less inclined to take preventive measures, as they do not anticipate a long lifespan and therefore do not see a need to preserve their health (Zen et al., 2012). In a qualitative survey of 9/11 public safety workers, many reported they avoided medical screenings after their exposure to Ground Zero and other attacked sites because they 'did not want to know what their long-term prospects for a full life are' (Demaria, Barrett, & Ryan, 2006).

Another mechanism by which trauma exposure may affect health behaviours is mortality salience, or greater conscious or nonconscious awareness of one's death (Pyszczynski, Greenberg, & Solomon, 1999). That is, people who experience traumatic encounters may become more cognisant of their mortality, which in turn affects motivation for improving or maintaining long-term health. This potential pathway linking trauma, mortality salience, and health behaviours is consistent with terror management health theory, which posits that mortality salience can influence motivation

toward health-related goals (Goldenberg & Arndt, 2008). Certain PHBs such as medical screenings can serve as reminders of mortality salience, and individuals may avoid such cues following trauma exposure, as demonstrated by the findings of decreased medical screening frequency among trauma-exposed individuals in our review. Alternatively, mortality salience may increase vigilance over taking care of one's health and increase PHB engagement in an effort to stave off illness and disease. This relationship is reflected in the literature on cancer survivors, which finds that fear of cancer recurrence can be a motivator for adaptive health behaviour change (Park & Gaffey, 2007).

Finally, trauma exposure and PTSD symptoms were linked to increased health behaviour engagement in some cases, which may be explained by efforts to cope. Individuals with trauma exposure and the most PTSD symptoms endorsed the greatest involvement in physical activity. Additionally, individuals with newly developed PTSD symptoms engaged in longer durations of very active physical activity compared to individuals without PTSD symptoms. Similarly, individuals with the most PTSD symptoms had the best diet quality, after controlling for trauma exposure. These findings may reflect efforts to cope with trauma by reducing stress with physical activity (Salmon, 2001) and efforts to compensate for the uncontrollability of stressful life events by exercising control over diet (e.g., Dalgleish et al., 2001). However, they may also reflect the extreme use of health behaviours, such as over-exercising and restrictive eating. Indeed, one qualitative study of female veterans found that many used exercise as a behavioural coping strategy, but that a subset used extreme degrees of exercise and food control to cope with deployment-related stress (Mattocks et al., 2012).

Methodological considerations

In addition to exploring these potential mechanisms, the literature on trauma and PHBs would benefit from addressing methodological limitations in subsequent work. Given that most of these studies employed a cross-sectional design, the evidence for the directionality of trauma exposure or PTSD symptoms affecting PHBs is limited to a few longitudinal studies. Therefore, it is possible that the results from cross-sectional studies indicate that health behaviour engagement affects PTSD symptoms (e.g., poor health exacerbates PTSD symptoms), or that a third variable explains their relationship (e.g., lower socio-economic status is associated with poorer health behaviours and more trauma exposure). Few studies controlled for demographic variables, like socio-economic status, that are known to covary with trauma exposure, PTSD, and health behaviours engagement. Furthermore, almost all reviewed studies relied on retrospective reporting for trauma history. Although this methodology is common in trauma research, most studies did not account for the amount of time lapsed since trauma exposure, which may have reduced the ability to detect associations between past traumas and current PHBs. One study asked participants to retrospectively report changes in PHBs (Adler et al., 2011), a method that is particularly vulnerable to recall bias and threatens validity (Ross, 1989). To address the limitations inherent in cross-sectional designs and retrospective reporting, more longitudinal studies with pre- and post-measurements that can study change in PHBs in relation to trauma exposure and PTSD onset are needed.

Beyond these broader study design issues, there are several challenges that are specific to the measurement of trauma exposure and PTSD symptoms. The dichotomisation of trauma exposure as present or absent erases variability and fails to acknowledge the cumulative nature of trauma history. It has been well documented that cumulative trauma exposure shares a dose–response relationship with many mental health outcomes, including PTSD and depression symptoms (e.g., Mollica, McInnes, Poole, & Tor, 1998). Given this gradated relationship, it is important to retain the continuous nature of the trauma exposure variable, as there may be more differences *within* the trauma-exposed group than *between* the two dichotomised groups. PTSD status was also dichotomised in several studies, grouping together those with no symptoms and those with subthreshold symptoms as 'healthy controls'. In fact, it was unclear in some studies if control groups had no or some symptoms of PTSD. This problem with dichotomisation is further complicated by the change in diagnostic criteria for PTSD from DSM-IV-TR to DSM-5. Whereas retaining the continuous nature

of PTSD allows the disorder to be understood on a continuum of severity, dichotomisation is dependent on diagnostic criteria, making it difficult to translate findings across different iterations of the DSM.

In addition to methodological challenges for assessing trauma exposure and PTSD, the measurement of PHBs has also been difficult to streamline. One of the main issues is that a substantial amount of the research on trauma and health behaviours does not use reliable and valid measures for assessing PHBs. Studies use an array of home-grown measures that are created by those researchers or researchers of other studies, rendering comparisons across studies difficult. This heterogeneity is particularly prevalent in the literature on trauma and physical activity, with a minority of the reviewed studies using an established measure. Another methodological limitation across studies is the use of one component of a health behaviour to represent the whole. For example, studies on trauma and physical activity tend to examine only one facet of physical activity such as duration, intensity, or frequency. Measuring multiple dimensions of physical activity contributes to stronger content validity, in that all components of the construct are measured. Similarly, studies on diet quality have taken different measurement approaches, with some studies looking at aggregate scores of overall diet quality and others looking at each food group separately. Compared to individual comparisons of food groups, aggregate scores of diet quality present more comprehensive assessments that consider balance across food groups. Finally, studies would benefit from using widely accepted guidelines for PHB engagement (e.g., ACSM recommendations for physical activity) as a frame of reference to contextualise findings.

Strengths and limitations

This review highlighted the gap in the literature about the complex relationships between trauma exposure, PTSD symptoms, and PHBs. Previous studies about trauma and health behaviours primarily focused on risky health behaviours. Of note, three systematic reviews examined the relationship shared by PTSD with physical activity and eating behaviours (Hall et al., 2015; Vancampfort et al., 2016; Whitworth & Ciccolo, 2016), but did not include studies that only measured trauma exposure. To tease apart the contributions of trauma exposure and PTSD symptoms to PHBs, the current review expanded its operationalisation of trauma by including studies that looked at the effects of trauma exposure above and beyond the effects of PTSD, or the effects of PTSD symptoms above and beyond the effects of trauma exposure. Furthermore, inclusion of different PHBs in our review allows for a more holistic understanding of the relationships between trauma and different facets of health. Our review provides a comprehensive summary of the ways in which PHBs, specifically physical activity, diet, and medical screenings, are defined and examined in the literature on trauma and PHBs. In particular, no other study has systematically reviewed the relationship between trauma and medical screenings.

As with strengths, limitations of this review must be noted. First, this review did not include all PHBs, as it intentionally focused only on PHBs with sufficient literature about the effects of trauma exposure and PTSD, and with strong linkages to chronic conditions for which trauma survivors are susceptible (e.g., cardiometabolic problems, cancer). It is important to note that trauma has been linked to other PHBs that were not included in this review, such as the relationship between medication adherence and PTSD symptoms (e.g., Kronish, Lin, Cohen, Voils, & Edmondson, 2014). For the PHBs that were reviewed, the number of studies analysed for each outcome was fairly small and the heterogeneity across studies prevented the formation of definitive conclusions. Therefore, only preliminary conclusions can be drawn based on the findings of this review. Furthermore, because most of the studies did not assess the intentions behind the health behaviours, it is assumed that health behaviours were undertaken for preventive reasons. However, participants may engage in health behaviours for other reasons, such as exercising for stress reduction. Another assumption is that greater engagement in health behaviours is adaptive, but extreme engagement in health behaviours may reflect an obsessional or maladaptive quality (e.g., over-

exercising, eating disorders, hypochrondriasis). Additionally, it is important to note that trauma exposure can lead to other presentations of psychological distress aside from PTSD, such as depression or anxiety disorders, that are known to impact health behaviour engagement (e.g., Allgöwer et al., 2001; McWilliams & Asmundson, 2001; Pirraglia et al., 2004). Given the scope of this review, we did not investigate associations with other mental health indices. Finally, our review may have been susceptible to positive publication bias, as only published articles were included in accordance with our eligibility criteria.

Clinical implications

Enriching our knowledge of the interplay between trauma exposure and health behaviours will inform clinical applications. Considering that greater cumulative trauma exposure is related to increased medical utilisation (Rosenberg et al., 2000), mental health clinicians working in integrated primary care settings should be encouraged to assess both trauma- and health behaviour-related issues. Clinicians may incorporate trauma history into case conceptualisations for clients who are struggling with behaviour-related health conditions, such as overweight or obesity. While clinicians typically assess for risky health behaviours (e.g., alcohol use, drug use), assessing engagement in PHBs is less common. Gathering data on PHBs would provide information about a client's self-care practices and risks for physical health problems. Among clients struggling to engage in PHBs, assessing trauma history and barriers to access (e.g., cultural beliefs, poverty) are particularly relevant in order to provide trauma-sensitive medical care.

In addition to assessing trauma history, clinicians are uniquely positioned to use their training in the biopsychosocial model to identify points of intervention. It would be beneficial for clinicians to explore with clients the reasons for their inability or reluctance to undertake preventive health measures. Clinicians can be instrumental in highlighting and challenging trauma-related cognitions that interfere with engagement in health-related behaviours and practices (e.g., fears of being assaulted during a cervical cancer screening). There is also burgeoning evidence that the relationship between trauma exposure and preventive health is bidirectional, such that PHBs help individuals cope with trauma. A meta-analysis of randomised control trials comparing physical activity interventions to control conditions found that increased physical activity reduced PTSD symptom severity (Rosenbaum et al., 2015). Interventions involving yoga, aerobic exercise, and resistance training decreased PTSD symptoms with small to moderate effect sizes. This finding suggests that physical activity may be a beneficial adjunct to traditional treatments for trauma, namely psychotherapy and medication.

Future directions for research

In reviewing the current state of the literature on trauma and PHBs, several gaps in the literature have been highlighted. Broadly speaking, the literature would benefit from measuring trauma exposure and PTSD symptoms as separate constructs, as trauma exposure makes additional contributions to physical health outcomes above and beyond the effects of PTSD symptoms. Moreover, researchers should carefully define their use of 'trauma exposure' to address the inconsistency with which the term is used across the literature. With respect to PHBs, few have been studied with respect to trauma. Compared to findings on physical activity and medical screenings, the research on diet quality is fairly limited. Similarly, research on other PHBs in relation to trauma, such as seatbelt use, is also limited and warrants further investigation before substantial conclusions can be drawn.

Given the current body of evidence for pathways linking trauma and preventive health that are independent of PTSD symptoms, future research should explore the other psychosocial factors that mediate the relationship between trauma exposure and PHBs. This review proposed several potential mechanisms (i.e., depressive symptoms, self-efficacy, sense of foreshortened future, fear of bodily arousal, re-traumatization, mortality salience, coping), all of which remain relatively

underexplored. Investigation of all these mechanisms will enlighten our understanding of the relationships shared by trauma exposure and health behaviours, as the causal pathways linking these variables are likely explained by multiple factors.

Disclosure statement

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Appendix A. Search Terms

PubMed

(trauma [ti] OR traumas [ti] OR traumatic [ti] OR ptsd [ti] OR posttraumatic [ti] OR 'post traumatic' [ti]) AND ('preventive health' [tiab] OR 'preventative health' [tiab] OR 'health behavior' [tiab] OR 'health behaviors' [tiab] OR 'behavioral health' [tiab] OR diet [Mesh] OR diet [tiab] OR 'eating behavior' [tiab] OR 'eating behaviors' [tiab] OR exercise [Mesh] OR exercise [tiab] OR 'physical activity' [tiab] OR 'medical screening' [tiab] OR 'cancer screening' [tiab] OR 'sexual behavior' [tiab] OR 'sexual behaviors' [tiab] OR 'sexual behaviour' [tiab] OR 'sexual behaviours' [tiab] OR contraceptive [tiab] OR contraceptives [tiab] OR condom [tiab] or condoms [tiab]) NOT ((animals[mh] NOT humans[mh]) OR 'brain injury' [tiab] OR 'brain injuries' [tiab] OR 'head trauma' [tiab] OR 'head traumas' [tiab] OR rat [tiab] OR rats [tiab] OR surgical [ti] OR surgery [ti] OR muscle [ti] OR knee [tiab] or 'spinal cord' [tiab] or 'chronic pain' [tiab] or orthopedic [tiab] or bone [tiab] or dental [tiab] or intervention [ti] or interventions [ti] or treatment [ti] or treatments [ti] or thorax [tiab] or artery [tiab] or pediatric [ti] or amputee [tiab] or tendon [tiab])

PsychInfo

(trauma OR traumas OR traumatic OR ptsd OR posttraumatic OR 'post traumatic') AND ('preventive health' OR 'preventative health' OR 'health behavior' OR 'health behaviors' OR 'behavioral health' OR diet OR diet OR 'eating behavior' OR 'eating behaviors' OR exercise OR exercise OR 'physical activity' OR 'medical screening' OR 'cancer screening' OR 'sexual behavior' OR 'sexual behaviors' OR 'sexual behaviour' OR 'sexual behaviours' OR contraceptive OR contraceptives OR condom or condoms) NOT ((animals NOT humans) OR 'brain injury' OR 'brain injuries' OR 'head trauma' OR 'head traumas' OR rat OR rats OR surgical OR surgery OR muscle OR knee or 'spinal cord' or 'chronic pain' or orthopaedic or bone or dental or intervention or interventions or treatment or treatments or thorax or artery or paediatric or amputee or tendon)