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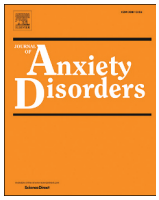

Review

PTSD and cognition in older adults: A systematic literature review

Jasmijn E. van Rossum [a,*], Semmy Op den Camp [a,b], Renske Uiterwijk [b], Kay Deckers [c], Vasiliki Orgeta [d], Bernice J.A. Gulpers [b], Sjacko Sobczak [a,b,e]

[a] Department of Neuropsychology and Psychopharmacology, Faculty of Psychology and Neuroscience; Maastricht University, the Netherlands
[b] Mondriaan Mental Health Center, Heerlen, Maastricht, the Netherlands
[c] Department of Psychiatry and Neuropsychology, Alzheimer Centrum Limburg, Mental Health and Neuroscience Research Institute (MHeNs), Maastricht University, PO Box 616, Maastricht 6200 MD, the Netherlands
[d] Division of Psychiatry, Faculty of Brain Sciences, University College London, London, United Kingdom
[e] Rotterdam University of Applied Sciences (RUAS), Research Center Innovations in Care, Rotterdam, the Netherlands

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ABSTRACT

Post-traumatic stress disorder (PTSD) is a disabling mental health disorder affecting psychosocial functioning and quality of life. This systematic review is the first to summarize existing global literature on the relationship between PTSD and specific domains of cognitive function in the general population of older adults. We searched PsycINFO, Medline and CINAHL up until November 1st 2024. Studies were included if they were longitudinal cohort or cross-sectional studies of adults aged 60 years and over with a clinical diagnosis of PTSD or sub-threshold PTSD symptoms, reporting on any domain of cognitive functioning using a standardised measure. Eighteen good or satisfactory quality articles met criteria for this review, of which three were longitudinal cohort studies and fifteen were cross-sectional studies. PTSD was associated with significant accelerated general cognitive decline and possible accelerated decline in attention and memory over time. Older adults with PTSD additionally performed significantly worse on measures of global cognitive function and memory compared to those without PTSD. For executive function results were mixed; two studies showed significant negative associations, whereas four other studies showed no significant differences between individuals with and without PTSD. Proactive screening of individuals with PTSD for cognitive decline and an additional focus of PTSD treatment on cognitive functioning are needed.

1. Introduction

Approximately 60–80 % of the general global population will, at least once in their life, be exposed to a potential traumatic event (De Vries & Olff, 2009; Frans, Rimmö, Åberg, & Fredrikson, 2005). The American Psychiatric Association (APA) DSM-5 describes this as an event of 'actual or threatened death, serious injury, or sexual violence' (American Psychiatric Association, 2013). Among survivors of these traumatic events, posttraumatic stress disorder (PTSD) is a common and serious mental health disorder (American Psychiatric Association, 2013). Lifetime prevalence rates of PTSD in the general population are approximately 7–8 % (De Vries & Olff, 2009; Kessler et al., 2017; Ohayon & Shapiro, 2000).

For individuals over the age of 60, somewhat lower lifetime prevalence rates are reported, ranging from 4.5 % (Pietrzak, Goldstein, Southwick, & Grant, 2012) to 7 % (Smith, Goldstein, & Grant, 2016). These age-related differences might stem from underrecognition of PTSD in older adults. Older adults may have more difficulty recognizing traumatic experiences and/or PTSD symptoms (Cook, McCarthy, & Thorp, 2017). This could be due to trauma occurring before PTSD was officially recognized in diagnostic classifications, such as the DSM in 1980, causing older adults to overlook the connection between current PTSD symptoms and pre-1980 traumatic experiences (Pless-Kaiser, Cook, Glick, & Moye, 2019). Additionally, symptom presentation may differ with age. Older adults are less likely to report avoidance symptoms, which could reflect natural aging, or it may indicate that long-term avoidance behaviours, such as avoiding certain places or events, become normalized and are no longer seen as efforts to avoid triggers (Pietrzak et al., 2012). Functional limitations, such as physical limitations, may also make it harder for older adults to engage in avoidance behaviours (van Dongen et al., 2022). Consequently, sub-threshold PTSD, in which not all needed diagnostic criteria for PTSD are

* Correspondence to: Maastricht University, FPN / NP&PP, P.O box 616, Maastricht 6200 MD, the Netherlands.
E-mail address: je.vanrossum@alumni.maastrichtuniversity.nl (J.E. van Rossum).

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met, may be more frequently diagnosed in older adults, with one study reporting a 6-month prevalence of subthreshold PTSD of 13.1 % in older adults versus 0.9 % in younger adults (van Zelst, Beekman, Deeg, & van Dyck, 2003).

In adults, PTSD is consistently associated with poor cognitive outcomes in various neurocognitive domains, including memory, attention, and executive function (Aupperle, Melrose, Stein, & Paulus, 2012; El-Hage, Gaillard, Isingrini, & Belzung, 2006; Moore & Zoellner, 2007; Qureshi et al., 2011; Rehman et al., 2021). In older adults, fewer studies on the association between PTSD and cognitive functioning exist, with most of these studies being cross-sectional (Schuitevoerder et al., 2013). Nonetheless, various cross-sectional studies show that older people with PTSD perform significantly worse on several measures of cognitive function compared to older individuals without PTSD (e.g. Burri, Maercker, Krammer, & Simmen-Janevska, 2013; Prieto, Moody, Valerio, & Hayes, 2022). These cognitive dysfunctions often lead to adverse outcomes, reducing quality of life and complicating social reintegration, which may lead to loneliness and social isolation (Roehr et al., 2017; Schnurr, Lunney, Bovin, & Marx, 2009; Smith, Schnurr, & Rosenheck, 2005; Vasterling, Verfaellie, & Sullivan, 2009; Wrocklage et al., 2016). Cognitive dysfunctions could also lead to poor outcomes and lower effectiveness of PTSD treatment because of difficulties focussing on the treatment at hand and difficulties remembering certain strategies taught in treatment (Catarino, Küpper, Werner-Seidler, Dalgleish, & Anderson, 2015). Stigma and limited access to services may prevent older adults from initially reporting their cognitive problems, further undermining the effectiveness of PTSD treatment (Casey, Greenberg, Nicassio, Harpin, & Hubbard, 2008; Nichter, Norman, Haller, & Pietrzak, 2019).

Over time, presence of cognitive deficits may lead to accelerated cognitive decline (Bettio, Rajendran, & Gil-Mohapel, 2017), with several longitudinal studies showing that PTSD predicts accelerated decline in memory performance over time (e.g. Roberts et al., 2022; Yehuda et al., 2006). For some individuals with PTSD, cognitive decline may progress to mild cognitive impairment (MCI) or dementia (Desmarais et al., 2020; Kuring, Mathias, & Ward, 2018). In recent years, PTSD has been redefined as a full systemic disorder (Lohr et al., 2015), where cumulative (life) stress is believed to lead to molecular damage, such as epigenetic changes, telomere shortening, and oxidative stress (Miller & Sadeh, 2014). These molecular changes in the stress response system, i.e. the allostatic load (Cohn-Schwartz, Hoffman, & Shrira, 2024; McEwen, 2013), affect various aspects of one's health, including the metabolism, cardiovascular system and brain structures (Lohr et al., 2015). These changes may accelerate aging and heighten the risk of triggering or exacerbating neurodegenerative processes, such as MCI dementia (Bennett, Grant, & Aldred, 2009; Greenberg, Tanev, Marin, & Pitman, 2014; Miller, Lin, Wolf, & Miller, 2018). However, only a few studies exist that have directly assessed this association, so most of the evidence remains indirect (Greenberg et al., 2014; Miller & Sadeh, 2014; Sies, Berndt, & Jones, 2017). Nevertheless, an increased prevalence of cognitive decline and dementia is found in older adults with PTSD versus those without PTSD (Qureshi et al., 2010). In a cohort study of male veterans, individuals with PTSD had an almost two-fold higher risk of developing dementia, than those without PTSD (Yaffe et al., 2010). Given that dementia is a major source of global disability, the rising global prevalence rate of dementia, and the lack of disease-modifying treatments, identifying risk factors for cognitive decline and dementia becomes crucial for preventive programs on dementia (World Health Organization, 2017).

Although several studies have linked PTSD to worse cognitive function in older adults, knowledge on the exact domains of cognition that are most likely to be affected remains limited (Schuitevoerder et al., 2013). Given that numerous articles have recently been published, an updated review, aligned with the latest literature, is needed to provide a robust estimate. Moreover, previous reviews have primarily focused on specific populations, such as male veterans or Holocaust survivors, with limited evidence available on the general population of older people. To improve clinical relevance of current findings on the association between PTSD and cognitive function, more studies based on the general population should be included. Previous reviews additionally lacked evidence on individuals with subthreshold levels of PTSD (Rehman et al., 2021; Schuitevoerder et al., 2013). Older individuals with subthreshold PTSD are inconsistently included in research on PTSD. However, these individuals are often seen in the clinic, as subthreshold PTSD is frequently diagnosed in older adults, possibly, because of underrecognition of PTSD symptoms (Cook et al., 2017; Pless-Kaiser et al., 2019; van Zelst et al., 2003). By not including older adults with subthreshold PTSD levels in reviews on PTSD and cognition, information on a significant amount of individuals with PTSD symptoms, as observed in the clinic, will be missed. Therefore, we aimed to include studies on individuals with subthreshold levels of PTSD in the current review. The primary aim of the present systematic review therefore was to provide an up-to-date estimate on the relationship between PTSD and cognitive function in older adults, including studies on the general population of older adults and comparing study results by cognitive domain.

2. Method

We adhered to the PRISMA guidelines of the Centre for Reviews and Dissemination for systematic reviews (Centre for Reviews and Dissemination, 2009). This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

2.1. Search strategy

We searched three databases (PsycINFO, Medline and CINAHL) up to 01 November 2024, using a comprehensive list of search terms (see Appendix A). It was chosen to limit our search to articles published in the last 20 years to ensure currently relevant information on the association between PTSD and cognition was included. We additionally hand-searched reference lists of relevant reviews and meta-analyses on this topic published in the last 20 years. Studies included in these reviews and meta-analyses, which also fulfilled our inclusion criteria, were included in the current review, regardless of whether these articles were published in the last 20 years. One author (J.E.V.R.) independently screened titles and abstracts of all articles identified to determine eligibility, which were checked by another author (S.O.D.C.). Any discrepancies between the two reviewers were resolved by consulting a third independent reviewer (S.S. or R.U.).

2.2. Selection criteria

Studies were included if they fulfilled the following inclusion criteria: 1) design: prospective, retrospective longitudinal cohort studies or cross-sectional studies investigating the association between PTSD and cognitive function; in 2) older adults aged 60 and over; 3) with a clinical diagnosis of PTSD, according to clinical diagnostic criteria of the DSM-3, DSM-3-R, DSM-4, DSM-5, ICD-9, ICD-10 or ICD-11, including subthreshold presentations. Subthreshold PTSD was defined as 'elevated levels of PTSD symptoms that do not meet full diagnostic criteria' (American Psychiatric Association, 2013); 4) that assessed any domain of cognitive function, either as an independent cognitive domain or global cognitive function, using a standardised measure. No exclusion criteria were applied.

The age 60 and over criterion was chosen, because most previous reviews and meta-analyses on the association between PTSD and cognitive functioning also included papers on individuals aged 60 and over (e.g. Rehman et al., 2021) and one of the aims of the current review was to give an update on these reviews. Moreover, as estimated by the World Health Organization (WHO), 22 % of the global population will be aged 60 or over by 2050 (World Health Organization, 2017), with the number of adults aged 60 and over living with neurodegenerative diseases, such as dementia, and/or mental conditions, such as PTSD, also

increasing. Understanding the association between PTSD and cognition in this age group will therefore become increasingly important.

2.3. Data extraction and quality assessment

After removing duplicates, two reviewers independently performed study selection based on the eligibility criteria (J.E.V.R. and S.O.D.C). Data extraction and quality assessment were performed by one author (J.E.V.R.) and checked by another author (S.O.D.C.), with discrepancies resolved by consulting a third author (S.S. or R.U.). A standardised data collection form was used to extract information on: study aim, sample size, study setting, diagnosis of PTSD or PTSD symptoms (in the case of subthreshold PTSD), measurement of cognitive function, statistical adjustment for confounders, and main findings. The Newcastle-Ottawa Scale (NOS) (Wells et al., 2000) was used to assess study quality of longitudinal studies. For the cross-sectional studies, an adapted version of the NOS was applied (see Appendix B).

3. Results

3.1. Systematic search results

The PRISMA flowchart of the search strategy is presented in Fig. 1. In total, 1793 articles were retrieved, with 1602 remaining after manual

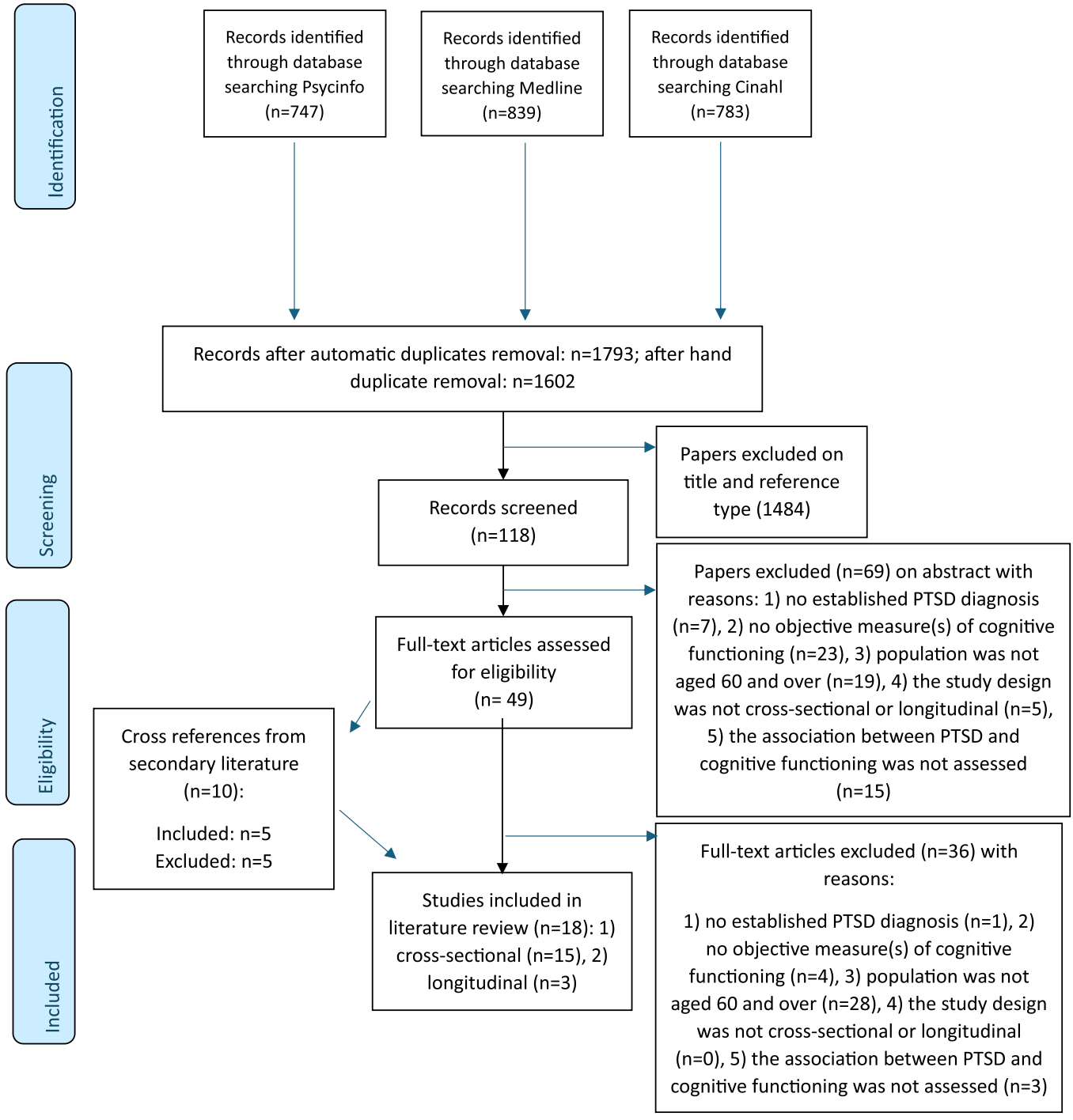

Fig. 1. PRISMA flow chart documenting the search and screening process.

deduplication. Following title, abstract, and reference type screening, 1553 articles were excluded as not relevant, leaving 49 articles to be screened via full text. Of these studies, 36 studies were excluded for the following reasons: in one article participants lacked an established PTSD or subthreshold PTSD diagnosis (Dikmen, Machamer, & Temkin, 2017), four articles did not use standardised cognitive measures (Bergman, 2013; Boelen & Lenferink, 2020; Borson, 2010; Wittekind, Muhtz, Moritz, & Jelinek, 2017), 28 articles focused on populations aged under 60 or did not provide age-specific data for age 60 and over (Antshel, Biederman, Spencer, & Faraone, 2016; Bano & Naz, 2020; Bergman, Mackay, & Pell, 2023; Bourgeois et al., 2020; Bremner et al., 2004; Brownlow, Brown, & Mellman, 2014; Chung, Jalal, & Khan, 2017; Cohen et al., 2013; Dimitrova et al., 2020; Geuze et al., 2009; Guez et al., 2011; Kaiser et al., 2020; Kaup et al., 2019; Kira et al., 2022; Koso & Hansen, 2006; Koso, Sarač-Hadžihalilović, & Hansen, 2012; Koso, Sarač-Hadzihalilovic, & Hansen, 2013; LaGarde, Doyon, & Brunet, 2010; Lin, Hofmann, Qian, & Li, 2015; Lopez et al., 2017; Martindale et al., 2021; Martinson, Sigmon, Craner, Rothstein, & McGillicuddy, 2013; Meštrović & Kozarić-Kovačić., 2014; Mozzambani et al., 2017; Nakayama et al., 2020; Nelson et al., 2009; Sumner et al., 2017; Yang et al., 2017), and three articles did not assess the PTSD-cognition association (Chaudieu et al., 2011; Gupta et al., 2023; Korinek et al., 2024). An additional ten articles were identified through reference list screening of prior reviews and meta-analyses, of which six met inclusion criteria for the current systematic review. However, two studies reported data on the same sample and measures (Golier et al., 2002; Golier, Yehuda, Lupien, & Harvey, 2003). Therefore, it was chosen to only include the most recent study on this sample. Characteristics of the included longitudinal articles are presented in Table 1.Table 2 presents characteristics of the cross-sectional studies. In total, 18 studies were included in the current review.

Of these 18 studies, three were prospective cohort studies following participants up to 14.0 years (Nilaweera et al., 2020), an average of 0.9 years (Roberts et al., 2022), and 5.0 years (Yehuda et al., 2006). Three articles used the baseline or first wave information of prospective longitudinal cohort studies and cross-sectionally examined the association between PTSD and cognitive functioning (Poff, Korinek, & Toan, 2024; Ranger, Bedard, & Taler, 2021; Saadi, Cruz-Gonzalez, Hwang, Cohen, & Alegria, 2021). The remaining 12 articles described cross-sectional studies (Burri et al., 2013; Golier et al., 2003, 2005; Goodman et al., 2007; Green, Fairchild, Kinoshita, Noda, & Yesavage, 2016; Hart et al., 2008; Noland et al., 2023; Prieto et al., 2022; Yehuda, Golier, Halligan, & Harvey, 2004; Yehuda et al., 2005; Yehuda et al., 2007a; Yehuda et al., 2007b).

Information on the quality of the different studies is presented in Tables 3 and 4. According to the Newcastle Ottawa Scale (NOS), all included studies were of satisfactory or good quality in terms of assessing the association between PTSD and cognitive functioning. All studies included a non-exposed cohort, adjusted for at least two confounders, and used objective outcome measures. In 6 studies, the standards of the NOS for ascertainment of exposure were not met (Burri et al., 2013; Nilaweera et al., 2020; Poff et al., 2024; Ranger et al., 2021; Roberts et al., 2022; Saadi et al., 2021), assessing PTSD symptoms with self-report questionnaires. Sixteen studies had non-representative samples of the general population of older adults aged 60 and over (Burri et al., 2013; Golier et al., 2003; Golier et al., 2005; Goodman et al., 2007; Green et al., 2016; Hart et al., 2008; Noland et al., 2023; Poff et al., 2024; Prieto et al., 2022; Roberts et al., 2022; Saadi et al., 2021; Yehuda et al., 2004; Yehuda et al., 2005; Yehuda et al., 2006; Yehuda et al., 2007a; Yehuda et al., 2007b). For instance, reporting data on male participants (e.g. Hart et al., 2008; Noland et al., 2023; Yehuda et al., 2005), Holocaust survivors (e.g. Golier et al., 2003; Yehuda et al., 2004), or nurses (Roberts et al., 2022) only.

3.2. Sample characteristics

As shown in Tables 1 and 2, sample sizes of the included articles ranged from 25 (Hart et al., 2008) to 23254 (Ranger et al., 2021), with mean participant age ranging from 60.6 (Yehuda et al., 2007b) to 80.1 years old (Hart et al., 2008). For Hart et al. (2008), the overall mean age was calculated from the reported means of three subgroups.

Study samples varied by ethnicity, race, and trauma exposure. Eleven of the eighteen included studies focused on civilians (Burri et al., 2013; Golier et al., 2003, 2005; Goodman et al., 2007; Nilaweera et al., 2020; Poff et al., 2024; Ranger et al., 2021; Roberts et al., 2022; Saadi et al., 2021; Yehuda et al., 2004, 2006). Ethnicity was mentioned in two civilian studies: one study reported on an almost entirely white sample (Roberts et al., 2022) and the other study reported on Latino and Asian individuals (Saadi et al., 2021). Most civilian trauma was Holocaust-related (five of the eleven included studies) (Golier et al., 2003, 2005; Goodman et al., 2007; Yehuda et al., 2004, 2006), followed by war (Burri et al., 2013; Poff et al., 2024) and health related trauma (Roberts et al., 2022).

The remaining seven articles examined war veterans (Green et al., 2016; Hart et al., 2008; Noland et al., 2023; Prieto et al., 2022; Yehuda et al., 2005; Yehuda et al., 2007a; Yehuda et al., 2007b). Six studies included only male participants (Green et al., 2016; Hart et al., 2008; Noland et al., 2023; Yehuda et al., 2005; Yehuda et al., 2007a; Yehuda et al., 2007b) and one (Prieto et al., 2022) had a 99.3 % male sample. All veteran studies involved combat-related trauma. Ethnicity was mentioned in three veteran studies, with two exclusively white samples (Prieto et al., 2022; Yehuda et al., 2007a), and one primarily non-Hispanic white sample (Noland et al., 2023).

3.3. Assessment of PTSD and cognitive functioning

As shown in Tables 1 and 2, all included studies assessed PTSD using structured clinical interviews and/or self-report measures. Eleven studies employed the Clinician Administered PTSD Scale (CAPS). Six of these studies used the CAPS-1 version of the CAPS to assess PTSD symptoms (Golier et al., 2003, 2005; Yehuda et al., 2005, 2006; Yehuda et al., 2007a; Yehuda et al., 2007b), one utilised the CAPS-2 version (Hart et al., 2008), and four used the CAPS-IV version (Green et al., 2016; Noland et al., 2023; Prieto et al., 2022; Yehuda et al., 2004). The CAPS-1 and CAPS-2 are based on DSM-III-R criteria to assess PTSD symptoms and the CAPS-IV is based on DSM-IV criteria. The remaining studies utilised the Short Screening Scale for PTSD (Burri et al., 2013; Roberts et al., 2022), the PTSD-inventory (Nilaweera et al., 2020), the Primary Care PTSD screen (Ranger et al., 2021), the Posttraumatic Stress Disorder Checklist for Diagnostic and Statistical Manual-5 (Poff et al., 2024; Saadi et al., 2021), and the Posttraumatic Diagnostic scale (Goodman et al., 2007).

Twenty-nine different tests and subtests were utilized to measure cognitive functioning in the eighteen studies included in this review (see Table 5). Results were categorized by cognitive domain—memory, attention, executive functioning, and general cognition—based on common usage in the literature and reporting practices in the included studies. Other domains were grouped under a fifth, other cognitive domains, category. We decided to categorise results on the basis of the neurocognitive domain measured according to the original authors of the included studies. For detailed descriptions of test definitions, functions, and associated brain regions, we refer to the original studies (Tables 1 and 2).

Substantial heterogeneity between studies in the measures and statistical procedures used to assess the association between PTSD and cognitive functioning was observed. Moreover, three out of the eighteen included studies did not mention effect size coefficients for one or more statistical tests performed in their study (Burri et al., 2013; Hart et al., 2008; Ranger et al., 2021). This heterogeneity prevented the possibility of direct comparisons between studies via meta-analysis. Therefore, we

Table 1
– Study information on the included longitudinal studies.

Study	Study quality*	Sample	How PTSD was established	Neuropsychological assessment	Statistical adjustment for confounders	Main findings
Nilaweera et al. (2020) Australia and France ESPRIT study Study goal: examine if lifetime major trauma with and without PTSD symptoms is associated with cognition and dementia risk later in life.	Good	General population study of community-dwelling older adults N = 1700 (41.0 %M) No trauma = 777 Trauma without PTSD symptoms = 637 Trauma with PTSD symptoms = 286 Mean age (SD)= 72.6 (5.22) Ethnicity unknown	PTSD-I	1. MMSE 2. BVRT 3. IST 4. TMT	-Age -Gender -Education -Morbidity -Depression	Lifetime major trauma with PTSD was associated with a significant decrease in general cognitive functioning in women (OR=1.46, $p = .04$, MMSE). For visual memory (OR=1.07, $p > .05$, BVRT), executive function (OR=0.78, $p = .20$, TMT), and verbal fluency (OR=1.09, $p > .05$, IST) no significant association with PTSD was observed. However, lifetime major trauma without PTSD was associated with significantly better executive functioning (OR=.69, $p = .01$, TMT part B) and global cognitive functioning (OR=.67, $p = .002$, MMSE) in men as compared to men without lifetime major trauma.
Roberts et al. (2022) USA The Nurses' Health Study II Study goal: assess the association between PTSD and cognitive functioning over time.	Good	General population study of middle-aged female nurses N = 12270 (0.0 %M) No PTSD symptoms = 4052 1–3 symptoms = 5058 PTSD (4–7 symptoms) = 3160 1.0 % Asian 0.6 % Black 1.3 % Hispanic 95.9 Non-Hispanic White 1.2 % Other ethnicity Mean age (SD)= 61.1 years (4.6)	SSS	Cogstate Brief Battery	-Age -Self-identified race -Ethnicity -Parental educational level at participant's birth -Participant's education level -BMI -Physical activity -Cigarette smoking -Alcohol consumption -Diet quality -Depressive symptoms	A higher number of PTSD symptoms was associated with accelerated cognitive decline in middle-aged women in all measured domains; psychomotor speed and attention ($\beta = -0.05$, $p = .02$), learning, and working memory ($\beta = -0.08$, $p < .001$) of the Cogstate Brief Battery as compared to women without PTSD.
Yehuda et al. (2006) USA Study goal: examine if the relationship between memory and PTSD symptoms differs over time	Good	Holocaust survivors with and without PTSD and Jewish controls without PTSD N = 46 (39.2 %M) PTSD= 14 No PTSD= 13 Control= 19 Mean age at follow-up (SD): PTSD= 72.9 (6.0) No PTSD= 72.7 (6.3) Control= 76.4 (6.8) Ethnicity unknown	CAPS−1 and the Structured Clinical Interview for DSM-IV	1.paired-associate learning test 2.word stem completion test 3.CVLT	-Age -Education -PTSD severity -WAIS-R vocabulary age-corrected scaled scores -WAIS-R block design age-corrected scaled score	Individuals with PTSD showed a greater decline in explicit memory performance of high associate word pairs, compared to non-exposed individuals (t = 2.35, $p = .03$ at baseline and t = 2.27, $p = .01$ at 5 year follow-up) (paired associate learning test). For implicit memory performance (words stem completion test) no significant difference in performance between individuals with and without PTSD was observed at both timepoints (t = .21, $p > .05$ at baseline and t = .02, $p > .05$ at follow-up).

*Quality of the study was assessed with the Newcastle-Ottowa Scale, see Table 3 for more information

Abbreviations: Benton's Visual Retention Test (BVRT); Body Mass Index (BMI); Clinician-Administered PTSD scale for DSM-5 (CAPS); California Verbal Learning Test (CVLT); Diagnostic Statistic Manual of Mental Disorders IV (DSM-IV); Enquête de Santé Psychologique- Risques, Incidence et Traitement study of neuropsychiatric disorders in geriatric populations (ESPRIT); Isaacs Set Test (IST); Mini Mental State Examination (MMSE); Odds Ratio (OR); Posttraumatic Stress Disorder (PTSD); Posttraumatic Stress Disorder Inventory (PTSD-I); Standard Deviation (SD); Structured Interview for Diagnosis of Dementia of Alzheimer Type, Multi-infarct Dementia and Dementia of other Etiology according to ICD-10 and DSM-III-R (SIDAM); Short screening scale for PTSD (SSS); Trail Making Test (TMT); Wechsler Adult Intelligence Scale-Revised (WAIS-R)

Table 2 –
Study information on the included cross-sectional studies.

Study	Study quality*	Sample	How PTSD was established	Neuropsychological assessment	Statistical adjustment for confounders	Main findings
Burri et al. (2013) Switzerland Subsample of the Verdingkind-cohort Study goal: examine the association between cognitive functioning, PTSD, and childhood trauma exposure.	Satisfactory	General population study of previous child labourers with and without PTSD N = 96 (57.3 %M) PTSD with childhood trauma= 10 PTSD with adult trauma= 12 Controls= 74 Mean age (SD): 77.5 years (6.3) Ethnicity unknown	SSS	The performance part of the SIDAM (including the MMSE)	-Gender -Depression	PTSD was associated with worse general cognitive functioning (X^2= 9.3, $p < .05$ and X^2= 10.1, $p < .05$), and lower scores on the cognitive domains of higher cortical function ($X^2 = 12.3$, $P < 0.001$), construction skills ($X^2 = 6.3$, $P < 0.05$), and verbal numeracy ($X^2 = 8.8$, $P < 0.05$), compared to individuals without PTSD, as measured with the SIDAM. All associations remained significant after controlling for depression, except for construction skills performance ($p > .05$)***.
Golier et al. (2003) USA Study goal: evaluate the impact of trauma related information on memory performance in aging	Satisfactory	Jewish Holocaust survivors with and without PTSD and Jewish controls with no Holocaust exposure N = 82 (36.6 %M) PTSD= 31 No PTSD Holocaust survivors= 16 Control= 35 Mean age (SD): PTSD group = 67.7 (5.6) No PTSD group = 67.4 (5.8) Control= 69.9 (6.7) Ethnicity unknown	Structured interviews, the CAPS−1, and the Structured Clinical Interview for DSM-IV	1.Paired associate recall test 2.Word stem completion test	-Age -Gender -Years of education -Estimated IQ -PTSD severity	Holocaust survivors with PTSD showed poorer explicit memory performance (Paired associate recall test) than survivors without PTSD and controls (F=4.93, $p = .01$). PTSD subjects also showed trauma-related facilitation of explicit memory (t = −2.66, $p = .01$). For implicit memory, no significant association with PTSD was observed; all three groups displayed less implicit memory for Holocaust-related words than for neutral words (F=1.79, $p = .17$, word stem completion test).
Golier et al. (2005) USA Study goal: examine whether there is an association between hippocampal volume, memory performance and PTSD	Satisfactory	Holocaust survivors with and without PTSD and non-exposed controls N = 47 (52.0 %M) PTSD= 14 No PTSD Holocaust survivors= 13 Controls= 20 Mean age (SD): PTSD = 70.5 (5.6) No PTSD = 68.5 (7.3) Control = 71.4 (6.4) Ethnicity unknown	CAPS−1	Guild memory test	-Age -Gender -BMI -Years of education -Head size -PTSD severity	Individuals with PTSD showed poorer immediate paragraph recall (F=7.23, $p = .002$), immediate pared associates recall (F3.97, $p = .03$), and delayed memory performance (F=8.42, $p = .001$) than (non-)exposed individuals without PTSD, as measured with the Guild memory test.
Goodman et al. (2007) Israel Study goal: examine whether schizophrenia inpatients with PTSD have more severe cognitive impairment than schizophrenia inpatients without PTSD.	Satisfactory	Population study of inpatients with Schizophrenia and PTSD who survived the Holocaust and non-exposed inpatients with Schizophrenia without PTSD N = 28 (46.4 %M) PTSD= 14 Non PTSD = 14 Mean age (SD): PTSD= 70.2 (6.0) No PTSD= 65.7 (6.1) Ethnicity unknown	PDS	1.WAIS- R Digit Span test 2.WAIS-R Digit symbol test 3.MMSE 4.Rey-Osterrieth Complex Figure test 5.TMT 6.RAVLT 7.Finger tapping test	-Age -Gender -Number of hospitalizations -Length of current hospitalization -Education -Marital status -Medication -Duration of schizophrenic episode -Depressive symptoms -PTSD severity	Survivors with PTSD performed significantly worse on measures of general cognitive performance (MMSE; F= 4.95, $p = .03$), recognition memory (RAVLT; F=10.87, $p = .004$ for recognition discriminability and F=8.12, $p = .01$ for recognition hits), and visuomotor speed (Digit Symbol test; F=5.74, $p = .028$), as compared to non-exposed individuals. There was also a non-significant trend for worse performance on visual scanning (TMT; F=4.75, $p = .066$) and

(*continued on next page*)

Table 2 – (*continued*)

Study	Study quality*	Sample	How PTSD was established	Neuropsychological assessment	Statistical adjustment for confounders	Main findings
						visuoconstructive skills (Rey-Osterrieth Complex Figure test; F=2.49, $p = .129$). For attention, as measured with the Digit Span test, no significant difference in performance between individuals with and without PTSD was found (F=1.98, $p = .174$ for Digit Span forward and F=0.66, $p = .426$ for Digit Span backward).
Green et al. (2016) USA Study goal: examine associations among cognitive functioning, PTSD and MetS in older veterans.	Satisfactory	War veterans with and without PTSD and/or with and without MetS N = 204 (100.0 %M) PTSD, without MetS= 55 PTSD with MetS = 82 MetS, without PTSD = 34 No PTSD and MetS= 33 Mean age (SD): PTSD+ /MetS-: 61.0 years (4.3) PTSD+ /MetS+ : 60.8 years (4.1) PTSD-/MetS+ : 65.6 years (6.8) PTSD-/MetS-: 66.1 years (7.2) Ethnicity unknown	CAPS-IV	1. RAVLT 2. TMT 3. CWIT 4. WAIS-III Digit Symbol test	-Age -Education -MetS	Individuals with PTSD and MetS did perform significantly worse on verbal memory (F=4.23, $p = .003$, R2 =.061,RAVLT) and executive function tasks (F=5.66, $p < .001$, R2 =.086 for the TMT and F=4.75, $p = .001$, R2 =.069 for the CWIT). When controlling for MetS, PTSD did not significantly impact cognitive performance on any of the measures (β =.06, $p > .05$ for RAVLT, β =.14, $p = .068$ for TMT and β =.10, $p > .05$ for CWIT). Therefore, MetS may, at least partially, mediate the association between PTSD and cognitive function in veterans.
Hart et al. (2008) USA Study goal: examine cognitive dysfunction associated with PTSD in former war prisoners	Satisfactory	Former WWII or Korean War prisoners with and without PTSD N = 25 (100.0 %M) 60.0 % German 16.0 % Japanese 4.0 % Korean PTSD= 56.0 % No PTSD= 44.0 % Mean age (SD): PTSD without another psychiatric disorder= 80.9 (2.3) PTSD with another psychiatric disorder= 79.3 (1.5) No PTSD= 80.0 (2.2)	CAPS−2	1.Boston Naming Test 2.Category Fluency 3.COWAT 4.TMT 5.WAIS-R Digit span tests 6.RAVLT 7. WMS-R Logic Memory test 8.Warrington Recognition Memory Test (faces) 9.Judgement of line orientation 10.Symbol Digit Modalities test	-Age -Education -IQ -Depressive symptoms	PTSD was significantly associated with worse visual scanning and psychomotor speed ($p < .05$ for the Symbol Digit Modalities test and $p < .05$ for the TMT part B)***, regardless of the presence of psychiatric comorbidities. Deficits in phonemic fluency (COWAT; $p < .03$)*** were only associated with individuals with PTSD and a psychiatric condition as compared to individuals without PTSD and psychiatric disorder. All other associations were non-significant ($p > .05$)***.
Noland et al. (2023) USA PTSD Apnea Clinical Study Study goal: examine the effects of PTSD and OSA on cognitive functioning in older adult veterans	Satisfactory	Older adult veterans with and without PTSD N = 175 (100.0 %M) 81.1 % Non-Hispanic white 18.9 % Other PTSD= 106 No PTSD= 69 Mean age (SD): PTSD= 61.5(4.3) No PTSD= 66.3 (6.5)	CAPS-IV	1.WAIS-III Digit Span subtests 2.CWIT 3.TMT part A and B 4.RAVLT 5.Rey-Osterrieth Complex Figure test 6.DKEFS colour naming subtest 7.DKEFS word reading subtest	-Age -Education -BMI -Sleep difficulties	PTSD significantly predicted poorer attention and processing speed performance (β = −.27, $t = -2.14$, $p = .03$) as compared to individuals without PTSD. For executive function (β = −0.20, $t = -1.33$, $p = .19$) and learning and memory (β = 0.03, $t = 0.17$, $p = .86$), no significant association with PTSD was reported. OSA predicted poorer learning and memory performance (β = −.20, $t = -1.98$, $p = .049$).
Poff et al. (2024) USA and Vietnam Vietnam Health and Aging Study	Satisfactory	Vietnamese adults who experienced the American war during young adulthood or adolescence	PCL−5	MMSE	-Age -War exposure -Social support and engagement	An association between PTSD symptoms and poorer global cognitive function (OR=.07, $p < .05$) was

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Table 2 – (*continued*)

Study	Study quality*	Sample	How PTSD was established	Neuropsychological assessment	Statistical adjustment for confounders	Main findings
Study goal: examine the cognitive function and self-rated memory of Vietnamese older adult		N = 2352 (48.8 %M)** Age group distribution: 59–64 = 31.4 % 65–69 = 23.7 % 70–74 = 16.7 % 75–79 = 11.6 % 80–84 = 8.5 % 85 + = 8.1 %			-Military participation -Socioeconomic status -high school education -household assets -(in)formal social activity -game participation	reported. Moreover, PTSD was associated with poorer self-rated memory (OR=.90, $p < .001$). Social engagement did not attenuate the effects of PTSD exposure.
Prieto et al. (2022) USA DoD-ADNI dataset Study goal: examine the association between PTSD, the number of experienced stressors, and cognitive outcomes	Satisfactory	Vietnam war veterans with and without a history of moderate-to-severe TBI and/or with and without PTSD N = 274 (99.3 %M)** 84,3 % white 8,0 % black 7,6 % Hispanic 7,7 % other Mean age (range) 69.8 years (60−85)	CAPS-IV	MoCA	-Age -Race -Ethnicity -Gender -Educational attainment -LSC-R score -TBI history -Cardiovascular symptoms and disease	A higher amount of PTSD symptoms, but not the number of reported stressful experiences, was associated with poorer general cognitive functioning (R2 =.142, $p = .001$, MoCA). Analysis of the specific MoCA domains showed that memory deficits may drive this association ($\beta = -.280$, $p < .001$).
Ranger et al. (2021) Canada Baseline data from a prospective longitudinal cohort study Canadian Longitudinal Study on Aging Study goal: evaluate the cognitive performance of older adults with PTSD and examine if social support can act as a cognitive reserve factor	Satisfactory	General population study of older adults N = 23254 (34.8 %M in the PTSD group, 49.7 %M in the control group) PTSD= 1096 No PTSD controls = 22158 Mean age (SD) = 62.1 years (9.9) Ethnicity unknown	PC-PTSD	1. COWAT 2. AFT 3. Victoria Stroop test 4. MAT 5. MPMT 6. RAVLT	-Age -Education -Sex -Depression levels -Sleep time -Alcohol frequency -Testing language -Social support	The PTSD group showed significant cognitive deficits compared to the no PTSD control group on two measures of executive functioning ($p < .01$, $\eta_p^2 = .02$ for the MAT and $p = .02$, $\eta_p^2 = .01$ for the Victoria Stroop test) and prospective memory ($p = .01$, $\eta_p^2 = .01$, MPMT). For declarative memory ($\chi 2\ (1) = 1.13$, $p = .29$, RAVLT) and the other two executive functioning tests ($p = .20$ for the COWAT*** and $p = .23$ AFT***), no significant group differences between the PTSD and control group were found. For the PTSD group, no significant moderator for the association with the cognitive tests was found.
Saadi et al. (2021) USA Positive Minds-Strong Bodies baseline data Study goal: examine associations between trauma exposures and PTSD with cognitive impairment and the possible attenuating role of sleep quality	Satisfactory	General population study of Latino and Asian older adults N = 220 (20.9 %M in the Latino group, 22.1 %M in the Asian group)** 60.9 % Latino 39.1 % Asian Mean age (SD) in the Latino group= 72.8 (7.0) Mean age (SD) in the Asian group= 77.5 (7.3)	PCL−5	MoCA	-Age -Gender -Education -Self-reported physical health - Race (Latino or Asian) -Depression -Daytime sleepiness -Anxiety	Higher PTSD symptoms were associated with general cognitive impairment (MoCA ≥25) in Asian (OR=.93 (.87 −.99 CI)), but not in Latino older adults (OR=.99 (.95–1.05 CI)). This association remained significant after adjusting for the possible confounders.
Yehuda et al. (2004) USA Study goal: examine which memory components are affected in Holocaust survivors with and without PTSD	Satisfactory	Holocaust survivors with and without PTSD and Jewish controls N = 102 (37.3 %M) PTSD= 36 No PTSD = 26 Controls not exposed to the Holocaust = 40 Mean age (SD): PTSD = 68.2 (5.6) No PTSD= 68.4 (6.4) Controls= 70.4 (6.8) Ethnicity unknown	CAPS-IV and the Structured Clinical Interview for DSM-IV	CVLT	-Age -IQ -PTSD severity	Individuals with PTSD showed significant deficits in the ability to learn new information, as measured with the CVLT, compared to both Holocaust survivors without PTSD and non-exposed controls (F=2.5, $p < .002$). It was determined that these group differences were an artifact of memory capacity (F=8.09, $p < .0005$).
Yehuda et al. (2005) USA	Satisfactory	Combat veterans with and without PTSD and veteran	CAPS−1 and the Structured	CVLT	-Age -Years of	Veterans with PTSD showed memory and learning

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Table 2 – (*continued*)

Study	Study quality*	Sample	How PTSD was established	Neuropsychological assessment	Statistical adjustment for confounders	Main findings
Study goal: examine memory and learning performance in older combat veterans with and without PTSD		controls who are unexposed to combat N = 65 (100.0 %M) White = 67.7 % African American= 16.9 % Hispanic/Latino= 15.4 % PTSD= 30 No PTSD= 20 Control= 15 Mean age (SD): PTSD= 65.6 (9.7) No PTSD= 67.6 (12.1) Control= 65.1 (9.6)	Clinical Interview for DSM-IV		education -WAIS-R vocabulary age-corrected scaled scores -WAIS-R block design age-corrected scaled score -War zone exposure -Ethnicity -Current or past substance abuse/ dependence -Depressive symptoms -PTSD severity	impairments (CVLT) compared to non-exposed veterans (Pillai's F= 2.56, $p = .003$), but only performance on the long-delay free recall part of the CVLT was significantly different between the combat veterans with and without PTSD (F=6.54, $p = .02$), when the association was corrected for intelligence (WAIS-R Vocabulary and Block design) and learning performance.
Yehuda et al. (2007)[a] USA Cross-sectional Study goal: examine whether individuals with and without PTSD differ in hippocampal volume and examine the relationship to memory performance and neuroendocrine activity.	Satisfactory	Veterans with and without chronic PTSD N = 33 (100.0 % M) Ethnicity: White= 69.7 % African American= 15.2 % Hispanic= 9.1 % Asian= 6.1 % PTSD= 17 No PTSD= 16 Mean age (SD): PTSD= 60.6 (7.0) No PTSD= 65.1 (9.9)	CAPS−1	1.WMS-III logical memory subtests 2.WAIS-III Digit Span subtests	-Age -Intelligence -Depressive symptoms -Past drug and alcohol use or dependence -Number of drinks in the past 90 days -PTSD severity	Subjects with PTSD did not differ from those without PTSD in hippocampal volume, but they did show worse memory, attention, and working memory performance, as measured with the logical memory subtests of the WMS-III (F=5.0, $p = .03$) and the WAIS-III Digit Span subtests (F=5.9, $p = .02$) respectively.
Yehuda et al. (2007)[b] USA Cross-sectional Study goal: examine the relationship between memory and glucocorticoid alterations in elders with PTSD.	Satisfactory	Veterans with and without PTSD N = 30 (100 %M) White= 70.0 % Black/Hispanic= 23.3 % Asian= 6.7 % PTSD= 17 No PTSD= 13 Mean age (SD): PTSD= 60.1 (7.3) No PTSD= 64.6 (9.8)	CAPS−1	1.WMS-III Logical memory test 2.WMS Digit Span subtests 3. WMS-III Letter Number sequencing test	-Age -Ethnicity -Age at focal trauma -Depressive symptoms -Anxiety symptoms -Cortisol levels -PTSD severity	The PTSD group performed significantly worse on all cognitive tasks (F=6.56, $p = .016$) as compared to the no PTSD group. Cortisol enhanced episodic memory performance in both groups (Logical memory task; F=8.9, $p = .006$), but only enhanced working memory performance in subjects with PTSD (Letter Number sequencing task; F=1.15, $p = .034$).

*Quality of the study was assessed with the Newcastle-Ottowa Scale, see Table 4 for more information
**Amount of individuals with a PTSD diagnosis is not mentioned in this article
***Effect size coefficients for this association were not mentioned in this article
Abbreviations: Animal Fluency Test (AFT); Body Mass Index (BMI); Clinician-Administered PTSD scale for DSM-5 (CAPS); Confidence Interval (CI); Color-Word Interference Test (CWIT); Controlled Oral Word Association Test (COWAT); California Verbal Learning Test (CVLT); Diagnostic Statistic Manual of Mental Disorders IV (DSM-IV); Intelligence Quotient (IQ); Life Stressor Checklist-Revised (LSC-R); Mental Alternation Test (MAT); Metabolic syndrome (MetS); Miami Prospective Memory Test (MPMT); Mini Mental State Examination (MMSE); Standard Deviation (SD); Montreal Cognitive Assessment (MoCA); Odds ratio (OR); Posttraumatic Diagnostic scale (PDS); Posttraumatic Stress Disorder (PTSD); Posttraumatic Stress Disorder Checklist for Diagnostic and Statistical Manual-5 (PCL-5); Posttraumatic Stress Disorder Checklist-Specific version (PCL-S); Primary Care PTSD screen (PC-PTSD); Rey Auditory Verbal Learning Test (RAVLT); Standard Deviation (SD); Structured Interview for Diagnosis of Dementia of Alzheimer Type, Multi-infarct Dementia and Dementia of other Etiology according to ICD-10 and DSM-III-R (SIDAM); Short screening scale for PTSD (SSS); Traumatic Brain Injury (TBI); Trail Making Test (TMT); The Wechsler Adult Intelligence Scale – Third Edition (WAIS-III); Wechsler Adult Intelligence Scale-Revised (WAIS-R); Wechsler's Memory Scale-III (WMS-III); World War II (WWII)

describe results narratively.

3.4. Methodological and statistical control for confounders

All included studies in Tables 1 and 2 controlled for at least two different demographic characteristics of the sample. The potential confounding effect of age was controlled for in all 18 included studies by evaluating age-equivalency between groups with statistical tests, matched comparison samples using methodological control or using age-related test norms (see Tables 1 and 2).

3.5. Effect of PTSD on general cognitive functioning

As can be observed in Tables 1 and 2, one included good quality longitudinal study (Nilaweera et al., 2020) and five satisfactory quality cross-sectional studies (Burri et al., 2013; Goodman et al., 2007; Poff et al., 2024; Prieto et al., 2022; Saadi et al., 2021) reported the effects of PTSD on general cognitive functioning. The only good quality longitudinal study on global cognitive performance showed accelerated global cognitive decline over 14 years in the group of older adults with PTSD as compared to individuals without PTSD (OR=1.46, $p = .04$) (Nilaweera et al., 2020). All cross-sectional studies reported that older adults with PTSD performed significantly worse on global cognitive functioning

Table 3
Quality scoring of the longitudinal cohort studies according to the Newcastle-Ottawa scale.

	Selection					Comparibility		Outcome		Overall quality
	Representativeness	Non-exposed cohort	Ascertainment of exposure	Outcome not at baseline	Adjusted for important factor	Adjusted for additional factor	Assessment of outcome	Follow-up	Adequacy of follow-up	
Nilaweera 2020	1	1	0	1	1	1	1	1	1	Good
Roberts 2022	0	1	0	1	1	1	1	1	1	Good
Yehuda 2006	0	1	1	1	1	1	1	1	1	Good

Table 4 –
Quality scoring of the cross-sectional studies according to the Newcastle-Ottawa scale.

	Selection					Comparibility		Outcome		Overall quality
	Representativeness	Non-exposed cohort	Ascertainment of exposure	Outcome not at baseline	Adjusted for important factor	Adjusted for additional factor	Assessment of outcome	Follow-up	Adequacy of follow-up	
Burri 2013	0	1	0	0	1	1	1	0	0	Satisfactory
Golier 2003	0	1	1	0	1	1	1	0	0	Satisfactory
Golier 2005	0	1	1	0	1	1	1	0	0	Satisfactory
Goodman 2007	0	1	1	0	1	1	1	0	0	Satisfactory
Green 2016	0	1	1	0	1	1	1	0	0	Satisfactory
Hart 2008	0	1	1	0	1	1	1	0	0	Satisfactory
Noland 2023	0	1	1	0	1	1	1	0	0	Satisfactory
Poff 2024	0	1	0	0	1	1	1	0	0	Satisfactory
Prieto 2022	0	1	1	0	1	1	1	0	0	Satisfactory
Ranger 2021	1	1	0	0	1	1	1	0	0	Satisfactory
Saadi 2021	0	1	0	0	1	1	1	0	0	Satisfactory
Yehuda 2004	0	1	1	0	1	1	1	0	0	Satisfactory
Yehuda 2005	0	1	1	0	1	1	1	0	0	Satisfactory
Yehuda 2007a	0	1	1	0	1	1	1	0	0	Satisfactory
Yehuda 2007b	0	1	1	0	1	1	1	0	0	Satisfactory

tasks than older adults without PTSD, as measured by the performance part of the SIDAM ($X2 = 9.3$, $p < .05$ and $X2 = 10.1$, $p < .05$) (Burri et al., 2013), the Mini Mental State Examination (MMSE) ($F = 4.95$, $p = .03$ for the study of Goodman et al., 2007; OR=.07, $p < .05$ for the study of Poff et al., 2024), and the Montreal Cognitive Assessment (MoCA) ($R2 = .142$, $p = .001$ for the study of Prieto et al., 2022; OR=.93 (.87 −.99 CI) for the study of Saadi et al., 2021). This association remained significant after controlling for all different confounders included in the studies, including age and anxiety (Burri et al., 2013; Goodman et al., 2007; Nilaweera et al., 2020; Poff et al., 2024; Saadi et al., 2021).

3.6. Effects on memory

As can be observed in Table 1, the three longitudinal good quality studies reporting on the association between PTSD and memory performance showed mixed results, with one study showing accelerated decline in memory performance in individuals with PTSD as compared to no PTSD ($\beta = -0.08$, $p < .001$) (Roberts et al., 2022), one study showing no significant difference between these two groups (OR=.78, $p > .05$) (Nilaweera et al., 2020), and one study showing a significant negative association between PTSD and explicit memory performance ($t = 2.35$, $p = .03$ at baseline and $t = 2.27$, $p = .01$ at 5 year follow-up), while showing no significant difference between individuals with and without PTSD on implicit memory performance ($t = .21$, $p > .05$ at baseline and $t = .02$, $p > .05$ at follow-up) (Yehuda et al., 2006).

Eleven satisfactory quality cross-sectional studies assessed effects of PTSD on memory (see Table 2). Results of these cross-sectional studies were mixed, with six studies showing that PTSD significantly worsens performance on memory tests, compared to individuals without PTSD (Golier et al., 2005; Goodman et al., 2007; Yehuda et al., 2004, 2005, 2007a, 2007b) and three studies reporting that individuals with PTSD do not perform significantly different from individuals without PTSD (Green et al., 2016; Hart et al., 2008; Noland et al., 2023).

Two cross-sectional (Golier et al., 2003; Ranger et al., 2021) and one longitudinal study (Yehuda et al., 2006) showed different effects of

Table 5 –
Tests and subtests utilised in the included studies categorised per domain.

	Cognitive functioning domain				
	General cognitive functioning	**Memory**	**Attention**	**Executive functioning**	**Other neurocognitive domains**
Tests and subtests utilised	The performance part of the SIDAM	RAVLT	The Digit Span subtest of the WAIS-III	The Letter Number sequencing subtest from the WMS-III	**Processing speed**
	The MMSE	BVRT	The Cogstate Brief Battery	The Cogstate Brief Battery	Digit Symbol subtest of the WAIS-III
	The MoCA	MPMT	The TMT part A	The TMT	The CWIT
		Warrington Recognition Memory Test (faces)		The AFT	DKEFS word reading subtest
		The Rey-Osterrieth Complex Figure test		The COWAT	DKEFS colour naming subtest
		The WMS-III logical memory subtests		The MAT	
		The Cogstate Brief Battery		The CWIT	**Construction skills and verbal numeracy**
		Paired associate recall test		The Victoria Stroop test	The performance part of the SIDAM
		Word stem completion test			
		The Guild memory test			**Psychomotor speed**
		The CVLT			The Cogstate Brief Battery
					The Digit Symbol Modalities test
					Visual scanning
					The TMT
					Visuoconstructive skills
					The Rey-Osterrieth Complex Figure test
					Verbal Fluency
					The Isaacs Set test
					Boston Naming test
					Category fluency test
					Spatial Orientation
					Judgement of line orientation test

Animal Fluency Test (AFT); Benton's Visual Retention Test (BVRT); California Verbal Learning Test (CVLT); Color-Word Interference Test (CWIT); Controlled Oral Word Association Test (COWAT); Delis-Kaplan Executive Functioning System (DKEFS); Mental Alternation Test (MAT); Miami Prospective Memory Test (MPMT); Mini-Mental State Examination (MMSE); Montreal Cognitive Assessment (MoCA); Rey Auditory Verbal Learning Test (RAVLT); Structured Interview for Diagnosis of Dementia of Alzheimer Type, Multi-infarct Dementia and Dementia of other Etiology according to ICD-10 and DSM-III-R (SIDAM); Trail Making Test (TMT); The Wechsler Adult Intelligence Scale – Third Edition (WAIS-III); Wechsler Adult Intelligence Scale-Revised (WAIS-R); Wechsler Memory Scale-III (WMS-III)

PTSD on different kinds of memory. Yehuda et al. (2006) ($t = 2.35$, $p = .03$ at baseline and $t = 2.27$, $p = .01$ at 5 year follow-up) and Golier et al. (2003) ($F=4.93$, $p = .01$) reported poorer explicit memory performance (i.e. conscious retrieval of past information, also known as declarative memory) in individuals with PTSD, as measured with the paired associate recall test, but no significant difference in implicit memory performance (i.e. unconscious retrieval of information) between individuals with and without PTSD, as measured with the word stem completion test ($t = .21$, $p > .05$ at baseline and $t = .02$, $p > .05$ at follow-up for Yehuda et al., 2006; $F=1.79$, $p = .17$ Golier et al., 2003). Ranger et al. (2021) reported significant poorer prospective memory performance (i.e. remembering information that is going to happen in the future) in the PTSD group compared to the no PTSD group, as measured with the Miami Prospective Memory Test (MPMT) ($\eta_p 2 = .01$, $p < .01$), while for explicit memory, as measured with the Rey Auditory Verbal Learning Test (RAVLT), no significant difference between individuals with and without PTSD was observed ($\chi 2\ (1) = 1.13$, $p = .29$).

3.7. Effects on attention

As can be seen in Table 1, the one good quality longitudinal study on attention showed that PTSD is associated with accelerated decline in attention performance as measured by the Cogstate Brief Battery ($\beta = -0.05$, $p = .02$) (Roberts et al., 2022). Two cross-sectional studies showed that individuals with PTSD performed significantly worse on attention tasks, as compared to individuals without PTSD, measured with the Digit Span subtest of the WAIS-III ($F=5.9$, $p = .02$) (Yehuda et al., 2007a) and the Trail Making Test (TMT) part A and the Digit Span subtest of the WAIS-III ($\beta = -.27$, $t = -2.14$, $p = .03$) (Noland et al., 2023). The third cross-sectional study on attention did not show any significant differences between individuals with and without PTSD on attention performance, as measured with the Digit Span subtests ($F=1.98$, $p = .174$ for Digit Span forward and $F=0.66$, $p = .426$ for Digit Span backward) (Goodman et al., 2007).

3.8. Effects on executive functioning

Two good quality longitudinal (Nilaweera et al., 2020; Roberts et al., 2022) and five satisfactory quality cross-sectional studies (Green et al., 2016; Hart et al., 2008; Noland et al., 2023; Ranger et al., 2021; Yehuda et al., 2007a) reported mixed findings on PTSD and executive functioning (see Tables 1 and 2). One longitudinal study reported PTSD being associated with accelerated decline in executive functioning performance over a one year follow-up period, as measured with the Cogstate Brief Battery ($\beta = -0.08$, $p < .001$) (Roberts et al., 2022). Another longitudinal study showed no significant difference in executive functioning performance of individuals with and without PTSD over a follow-up period of 14 years, as measured with the TMT ($OR=0.78$, $p = .20$) (Nilaweera et al., 2020).

Three cross-sectional studies reported no significant differences in executive functioning performance between individuals with and without PTSD, measured by the TMT ($\beta = .14$, $p = .068$) and Color-Word

Interference test (CWIT) (β =.10, $p > .05$) (Green et al., 2016), the TMT part b and CWIT (β = −0.20, t = -1.33, $p = .19$) (Noland et al., 2023), and the Controlled Oral Word Association Test (COWAT) ($p > .05$) and the digit span test ($p > .05$) (Hart et al., 2008). In this study of Hart and colleagues, no effect size coefficients were mentioned for these associations. One cross-sectional study reported poorer executive functioning performance in individuals with PTSD, compared to individuals without PTSD, measured by the Digit Span test (F=6.56, $p = .016$) (Yehuda et al., 2007b).

Ranger et al. (2021) reported mixed results depending on the test used. PTSD was linked to poorer performance on the Victoria Stroop test (ηp2 = .01, $p = .02$), measuring inhibition and mental control, and the Mental Alternation Test (MAT) (η_p^2 =.02, $p < .01$), measuring set shifting, compared to individuals without PTSD. However, no significant effect of PTSD on executive functioning was observed when using the COWAT ($p = .20$) and the Animal Fluency Test (AFT) ($p = .23$). Both measuring verbal fluency. For the associations between PTSD and COWAT or AFT performance, no effect size coefficients were mentioned in the study.

3.9. Effects on other cognitive domains

Two included good quality longitudinal (Nilaweera et al., 2020; Roberts et al., 2022) and four included satisfactory quality cross-sectional studies investigated effects of PTSD on processing speed, visual scanning, psychomotor speed, visuoconstructive skills, verbal fluency, spatial orientation, construction skills, and verbal numeracy (Burri et al., 2013; Goodman et al., 2007; Hart et al., 2008; Noland et al., 2023). In one longitudinal study, PTSD was associated with accelerated decline in psychomotor speed performance, measuring the time it takes to process new information and physically respond to it, measured with the Cogstate Brief Battery (β = −0.05, $p = .02$) (Roberts et al., 2022). The longitudinal study by Nilaweera and colleagues (2020) showed no significant difference in verbal fluency performance between individuals with and without PTSD over time (OR=.69, $p > .05$), as measured with the Isaacs Set test (IST) (Nilaweera et al., 2020). This verbal fluency tests assessed one's ability to generate words.

In one cross-sectional study, individuals with PTSD performed significantly worse on construction skills (i.e. the ability to organise and manually manipulate spatial information to make a design) ($X^2 = 6.3$, $p < 0.05$), and verbal numeracy (i.e. the ability to understand, reason with and apply numerical concepts) ($X^2 = 8.8$, $p < 0.05$), as measured by the performance part of the SIDAM (Burri et al., 2013), compared to individuals without PTSD. However, when controlling for depressive symptoms, the PTSD-construction skill association was no longer significant ($p >.05$). Moreover, individuals with PTSD performed significantly worse on visual scanning ($p < .05$) and psychomotor speed ($p < .05$), as measured with the TMT part A and the Digit Symbol Modalities test (Hart et al., 2008). In this study, no effect size coefficients were mentioned for these associations. Psychomotor speed is defined as the time it takes one to process and understand new information, and to physically respond to it. Visual scanning on the other hand, does not require a response, and solely focusses on one's ability to use ocular strategies to efficiently and quickly explore visual information. In the study of Goodman et al., 2007, significant poorer performance of individuals with PTSD on psychomotor speed, compared to individuals without PTSD, was also reported, as measured with the WAIS-R Digit Symbol test (F=5.74, $p = .028$) (Goodman et al., 2007). In this study, non-significant trends for worse performance on visual scanning, as measured with the TMT part A (F=4.75, $p = .066$), and visuoconstructive skills, as measured with the Rey-Osterrieth Complex Figure test (F=2.49, $p = .129$), compared to non-trauma exposed individuals, were also observed (Goodman et al., 2007). In the cross-sectional study of Noland et al., 2023 significant poorer performance of individuals with PTSD on processing speed, compared to individuals without PTSD, as measured with the TMT part A, the Digit Span subtests, and the Delis Kaplan Executive Functioning System (DKEFS) colour naming and word reading subtests, was reported (β = −.27, $t = -2.14$, $p = .03$) (Noland et al., 2023).

4. Discussion

This systematic review aimed to provide an up-to-date overview of the association between PTSD and cognitive functioning in older adults. It is the first review to explore the link between PTSD and specific domains of cognitive functioning in older adults by including studies on individuals with subthreshold levels of PTSD, as well as studies on the general population, rather than focusing on war veterans or Holocaust survivors only, making our results more representative of older people in general. Three good quality prospective longitudinal cohort studies and fifteen satisfactory quality cross-sectional studies were included. The one good quality longitudinal study on global cognitive performance showed accelerated global cognitive decline in individuals with PTSD compared to individuals without PTSD. Similarly, all five included cross-sectional studies on global cognitive functioning found significant poorer global cognitive performance in the PTSD group compared to non-PTSD controls, even after adjusting for confounders such as age.

Accelerated decline of cognitive performance in older adults with PTSD, as compared to non-PTSD controls, was also observed for the separate cognitive domains, with two out of three good quality longitudinal studies on memory showing a significant decline in memory performance and the one good quality longitudinal study on attention showing significant decline in attention performance. Longitudinal results on executive function were mixed, with one good quality longitudinal study reporting accelerated decline in executive functioning performance as compared to individuals without PTSD, and one longitudinal study reporting no significant difference between individuals with and without PTSD. These findings indicate that accelerated global cognitive decline and accelerated decline in memory and attention performance may be associated with PTSD.

For memory performance, most included cross-sectional studies reported significant poorer memory performance in the PTSD group compared to non-PTSD controls. Three studies categorized results by memory domain. These studies showed significant poorer prospective memory performance for individuals with PTSD, as compared to those without PTSD and no significant differences between the two groups for implicit memory performance. For explicit memory performance, results differed between studies, with two studies showing significant poorer explicit memory performance in the PTSD group, compared to the no PTSD group, and one study showing no significant differences in explicit memory performance between the two groups. This discrepancy may stem from differences in neuropsychological tests used: studies showing significant effects used paired associate recall (written memory), while the one showing no effect used the RAVLT (auditory memory). These findings suggest PTSD may affect written and auditory memory differently, although further research is needed to confirm this.

The cross-sectional studies on attention showed mixed findings, with two studies showing a significant negative association between PTSD and attention and one study showing no significant differences in attention performance between individuals with and without PTSD. However, two out of the three cross-sectional studies reported small sample size (Goodman et al., 2007; Yehuda et al., 2006), which may have resulted in loss of statistical power to detect effects. Future studies are needed to draw certain conclusions on the cross-sectional association between attention and PTSD.

For executive function, results were similar, with one out of five cross-sectional studies reporting significant poorer executive functioning performance for individuals with PTSD, and three cross-sectional studies reporting no significant differences between people with and without PTSD. One cross-sectional study reported mixed results for the association between PTSD and executive functioning, with no significant differences between individuals with and without PTSD

on measures of verbal fluency, but significant poorer performance of individuals with PTSD on measures of inhibition, mental control, and set shifting. Possibly, the effects of PTSD on executive function performance may differ for different executive function domains.

Cross-sectional and longitudinal studies on other neurocognitive domains reported significant poorer performances for individuals with PTSD, compared to individuals without PTSD, on verbal numeracy, psychomotor speed, visuomotor speed, visual scanning, and processing speed.

Effects of PTSD may thus affect many different cognitive domains, potentially leading to various different problems in the daily lives of older adults with PTSD. No conclusions can be drawn on the effects of subthreshold PTSD, as none of the studies directly addressed its impact on cognitive performance. However, three included studies measured the association between cognitive performance and PTSD symptoms, instead of PTSD diagnosis (Prieto et al., 2022; Roberts et al., 2022; Saadi et al., 2021), showing that higher PTSD symptoms were associated with general cognitive impairment (Prieto et al., 2022; Saadi et al., 2021), and accelerated cognitive decline in learning, working memory, psychomotor speed, and attention (Roberts et al., 2022). Unfortunately, these studies did not differentiate between subthreshold and clinical PTSD or specify symptom thresholds for these effects.

4.1. Implications for theory

A prior meta-analysis by Schuitevoerder et al. (2013) revealed worse cognitive performance in older adults with PTSD compared to individuals without PTSD. The current review confirms and strengthens these results by including more articles with larger sample sizes (e.g. Nilaweera et al., 2020; Ranger et al., 2021) and including more studies reporting on the general population rather than on war veterans and Holocaust survivors only (e.g. Nilaweera et al., 2020; Saadi et al., 2021). Schuitevoerder et al. (2013) reported that the association between PTSD and cognitive functioning in older adults may be due to worse memory performance. Unfortunately, no meta-analysis could be performed in the current study due to the heterogeneity of the tests and statistical measures used in the included studies. Nevertheless, when looking at separate study results, most studies included in this review observed significantly worse memory performance of individuals with PTSD compared to individuals without PTSD. Multiple included studies also reported poorer performance of individuals with PTSD on measures of global cognitive performance and attention, compared to older people without PTSD.

The association between PTSD and cognitive dysfunction, especially in memory and attention, is consistent with findings in younger adults (Johnsen & Asbjørnsen, 2008; Scott et al., 2015; Woon, Farrer, Braman, Mabey, & Hedges, 2017). Contradictory findings are observed for executive functioning.

Significant associations are generally reported in younger adults (Scott et al., 2015; Woon et al., 2017). Results in older adults are more mixed, with studies showing a significant association between PTSD and executive functioning performance and studies showing no significant association. The decline of PTSD's impact on executive functioning over time, potentially becoming non-significant by the age of 60, seems unlikely considering persistent associations with other cognitive domains and multiple included studies reporting a significant negative association between PTSD and executive functioning. It may be possible that performance of all older adults has a steeper decline on executive functioning tasks, as compared to performance on the other cognitive domains, making it more difficult to determine any significant differences in deterioration of executive functioning performance in the PTSD group as compared to the control group. Discrepancies between results for adults aged 60 and over and younger adults may also be due to the heterogeneity of the executive functioning domain. The executive functioning domain consists of many different subdomains, such as inhibition, working memory, and set shifting. Possibly, a significant difference in performance between individuals with and without PTSD is present for one, or multiple, certain subdomain(s) of executive functioning, while for other subdomains no significant difference in performance is present. This phenomenon was also observed in the study of Ranger et al. (2021), included in the current review. Perhaps the studies on younger adults investigated other executive functioning subdomains compared to the studies on adults aged 60 and over. Unfortunately most studies on executive functioning did not specify which executive functioning subdomain they measured or applied multiple different tests, which all measured different subdomains. Therefore, it is recommended that future studies on executive functioning clearly divide results by type of executive functioning subdomain.

4.2. Possible underlying mechanisms for the association between PTSD and cognitive functioning

Underlying mechanisms for the association between PTSD and cognitive functioning are currently unknown. A possible underlying mechanism was mentioned in our introduction, stating that PTSD has recently been reconceptualised as a systemic disorder, where cumulative (life) stress is believed to lead to molecular damage (Miller & Sadeh, 2014). These molecular changes in the stress response system, i.e. the allostatic load (Cohn-Schwartz et al., 2024; McEwen, 2013), affect various aspects of one's health, including brain structures (Lohr et al., 2015). These changes may worsen cognitive functioning and heighten the risk of triggering or exacerbating neurodegenerative processes (Bennett et al., 2009; Greenberg et al., 2014; Miller et al., 2018). For instance, prolonged stress exposure could damage brain structures crucial for cognitive functioning, such as the prefrontal cortex and hippocampus (Friedman et al., 2019; Miller et al., 2018), indirectly leading to cognitive dysfunctions. PTSD particularly affects the functional connectivity within the brain's default mode network (DMN), which is active during rest rather than goal-directed tasks (Raichle, 2015). The DMN involves brain areas like the hippocampus, posterior cingulate cortex, and lateral parietal cortex, which are also crucial for memory, attention, and working memory (Akiki et al., 2018; Leech & Sharp, 2014; Peters, Kaiser, Rahm, & Bledowski, 2015).

The complexity of the PTSD-cognitive functioning association can also be an epiphenomenon. Among factors which may interfere with cognition and are also often present in PTSD are for example reduced social interaction, sleep deprivation, and unhealthy lifestyle habits. Comorbid psychiatric and somatic conditions, such as anxiety, ADHD, traumatic brain injury, or cardiovascular disease, commonly associated with PTSD, may contribute to cognitive dysfunctions observed in individuals with PTSD, as they are associated with poorer cognitive performance, independent of PTSD (Edmondson & Cohen., 2013; Eysenck, 2015; Monsour, Ebedes, & Borlongan, 2022; Silva et al., 2013). Studies suggest that depressive symptoms may partly mediate the PTSD-cognitive performance association, linking PTSD symptoms to depressive symptoms, which are associated with impaired cognition (Cohn-Schwartz et al., 2024). Prevalence rates of comorbid major depressive disorder in older adults with PTSD vary between 14.7 %–62.5 % (Baltjes, Cook, van Kordenoordt, & Sobczak, 2023). Comorbid depressive symptoms in individuals with PTSD are associated with increased suicidality, worse quality of life, and lower PTSD-treatment effectiveness (Panagioti, Gooding, & Tarrier, 2012; Raab, 2015; Rosen, Ortiz, & Nemeroff, 2020). Moreover, previous studies in younger adults show that comorbid depressive symptoms are associated with worse executive function, verbal memory, and processing speeds performance, as compared to individuals with PTSD without comorbid depressive symptoms (Koopowitz et al., 2021; Nijdam, Gersons, & Olff, 2013; Olff, Polak, Witteveen, & Denys, 2014). To our knowledge, no research has examined the effects of the interaction between PTSD and comorbid depressive symptoms on cognitive performance in older adults. Nevertheless, studies on younger adults highlight the importance of distinguishing between individuals with PTSD with and without comorbid

depression, as their cognitive profiles may also differ in older adults. This is especially relevant when assessing PTSD according to DSM-5 criteria, which includes a diagnostic cluster for negative alterations in mood and cognition in PTSD diagnosis, a feature not present in other diagnostic systems, such as the DSM-4 or ICD-11 (American Psychiatric Association, 2013). The inclusion of this diagnostic cluster connects PTSD to depressive symptoms, in which negative alterations in mood and cognition are also present. In the current review, one of the eighteen included studies assessed PTSD according to DSM-5 criteria (Saadi et al., 2021), finding an association between PTSD symptoms and general cognitive impairment in Asian but not Latino older adults. Unfortunately, this study did not report separate study results for individuals with and without comorbid depressive symptoms. Therefore, no conclusion can be drawn on different cognitive profiles for individuals with and without comorbid depression.

Multimorbidity (more than 2 disease at a point in time) and associated polypharmacy (more than 5 different medicines) may be other interfering factors which are highly clinical relevant. Although some studies included in this review controlled for anxiety (e.g. Saadi et al., 2021; Yehuda et al., 2007b) and one study controlled for the effects of metabolic syndrome (Green et al., 2016), few address other comorbidities like cardiovascular diseases or ADHD. Future research should account for these potential confounders and separate study results for individuals with and without comorbid depressive symptoms, to better understand the PTSD-cognition relationship.

4.3. Strengths and limitations

Previous reviews on cognitive functioning in individuals with PTSD did not classify neuropsychological tests by neurocognitive domain (e.g. Rehman et al., 2021; Schuitevoerder et al., 2013). The current review is the first to do so, helping to identify specific cognitive domains affected by PTSD.

This review is the first to include multiple studies on the association between PTSD and cognitive functioning reporting on the general population of older adults. Unlike previous reviews, which focused on male combat veterans and Holocaust survivors (Schuitevoerder et al., 2013), this review encompassed various populations, including non-veterans and nurses, enhancing sample representativeness. Most included studies additionally had a mixed gender distribution, focussing on both females and males. This review is also the first to mention ethnicity of all included studies and to include at least one study with a fully non-white sample, further increasing the representativeness of our results to the general population.

All eighteen studies included in this review were of satisfactory or good quality to assess the association between PTSD and cognitive functioning and at least two different possible confounders were controlled for in every included study, enhancing the certainty of our results. However, only three of the eighteen included studies were good quality prospective longitudinal cohort studies, precluding any consistent conclusions on temporal effects of PTSD on cognitive performance, i.e. whether PTSD causes worse cognitive performance at the moment of PTSD diagnosis or whether it is also linked to future decline of cognitive performance. Few longitudinal studies showed persistent cognitive deficits up to 14 years post-PTSD diagnosis, but, since most studies only compared cognitive test results of individuals with PTSD to individuals without PTSD and not to previous results of the same individuals with PTSD, more general good quality prospective longitudinal studies comparing cognitive results in the same group over time are needed to confirm temporal effects of PTSD on cognitive functioning. Future studies should report on sufficient sample sizes to ensure enough statistical power to detect effects on cognitive functioning in individuals with PTSD, as multiple currently included studies may have too small sample sizes (e.g. Goodman et al., 2007; Hart et al., 2008; Yehuda et al., 2006). Results based on these studies make it difficult to draw any certain conclusions on the association between PTSD and cognitive functioning, especially for attention, as two out of the three included cross-sectional studies on attention reported on a small number of older people (Goodman et al., 2007; Yehuda et al., 2006).

The heterogeneity of PTSD and cognitive measures utilised in the included studies, hindering direct comparisons between studies via meta-analysis, is another limitation of the current review. A meta-analysis could create more certainty on the association between PTSD and cognitive functioning. Standardisation of measurements in future work is therefore recommended. Three studies included in the current review did not mention effect size coefficients of the association between PTSD and cognitive function in their study, merely mentioning the significance level of the association (Burri et al., 2013; Hart et al., 2008; Ranger et al., 2021). These effect sizes not being available for review also hindered the possibility to conduct a meta-analysis. In accordance with APA guidelines, it is recommended that future studies report effect size coefficients of all statistical tests performed.

Lastly, our study results could be biased by our selection criteria for PTSD diagnosis. It was decided to include studies in which participants had a PTSD or subthreshold PTSD diagnosis, according to clinical diagnostic criteria of the DSM-3, DSM-3-R, DSM-4, DSM-5, ICD-9, ICD-10 or ICD-11, to be able to include more studies on the effects of PTSD on cognitive functioning, as various studies did not use any diagnostic tool to diagnose PTSD. Therefore, PTSD diagnosis could have also been made by clinical examination without any diagnostic tool. Clinical examination without any diagnostic tool, however, introduces the possible modifying effect of interviewer bias. Future studies should always assess PTSD levels with help of a diagnostic tool, preferably the CAPS-5.

4.4. Implications for practice and recommendations for future research

The longitudinal studies included in the current review showed that PTSD is associated with accelerated decline in cognitive performance, identifying PTSD as a potential risk factor for cognitive decline in older people. A proactive approach of regular cognitive assessment of PTSD patients, screening for those at risk of cognitive decline, which may potentially lead to MCI or dementia, is recommended. Preventive interventions, such as promoting a healthy lifestyle (Mangialasche, Kivipelto, Solomon, & Fratiglioni, 2012; Middleton & Yaffe, 2009), could be implemented in the care of individuals at risk for cognitive decline, to potentially delay MCI and dementia onset, which could reduce healthcare costs, as dementia is one of the major sources of global disability (Livingston et al., 2017; Prince et al., 2013). Fear of further deterioration of cognitive performance and stigmatisation around cognitive problems however need to be carefully managed so it does not lead to social distancing and not seeking treatment, which could diminish effects of PTSD treatment (Casey et al., 2008; Nichter et al., 2019). Psychoeducation on cognitive dysfunctions associated with PTSD, MCI, and dementia, and teaching coping strategies, are needed to mitigate the negative consequences and fear of cognitive dysfunction. PTSD treatment should also be tailored to the needs of the individual with PTSD, focussing on global cognition, memory, and attention problems, in addition to trauma. It should for instance, integrate memory strategies, such as using repetition and planning with help of an agenda, and support for reintegration into work and society to prevent (premature) discontinuation of work and social isolation.

Future research recommendations include standardisation of measurement tools, by publishing specific recommendations on the preferred measurement tools available for every neurocognitive domain. PTSD should be measured with a diagnostic tool, preferably the CAPS-5, to minimise possible moderation effects of interviewer bias (Havermans et al., 2025). The CAPS has good sensitivity and specificity (Hovens et al., 1994), high internal consistency, with an alpha of.94 for the CAPS total score (Blake et al., 1995), and good test-retest reliability ranging from.90–.98 (Blake et al., 1995). Future studies should additionally report effect size coefficients of all statistical tests performed in their study to enable future meta-analysis. Moreover, results of future studies

should be divided by neurocognitive domain and report on large samples. More studies should be performed on effects of PTSD on attention, different memory subdomains (e.g. implicit and explicit memory), different executive function subdomains, and the effects of subthreshold PTSD on cognitive performance. The predominance of cross-sectional studies precluded any consistent conclusions on temporal effects of PTSD on cognitive performance. More good quality prospective longitudinal studies comparing results of individuals with PTSD over time should be performed to understand long-term effects of PTSD on cognition, as well as to investigate any possible link with MCI or dementia. Finally, future studies on PTSD and cognition should also account for potential confounders of the PTSD-cognitive function relationship, such as polypharmacy or comorbid conditions often observed in individuals with PTSD (e.g. ADHD or traumatic brain injury). To account for the mediative effects of depression on the PTSD-cognition association, future studies should also consider analysing results by presence of depressive symptoms, as cognitive profiles may differ between older people with or without co-morbid depression.

5. Conclusion

In adults aged 60 and over, PTSD is observed to be associated with poorer cognitive functioning, especially in global cognitive functioning and memory. Longitudinal studies showed that PTSD is associated with significant accelerated cognitive decline for global cognition, and possible decline in memory and attention performance. For executive functioning, longitudinal and cross-sectional study results were mixed, with studies showing accelerated decline or significant differences in executive functioning performance between individuals with and without PTSD and studies showing no significant differences between these two groups. Further research is needed to clarify the association between PTSD and cognition, especially on distinct cognitive domains and the association between subthreshold PTSD and cognitive performance. Treatments of older adults with PTSD should not only focus on trauma, but additionally consider treating and screening for cognitive symptoms and decline.

CRediT authorship contribution statement

van Rossum Jasmijn Elise: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Semmy Op den Camp:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Renske Uiterwijk:** Writing – review & editing, Validation, Supervision, Investigation. **Kay Deckers:** Writing – review & editing, Methodology, Investigation. **Vasiliki Orgeta:** Writing – review & editing. **Gulpers Bernice:** Writing – review & editing. **Sjacko Sobczak:** Writing – review & editing, Validation, Supervision, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. – Search strategy and search terms

PsycINFO, Medline, and CINAHL were searched to identify eligible articles. The terms post-traumatic stress disorder, PTSD, post traumatic stress disorder, posttraumatic stress disorder or post-traumatic were combined with the search terms aged 60 and over, adult, elderly, older adult, aged or late adulthood to delineate our study population. Moreover, the terms cognit*, neurocognit*, neuropsycho*, cognitive functioning, intraindividual coefficient of variation (ICV), global cognitive functioning, Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MOCA), attention, working memory, language, executive function, memory, visuoconstruction, visuospatial abilities or fine motor skills were added to our search across the search engines to investigate the relationship between PTSD and cognitive functioning. NOT treatment or therapy was added to put the focus on the association between PTSD and cognition while excluding articles on Cognitive Behavioural Therapy (CBT). We hand-searched reference lists of relevant previous meta-analyses and systematic reviews on this topic for inclusion. Two reviewers (J.E.V.R. and S.O.D.C) independently screened abstracts of all articles identified to determine eligibility.

Appendix B. – Rating of the Newcastle-Ottawa Scale (NOS) for longitudinal and cross-sectional studies

Longitudinal studies are rated on:

- Representativeness of the sample
- Whether a non-exposed cohort was included in the study (if included, 1 point was given)
- Ascertainment of exposure
- -Whether the outcome (cognitive functioning) was not present (i.e. not measured) at baseline
- -Whether there was adjusted for important other factors (e.g. age)
- -Whether there was adjusted for additional factors (1 point if there was adjusted for additional factors)
- -Assessment of outcome
- Whether a follow-up period was present
- -Adequacy of the follow-up

A total of 9 points could be given to the longitudinal studies.

Cross-sectional studies are rated on:

- Representativeness of the sample
- Whether a non-exposed cohort was included in the study (if included, 1 point was given)
- Ascertainment of exposure
- -Whether there was adjusted for important other factors (e.g. age)
- -Whether there was adjusted for additional factors (1 point if there was adjusted for additional factors)
- -Assessment of outcome

A total of 6 points could be given to the cross-sectional studies.

Data Availability

No data was used for the research described in the article.

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