What Are the Predictors of Post-traumatic Stress Disorder Among Road Traffic Accident Survivors

A Systematic Review

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Abstract: Traffic accidents put tremendous burdens on the psychosocial aspects of communities. Post-traumatic stress disorder (PTSD), after an accident, is one of the most prevalent and incapacitating psychiatric conditions worldwide. In this systematic review, we aimed to investigate the predictors of PTSD in traffic accident victims. Primary search was conducted in November 2021 and updated in 2023. Studies were excluded if they used any analysis except regression for predictors. Cumulatively, primary and update searches retrieved 10,392 articles from databases, and of these, 87 studies were systematically reviewed. The predictors were categorized into sociodemographics, pretrauma, peritrauma, and post-trauma factors. The PTSD assessment time varied between 2 weeks and 3 years. Being a woman, having depression and having a history of road traffic accidents pretraumatically, peritraumatic dissociative experiences, acute stress disorder diagnosis, rumination, higher injury severity, and involvement in litigation or compensation after the trauma were significant predictors of PTSD.

Key Words: Stress disorders, post-traumatic, PTSD, crashes, traffic, accidents, traffic

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There are often long-lasting physical and psychological effects from road accidents. The care process for accident victims involves different specialties. However, little information is available regarding the risk factors for developing psychiatric diseases, such as post-traumatic stress disorder (PTSD) after accidents, and how psychological issues affect medical care (Hasselberg et al., 2019; Heron-Delaney et al., 2013). PTSD is one of the most prevalent and incapacitating psychiatric diseases in the world after an encounter, such as a car accident, terrorist attack, nuclear accident, or natural disaster (flood, hurricane, earthquake) (Galea et al., 2005; Mosaku et al., 2014). According to the World Health Organization's (WHO) Global Burden of Disease Survey, mental illnesses, especially disorders linked to stress, will rank as the second most common cause of disability globally by 2020 (Lopez and Murray, 1998). It is a public health issue closely related to poor quality of life and higher poverty levels, unemployment, unstable living conditions, and changes in social networks. A range of circumstances contribute to the occurrence of PTSD, and considerable studies in several nations, including East Africa, have found wide heterogeneity in the factors linked with PTSD among individuals. However, female sex, lack of social support, divorce, pretraumatic depressive symptoms, personal or family history of mental illness, common mental disorders, the severity of the injury, history of near misses, use of psychiatric medication, anxiety, depression, and history of a road accident were among the main factors identified in the literature as significantly associated with PTSD (Beck and Coffey, 2007; Bedaso et al., 2020; Fekadu et al., 2019; Juma et al., 2020; Kenardy et al., 2018; Liu et al., 2017).

Despite road safety guidelines, vehicle safety, and driver education advancement, millions of people are injured in car accidents yearly. Many of these people will develop PTSD, which can become chronic. Therefore, it is crucial to identify these people early to intervene and prevent further impairment and disabilities. Many articles have been published to determine the risk factors or predictors of PTSD after road traffic accidents (RTAs). A previous study by Heron-Delaney and colleagues in 2013 determined the possible risk factors for PTSD after RTAs (Heron-Delaney et al., 2013). Herein, we aimed to do a systematic review, update the previous study on the predictors, and decide which factors are most common in different regions.

METHODS

According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), this systematic review was conducted using the following keywords:

((("Accidents, Traffic"[Mesh]) OR ((((((((((("Traffic Accident*"[Title/Abstract]) OR ("Traffic Collision*"[Title/Abstract])) OR ("Traffic Crash*"[Title/Abstract])) OR ("road accident*"[Title/Abstract])) OR ("motorcycle accident*"[Title/Abstract])) OR ("motorcar accident*"[Title/Abstract])) OR ("motor vehicle accident*"[Title/Abstract])) OR (accident*[Title/Abstract])) OR (incident[Title/Abstract])) OR ("road traffic"[Title/Abstract])) OR ("motorcycle traffic accident*"[Title/Abstract]))) AND (((("Stress Disorders, Post-Traumatic"[Mesh]) OR ((((((PTSD [Title/Abstract]) OR ("Moral Injur*"[Title/Abstract])) OR ("Post-traumatic Neuroses"[Title/Abstract])) OR ("Post traumatic Neuroses"[Title/Abstract])) OR ("Post-traumatic Neuroses"[Title/Abstract])) OR ("Posttraumatic Stress Disorder*"[Title/Abstract])) OR ("Post traumatic Stress Disorder*"[Title/Abstract]))) OR ("Post-traumatic Stress Disorder*"[Title/Abstract])) in PubMed, Ovid, ProQuest, Scopus, Web of Science, and Cochrane Library. No specific limitations for the search were defined. The initial search was conducted on November 2021. Primarily 10,089 records were retrieved. After deleting duplicates, 5,231 abstracts were recovered, and

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4,633 articles were removed. From the remaining 598 full-text articles, 514 were excluded, and 84 studies were included. The reference lists of included studies were also checked. The update search was performed in February of 2023. Three hundred three studies were retrieved, and among them, three studies were included.

INCLUSION/EXCLUSION CRITERIA

The inclusion criteria were as follows: studies with RTA survivors diagnosed with PTSD. All populations, including adults and children, were included in this systematic review. Case studies and dissertations were excluded. In case of not having access to full text, the study was excluded. We only entered studies with regression for predictors in the main data extraction table, which involves estimating the best straight line to summarize the association (Crawford, 2006). Other studies with analysis, except the regression model to predict PTSD in RTA survivors, are added to the supplementary Table 2 (http://links.lww.com/JNMD/A178).

Study Selection

All of the retrieved results were imported to the EndNote reference manager. After deleting duplicates, the selection process was performed by two independent researchers separately in both in-title and full-text ways, cross-checked, and, in case of any conflicts, resolved by discussion or comment from the third author.

Data Extraction

We categorized all included predictors into four groups:

(1) sociodemographics were sex, age, marital status, education, income, race, use of substances, alcohol consumption, work status, and family communication;
(2) pretrauma factors were depression, psychiatric disease before the RTA, chronic disease before RTA, previous RTA, and road user type;
(3) peritrauma factors were peritraumatic dissociative experiences, cognitive processing during RTA, self-perceived threat, death threat, witnessing death, accident severity, and injury severity; and
(4) post-trauma factors were acute stress disorder (ASD), pain severity, anxiety, rumination, poor social support, baseline heart rate (HR) or blood pressure (BP), cortisol levels at initial assessment, and involvement in litigation or compensation. We also categorized significant predictors by WHO regions.

Then, two independent reviewers applied the modified standard JBI data extraction tool to extract data from eligible articles. Extracted data were as follows: first author, publication date, WHO region of study, the time point of the assessment, and predictors evaluated using regression analysis. Any disagreement was settled by discussion or a third reviewer's comment. Results are presented in Tables 1–4. In addition, less cited predictors are shown in the supplementary Table 1 (http://links.lww.com/JNMD/A178).

Assessment of Methodological Quality

According to standardized critical appraisal instruments from the Joanna Briggs Institute, eligible studies underwent critical appraisal by two independent reviewers at the study level. Any reviewer disagreements were resolved by discussion or consultation with the third reviewer. Studies with a half or higher score in questions were included as high or moderate-quality studies (available at https://jbi.global/critical-appraisal-tools).

RESULTS

Study Inclusion

Both primary and update searches retrieved a total of 10,392 articles from databases. After removing duplicates ($n = 4,858$), reviewing the titles/abstracts, and reading the full text of eligible articles, 623 full texts were evaluated, and 87 studies were systematically reviewed (Fig. 1).

Methodological Quality

Eligible studies were reviewed using the JBI Evidence Quality Evaluation Checklist. Results demonstrated that all the included studies had moderate to high quality (more than 70% "yes" response).

Characteristics of Included Studies

The full details of included studies are presented in Tables 1–4. Figure 2 depicts the prevalent predictors based on WHO regions. According to these regions, two included studies were located in the Eastern Mediterranean region, with total participants of 528 people. The Southeast Asian region also had two studies with 354 participants. The African region had five included studies with a total of 1,703 participants. The 18 studies of the Western Pacific region had cumulatively 2,788 participants. In the European area, 5,444 people were members of 26 studies, and 24 studies in the American region had a total of 8,061 participants.

Sociodemographics

Sex

Sex was the most cited factor among sociodemographics. Accordingly, female participants were more susceptible to being diagnosed with PTSD (Blanchard et al., 1996b; Chossegros et al., 2011; Daddah et al., 2022; Dougall et al., 2001; Ehlers et al., 1998; Fujita and Nishida, 2008; Irish et al., 2008, 2011; Kessler et al., 2021; Khodadadi-Hassankiadeh et al., 2017b; Li et al., 2021; Mayou et al., 2002; Nishi et al., 2013; Ryb et al., 2009; Stallard and Smith, 2007; Ursano et al., 1999a; Williams et al., 2015; Yaşan et al., 2009; Yohannes et al., 2018). However, nonsignificant results were more prominent than significant results (Bedaso et al., 2020; Coronas et al., 2008, 2011; Dougall et al., 2001; Ehlers et al., 1998; Freedman et al., 2002; Fuglsang et al., 2004; Fujita and Nishida, 2008; Huh et al., 2017; Irish et al., 2008; Kassam-Adams et al., 2009; Keppel-Benson et al., 2002; Kovacevic et al., 2021; Kupchik et al., 2007; Landolt et al., 2005; Lee et al., 2021; Matsuoka et al., 2008; Naim et al., 2014; Pervanidou et al., 2007; Pires and Maia, 2013; Ryb et al., 2009; Stallard et al., 2001; Ursano et al., 1999a; Vaiva et al., 2003; Yaşan et al., 2009; Yoshino et al., 2022). In addition, the time interval from RTA to PTSD diagnosis in studies with sex as a significant predictor varied between 4 weeks and 3 years. Sex was a significant predictor in 18 studies with 8,704 participants. In detail, there were seven studies in America (total $N = 5,228$), five studies in Europe (total $N = 1,678$), two studies in Eastern Mediterranean (total $N = 528$), three studies in the Western Pacific (total $N = 405$), and two studies in Africa (total $N = 865$).

Age

Age was the other factor observed for PTSD prediction. It was associated with the diagnosis of PTSD from 6 weeks to 2.5 years. However, age had more nonsignificant relations that varied between 1 and 18 months (Bedaso et al., 2020; Coronas et al., 2011; Holeva et al., 2001; Huh et al., 2017; Irish et al., 2008; Keppel-Benson et al., 2002; Kupchik et al., 2007; Lee et al., 2021; Landolt et al., 2005; Li et al., 2021; Matsuoka et al., 2008; Nishi et al., 2013; Papadakaki et al., 2017; Pervanidou et al., 2007; Ryb et al., 2009; Vaiva et al., 2003; Williams et al., 2015; Yohannes et al., 2018). In studies by de Vries et al. (1999) and Khodadadi-Hassankiadeh et al. (2017b), the age of participants involved in an accident showed an inverse association with PTSD rates. The results show that age under 30 years significantly predicts PTSD after RTA. Lee et al. (2021) reported that older students' age was a predictor 2.5 years after the accident (Lee et al., 2021). A study by Maltais et al. (2022) has said that people older than 65 years are more

TABLE 1. Sociodemographic Factors

Predictor	Significant	Nonsignificant
Sex	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (13), Irish et al. (26), 1 mo: Nishi et al. (16), Ursano et al. (15), Dougall et al. (29), 1 to 4 mos: Blanchard et al. (28), Yohannes et al. (14) 2 mos: Kessler et al. (31), 4 to 12 mos: LI et al. (17), 6 mos: Ryb et al. (24), Chossegros et al. (23), Williams et al. (20), Fujita et al. (22), 8 mos: Stallard et al. (21), 12 mos: Ehlers et al. (19), Irish et al. (25), Daddah et al. (30), Yaşan et al. (18), 3 yr: Mayou et al. (27)	1 mo: Kovacevic et al. (32) (male), Matsuoka et al. (50), Stallard et al. (47), 1 to 4 mos: Coronas et al. (35), 2 mos: Vaiva et al. (37) (male), Coronas (44), 4 mos: Pires et al. (34), Freedman et al. (38) (male), Ehlers et al. (19), Yaşan (18), Naim (46), 6 mos: Ursano et al. (15), Pervanidou et al. (48), Yaşan et al. (18), Kassam-Adams et al. (45), Irish et al. (25), Dougall et al. (29), Holeva et al. (52) 8 mos: Keppel-Benson et al. (41), Fuglsang et al. (43), 12 mos: Landolt et al. (42), Ryb et al. (24), 14 mos: Fujita et al. (22) 18 mos: Huh et al. (39), Bedaso et al. (8), 2.5 to 3 yrs: Lee et al. (33), Kupchik et al. (36), Yoshino (49)
Age	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (13) (<30 yrs), 6 mos: Irish et al. (25), 3 to 12 mos: Mărean et al. (75), 6 to 12 mos: Vries et al. (53) (younger), 2.5 to 3 yr: Maltias et al. (54) (>65 yrs), Lee et al. (33) (2.5 yrs), 12 to 15 yrs: Williams et al. (20)	1 mo: Nishi et al. (16) (1 month), 1 to 4 mos: Coronas et al. (35), Blanchard et al. (28), Yohannes et al. (14), 2 mos: Vaiva et al. (37), 4 to 12 mos: LI et al. (17), 6 mos: Pervanidou et al. (48), Holeva et al. (52), Ryb et al. (24), Williams et al. (20), 6 to 12 mos: Fuglsang et al. (43) 9 mos: Keppel-Benson et al. (41), Fuglsang et al. (43), 12 mos: Papadakaki et al. (51)Landolt et al. (42), Irish et al. (25), Ryb et al. (24), 18 mos: Huh et al. (39), Bedaso et al. (8), 2.5 to 3 yrs: Kupchik et al. (36), Lee et al. (33) (family)
Education	2 mos: Kessler et al. (31), 3 mos: Suliman et al. (58), 6 mos: Suliman et al. (58), 6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (2017a) (56) (Below high school), 2.5 yrs: Lee et al. (33)	1 mo: Arora et al. (55) (Below higher secondary), Nishi et al. (16), 1 to 4 mos: Blanchard et al. (28), 3 mos: Yaşan et al. (18), 6 weeks to 6 mos: Matsuoka et al. (50), 6 mos: Papadakaki et al. (51), Dougall et al. (29), Yaşan et al. (18), 12 mos: Arora et al. (55) (Below higher secondary), Yaşan et al. (18), 18 mos: Huh et al. (39), Bedaso et al. (8), 3 yr: Kupchik et al. (36)
Marital status	2.5 yrs: Lee et al. (33) (missing), 6 mos: Chossegros et al. (23) (divorced or separated)	6 weeks: Papadakaki et al. (51), 1 to 4 mos: Blanchard et al. (28), Yohannes et al. (14), 4 to 12 mos: LI et al. (17), 12 mos: Papadakaki et al. (51), 18 mos: Huh et al. (39), Bedaso et al. (8), 2.5 to 3 yrs: Maltias et al. (54), Lee et al. (33) (student, missing), Kupchik et al. (36)
Race	1 mo: Ursano et al. (57), 3 mos: Suliman et al. (58), 1 to 4 weeks: Blanchard et al. (28), 1 to 4 mos: Blanchard et al. (62),6 mos: Suliman et al. (58)	3 mos: Ursano et al. (57), 6 mos: Williams et al. (20), Kassam-Adams et al. (45)
Income	12 mos: Yaşan et al. (18), Daddah et al. (30), Kobayashi et al. (60), 3 yr: Mayou et al. (27)	1 mo: Ursano et al. (15), 3 mos: Yaşan et al. (18), 6 weeks to 6 mos: Irish et al. (26), 6 mos: Yaşan et al. (18), Kassam-Adams et al. (45), Irish et al. (25), Ursano et al. (15), Williams et al. (20) (6 mos), 12 mos: Irish et al. (25), 18 mos: Bedaso et al. (8), Huh et al. (39), 2.5 yrs: Lee et al. (33) (family).
Work status	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (56) (no RTW), 12 mos: Daddah et al. (30) (no RTW)	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (13) (Employed/ Self-employed), 3 mos: Yaşan et al. (18), 6 mos: Yaşan et al. (18), 1 to 4 mos: Blanchard et al. (28), 18 mos: Huh et al. (39) (unemployment after), 3 yr: Maltias et al. (54)
Family communication	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (56), 9 mos: Wu et al. (61) (poor)	1 mo: Fekadu et al. (7) (poor), 1 to 4 mos: Blanchard et al. (28)
Use of substance		1 to 4 mos: Blanchard et al. (62) (pretrauma) 3 mos: Bedaso et al. (8), 1 to 12 mos: Arora et al. (55) (by the driver)
Alcohol consumption	1 mo: Fekadu et al. (7) (after RTA), 12 mos: Blanchard et al. (62), 2.5 yrs: Lee et al. (33) (family)	1 mo: Kovacevic et al. (32), 1 to 4 mos: Blanchard et al. (62) (1 to 4 mos), 6 mos: Kovacevic et al. (32), 2.5 yrs: Lee et al. (33) (students)

RTW indicates return to work.

susceptible to being diagnosed with PTSD 3 years after a train derailment. Age was a significant predictor in seven studies with 6,101 participants. In detail, there were four studies in America (total $N = 4,812$), one study in Europe (total $N = 633$), one study in Eastern Mediterranean (total $N = 528$), and one study in the Western Pacific (total $N = 128$).

Education

Education was primarily reported between 1 and 18 months (Arora et al., 2021; Bedaso et al., 2020; Blanchard et al., 1996b; Dougall et al., 2001; Huh et al., 2017; Kessler et al., 2021; Kupchik et al., 2007; Matsuoka et al., 2008; Nishi et al., 2013; Papadakaki et al., 2017; Yaşan et al., 2009). Patients with lower levels of education had significant results in only three of included studies (Khodadadi-Hassankiadeh et al., 2017a; Khodadadi-Hassankiadeh et al., 2017b). Education was a significant predictor in four studies with 1,426 participants. In detail, there was one study in America (total $N = 666$), one study in Eastern Mediterranean (total $N = 528$), and one study in the Western Pacific (total $N = 128$).

Marital Status

Marital status was a predictor in families with unknown status but was not remarkable among students after 2.5 years of the accident

TABLE 2. Pretrauma Factors

Predictor	Significant	Nonsignificant
Previous RTA	Ten days: van den Heuvel et al. (64), 1 mo: Kovacevic et al. (32), Delahanty et al. (70), 4 mos: Freedman et al. (38), 6 mos: Kassam-Adams et al. (45), Gabert-Quillen et al. (71), 9 mos: Keppel-Benson et al. (41), 12 mos: Gabert-Quillen et al. (71), Kobayashi et al. (60), 18 mos: Bedaso et al. (8),	2 weeks: Ehring et al. (72), 1 mo: Ehring et al. (72), 3 mos: Ehring (72) , 6 mos: Holeva et al. (52), Ehring et al. (72), 4 to 6 weeks: Matsuoka et al. (50), 1 to 4 mos: Blanchard et al. (62), 3 yr: Kupchik et al. (36)
Psychiatric disease before the RTA	1 mo: Nishi et al. (16), Fekadu et al. (7), 1 to 4 mos: Blanchard et al. (62), 6 mos: Chossegros et al. (23), 12 mos: Ehlers et al. (19), 18 mos: Huh et al. (39)	1 mo: Coronas et al. (35), Kovacevic et al. (32), 4 to 6 weeks: Matsuoka et al. (50), 4 mos: Coronas et al. (35), 18 mos: Huh et al. (39)
Chronic disease before RTA	5 mos: Fujita et al. (22), 14 mos: Fujita et al. (22)	1 to 4: mos: Bedaso et al. (8), 6 mos: Kovacevic et al. (32)3 yr: Mayou et al. (27)
The lifetime incidence of PTSD	1 mo: Delahanty et al. (69), Ursano et al. (15), Ursano et al. (57), 1 to 4 mos: Coronas et al. (44), 3 mos: Ursano et al. (57)	1 to 4 mos: Blanchard et al. (62), 6 mos: Ursano et al. (15)
Depression	Ten days: van den Heuvel et al. (64), 1 mo: Hodgson et al. (67), 1 to 4 mos: Yohannes et al. (14), Blanchard et al. (62), Bedaso et al. (8), 4 to 6 weeks: Wang et al. (68),6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (56), Khodadadi-Hassankiadeh et al. (13),3 mos: Ning et al. (66), Hodgson et al. (67), 6 mos: Irish et al. (25), Ryb et al. (24), Lemos et al. (63), 8 mos: Miniati et al. (65), 12 mos: Irish et al. (25), 2.5 yrs: Lee et al. (33) (family, and students)	6 weeks: Stallard et al. (47) (6 weeks), 3 yr: Kupchik et al. (36),

(Chossegros et al., 2011; Lee et al., 2021). Most of the studies had nonpredicting results for marital status (Bedaso et al., 2020; Blanchard et al., 1996b; Huh et al., 2017; Kupchik et al., 2007; Lee et al., 2021; Li et al., 2021; Maltais et al., 2022; Papadakaki et al., 2017; Yohannes et al., 2018). Marital status was a significant predictor in two studies with 669 participants. In detail, one study was in Europe (total $N = 541$) and one in Western Pacific (total $N = 128$).

Race

Race was a predictor 1 month after the accident (Blanchard et al., 1995b, 1996b; Suliman et al., 2014; Ursano et al., 1999b). However, it did not predict PTSD at 3 to 6 months (Kassam-Adams et al., 2009; Ursano et al., 1999b; Williams et al., 2015). Race was a significant predictor in four studies with 432 participants. In detail, there were three studies in America (total $N = 328$) and one study in Southeast Asia (total $N = 104$).

TABLE 3. Peritrauma Factors

Predictor	Significant	Nonsignificant
Road user type	1 mo: Kovacevic et al. (32), 2 mos: Kessler et al. (31) (passenger), 3 to 12 mos: Măirean et al. (75), 6 mos: Nishi et al. (16) (nondriver), Chossegros et al. (23) (four-wheel motor vehicle), 12 mos: Jeavons et al. (74)	4 to 6 weeks: Matsuoka et al. (50) (nondriver), 1 to 4 mos: Blanchard et al. (62), Bedaso(8), 3 mos: Naim et al. (46),6 to 12 mos: Vries et al. (53), 9 mos: Keppel-Benson et al. (41), 12 mos: Papadakaki et al. (51),
Peritraumatic dissociative experiences	2 weeks: Ehring et al. (72), 1 mo: Hodgson et al. (67) (1 mo), Murray et al. (77) (1,6 mos), Ursano et al. (57), Ehring et al. (72), Murray et al. (77), Irish et al. (26), 2 mos: Kessler et al. (31) (2 mos), 3 mos: Ursano et al. (57), Ehring et al. (72), Naim et al. (46), 4 mos: Pires et al. (34) (4 mos), 6 mos: Irish et al. (26) (6 weeks, 6 mos), Lemos et al. (63), Ehring et al. (72), Bryant et al. (73), Murray et al. (77), Irish et al. (26), 12 mos: Ehlers et al. (19) (12 mos), Ehring et al. (76)	5 weeks: Allenou et al. (78), 3 yrs: Mayou et al. (27)
Self-perceived threat	1 mo: Kovacevic et al. (32), Dougall et al. (29),Ehring et al. (72), 4 to 6 weeks: Matsuoka et al. (50), 1 to 4 mos: Blanchard et al. (82), 3 mos: Ehring et al. (72), 5 mos: Fujita et al. (22), 6 mos: Nishi et al. (16), Berna et al. (81), Hyun et al. (80), Ehring et al. (72), 12 mos: Ehlers et al. (19), 14 mos: Fujita et al. (22), 3 yrs: Maltias et al. (54),	6 weeks: Irish et al. (26) (6 weeks, 6 mos), 3 mos: Ehlers et al. (19), 6 mos: Dougall et al. (29), Kassam-Adams et al. (45), Irish et al. (26), 12 mos: Landolt et al. (42), Dougall et al. (29), 3 yrs: Mayou et al. (27)
Cognitive processing during RTA	2 weeks: Ehring et al. (72), 1 mo: Ehring et al. (72), 3 mos: Ehring et al. (72), 6 mos: Ehring et al. (72), Ehring et al. (79) (6 mos), 12 mos: Ehring et al. (76) (<12 mos)	
Threat of death	1 to 4 weeks: Blanchard et al. (28), 1 mo: Arora et al. (55), Blanchard et al. (62), 3 mos: Jeavons et al. (74), 4 mos: Blanchard et al. (62), 6 mos: Ryb et al. (24), Jeavons et al. (74), 12 mos: Arora et al. (55), Ryb et al. (24), 3 yrs: Maltias et al. (54)	
Witnessed death	1 mo: Arora et al. (55) (1–12 mos), 1 to 4 mos: Blanchard et al. (62), 6 mos: Ryb et al. (24),12 mos: Arora et al. (55), Ryb et al. (24)	
Accident severity	1 mo: Kovacevic et al. (32) (mild), 6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (56) (Moderate Severe), 6 mos: Frommberger et al. (83) (severe)	

TABLE 4. Post-trauma Factors

Predictor	Significant	Nonsignificant
Injury severity	1 mo: Delahanty et al. (70) (low), Delahanty et al. (69) (low), 1 to 4 weeks: Blanchard et al. (28) (high), 1 to 4 mos: Blanchard et al. (82) (high), 2 mos: Coronas et al. (44) (high), 4 mos: Coronas et al. (35) (moderate/ Severe), 6 mos: Hamanaka et al. (86) (High), Frommberger et al. (83) (high), Chossegros et al. (23) (high), Hyun et al. (80), 8 mos: Stallard et al. (21) (high), 9 mos: Keppel Benson et al. (41) (moderate/ Severe), 10 to 22 mos: Selly et al. (136) (moderate/ Severe), 3 yrs: Maltias et al. (54) (3 yrs)	1 mo: Coronas et al. (35) (high), Murray et al. (77) (high), Dougall et al. (29) (high), 4 to 6 weeks: Matsuoka et al. (50) (high), 3 mos: Ehlers et al. (19) (high), Jeavons et al. (74) (high), 5 mos: Fujita et al. (22), 6 mos: Jeavons et al. (74) (high), Murray et al. (77), Kassam-Adams et al. (45) (high), Holeva et al. (52) (high), Ryb et al. (24) (high), Bryant et al. (84) (high), Fuglsang et al. (43) (high), 6 to 12 mos: Vries et al. (53), 12 mos: Landolt et al. (42), Bryant et al. (85) (high), Ehlers et al. (19) (high), Ryb et al. (24) (high), 3 yrs: Mayou et al. (27) (high), Kupchik et al. (36), Yoshino et al. (49)
Pain severity	6 weeks to 6 mos: Khodadadi-Hassankiadeh et al. (13) (No pain), 2 mos: Kessler et al. (31), 2 yrs: Fedoroff et al. (90), 3.5 yrs: Beck et al. (89)	
Hospitalization after the RTA	1 mo: Kovacevic et al. (32), 6 mos: Frommberger et al. (83), 12 mos: Jeavons et al. (74), Daddah et al. (30), 3 yrs: Yoshino et al. (49) (parents)	3 mos: Ehlers et al. (19), 6 mos: Bryant et al. (84), 3 yrs: Yoshino et al. (49) (children), Mayou et al. (27)
ASD	2 mos: Vaiva et al. (37), Kessler et al. (31), 3 mos: Yaşan et al. (18), Schäfer et al. (87) (3 mos), 4 mos: Pires et al. (34), LI et al. (17) (4–12 mos), 6 mos: Hamanaka et al. (86), Holeva et al. (52), Kassam-Adams et al. (45) (parents), Bryant et al. (73), Yaşan et al. (18), Fuglsang et al. (43), Bryant et al. (84), 12 mos: Yaşan et al. (18), LI et al. (17) (4–12 mos), 2 yrs: Bryant et al. (88)	6 mos: Kassam-Adams et al. (45) (child)
Anxiety	6 weeks: Wang et al. (68), 1 to 4 mos: Blanchard et al. (28), 6 mos: Mehnert et al. (91), 2 yrs: Fedoroff et al. (90)	6 mos: Ursano et al. (15)
Rumination	2 weeks: Ehring et al. (72), 1 mo: Ehring et al. (72), Fekadu et al. (7), Murray et al. (77),3 mos: Ehring et al. (72), 3 to 12 mos: Măirean et al. (75), Ehlers (19), 6 mos: Ehring et al. (72), Murray et al. (77), 8 mos: Stallard et al. (21), 12 mos: Ehring et al. (76), Koren et al. (137), 2.5 to 3 yrs: Lee et al. (33), Mayou et al. (27)	
Thought suppression	2 weeks: Ehring et al. (72), 1 mo: Ehring et al. (72), 3 mos: Ehring et al. (72), 6 mos: Ehring et al. (72) 8 mos: Stallard et al. (21) (8 mos), 3 yrs: Mayou et al. (27) (3 yrs)	
Social support	2 weeks: Ehring et al. (72) , 1 mo: Ehring et al. (72), 1 to 4 mos: Yohannes et al. (14), 3 mos: Ehring et al. (72), Ning et al. (66) (3 mos), 6 mos: Ehring et al. (72), 9 mos: Keppel-Benson et al. (41), Holeva et al. (52) (6 mos), 12 mos: Kobayashi et al. (60) (12 mos), 2.5 yrs: Lee et al. (33) (students)	5 mos: Fujita et al. (22), 6 mos: Dougall et al. (29), 12 mos: Dougall et al. (29), 14 mos: Fujita et al. (22), 3 yrs: Maltias et al. (54)
Baseline HR or BP	1 mo: Coronas et al. (35) (HR), 4 to 6 weeks: Matsuoka et al. (50) (HR), 4 mos: Coronas et al. (35) (HR), 6 mos: Bryant et al. (84) (HR- 6 mos), 2 yrs: Bryant et al. (88) (HR = 95, 2 yrs)	1 mo: Coronas et al. (35) (BP), 4 mos: Coronas et al. (35) (BP), 6 mos: Bryant et al. (84) (HR), Ryb et al. (24) (HR), Ehring et al. (79) (BP), 12 mos: Ryb et al. (24) (HR)
Cortisol levels	1 mo: Delahanty et al. (70) (urinary), Delahanty et al. (69) (urinary), 3 mos: Cieslak et al. (92), 6 mos: Pervanidou et al. (48) (salivary)	6 mos: Ehring et al. (79) (in emergency room), Pervanidou et al. (48) (serum)
Memory disorganization	2 weeks: Ehring et al. (72), 1 mo: Ehring et al. (72), 3 mos: Ehring et al. (72), 6 mos: Ehring et al. (72), 12 mos: Ehring et al. (76)	
Involving in litigation/ compensation	1 mo: Kovacevic et al. (32) (not), 4 to 4 weeks: Blanchard et al. (28),5 mos: Fujita et al. (22), 6 mos: Bryant et al. (85), 12 mos: Ehlers et al. (19),14 mos: Fujita et al. (22),3 yrs: Mayou et al. (27)	1 to 4 mos: Yohannes et al. (14)

Income

Income was a predictor between 12 months and 3 years (Daddah et al., 2022; Kobayashi et al., 2019; Mayou et al., 2002; Yaşan et al., 2009). However, on the other hand, it almost did not predict PTSD between 6 weeks and nearly 1 year (Bedaso et al., 2020; Huh et al., 2017; Lee et al., 2021; Ursano et al., 1999a; Williams et al., 2015; Yaşan et al., 2009). Income was a significant predictor in four studies with 1,080 participants. In detail, there was one study in America (total $N = 120$), 25 studies in Europe (total $N = 1,535$), and one study in Africa (total $N = 865$).

Work Status

Work status after RTA was another associated factor that was demonstrated to be a predictor in two studies by Khodadadi-Hassankiadeh et al. (2017a) and Daddah et al. (2022). Based on their results, no return to work between 6 weeks to 12 months after RTA was a predictor of later PTSD. However, in another study by Khodadadi-Hassankiadeh et al. (2017b), being employed or self-employed before the RTA was not a predictor. Studies by Yaşan et al. (2009), Huh et al. (2017), and Maltais et al. (2022) observed that unemployment after the RTA in 3 months to 3 years was also not a predictor. Finally, Blanchard et al. (1995a, 1995b) did not prove the work status before the RTA to be a predictor after the RTA in 1 to 4 months. Studies with nonsignificant results occurred between 6 weeks and 18 months (Blanchard et al., 1995a, 1995b; Huh et al., 2017; Khodadadi-Hassankiadeh et al., 2017b; Yaşan et al., 2009). Work status was a significant predictor in two studies with 1,393 participants. In detail, there was one study in Eastern Mediterranean (total $N = 528$) and one in Africa (total $N = 865$).

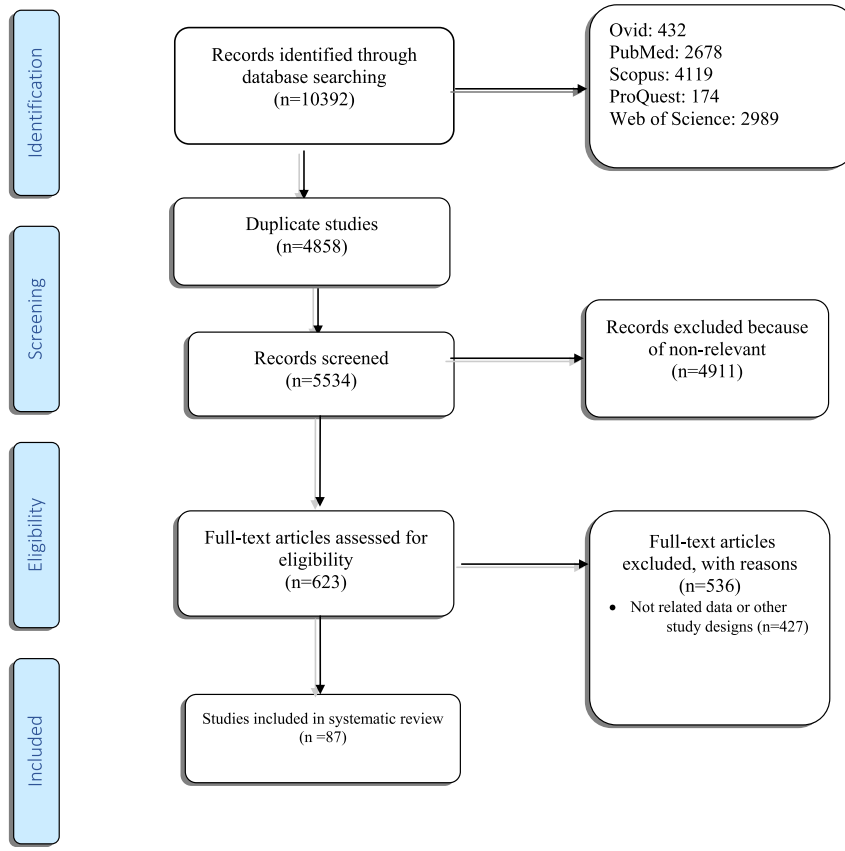

FIGURE 1. PRISMA flow diagram shows the searching and screening processes.

Family Communication

Family communication showed a significant prediction of PTSD in only two studies that assessed PTSD in 6 weeks to 9 months after an accident (Khodadadi-Hassankiadeh et al. (2017a); Wu et al., 2016). However, poor familial communication was not predicted in studies by Fekadu et al. (2019) and Blanchard et al. (1996b) in 1 to 4 months. Family communication was a significant predictor in two studies with 1,065 participants. In detail, there was one study in Eastern Mediterranean (total $N = 528$) and one in the Western Pacific (total $N = 537$).

Substance and Alcohol Consumption

Using substances before RTA was not a predictor from 1 to 12 months after the accident (Arora et al., 2021; Bedaso et al., 2020; Blanchard et al., 1996a). *Alcohol consumption* was a significant predictor in families of children in the Sewol ferry accident after 2.5 years, but not in the students (Lee et al., 2021). In addition, overusing alcohol after the RTA was a predictor after 12 months (Blanchard et al., 1996a; Fekadu et al., 2019). However, studies by Kovacevic et al. (2021) showed no significant prediction in 1 to 6 months. Alcohol consumption was a

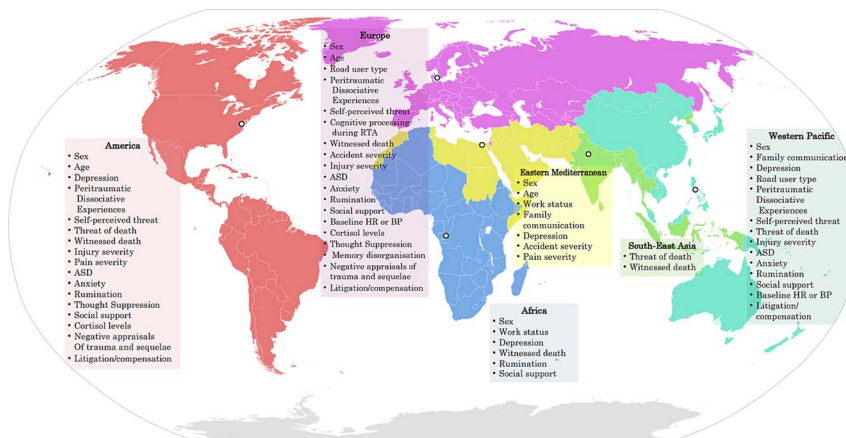

FIGURE 2. World map and predictors of PTSD based on WHO regions.

significant predictor in four studies with 475 participants. In detail, there was one study in America (total $N = 48$), two studies in the Western Pacific (total $N = 665$), and one study in Africa (total $N = 229$).

Pre-trauma Predictors

Depression

Depression was almost significantly associated with PTSD between 10 days and 2.5 years after the trauma (Bedaso et al., 2020; Blanchard et al., 1995a, 1995b; da Conceição Lemos, 2013; Hodgson and Webster, 2011; Irish et al., 2008; Khodadadi-Hassankiadeh et al., 2017b; Miniati et al., 2021; Ning et al., 2017; Ryb et al., 2009; van den Heuvel et al., 2016; Wang et al., 2005; Yohannes et al., 2018). Although most studies reported it as a pretrauma factor, studies by Khodadadi-Hassankiadeh et al. (2017a) and Hodgson and Webster (2011) demonstrated depression as a post-traumatic predictor between 1 and 6 months. In addition, two studies by Kupchik and Stallard showed that depression did not significantly report PTSD in 6 weeks (Coronas et al., 2008; Huh et al., 2017; Kovacevic et al., 2021; Nishi et al., 2013). Depression was a significant predictor in 14 studies with 2,696 participants. In detail, there were three studies in America (total $N = 611$), two studies in Europe (total $N = 327$), two studies in Eastern Mediterranean (total $N = 528$), three studies in Africa (total $N = 539$), and four studies in Western Pacific (total $N = 691$).

The Previous Psychiatric Disease

The psychiatric disease before the RTA was a predictor from 2 weeks of trauma to 18 months (Blanchard et al., 1995a, 1995b; Chossegros et al., 2011; Ehlers et al., 1998; Fekadu et al., 2019; Huh et al., 2017; Nishi et al., 2013). However, in the four included studies, it was not considered a predictor of PTSD in that same time interval (Coronas et al., 2008; Huh et al., 2017; Kovacevic et al., 2021; Nishi et al., 2013). The previous psychiatric disease was a significant predictor in one study with 2,045 participants. In detail, there was one study in America (total $N = 48$), two studies in Europe (total $N = 1,508$), two studies in the Western Pacific (total $N = 190$), and one study in Africa (total $N = 299$).

Previous Chronic Disease

Chronic disease before RTA was only significant in one study 5 and 14 months after RTA (Fujita and Nishida, 2008). Studies by Bedaso et al. (2020), Kovacevic et al. (2021), and Mayou et al. (2002) did not predict PTSD in 3 months to 3 years. Accordingly, patients who used fewer drugs before the RTA were predictors for the lower incidence of PTSD at 1 month, not 6 months (Kovacevic et al., 2021). Chronic disease before RTA was a significant predictor in one study, with 93 participants in the Western Pacific region.

The Lifetime Incidence of PTSD

The lifetime incidence of PTSD was more reported to be significant in early-onset PTSD between 1 and 4 months (Coronas et al., 2008; Delahanty et al., 2000; Ursano et al., 1999a, 1999b). Despite that, in a study by Ursano et al. (1999a), previous PTSD diagnoses did not demonstrate to be a predictor (Suliman et al., 2014). The lifetime incidence of PTSD was a significant predictor in four studies with 281 participants. In detail, there were three studies in America (total $N = 221$) and one study in Europe (total $N = 60$).

Previous RTA History

Having *no previous RTA* was associated with lower levels of PTSD (Blanchard et al., 1995a, 1995b). In addition, experiences of the latter RTA predicted PTSD in 10 days to 12 months (Bedaso et al., 2020; Delahanty et al., 2000; Freedman et al., 2002; Gabert-Quillen et al., 2012; Kassam-Adams et al., 2009; Keppel-Benson et al., 2002; Kobayashi et al., 2019; Kovacevic et al., 2021; van den Heuvel et al., 2016). However, some studies reported previous RTA as a nonsignificant predictor in 2 weeks to 6 months (Bryant and Harvey, 2003; Ehring et al., 2008b; Holeva et al., 2001; Kupchik et al., 2007; Matsuoka et al., 2008). Previous RTA history was a significant predictor in nine studies with 1,618 participants. In detail, there were six studies in America (total $N = 879$), one study in Europe (total $N = 200$), and two studies in Africa (total $N = 539$).

Peritrauma Factors

Road User Type

In road user types, four-wheel motor vehicle drivers were predictors for PTSD 6 months after RTA (Chossegros et al., 2011). In the study by Nishi et al. (2013), being a nondriver was associated with PTSD. Otherwise, being a codriver or passenger and driver was meant to be a predictor at 1 and 12 months (Jeavons, 2000; Kessler et al., 2021; Kovacevic et al., 2021; Măirean, 2019). In some studies, road user type was not a predictor of PTSD from 1 month to 1 year (Bedaso et al., 2020; Blanchard et al., 1996b; de Vries et al., 1999; Keppel-Benson et al., 2002; Matsuoka et al., 2008; Naim et al., 2014; Papadakaki et al., 2017). However, road user type was a significant predictor in six studies with 2,218 participants. In detail, there was one study in America (total $N = 666$), three studies in Europe ($N = 1,374$), and two studies in Western Pacific (total $N = 178$).

Peritraumatic Dissociative Experiences

Most studies on *peritraumatic dissociative experiences* were significant predictors for PTSD, except two (Bryant and Harvey, 2003; da Conceição Lemos, 2013; Ehlers et al., 1998; Ehring et al., 2006, 2008b; Hodgson and Webster, 2011; Irish et al., 2011; Kessler et al., 2021; Murray et al., 2002; Naim et al., 2014; Pires and Maia, 2013; Ursano et al., 1999a). A survey by Allenou et al. (2010) on peritraumatic dissociative experiences did not predict PTSD in mothers of children who have experienced an RTA. Mayou et al. (2002) found that peritraumatic dissociation after 3 years did not predict PTSD. The time point of assessment varied between 2 weeks and 6 months. Peritraumatic dissociative experiences were significant predictors in 13 studies with 3,857 participants. In detail, there were four studies in America (total $N = 1,180$), eight studies in Europe (total $N = 2,344$), and one study in the Western Pacific (total $N = 333$).

Cognitive Processing During RTA

The cognitive processing during RTA was assessed by Ehring and colleagues in three studies, showing that the factor was a predictor of PTSD in 2 weeks to less than 12 months (Ehring et al., 2008a; Ehring et al., 2006; Ehring et al., 2008b). The self-perceived threat was a predictor between 2 weeks and 3 years (Berna et al., 2012; Blanchard et al., 1995a, 1995b; Dougall et al., 2001; Ehlers et al., 1998; Ehring et al., 2008b; Fujita and Nishida, 2008; Hyun and Bae, 2017; Kovacevic et al., 2021; Maltais et al., 2022; Matsuoka et al., 2008; Nishi et al., 2013). Nonsignificant results were assessed between 3 to 12 months (Dougall et al., 2001; Ehlers et al., 1998; Landolt et al., 2005). Cognitive processing during RTA was a significant predictor in two studies with 248 participants. There were two studies in the European region.

Threat of Death

The death threat was a significant predictor in RTA survivors between 1 month and 3 years (Arora et al., 2021; Blanchard et al., 1996a, 1996b; Jeavons, 2000; Maltais et al., 2022; Ryb et al., 2009). In addition, the threat of death was a significant predictor in 5 studies with 895 participants. In detail, there were three studies in America (total $N = 573$), one study in Eastern Mediterranean (total $N = 250$), and one study in the Western Pacific (total $N = 72$).

Witnessing Death

Witnessing death predicted PTSD 12 months after the accident (Arora et al., 2021; Blanchard et al., 1996a; Fekadu et al., 2019; Ryb

et al., 2009). Witnessing death was a significant predictor in three studies with 665 participants. In detail, there were two studies in America (total $N = 415$) and one study in the Western Pacific (total $N = 250$).

Accident Severity

Accident severity was also a predictor of PTSD (Frommberger et al., 1998; Khodadadi-Hassankiadeh et al. 2017a; Kovacevic et al., 2021). The assessment time point of injury severity was between 1 week and 22 months for significant predictors and 1 month and 3 years for nonsignificant results (Bryant and Harvey, 1995; Bryant et al., 2000; Coronas et al., 2011; de Vries et al., 1999; Dougall et al., 2001; Ehlers et al., 1998; Fuglsang et al., 2004; Fujita and Nishida, 2008; Holeva et al., 2001; Jeavons, 2000; Kassam-Adams et al., 2009; Kupchik et al., 2007; Landolt et al., 2005; Matsuoka et al., 2008; Mayou et al., 2002; Murray et al., 2002; Ryb et al., 2009; Yoshino et al., 2022). In most studies, the high injury severity predicted PTSD in 1 to 22 months (Blanchard et al., 1996b; Chossegros et al., 2011; Coronas et al., 2011; Frommberger et al., 1998; Hamanaka et al., 2006; Keppel-Benson et al., 2002; Stallard and Smith, 2007). However, in two studies by Delahanty and colleagues, low levels of injury severity were a predictor of PTSD 1 month after RTA (Delahanty et al., 2000, 2003). Accident severity was a significant predictor in three studies with 880 participants. In detail, there were two studies in Europe (total $N = 352$) and one study in Eastern Mediterranean (total $N = 528$).

Post-trauma Factors

Acute Stress Disorder

ASD was significant in most included studies (Bryant et al., 2000, 2003; Bryant and Harvey, 2003; Fuglsang et al., 2004; Hamanaka et al., 2006; Holeva et al., 2001; Kassam-Adams et al., 2009; Kessler et al., 2021; Li et al., 2021; Pires and Maia, 2013; Schäfer et al., 2006; Vaiva et al., 2003; Yaşan et al., 2009). In a survey by Kassam-Adams et al. (2009), ASD did not predict PTSD in children injured in a traffic-related accident but did forecast it in their parents after 6 months. The time interval of assessment varied between 3 months and 2 years postaccident. ASD was a significant predictor in 13 studies with 2,606 participants. In detail, there were two studies in America (total $N = 917$), seven studies in Europe (total $N = 1,109$), and four studies in the Western Pacific (total $N = 580$).

Pain Severity

Pain severity was a significant predictor between 6 weeks and 6 months (Beck et al., 2003; Fedroff et al., 2000; Kessler et al., 2021; Khodadadi-Hassankiadeh et al., 2017b). In addition, pain severity was a significant predictor in four studies with 1,360 participants. In detail, there were three studies in America (total $N = 832$) and one study in Eastern Mediterranean (total $N = 528$).

Hospitalization

Hospitalization after the RTA was another factor that showed significant associations with PTSD after 1 week to 1 year (Daddah et al., 2022; Frommberger et al., 1998; Jeavons, 2000; Kovacevic et al., 2021; Yoshino et al., 2022). However, in a time point from 3 months extended to 3 years after RTA, hospitalization was not predicting PTSD anymore (Blanchard et al., 1996b; Bryant et al., 2000; Ehlers et al., 1998). Hospitalization was a significant predictor in five studies with 1,472 participants. In detail, there were two studies in Europe (total $N = 352$), two studies in the Western Pacific (total $N = 255$), and one study in Africa (total $N = 865$).

Anxiety

Anxiety significantly predicts PTSD between 1 and 6 months (Fedroff et al., 2000; Mehnert et al., 2012; Wang et al., 2005). However, 6 months after an accident, one study by Ursano et al. (1999a) and colleagues showed nonsignificant results for anxiety, predicting PTSD. Besides the study of Blanchard and colleagues that observed participants' anxiety before the accident, a study by Blanchard demonstrated the prediction of PTSD using anxiety after the accident (Blanchard et al., 1996b). Anxiety was a significant predictor in four studies with 376 participants. In detail, there were two studies in America (total $N = 239$), one study in Europe (total $N = 73$), one study in the Western Pacific (total $N = 64$), and two studies in Africa (total $N = 865$).

Rumination

Rumination after the accident was a significant predictor of PTSD in all the included studies between 2 weeks and 2.5 years (Ehlers et al., 1998; Ehring et al., 2006, 2008b; Fekadu et al., 2019; Măirean, 2019; Mayou et al., 2002; Murray et al., 2002; Stallard and Smith, 2007). In addition, rumination was a significant predictor in 10 studies with 2,677 participants. In detail, there was one study in America (total $N = 97$), seven studies in Europe (total $N = 2,153$), two studies in Eastern Mediterranean (total $N = 528$), and one study in the Western Pacific (total $N = 128$).

Thought Suppression

Thought suppression also predicted PTSD for 3 years (Blanchard et al., 1996b; Ehring et al., 2008b; Stallard and Smith, 2007). Thought suppression was a significant predictor in three studies with 244 participants. In detail, one study was in America (total $N = 97$) and two in Europe (total $N = 1,588$).

Social Support

Poor social support later in the accident predicted PTSD after 2 weeks to 2 years (Ehring et al., 2008b; Holeva et al., 2001; Keppel-Benson et al., 2002; Kobayashi et al., 2019; Lee et al., 2021; Ning et al., 2017; Yohannes et al., 2018). But in two studies by Dougall et al. (2001) and Fujita and Nishida (2008), 5 months to 14 months after the accident, social support was not predicting PTSD. Social support was a significant predictor in seven studies with 1,095 participants. In detail, there were two studies in America (total $N = 220$), two studies in Europe (total $N = 581$), two studies in the Western Pacific (total $N = 294$), and one study in Africa (total $N = 492$).

HR, BP, and Cortisol Levels

Baseline HR or BP in emergency department (ED) forecasted PTSD after 1 month to 2 years postaccidentally (Bryant et al., 2000, 2003; Coronas et al., 2011; Kobayashi et al., 2019; Matsuoka et al., 2008; Ning et al., 2017). On the other hand, the BP and HR of victims were not predictors in 1 to 6 months postaccident (Bryant et al., 2000; Coronas et al., 2011; Ehring et al., 2008a; Ryb et al., 2009). Cortisol levels at initial assessment, whether in serum, urine, or saliva, had significant associations with PTSD diagnosis during 1 to 6 months after (Cieslak et al., 2011; Delahanty et al., 2000, 2003; Pervanidou et al., 2007). Studies by Pervanidou et al. (2007) and Ehring et al. (2008b) found that salivary cortisol levels were significant predictors of PTSD, whereas serum cortisol was not. HR and BP were significant predictors in four studies with 511 participants. In detail, there was one study in Europe (total $N = 119$), three studies in the Western Pacific (total $N = 392$), and two studies in Africa (total $N = 865$). Cortisol level was a significant predictor in four studies with 244 participants. In detail, there was one study in Europe (total $N = 56$) and three in America (total $N = 188$).

Memory Disorganization

Memory disorganization between 2 weeks and less than 1 year also predicted PTSD (Ehring et al., 2006, 2008b; Vaiva et al., 2003). Negative appraisals of trauma and sequelae significantly predicted

PTSD until 1-year post-trauma (Ehring et al., 2006, 2008b; Stallard and Smith, 2007). Memory disorganization was a significant predictor in two studies with 248 participants in the European region.

Litigation or Compensation

Finally, engaging in litigation or compensation from 1 week to 3 years after an accident strongly predicted PTSD (Blanchard et al., 1996b; Bryant and Harvey, 1995; Coronas et al., 2011; Ehlers et al., 1998; Fujita and Nishida, 2008; Kovacevic et al., 2021; Mayou et al., 2002). Only one study by Yohannes et al. (2018) from the African region did not predict PTSD. Litigation or compensation was a significant predictor in six studies with 1,474 participants. In detail, there was one study in America (total N = 158), three studies in Europe (total N = 1,167), and two studies in Western Pacific (total N = 149).

DISCUSSION

In this study, we systematically reviewed the associated factors of PTSD in accident survivors. Our results were divided into four subgroups: sociodemographics, pretrauma, peritrauma, and post-trauma factors. Significant results were more prominent for sex and age in sociodemographics. The top results of pretrauma factors were depression and a history of previous RTA. Peritraumatic dissociative experiences, self-perceived threat, and injury severity were reported more significantly for peritrauma predictors. Finally, being diagnosed with ASD, having rumination about the accident, and being involved in litigation or compensation predicted PTSD after the accident. Most factors are significant predictors in America, Europe, and the Western Pacific regions. The possible reason is that more studies have been developed in this era.

Sex

Female sex is proposed as a potential risk factor for PTSD in accident survivors (Iteke et al., 2011). Seventeen of our included studies showed a significant association between women accident survivors with PTSD. Although in the systematic review by Heron-Delaney et al. (2013), sex was not reported as a predictor of PTSD. The reason can be that they included studies with correlation analysis. The possible causality can be a lower ability to cope with stressful situations in females and higher vulnerability (AlShardan et al., 2020; Wrenger et al., 2008). Besides experiencing more dissociative reactions by women, differences in response mechanisms to trauma and different self-schemas between males and females can explain this (Bryant and Harvey, 2003). Most of the studies in most regions accounted for sex as a predictor.

Age

Age did not show a significant relation with PTSD in most studies (Angerpointner et al., 2020; Asuquo et al., 2017; Bryant et al., 2004; Fitzharris et al., 2006; Gouweloos et al., 2016). Except for one, all effective results included in this study reported that the younger age of survivors was a predictor for PTSD (de Vries et al., 1999; Williams et al., 2015). However, Lee et al. (2021) found that older students were more susceptible to PTSD. It was probably because older students were vulnerable because of dropouts during school years or starting school later than their classmates (Lee et al., 2021). One possible explanation for lower PTSD symptoms in older people is that they have experienced more stressful events and have mature emotion regulation skills to overcome distress (Scott et al., 2013). Age was a significant predictor in America, Europe, and Southwestern regions.

Education

Most of the included studies had nonsignificant results for education (Khodadadi-Hassankiadeh et al., 2017b; Lee et al., 2021; Suliman et al., 2014). Previous studies have also demonstrated that education level was not a prominent predictor (Tierens et al., 2012). However, there has been a report that a higher level of education was a predictor of PTSD (Ongecha-Owuor et al., 2004). On the other hand, another demonstrated that lower educational status was associated with PTSD (Tierens et al., 2012). The different coping and dysfunctional cognitive styles in lower education and knowledge of possible consequences of accidents in higher-educated victims could explain the difference. Education was accounted as a significant predictor in all of the regions except Europe. This might be because we only observed studies with regression analysis.

Social and Family Support

Patients with more social and family support experienced fewer negative appraisals and more protective effects against threat perceptions, leading to fewer PTSD symptoms (Bal et al., 2009). A study by Lubomirsky et al. (2014) demonstrated that visiting family members and friends in ED could diminish anxiety and distress after trauma, probably causing lower PTSD risk. The influence of family and friend support on post-trauma cognition and PTSD diagnoses was observed, revealing a negative association with post-trauma cognition. Also, post-trauma cognition had a positive association with PTSD (Woodward et al., 2015). Family support significantly predicted PTSD in Eastern Mediterranean and Western Pacific countries.

On the other hand, social support was a predictor in Western Pacific, Europe, and American studies. The prominent roles of families can explain this difference in traditional Eastern societies and their impact on decreasing psychological trauma (Shibre et al., 2003). In addition, patients in studies with significant family roles in PTSD are adolescents and younger adults, which are more related to their families' emotional and instrumental support. The other possible causality is the lower number of published studies on this era in the Eastern Mediterranean and Western Pacific. Regarding social support, the difference can be because Asian people have less desire or opportunity to seek social support in difficulties (Bi et al., 2021). Overall, familial support did not show solid associative results in our included studies. However, social support had noticeable effects in this study, supporting previous studies.

Previous Psychological History

There is an established relationship between previous psychological history and PTSD (Wrenger et al., 2008). Overall, prior history of psychiatric illness is a predictor of later PTSD (Ongecha-Owuor et al., 2004). Some studies have demonstrated that axis I diagnosis is increased in victims of accidents (Brown et al., 2000). It has been said that the most co-occurred diagnosis with PTSD is major depressive disorder (MDD). History of depression was also associated with PTSD in victims, just like previous emotional problems (Blanchard et al., 1995a, 1995b). Adolescent survivors are more susceptible to MDD disorder and PTSD than older people (Nooner et al., 2012). There are two possible explanations for PTSD and MDD comorbidity. First, the symptoms overlap between these syndromes after traumatic events. Second, it might be a trauma-related phenotype distinct from MDD (Flory and Yehuda, 2015). In addition, a more significant proportion of females with MDD right after the accident have a greater risk of PTSD development (Bryant and Harvey, 2003). Therefore, the previous diagnosis of depression predicted PTSD in most of our included studies.

Previous Trauma History

A previous trauma history can increase the odds of PTSD (Tierens et al., 2012), probably because patients with prior experience of RTA stress can experience severe exacerbations later. It has been reported that patients with two or more previous traumatic histories in childhood, including assaultive traumas, have a nearly fivefold higher risk for PTSD in adulthood than patients with no history of trauma (Breslau et al., 1999). Our included studies also replicate these findings.

However, not only can major trauma lead to PTSD, but patients involved in minor trauma can also progress to PTSD (97). This finding is replicated in two studies by Delahanty and colleagues, which are included (69,70).

Acute Stress Disorder

ASD comprises main symptoms, including dissociation, reexperience, avoidance, and hyperarousal, and each cluster has different predicting potency for PTSD (Harvey and Bryant, 1999a). Reexperience and hyperarousal symptoms are proven to have significant predicting effects on PTSD (Cushing and Braun, 2018). However, dissociation symptoms do not have a specific predictive value for PTSD (Harvey and Bryant, 1999b). In a study by Kangas et al. (2005), emotional numbing, reliving the experience, and motor restlessness were symptoms of ASD that predicted PTSD better than other symptoms. Among the included studies, one study by Kassam-Adams et al. (2009), ASD, did not predict PTSD in children after 6 months. A possible explanation is that children could have an incomplete perception of potential threats.

Rumination

Rumination is defined as an involuntary and persistent intrusive thought perceived as a cognitive coping strategy in PTSD that keeps the victim from thinking about the traumatizing event (Brinker and Dozois, 2009; Rippere, 1977). Rumination helps to reduce and control distress after negative interpretations of trauma (Roley et al., 2015). Consequently, rumination leads to inaccurate and misleading details of the trauma (Ehring et al., 2008c). In a previous study by Michael et al. (2007), rumination has been shown to predict the results of PTSD in victims of assault. There are different types of rumination related to PTSD, including counterfactual thinking, anticipatory thoughts, repetitive thoughts, and problem-focused rumination (Ehlers and Clark, 2000; Lavender and Watkins, 2004). The study by Roley et al. (2015) investigated the mediating role of rumination between MDD and PTSD. Based on the results, anticipatory and repetitive rumination mainly occur in comorbid PTSD and MDD. All of our included studies reported rumination as a significant predictor.

HR and BP at Baseline

It is proposed that higher HR levels are associated with PTSD. On this basis, the higher HR can be interpreted as an unconditioned response to acute trauma (Shalev et al., 1998). Along with Coronas's study (22) results, Shaikh al arab et al. (2012) found that basal mean heart rate variability (HRV) measures were associated with acute PTSD. Patients with lower HRV show an increased risk of developing PTSD. Serum cortisol had the lowest level in PTSD survivors of accidents (McFarlane et al., 1997). There is a hypothesis that increased sensitivity of the negative feedback system of the hypothalamic–pituitary–adrenal axis causes hypocortisolism and increases the risk of later PTSD (Yehuda et al., 1997). Here, although all of the results about HR predicting PTSD were significant between included studies, BP was not significantly associated with PTSD.

Peritraumatic Dissociation

Peritraumatic dissociation is depersonalization, derealization, dissociative amnesia, out-of-body experiences, emotional numbness, and altered time perception (Thompson-Hollands et al., 2017). Using peritraumatic dissociation, most of the studies in this review predicted PTSD. In addition, many studies have reported significant associations between peritraumatic dissociation and PTSD diagnosis and severity (Gershuny et al., 2003; Lensvelt-Mulders et al., 2008; Werner and Griffin, 2012). Although some studies claim dissociation has a protective role in trauma survivors with decreasing conscious awareness and pain during trauma, others say that peritraumatic dissociation may jeopardize information processing after the trauma, leading to diminished memory and recovery (Michael et al., 2007).

Briefly, we reviewed the predictor factors of PTSD after traffic accidents. Based on our results, the female sex was more susceptible to PTSD. Having depression before the trauma, a history of previous RTA, peritraumatic dissociative experiences, ASD diagnosis, rumination, higher injury severity, and involvement in litigation or compensation were other significant predictors of PTSD after trauma. This study faced a limitation; meta-analysis was impossible because of the heterogeneity of assessments. Further studies can observe the impact of risk factors on the treatment.

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DISCLOSURE

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AUTHOR CONTRIBUTION

Z.S., P.H.: data screening, data extraction, writing—original draft preparation.

H.S., H.S.B.: conceptualization, methodology, formal analysis and investigation, supervision.

F.P.: literature search.

All authors approved the final version of the manuscript.

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