

Prevalence of posttraumatic stress disorder among road traffic accident survivors

A PRISMA-compliant meta-analysis

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Abstract

Background: Involvement in road traffic accidents (RTAs) may put individuals at increased risk for a wide range of psychiatric disorders, among which posttraumatic stress disorder (PTSD) presents a public health issue. However, a great disparity was observed among studies exploring the prevalence of PTSD among RTA survivors. This meta-analysis aimed to explore the pooled prevalence of PTSD among RTA survivors.

Methods: Electronic databases of PubMed, Embase, Web of Science, PsycARTICLES, PsycINFO, and CINAHL were searched to identify relevant studies. Study selection and data extraction were conducted independently by 2 investigators, and a meta-analysis was performed to synthesize the data. Heterogeneity among studies was evaluated using the Cochran Q test and quantified using the I^2 statistic. Subgroup analyses were performed to identify the source of the heterogeneity. The possibility of publication bias was assessed using Egger linear test.

Results: Fifteen eligible studies containing 6804 RTA survivors were identified in this meta-analysis, of which 1489 were identified with PTSD. The pooled prevalence of PTSD among RTA survivors was 22.25% (95% confidence interval: 16.71%–28.33%). A high degree of heterogeneity was observed across studies ($I^2=97.1\%$, $P<.001$), with reported PTSD prevalence ranging from 6.3% to 58.3%. Subgroup analyses found that the prevalence of PTSD among RTA survivors varied significantly across studies in relation to the instrument used to assess PTSD, country, race, gender, and education level ($P<.05$).

Conclusion: The high pooled prevalence of PTSD among RTA survivors found in this study significantly underscores the need for providing timely and effective intervention strategies for RTA survivors.

Abbreviations: CI = confidence interval, PTSD = posttraumatic stress disorder, RTA = road traffic accident.

Keywords: meta-analysis, posttraumatic stress disorder, prevalence, road traffic accident

1. Introduction

Over 50 million people worldwide experience trauma through road traffic accidents (RTAs) yearly, and by the year 2020, the injury caused by RTA will be the 3rd-leading cause of disability.^[1] Accumulated evidence has shown that involvement in RTA may put individuals at increased risk for a wide range of psychiatric disorders, including posttraumatic stress disorder

(PTSD), depression, anxiety, etc.^[2–4] In particular, PTSD presents a public health issue in RTA-related population.^[5,6]

PTSD is characterized by intrusion, avoidance, hyperarousal, and negative alterations in cognition and mood according to the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders-V.^[7] PTSD can lead to not only physical and psychological impairment but also high healthcare costs.^[8–10] For example, Landolt et al^[11] found that early PTSD symptoms could have negative influence on health-related quality of life among injured children and adolescents following RTA, and Bartoli et al^[12] found that individuals with PTSD have a greater risk of metabolic syndrome and obesity.^[13] Furthermore, Chan et al^[14] interviewed 391 RTA survivors in South Australia at about 9 months after the accident and found that compared with those without PTSD, individuals with PTSD incurred higher healthcare costs. In this regard, a reliable estimate of the prevalence of PTSD among RTA survivors is of great importance, as it may help the service providers to predict the number of RTA survivors who may develop PTSD, and thus providing timely and effective intervention strategies.

However, a great disparity was observed across studies exploring the prevalence of PTSD among RTA survivors, ranging from 6% to 50%,^[15,16] indicating the necessity to estimate the pooled prevalence. Therefore, this meta-analysis aimed to explore the pooled prevalence of PTSD among RTA survivors.

Editor: Zelena Dora.

The authors have no funding and conflicts of interest to disclose.

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Medicine (2018) 97:3(e9693)

Received: 23 July 2017 / Received in final form: 27 December 2017 / Accepted: 28 December 2017

<http://dx.doi.org/10.1097/MD.0000000000009693>

2. Methods

2.1. Ethical approval

Ethical approval was not required for this meta-analysis since this meta-analysis utilized published data which were already ethically approved.

2.2. Search strategy

This study was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Electronic databases of PubMed, Embase, Web of Science, PsycARTICLES, PsycINFO, and CINAHL were searched from their inception to September 2017. Instead of using “key words,” this study used “title” or “abstract,” to enroll more relevant articles. For example, search terms for the database of PubMed was “(((posttraumatic stress disorder[Title/Abstract]) OR post traumatic stress disorder[Title/Abstract]) OR PTSD [Title/Abstract]) AND (((road traffic accident[Title/Abstract]) OR road traffic crash[Title/Abstract]) OR motor vehicle accident [Title/Abstract]) OR motor vehicle crash[Title/Abstract])”. The reference lists for full articles were also identified in this study.

2.3. Eligibility criteria

The inclusion criteria for this meta-analysis were: observational studies focusing on RTA survivors; sample size ≥ 200 ; examined PTSD with specific reference to RTA at least 1 month after the accident; provided a clear definition of the diagnosis of PTSD; reported a binary outcome for PTSD with “Yes” or “No”; and provided information about the sample size and the prevalence of PTSD among RTA survivors. The exclusion criteria were: full article not written in English; and reviews, comments, or case reports. Besides, if repeated data were observed across studies with the same follow-up period, only the earlier publication was included.

2.4. Data extraction

Two investigators (WL and MX) independently identified the eligibility of articles and extracted data from eligible articles. Any discrepancies between them were resolved by consensus. Data extracted from eligible articles for this study were: first author, year of publication, country, study design, time point of PTSD assessment, injury severity, instrument used to assess PTSD, number of survivors with PTSD, sample size, prevalence of PTSD, and quality of study. Besides, if necessary, data on race, gender, marital status, education level, and position in vehicle were also extracted to perform subgroup analyses.

2.5. Quality assessment

The Agency for Healthcare Research and Quality was used to assess the quality of eligible articles.^[17,18] It consists of 11 items, each with 3 possible answers “Yes” or “No” or “Unclear.” The response of “Yes” for each item is scored “1,” and the response of “No” or “Unclear” is scored “0.” Therefore, the total score of this instrument ranges from 0 to 11, with 0 to 3, 4 to 7, and 8 to 11 indicating low, moderate, and high quality, respectively.

2.6. Statistical analysis

Statistical analyses for this study were conducted using the R statistical software version 3.2.0. Heterogeneity across studies

was evaluated using χ^2 test for Cochran Q statistic and quantified with the I^2 statistic, with $I^2 \geq 25\%$, $\geq 50\%$, and $\geq 75\%$ indicating low, moderate, and high heterogeneity, respectively.^[19] The pooled prevalence of PTSD among RTA survivors was combined using Freeman–Tukey double arcsine method by a fixed effects model if the P value of χ^2 test for Cochran Q statistic was at least 0.05. Otherwise, a random effects model was used.^[20] Sensitivity was assessed by the effect of low-quality articles on the stability of the pooled prevalence.^[21,22] Publication bias was evaluated using the Egger linear test and a funnel plot for asymmetry was presented.^[23] Besides, if necessary, subgroup analyses according to the time point of PTSD assessment, instrument used to assess PTSD, country, race, gender, marital status, education level, and position in vehicle were performed to identify the source of the heterogeneity. The χ^2 tests were used to compare the difference within each subgroup and the significance level was set at $P < .05$.

3. Results

3.1. Search results

A total of 616 articles were yielded by the search strategy of this study. After removing duplicates, 432 articles were screened for eligibility. After abstracts screening, 69 full articles were shortlisted for eligibility. Among the 69 articles, 16 were excluded for neither reporting the prevalence of PTSD among RTA survivors nor reporting a binary outcome (“Yes” or “No”) of PTSD, 34 were excluded for having a sample size of less than 200, and 4 were excluded for repeated data. Finally, 15 eligible articles were included in this meta-analysis (Fig. 1).

3.2. Study characteristics

Table 1 shows the characteristics of eligible studies. Fifteen studies conducted in 7 countries were included. A total of 6804 RTA survivors were assessed, of which 1489 were identified with PTSD. Among the 15 eligible studies, 4 were longitudinal and 11 were cross-sectional. Besides, 6 used self-report questionnaire to assess PTSD and 9 used structured interview. The time points of PTSD assessment among these studies ranged from 1 month to 37 years after RTA. Additionally, according to the Agency for Healthcare Research and Quality assessment, 3 were considered low quality and 12 were considered moderate quality.

3.3. Pooled prevalence of PTSD among RTA survivors

A high degree of heterogeneity was observed across studies ($I^2 = 97.1\%$, $P < .001$), with the reported prevalence of PTSD ranging from 6.3%^[15] to 58.3%.^[29] The pooled prevalence of PTSD among RTA survivors was 22.25% (95% confidence interval [CI]: 16.71%–28.33%) by a random effects model. Figure 2 presents the details.

3.4. Sensitivity analysis and publication bias

After excluding 3 articles with low quality, the pooled prevalence of PTSD among RTA survivors decreased slightly from 22.25% (95% CI: 16.71%–28.33%) to 22.12% (95% CI: 16.84%–27.88%), suggesting low sensitivity of this meta-analysis.

Publication bias was not observed in this meta-analysis, with P value for the Egger linear test being 0.289 ($t = 1.097$). Consistent with the result of Egger linear test, the funnel plot was symmetrical (Fig. 3).

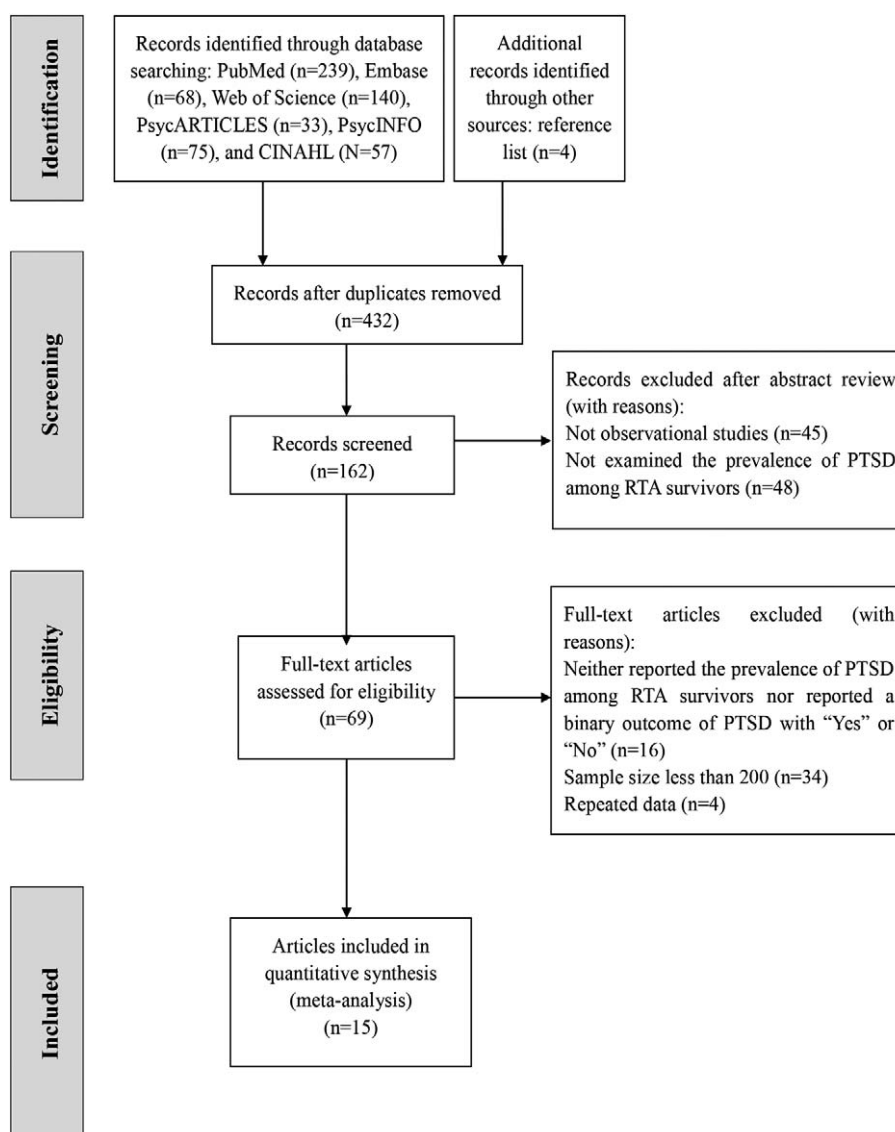


Figure 1. Flow chart of study identification and selection.

3.5. Subgroup analyses

Table 2 displays the results of subgroup analyses. The pooled prevalence of PTSD assessed at less than 1 year and at 1 year or more after RTA was 17.33% (95%CI: 12.71%–22.50%) and 18.14% (95%CI: 12.57%–24.46%), respectively. The pooled prevalence of PTSD assessed using structured interview and self-report questionnaire was 23.76% (95%CI: 14.15%–34.95%) and 19.92% (95%CI: 15.76%–24.44%), respectively. In addition, the pooled prevalence of PTSD among female and male RTA survivors was 27.61% (95%CI: 17.44%–39.08%) and 20.49% (95%CI: 12.37%–30.00%), respectively.

The heterogeneity was high within most subgroups. However, the heterogeneity was quite low when estimating the pooled prevalence of PTSD among RTA survivors in Australia ($I^2 = 37.7\%$, $P = .186$) and those who occupied the position of driver in a vehicle ($I^2 = 0.0\%$, $P = .898$). Subgroup analyses also indicated that the prevalence of PTSD among RTA survivors varied significantly across studies in relation to the instrument used to assess PTSD, country, race, gender, and education level ($P < .05$).

4. Discussion

This meta-analysis included 15 eligible articles conducted in 7 countries with a total of 6804 participants, of which 1489 were identified with PTSD. The reported prevalence of PTSD among RTA survivors ranged from 6.3%^[15] to 58.3%^[29] among eligible studies, and the pooled prevalence was 22.25% (95% CI: 16.71%–28.33%). To the best of our knowledge, this is the 1st meta-analysis to estimate the pooled prevalence of PTSD among RTA survivors.

The pooled prevalence of PTSD among RTA survivors found in this study (22.25%, 95% CI: 16.71%–28.33%) was lower than that among earthquake survivors (23.66%, 95% CI: 19.34–28.27%).^[21] However, this rate was higher than that among flood survivors (15.74%, 95% CI: 11.25%–20.82%) and survivors of stroke and transient ischemic attack (13%, 95% CI: 11%–16%) found in previous meta-analyses.^[37,38] The difference in the severity of trauma may account for the difference in the pooled prevalence observed among these studies.^[21] Notably, many countries have witnessed a rapid increase in the

Table 1

Characteristics of eligible studies included in this meta-analysis.

First author	Year of publication	Country	Study design	Time point of PTSD assessment	Injury severity	Instrument used to assess PTSD				Quality of study	
						Self-report questionnaire	Structured interview	Number of survivors with PTSD	Sample size		Prevalence, %
Ehlers ^[24]	1998	United Kingdom	Longitudinal	3 mo	Attended accident and ED	PSS (DSM-IV)		205	888	23.1	Moderate
Holeva ^[25]	2001	United Kingdom	Longitudinal	1 y				129	781	16.5	
Mayou ^[26]	2002	United Kingdom	Cross-sectional	4–6 mo	Attended accident and ED	PI (DSM-III-R)		61	265	23.0	Moderate
Chan ^[14]	2003	Australia	Cross-sectional	3 y	Attended ED	PSS (DSM-IV)		60	546	11.0	Moderate
Orngecha ^[27]	2004	Kenya	Cross-sectional	9 mo	Not reported	PCL-C (DSM-IV)		103	355	29.0	Moderate
Shalev ^[28]	2005	Israel	Cross-sectional	≥ 1 mo	Attended the orthopedic and trauma clinic	DSM-IV		35	264	13.3	Low
Beck ^[29]	2006	USA	Cross-sectional	4 mo	Attended ED	CAPS (DSM-IV)		65	354	18.4	Moderate
Coffey ^[30]	2006	USA	Cross-sectional	≥ 6 mo	Sought psychological help	CAPS (DSM-IV)		130	223	58.3	Low
Chossegros ^[31]	2011	France	Cross-sectional	≥ 1 mo	Hospitalized	CAPS (DSM-IV)		99	229	43.2	Moderate
Hamazaki ^[5]	2014	Japan	Cross-sectional	6 mo	Attended the acute critical care center	PQLS (DSM-IV)		100	541	18.5	Moderate
Hruska ^[32]	2014	USA	Cross-sectional	6 wk	Attended a level-1 trauma center	CAPS (DSM-IV)		15	237	6.3	Low
Naim ^[33]	2014	Israel	Cross-sectional	3 mo	Minor	CAPS (DSM-IV)		25	249	10.0	Moderate
Beck ^[34]	2015	USA	Cross-sectional	2 y, 11 mo (average)	Severe	CAPS (DSM-IV)		28	415	6.7	Moderate
Kenardy ^[35]	2017	Australia	Longitudinal	6 mo	Minor	CID-PTSD (DSM-IV)		166	301	55.1	Moderate
				12 mo				78	325	24.0	Moderate
				24 mo				65	299	21.7	
				6 mo				78	309	25.2	
Platts-Mills ^[36]	2017	USA	Longitudinal	6 mo	Attended ED	ISE-R (DSM-IV)		47	223	21.1	Moderate

CAPS = Clinician Administered PTSD Scale, CID-PTSD = Composite International Diagnostic Interview module for PTSD, DSM = Diagnostic and Statistical Manual of Mental Disorders, ED = Emergency Department, ISE-R = Impact of Event Scale-Revised, PCL-C = Posttraumatic Checklist-Civilian version, PQLS = Posttraumatic Checklist Scale, PI = Penn Inventory, PSS = Posttraumatic Stress Symptom Scale, PTSD = posttraumatic stress disorder.

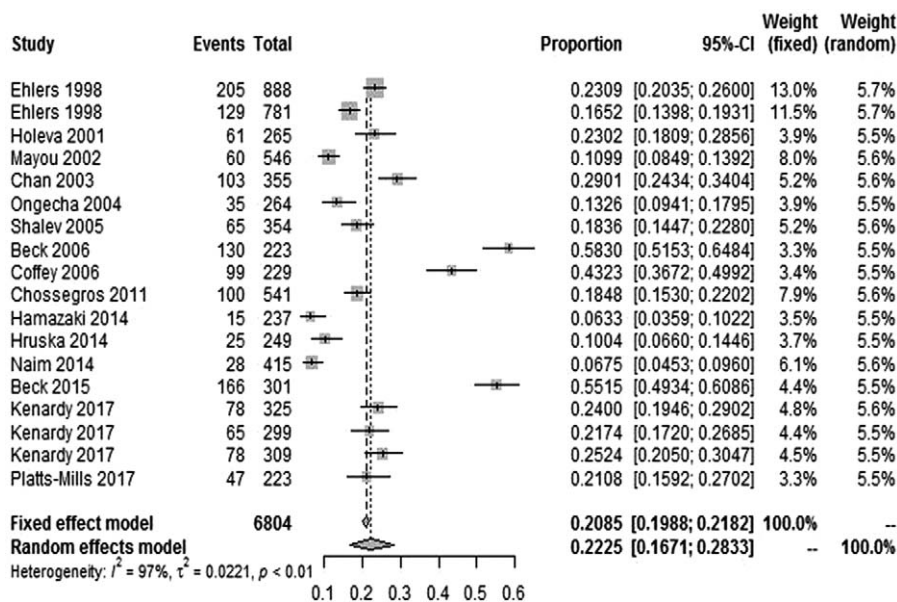


Figure 2. Forest plot presenting the prevalence of PTSD among RTA survivors. PTSD=posttraumatic stress disorder, RTA=road traffic accident.

number of motor vehicles over the past few decades, which may contribute a lot to the rapid increase in the occurrence of RTA.^[27] Therefore, more psychological resources should be allocated to RTA survivors, and early assessment of PTSD symptoms in this population needs to be implemented urgently.

Subgroup analyses showed that the pooled prevalence of PTSD identified at less than 1 year after RTA was slightly lower than that identified at 1 year or more after RTA (17.33% vs 18.14%), but the difference was not significant. This finding was inconsistent with previous meta-analyses. Dai et al^[21] found that the pooled prevalence of PTSD identified at 9 months or less after earthquake was significantly higher than that assessed at more than 9 months after earthquake (28.76% vs 19.48%). The same tendency of PTSD prevalence over time was also found in a

meta-analysis focusing on survivors of stroke and transient ischemic attack.^[38] One possible reason for the contradictory results found between this study and previous related studies may be the fact that the heterogeneity across studies included in the subgroup of time point of PTSD assessment in this meta-analysis was high. Specifically, the I^2 statistics for studies exploring the prevalence of PTSD identified at less than 1 year after RTA was 93.8%, while for studies exploring the prevalence of PTSD identified at 1 year or more after RTA, the I^2 statistics was 91.1%.

Additionally, subgroup analyses found that the prevalence of PTSD assessed using structured interview was significantly higher than that assessed using self-report questionnaire. Numerous studies have indicated that compared with the structured interview, self-report questionnaires, such as the posttraumatic checklist and posttraumatic stress symptom scale, have high specificity and sensitivity.^[30,39] The difference in the PTSD prevalence found across studies using self-report questionnaire and the structured interview could be explained by the difference in sample sources. In general, studies using the structured interview were more likely to enroll participants in clinic-based venues with severe injury, while studies using the self-report questionnaires were more likely to enroll participants in population-based venues with minor injury.

Moreover, subgroup analyses indicated that the prevalence of PTSD among RTA survivors differed significantly by country and race, which may be explained by the difference in social, cultural, and biological characteristics. For example, it has been indicated that compared with the white population, African Americans were more likely to experience race-related discrimination and were also more likely to experience violent assault.^[40,41] Additionally, ethnic difference in the frequency of genetic polymorphisms may lead to different prevalence of PTSD.^[42-44]

Subgroup analyses also indicated that the prevalence of PTSD among RTA survivors differed significantly across gender and education levels. Specifically, female RTA survivors and less than college level of education RTA survivors were more likely to develop PTSD than their counterparts. Gender difference in

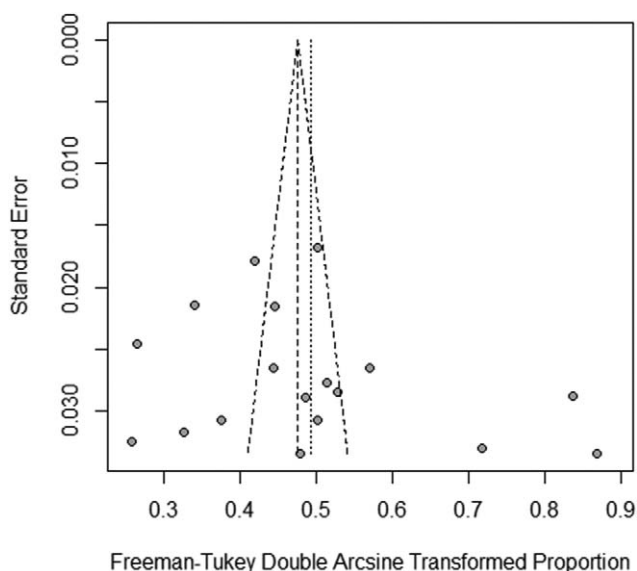


Figure 3. Funnel plot of the 15 studies included in this meta-analysis.

Table 2**Subgroup analyses of posttraumatic stress disorder among road traffic accident survivors.**

Subgroup		Number of studies	Pooled prevalence (95% CI), %	P value for heterogeneity	I ² , %	P value between groups
Time point of PTSD assessment						.111
	<1 y	10	17.33 (12.71–22.50)	<.001	93.8	
	≥1 y	4	18.14 (12.57–24.46)	<.001	91.1	
Instrument used to assess PTSD						<.001*
	Self-report questionnaire	7	19.92 (15.76–24.44)	<.001	90.4	
	Structured interview	11	23.76 (14.15–34.95)	<.001	98.0	
Country						<.001*
	USA	5	36.12 (17.80–56.82)	<.001	98.2	
	Australia	4	25.05 (22.10–28.12)	.186	37.7	
	United Kingdom	4	18.04 (12.62–24.18)	<.001	92.7	
	Israel	2	11.93 (3.03–25.47)	<.001	95.9	
Race						.014*
	White	2	29.08 (10.78–51.84)	<.001	95.3	
	Black	2	48.70 (14.72–83.34)	.004	87.9	
Gender						<.001*
	Male	8	20.49 (12.37–30.00)	<.001	92.9	
	Female	8	27.61 (17.44–39.08)	<.001	94.0	
Marital status						.825
	Married	4	25.55 (13.19–40.30)	<.001	94.1	
	Unmarried	4	24.38 (15.30–34.78)	<.001	88.8	
Education level						<.001*
	<College	5	30.11 (16.11–46.29)	<.001	95.7	
	≥College	4	16.03 (07.70–26.53)	.002	80.2	
Position in vehicle						.536
	Passenger	2	18.59 (07.22–33.48)	.045	75.1	
	Driver	2	18.75 (13.53–24.55)	.898	0.0	

CI = confidence interval, PTSD = post-traumatic stress disorder.

* P value between groups <.05.

PTSD could be largely attributed to gender difference in coping strategies when facing trauma, as well as gender difference in interpretation of trauma.^[45–47] For example, it has been well-established that female subjects interpret trauma more negatively than their male counterparts.^[45] Similarly, coping strategies for individuals with low education level were poorer than for those with high education level, thus affecting PTSD status.^[48–50]

Certain limitations should be acknowledged in this study. First, this meta-analysis included 15 eligible articles with none of them considered high quality. However, the inclusion of studies with a sample size of at least 200 would enhance the representability of the samples in the included studies, thus adding more confidence when estimating the pooled prevalence. Second, the heterogeneity was high within most subgroups. Though several studies found that smoking status, previous psychiatric illness, and posttraumatic amnesia may be associated with the prevalence of PTSD among RTA survivors,^[15,27,31] subgroup analyses according to these factors were unable to conduct, since very few studies have reported relevant information. Therefore, future studies need to explore more factors associated with PTSD among RTA survivors. Third, though injury severity, an important predictive factor of PTSD following RTA, was reported in many eligible articles,^[26,31] it was not possible to pool studies according to injury severity since the measurement of injury severity was inconsistent and mostly based on the authors' description of injury severity. Therefore, future studies should use standard measurements to assess injury severity, such as the New Injury Severity Score.^[31]

Despite the preceding limitations, this study has several strengths. First, to the best of our knowledge, this is the first

meta-analysis estimating the pooled prevalence of PTSD among RTA survivors. A reliable estimate of the prevalence of PTSD among RTA survivors may help the service providers to predict the number of survivors who may develop PTSD, thus providing timely and effective intervention strategies. Second, different prevalence found in the subgroup analyses will be helpful to identify factors associated with PTSD. Finally, low sensitivity and no risk of publication bias identified in this meta-analysis significantly add confidence when interpreting the results of this study.

5. Conclusions

The pooled prevalence of PTSD among RTA survivors was 22.25% (95% CI: 16.71%–28.33%). The prevalence of PTSD among RTA survivors varied significantly across studies in relation to the instrument used to assess PTSD, country, race, gender, and education level. The findings of this study significantly underscore the need for providing timely and effective intervention strategies for RTA survivors.

Acknowledgments

The authors thank to all authors of the eligible articles included in this meta-analysis.

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