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Review Article

Prevalence of road traffic accidents during the COVID-19 pandemic: A systematic review and meta-analysis

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Abstract

Introduction: At the beginning of the novel coronavirus disease COVID-19 pandemic, many countries around the world closed their centers and imposed restrictions on urban and interurban traffic. This situation had a significant impact on the occurrence of road traffic accidents. The present systematic review aimed to determine the prevalence of road accidents during the COVID-19 implemented lockdowns.

Methods: This systematic review and meta-analysis were conducted based on the Joanna Briggs Institute (JBI) instructions. Two independent reviewers screened articles based on the inclusion criteria for the review and eligible studies for methodological quality using an appropriate appraisal checklist based on the study type. The statistical analysis was performed using the Comprehensive Meta-Analysis (CMA) software. Considering the heterogeneity among studies, a random effect model was adopted to estimate the pooled effect with 95% CI for binary outcomes.

Results: The initial search of databases yielded 849 potentially relevant articles, of which, 44 studies were included in this systematic review and of them, 36 were considered for meta-analysis. The random effect model showed an overall prevalence of injury before the lockdown of 24.9% (95% confidence interval: 20.0%-30.5%). Also, the prevalence of injury during the COVID-19 lockdown was 18.8% (95% CI: 14.7%-23.6%). Begg and Mazumdar's correlation found no publication bias in the meta-analysis.

Conclusion: Road traffic injuries, as one of the main causes of death worldwide, took on a new face with the advent of COVID-19. We have found that there is a relatively high prevalence of road traffic accidents before COVID-19 compared to pandemic period.

Introduction

According to the definition of the World Health Organization (WHO), an accident is an unprecedented event that causes detectable damage.[1] Overall, it is estimated that 600 million people worldwide are affected by accidents, occurring in the roads each year.[2] Accidents are one of the most important causes of death and disability that threaten human societies, as well as road traffic accidents (RTAs) are one of the most common accidents that endanger the lives of many people in the world every year.[3] Annual traffic accidents cause the death of 1.24 million people in the world and also lead to the disability of 20-50 million people most likely caused by accidents between pedestrians and vehicles.[4] According to the WHO report, traffic accidents are the 8th, 1st, and 9th leading causes of global death, the death in the age of 5-29 years, and disability, respectively. Traffic accidents are affected by various factors of the vehicle, the environment/human, and multiple scoring to describe the severity of injuries.[5]

In December 2019, researchers in Wuhan, China, announced the WHO to a new emerging respiratory virus, called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 is a disease caused by SARS-CoV-2 and recognized as a global public health emergency which was introduced as a pandemic on March 11, 2020.[2]

At the beginning of this pandemic, due to the fact that the nature of this disease and how it was transmitted was unclear, many countries around the world closed their educational centers, shopping centers, sports centers and etc. and imposed restrictions on urban and interurban traffic. Therefore, this situation had a significant impact on the occurrence of RTAs.[2-4]

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Injury mechanism was changed during the COVID-19 pandemic in the world. For example the most common mechanism of injury in trauma patients who were referred to hospitals during the pandemic was RTAs.[4,6] During the COVID-19 pandemic lockdowns the rate of domestic violence was increased,[7] however the number of patients with head trauma decreased significantly but the injuries were more severe.[8] Also, the number of trauma patients with orthopedic injuries decreased significantly but, hand injuries that led to hand nerve involvement increased significantly during this period.[9-11]

According to the results of the initial search in the electronic databases, the present systematic review aimed to determine the prevalence of road accidents during the COVID-19 pandemic lockdowns.

Methods

This systematic review and meta-analysis were conducted to evaluate the global prevalence of RTAs during the COVID-19 pandemic. We adhered to the JBI manual for evidence synthesis in conducting this systematic review.[12]

Inclusion criteria for systematic reviews of prevalence and incidence

Population

The adults over 16 years old who had an accident with one type of vehicle or as a pedestrian during the COVID-19 pandemic were included.

Condition

The COVID-19 pandemic was considered a condition. In the meta-analysis, studies that compared the numbers of RTAs before and during the pandemic lockdown were included. In those studies that compared the number of accidents more than one year before the pandemic, only one year was considered as 'before the pandemic time'.

Context

Studies of RTAs during the COVID-19 pandemic published around the world were included.

Exclusion criteria

Studies evaluating children's accidents were excluded. Also, studies that didn't report accident numbers during the COVID-19 pandemic were excluded.

Search strategy

The search strategy aimed to consider only published studies. A preliminary limited search of MEDLINE was undertaken in order to develop a search strategy. The main keywords for search, based on the research question, were traffic accident, traffic collision, traffic crashes, traffic injury, traffic wound, traffic traumas, road traffic, COVID-19, 2019-nCoV, Coronavirus, 2019-CoV, SARS-nCoV-2, SARS-CoV-2. Based on the main identified keywords, both free text and controlled vocabularies were searched across the included databases. The reference list of all included studies was screened for any additional research. The studies published only in English that were included in the meta-analysis.

Information sources

The following databases were searched: PubMed, ISI Web of Knowledge, Scopus, ProQuest, and the Cochrane Library. The full search strategy for each database is indicated in Supplementary file 1.

Study selection

After entering all the identified citations into the Endnote version X8 software, the duplicates were removed. Two independent reviewers screened the titles and abstracts based on the inclusion criteria for the review. The studies that met the inclusion criteria were retrieved in full and assessed in detail.

Assessment of methodological quality

Two independent reviewers assessed included studies for methodological quality using an appropriate appraisal checklist based on the study type, all from JBI.[13] Any disagreements between the reviewers were resolved through discussion, when there was discrepancy, a third reviewer independently appraised the paper. After summing the checklists' questions, papers which reached a score of 70% in Yes answers and above were regarded as low risk of bias. This definition was based on consensus among the authors, who acknowledged that any such cutoffs are arbitrary. No studies were excluded based on quality.

Data extraction

Two independent reviewers extracted data from the included articles using the standardized data extraction tool from JBI.[13] Based on this tool, the extracted data included study citation, country, study design, COVID-19 lockdown period, number of participants, age and gender, number of accidents before and during the lockdown, and overall results. Any disagreement among the reviewers was resolved through discussion.

Data analysis

Studies with sufficient data to examine the prevalence of traffic accidents during COVID-19 were included in the meta-analysis. The statistical analysis was performed with the Comprehensive Meta-Analysis (CMA). Considering the heterogeneity among studies, a random effect model was adopted to estimate the pooled effect with 95% CI for binary outcomes. The I^2 statistic and Cochran Q test were used to assess statistical heterogeneity. To identify and assess sources of heterogeneity, we planned a-priori subgroup analyses to assess RTAs based on the geographical context. For investigating the publication bias, we used a funnel plot and the Egger test.

Results

Study inclusion

The initial search of databases yielded 849 potentially relevant articles. A total of 314 articles were recognized and removed as duplicates. Of 535 records screened, 468 were excluded after reviewing titles and abstracts. Twenty-one studies were excluded after full-text review for different reasons, including no access to full text (n = 4), non-English language (n = 1), any crude data reported (n = 14), and modeling study (n = 2). Based on the hand search of Google Scholar, 78 studies were identified, of which, six were included in further analysis. Finally, as shown in the PRISMA 2020 flow diagram in Figure 1, a total of 44 studies were included in this systematic review, of which 36 studies were considered for the meta-analysis.

The main characteristics of the included studies

The types of included studies were cohort, case-control, cross-sectional, time-series analysis, and difference-in-difference. Of 44 included studies, eight (18%) were conducted in India,[2,8,10,14-18] seven in the UK,[3,4,9,19-22] six in the USA,[6,23-27] three in Ireland,[7,28,29] three in South Africa,[30-32] three in Spain,[33-35] two in France,[36,37] and two in Australia.[38,39] Other 10 studies were conducted in Turkey,[40] New Zealand,[41] China,[42] South Korea,[11] Scotland,[43] Brazil,[44] Finland,[45] Israel,[46] Rwanda,[47] and Greece.[48] The number of total participants in 44 studies before COVID-19 was 1 510 717, and the number of participants during the COVID-19 pandemic was 754 496. Among the 18 studies reported the percentage of gender, the proportion of male participants was always above 50%, except for three studies (47.21%, 46.37%, and 46.75%). Thirty-nine of the included studies had mentioned the lockdown period, most of them were included between March 2020 and May 2020 except for two studies from China[42] and South Korea[11] which the lockdown periods were between January to May and May to September. The average lockdown period was 55.28 days. The main characteristics of the included studies are shown in Supplementary file 2.

Quality of included studies

Study quality varied by study design. Appropriate checklists were used for the studies with the designs of cohort, case-control, cross-sectional, time-series analysis, and difference-in-difference. The checklist for cross-sectional studies included eight questions, case-control studies included 10 questions, and cohort studies included 11 questions. Twenty-one (47%) of the 44 studies were at high or unclear risk of bias. However, based on the consensus among reviewers, none of the studies were excluded because of the high risk of bias. Table 1 indicates the results of the methodological quality assessment of the included studies.

Results of meta-analysis

Thirty-six studies were included in the meta-analysis.

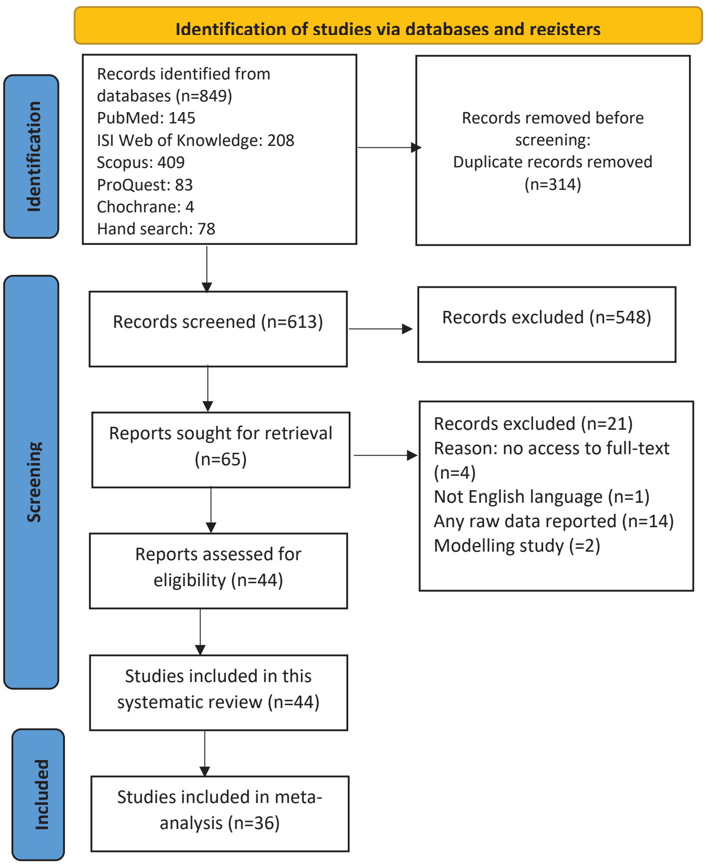

Figure 1. PRISMA flow diagram

Table 1. Results of quality appraisal

First Author (year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Abhilash (2020)[2,a]	Yes	Yes	No	No	No	No	No	Yes			
Ajayi (2020)[3,a]	Yes	Yes	No	No	No	No	No	Yes			
Campbell (2020)[4,b]	Yes	Yes	Yes	Unclear	No	No	No	No	Yes	Yes	
Chiba (2020) [23,b]	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	
Crenn (2020)[36,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Dicker (2020)[41,a]	Yes	Yes	Yes	Yes	No	No	Yes	Yes			
Donovan (2020) [19†]	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	
Doucette (2020)[6,a]	Yes	Yes	Yes	Yes	Yes	n/a	Yes	Yes			
Fahy, S (2020)[7,a]	Yes	Yes	Unclear	Unclear	No	No	Unclear	Yes			
Goyal (2020)[8,a]	Yes	Yes	Unclear	Unclear	No	No	Unclear	Yes			
Hampton (2020)[9,a]	Yes	Yes	Unclear	Unclear	No	No	Unclear	Yes			
Jacob (2020)[38,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Kamine (2020)[25,a]	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes			
Lubbe (2020)[26,a]	Yes	Yes	Unclear	Unclear	No	No	Unclear	Yes			
McDonnell (2020)[43,a]	Yes	Yes	Yes	Yes	No	No	Yes	Yes			
Nuñez (2020)[33,a]	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes			
Qureshi (2020)[27,a]	Yes	Yes	Yes	Yes	Yes	n/a	Yes	Yes			
Saladié (2020)[34,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Vandoros (2020)[48,a]	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes			
Zsilavecz (2020)[32,a]	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes			
Bhat (2021)[14,a]	Yes	Yes	No	No	No	No	No	Yes			
Carkci (2021)[40,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Harmon (2021)[24,a]	Yes	Yes	Unclear	Yes	No	No	Yes	Yes			
Hazra (2021)[10,a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Horan (2021)[28,a]	Yes	Yes	Yes	Yes	No	No	Yes	Unclear			
Huang (2021)[42,b]	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Not applicable	Yes	
Jefferies (2021)[29*]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Kaushik (2021)[15,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Unclear	Yes			
Lee (2021)[11,a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes			
Moyer (2021)[37,c]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Navsaria (2021)[30*]	Yes	Yes	Unclear	Unclear	No	No	Unclear	Yes			
Nayak (2021)[17,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Nia (2021)[39,a]	Yes	Yes	Yes	Yes	No	No	Yes	Yes			
Rajput (2021)[20,c]	Yes	Yes	Yes	Unclear	Unclear	Unclear	Yes	Yes	Unclear	Unclear	Yes
Ribeiro-Junior (2021)[44,a]	Yes	Yes	No	No	No	No	No	Yes			
Riuttanen (2021)[45,c]	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	Yes	Not applicable	Not applicable	Yes
Rozenfeld (2021)[46,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Sephton (2021)[21,a]	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes			
Solà-Muñoz (2021)[35*]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Uwamahoro (2021)[47,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			
Venter (2021)[31,a]	Yes	Yes	Unclear	Unclear	Unclear	Unclear	Unclear	Yes			
Waseem (2021)[22,a]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes			

[a] Cross-sectional study quality appraisal questions: 1. Were the criteria for inclusion in the sample clearly Defined? 2. Were the study subjects and the setting described in detail? 3. Was the exposure measured in a valid and reliable way? 4. Were objective, standard criteria used for measurement of the condition? 5. Were confounding factors identified? 6. Were strategies to deal with confounding factors stated? 7. Were the outcomes measured in a valid and reliable way? 8. Was appropriate statistical analysis used?

[b] Case-control study quality appraisal questions: 1. Were the groups comparable other than the presence of disease in cases or the absence of disease in controls? 2. Were cases and controls matched appropriately? 3. Were the same criteria used for the identification of cases and controls? 4. Was exposure measured in a standard, valid, and reliable way? 5. Was exposure measured in the same way for cases and controls? 6. Were confounding factors identified? 7. Were strategies to deal with confounding factors stated? 8. Were outcomes assessed in a standard, valid, and reliable way for cases and controls? 9. Was the exposure period of interest long enough to be meaningful? 10. Was appropriate statistical analysis used?

[c] Cohort study quality appraisal questions: 1. Were the two groups similar and recruited from the same population? 2. Were the exposures measured similarly to assign people to both exposed and unexposed groups? 3. Was the exposure measured in a valid and reliable way? 4. Were confounding factors identified? 5. Were strategies to deal with confounding factors stated? 6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)? 7. Were the outcomes measured in a valid and reliable way? 8. Was the follow-up time reported and sufficient to be long enough for outcomes to occur? 9. Was the follow up complete, and if not, were the reasons for the loss to follow-up described and explored? 10. Were strategies to address incomplete follow up utilized? 11. Was appropriate statistical analysis used?

According to the results, out of 36 studies, 35 were eligible to evaluate the prevalence of injury before lockdown. Considering that the I^2 was more than 50% which demonstrates the high heterogeneity of the studies, we used the random effect model here and for all additional analyses showed an overall prevalence of injury before the lockdown of 24.9% (95% confidence interval: 20.0%-30.5%). The prevalence rates of the individual studies and the total prevalence of injury before the lockdown are shown in Figure 2.

The prevalence rates of the individual studies and the total prevalence of injury during lockdown are shown in Figure 3. In the fixed method analysis, the prevalence of injury was 8.6% (95% CI: 8.6%-8.7%), while I^2 was more than 50%, demonstrating the high heterogeneity of the studies. Here, the random effect model was used for all additional analyses that showed an overall injury prevalence of 18.8% (95% CI: 14.8%-23.6%). Subgroup analysis for the pre-pandemic and during the pandemic era was performed based on the geographical area of studies, which is indicated in Figures 4 and 5.

Publication bias

To assess the publication bias of the selected studies, a funnel plot was drawn. Begg and Mazumdar's correlation found no publication bias in the meta-analysis (Figure 6).

Discussion

This systematic review and meta-analysis was designed to evaluate the global prevalence of RTAs during the COVID-19 pandemic. A total of 44 studies were included in this systematic review to provide the prevalence of RTAs and 36 of them were considered for meta-analysis. The findings of our study indicated a significant decrease in the prevalence of road traffic injury during the lockdown period (18.8%) in comparison with the pre-lockdown period (24.9%). Several factors influence the relationship between COVID-19 and the prevalence of motor vehicle crash (MVC). These factors include reduced mobility by motor vehicles due to traffic restrictions and working from home, increased probability of speeding due to reduced traffic volume, distraction, and economic distress related to job loss during the pandemic, disordered sleep quality because of changes in sleep patterns, etc.[41,48]

It is worth noting that the mobility restrictions during the COVID-19 pandemic changed the traffic conditions, therefore, the trend of traffic accidents during the pandemic modified.[9] Besides, traffic restrictions reduced the application of motor vehicles on the roads due to decreased rate of mobility and travel.[9,23,42] Remote

Study name	Statistics for each study				
	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Abhalish, P (2020)	0.532	0.512	0.553	3.087	0.002
Ajayi, B (2020)	0.133	0.104	0.169	-13.062	0.000
Bhat, AK (2021)	0.751	0.716	0.783	11.962	0.000
Campell, E (2020)	0.545	0.341	0.735	0.426	0.670
Carkci, E (2021)	0.133	0.111	0.160	-17.154	0.000
Chiba, H (2020)	0.406	0.378	0.435	-6.321	0.000
Crenn, V (2020)	0.111	0.073	0.166	-8.768	0.000
Dicker, B (2020)	0.042	0.041	0.042	-480.746	0.000
Donovan, R.I. (2020)	0.141	0.093	0.208	-7.496	0.000
Fahy, S (2020)	0.057	0.031	0.104	-8.588	0.000
Goyal, N (2020)	0.484	0.406	0.562	-0.402	0.688
Hampton, M (2020)	0.177	0.130	0.236	-8.258	0.000
Haque, A (2021)	0.691	0.658	0.723	10.429	0.000
Harmon, K.J. (2021)	0.092	0.091	0.092	-595.291	0.000
Hazra, D (2021)	0.649	0.612	0.684	7.585	0.000
Horan, J (2021)	0.063	0.045	0.087	-15.050	0.000
Jefferies, O (2021)	0.544	0.415	0.668	0.661	0.508
Kaushik, G (2021)	0.518	0.471	0.565	0.763	0.446
Lee, M.H (2021)	0.140	0.129	0.151	-39.896	0.000
Lubbe, R (2020)	0.325	0.282	0.371	-7.046	0.000
MacDonald, D (2020)	0.057	0.047	0.069	-27.529	0.000
Moyer, J (2021)	0.078	0.071	0.087	-44.176	0.000
Nayak, N (2021)	0.718	0.632	0.790	4.678	0.000
Nia, A (2021)	0.260	0.157	0.398	-3.244	0.001
Nu?ez, J (2020)	0.029	0.025	0.033	-45.814	0.000
Rajput, K (2021)	0.158	0.124	0.199	-11.690	0.000
Reddy, M (2020)	0.269	0.250	0.289	-19.900	0.000
Ribeiro-Junior, MAF (2021)	0.084	0.082	0.086	-174.170	0.000
Riuttanen, A (2021)	0.509	0.435	0.582	0.228	0.820
Rozenfeld, M (2021)	0.232	0.221	0.243	-37.063	0.000
Sephton, BM (2021)	0.054	0.047	0.062	-37.852	0.000
Solà?Mu?oz, S (2021)	0.714	0.694	0.733	18.691	0.000
Uwamahoro, Ch (2021)	0.474	0.426	0.523	-1.038	0.299
Venter, A (2021)	0.396	0.382	0.411	-13.503	0.000
Zsilavecz, A (2020)	0.293	0.244	0.346	-6.998	0.000
	0.249	0.200	0.305	-7.674	0.000

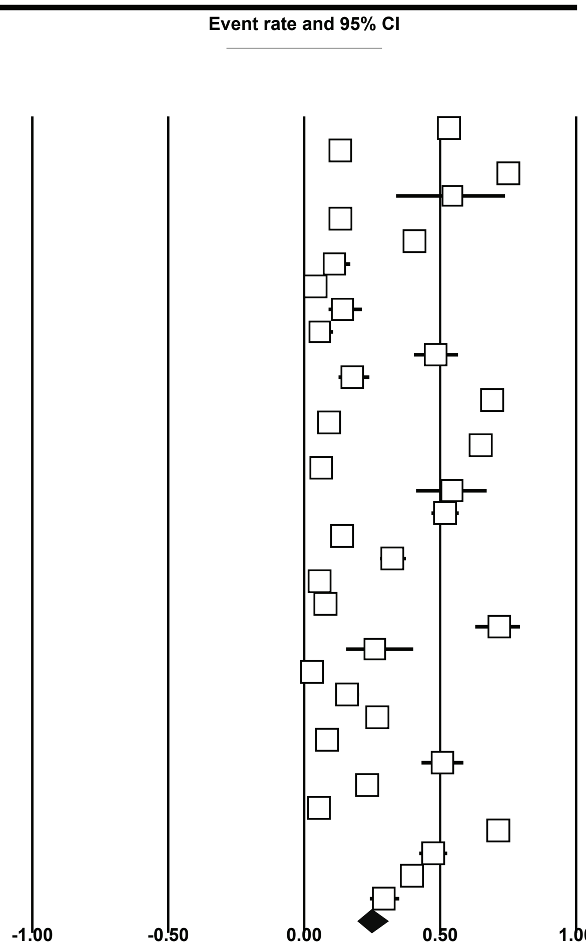

Figure 2. Prevalence of injury before lockdown in the individual studies of the selected literature

Study name	Event rate	Lower limit	Upper limit	Z-Value	p-Value
Abhalish, P (2020)	0.394	0.367	0.422	-7.290	0.000
Ajayi, B (2020)	0.216	0.168	0.273	-8.147	0.000
Bhat, AK (2021)	0.302	0.247	0.364	-5.893	0.000
Campell, E (2020)	0.333	0.158	0.571	-1.386	0.166
Carkci, E (2021)	0.115	0.072	0.180	-7.674	0.000
Chiba, H (2020)	0.280	0.256	0.306	-14.680	0.000
Crenn, V (2020)	0.106	0.071	0.154	-9.669	0.000
Dicker, B (2020)	0.014	0.013	0.016	-95.661	0.000
Donovan, R.I. (2020)	0.066	0.032	0.132	-6.774	0.000
Fahy, S (2020)	0.029	0.011	0.076	-6.889	0.000
Goyal, N (2020)	0.512	0.426	0.597	0.264	0.792
Hampton, M (2020)	0.069	0.033	0.138	-6.630	0.000
Haque, A (2021)	0.081	0.081	0.082	-534.749	0.000
Harmon, K.J. (2021)	0.325	0.281	0.372	-6.870	0.000
Hazra, D (2021)	0.078	0.056	0.107	-13.845	0.000
Jacob, S (2020)	0.357	0.228	0.511	-1.825	0.068
Kamine, T.H. (2020)	0.374	0.305	0.448	-3.299	0.001
Kaushik, G (2021)	0.169	0.153	0.186	-26.443	0.000
Lee, M.H (2021)	0.296	0.250	0.348	-7.215	0.000
Lubbe, R (2020)	0.026	0.019	0.036	-20.885	0.000
MacDonald, D (2020)	0.146	0.122	0.173	-17.129	0.000
Moyer, J (2021)	0.101	0.086	0.119	-23.876	0.000
Nayak, N (2021)	0.429	0.289	0.580	-0.923	0.356
Nia, A (2021)	0.140	0.064	0.278	-4.133	0.000
Nu?ez, J (2020)	0.035	0.022	0.055	-13.803	0.000
Qureshi, A (2020)	0.515	0.455	0.576	0.496	0.620
Reddy, M (2020)	0.082	0.079	0.084	-140.197	0.000
Ribeiro-Junior, MAF (2021)	0.479	0.392	0.568	-0.454	0.650
Riuttanen, A (2021)	0.554	0.423	0.677	0.800	0.424
Rozenfeld, M (2021)	0.174	0.163	0.186	-37.300	0.000
Sephton, BM (2021)	0.044	0.036	0.054	-29.464	0.000
Solà?Mu?oz, S (2021)	0.628	0.597	0.658	7.904	0.000
Uwamahoro, Ch (2021)	0.536	0.466	0.605	1.004	0.315
Venter, A (2021)	0.317	0.301	0.333	-20.352	0.000
Waseem, S (2021)	0.188	0.127	0.269	-6.183	0.000
Zsilavecz, A (2020)	0.214	0.157	0.286	-6.616	0.000
	0.188	0.147	0.236	-9.864	0.000

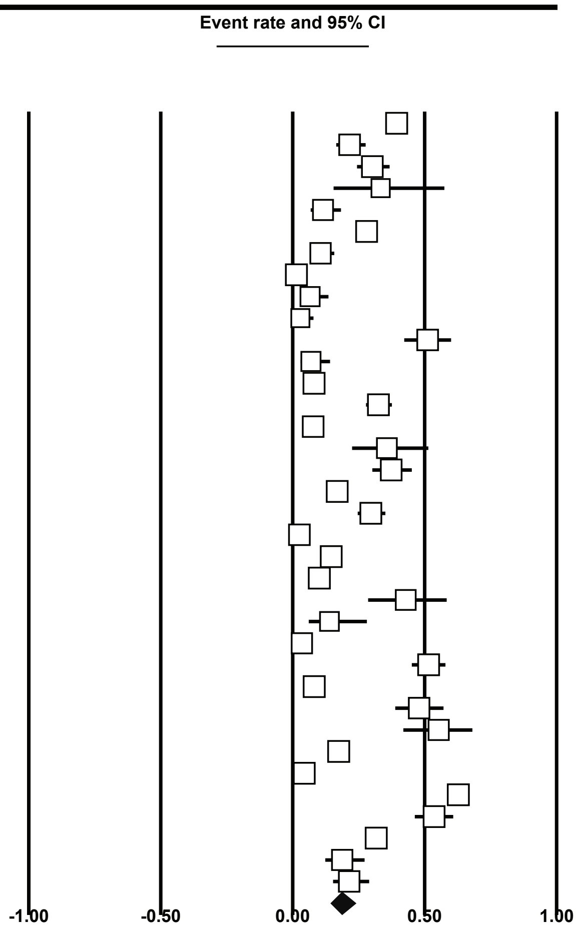

Figure 3. Prevalence of injury during lockdown in the individual studies of the selected literature

Model	Group by Subgroup within study	Study name	Subgroup within study	Event rate	Lower limit	Upper limit	Z-Value	p-Value
	East Asia and Pacific	Dicker, B (2020)	East Asia and Pacific	0.042	0.041	0.042	-480.746	0.000
	East Asia and Pacific	Lee, M.H (2021)	East Asia and Pacific	0.140	0.129	0.151	-39.896	0.000
Random	East Asia and Pacific			0.077	0.023	0.234	-3.765	0.000
	Europe	Ajayi, B (2020)	Europe	0.133	0.104	0.169	-13.062	0.000
	Europe	Campell, E (2020)	Europe	0.545	0.341	0.735	0.426	0.670
	Europe	Carkci, E (2021)	Europe	0.133	0.111	0.160	-17.154	0.000
	Europe	Crenn, V (2020)	Europe	0.111	0.073	0.166	-8.768	0.000
	Europe	Donovan, R.I. (2020)	Europe	0.141	0.093	0.208	-7.496	0.000
	Europe	Fahy, S (2020)	Europe	0.057	0.031	0.104	-8.588	0.000
	Europe	Hampton, M (2020)	Europe	0.177	0.130	0.236	-8.258	0.000
	Europe	Horan, J (2021)	Europe	0.063	0.045	0.087	-15.050	0.000
	Europe	Jefferies, O (2021)	Europe	0.544	0.415	0.668	0.661	0.508
	Europe	MacDonald, D (2020)	Europe	0.057	0.047	0.069	-27.529	0.000
	Europe	Moyer, J (2021)	Europe	0.078	0.071	0.087	-44.176	0.000
	Europe	Nia, A (2021)	Europe	0.260	0.157	0.398	-3.244	0.001
	Europe	Nu?ez, J (2020)	Europe	0.029	0.025	0.033	-45.814	0.000
	Europe	Rajput, K (2021)	Europe	0.158	0.124	0.199	-11.690	0.000
	Europe	Riuttanen, A (2021)	Europe	0.509	0.435	0.582	0.228	0.820
	Europe	Sephton, BM (2021)	Europe	0.054	0.047	0.062	-37.852	0.000
	Europe	Solà?Mu?oz, S (2021)	Europe	0.714	0.694	0.733	18.691	0.000
Random	Europe			0.163	0.076	0.314	-3.759	0.000
	Latin America and Caribbean	Ribeiro-Junior, MAF (2021)	Latin America and Caribbean	0.084	0.082	0.086	-174.170	0.000
Random	Latin America and Caribbean			0.084	0.082	0.086	-174.170	0.000
	Middle East and North Africa	Rozenfeld, M (2021)	Middle East and North Africa	0.232	0.221	0.243	-37.063	0.000
Random	Middle East and North Africa			0.232	0.221	0.243	-37.063	0.000
	North America	Chiba, H (2020)	North America	0.406	0.378	0.435	-6.321	0.000
	North America	Harmon, K.J. (2021)	North America	0.092	0.091	0.092	-595.291	0.000
	North America	Lubbe, R (2020)	North America	0.325	0.282	0.371	-7.046	0.000
Random	North America			0.243	0.069	0.581	-1.521	0.128
	South Asia	Abhalish, P (2020)	South Asia	0.532	0.512	0.553	3.087	0.002
	South Asia	Bhat, AK (2021)	South Asia	0.751	0.716	0.783	11.962	0.000
	South Asia	Goyal, N (2020)	South Asia	0.484	0.406	0.562	-0.402	0.688
	South Asia	Hazra, D (2021)	South Asia	0.649	0.612	0.684	7.585	0.000
	South Asia	Kaushik, G (2021)	South Asia	0.518	0.471	0.565	0.763	0.446
	South Asia	Nayak, N (2021)	South Asia	0.718	0.632	0.790	4.678	0.000
	South Asia	Reddy, M (2020)	South Asia	0.269	0.250	0.289	-19.900	0.000
Random	South Asia			0.562	0.418	0.697	0.848	0.397
	Sub-Saharan Africa	Haque, A (2021)	Sub-Saharan Africa	0.691	0.658	0.723	10.429	0.000
	Sub-Saharan Africa	Uwamahoro, Ch (2021)	Sub-Saharan Africa	0.474	0.426	0.523	-1.038	0.299
	Sub-Saharan Africa	Venter, A (2021)	Sub-Saharan Africa	0.396	0.382	0.411	-13.503	0.000
	Sub-Saharan Africa	Zsilavecz, A (2020)	Sub-Saharan Africa	0.293	0.244	0.346	-6.998	0.000
Random	Sub-Saharan Africa			0.463	0.310	0.624	-0.440	0.660

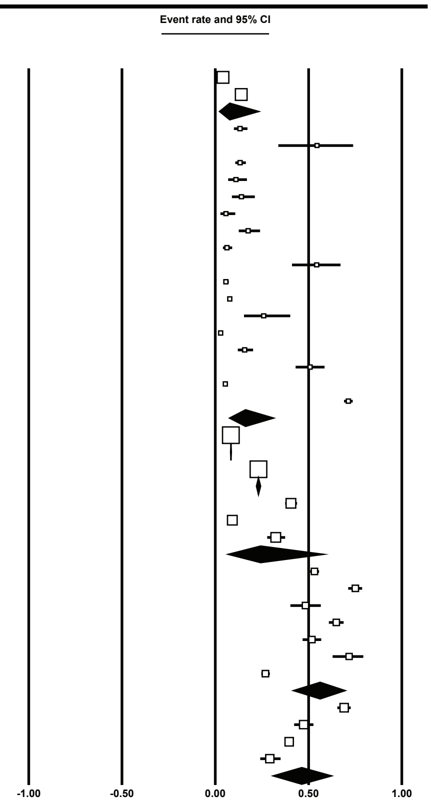

Figure 4. Subgroup analysis based on the geographical zone for the pre-pandemic era

Model	Group by Subgroup within study	Study name	Subgroup within study	Event rate	Lower limit	Upper limit	Z-Value	p-Value
	East Asia and Pacific	Dicker, B (2020)	East Asia and Pacific	0.014	0.013	0.016	-95.661	0.000
	East Asia and Pacific	Jacob, S (2020)	East Asia and Pacific	0.357	0.228	0.511	-1.825	0.068
	East Asia and Pacific	Lee, M.H (2021)	East Asia and Pacific	0.296	0.250	0.348	-7.215	0.000
Random	East Asia and Pacific			0.130	0.010	0.691	-1.378	0.168
	Europe	Ajayi, B (2020)	Europe	0.216	0.168	0.273	-8.147	0.000
	Europe	Campell, E (2020)	Europe	0.333	0.158	0.571	-1.386	0.166
	Europe	Carkci, E (2021)	Europe	0.115	0.072	0.180	-7.674	0.000
	Europe	Crenn, V (2020)	Europe	0.106	0.071	0.154	-9.669	0.000
	Europe	Donovan, R.I. (2020)	Europe	0.066	0.032	0.132	-6.774	0.000
	Europe	Fahy, S (2020)	Europe	0.029	0.011	0.076	-6.889	0.000
	Europe	Hampton, M (2020)	Europe	0.069	0.033	0.138	-6.630	0.000
	Europe	MacDonald, D (2020)	Europe	0.146	0.122	0.173	-17.129	0.000
	Europe	Moyer, J (2021)	Europe	0.101	0.086	0.119	-23.876	0.000
	Europe	Nia, A (2021)	Europe	0.140	0.064	0.278	-4.133	0.000
	Europe	Nu?ez, J (2020)	Europe	0.035	0.022	0.055	-13.803	0.000
	Europe	Riuttanen, A (2021)	Europe	0.554	0.423	0.677	0.800	0.424
	Europe	Sephton, BM (2021)	Europe	0.044	0.036	0.054	-29.464	0.000
	Europe	Solà?Mu?oz, S (2021)	Europe	0.628	0.597	0.658	7.904	0.000
	Europe	Waseem, S (2021)	Europe	0.188	0.127	0.269	-6.183	0.000
Random	Europe			0.137	0.067	0.259	-4.560	0.000
	Latin America and Caribbean	Ribeiro-Junior, MAF (2021)	Latin America and Caribbean	0.479	0.392	0.568	-0.454	0.650
Random	Latin America and Caribbean			0.479	0.392	0.568	-0.454	0.650
	Middle East and North Africa	Rozenfeld, M (2021)	Middle East and North Africa	0.174	0.163	0.186	-37.300	0.000
Random	Middle East and North Africa			0.174	0.163	0.186	-37.300	0.000
	North America	Chiba, H (2020)	North America	0.280	0.256	0.306	-14.680	0.000
	North America	Harmon, K.J. (2021)	North America	0.325	0.281	0.372	-6.870	0.000
	North America	Kamine, T.H. (2020)	North America	0.374	0.305	0.448	-3.299	0.001
	North America	Lubbe, R (2020)	North America	0.026	0.019	0.036	-20.885	0.000
	North America	Qureshi, A (2020)	North America	0.515	0.455	0.576	0.496	0.620
Random	North America			0.241	0.116	0.435	-2.544	0.011
	South Asia	Abhalish, P (2020)	South Asia	0.394	0.367	0.422	-7.290	0.000
	South Asia	Bhat, AK (2021)	South Asia	0.302	0.247	0.364	-5.893	0.000
	South Asia	Goyal, N (2020)	South Asia	0.512	0.426	0.597	0.264	0.792
	South Asia	Hazra, D (2021)	South Asia	0.078	0.056	0.107	-13.845	0.000
	South Asia	Kaushik, G (2021)	South Asia	0.169	0.153	0.186	-26.443	0.000
	South Asia	Nayak, N (2021)	South Asia	0.429	0.289	0.580	-0.923	0.356
	South Asia	Reddy, M (2020)	South Asia	0.082	0.079	0.084	-140.197	0.000
Random	South Asia			0.240	0.123	0.417	-2.762	0.006
	Sub-Saharan Africa	Haque, A (2021)	Sub-Saharan Africa	0.081	0.081	0.082	-534.749	0.000
	Sub-Saharan Africa	Uwamahoro, Ch (2021)	Sub-Saharan Africa	0.536	0.466	0.605	1.004	0.315
	Sub-Saharan Africa	Venter, A (2021)	Sub-Saharan Africa	0.317	0.301	0.333	-20.352	0.000
	Sub-Saharan Africa	Zsilavecz, A (2020)	Sub-Saharan Africa	0.214	0.157	0.286	-6.616	0.000
Random	Sub-Saharan Africa			0.252	0.093	0.525	-1.792	0.073

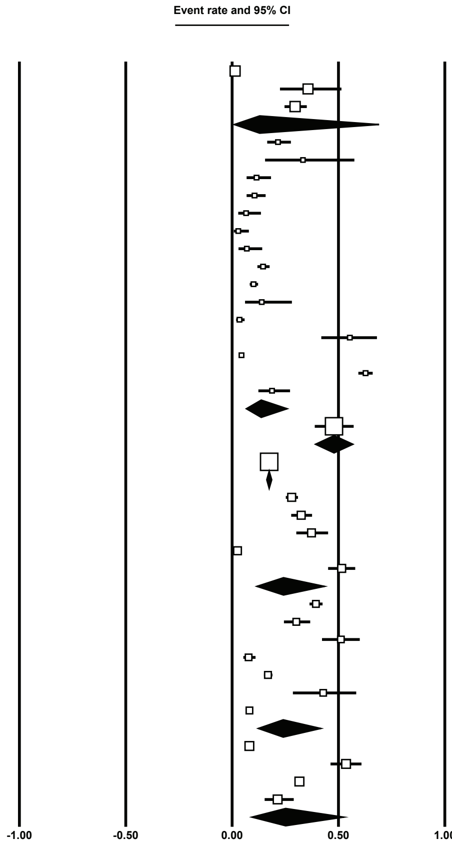

Figure 5. Subgroup analysis based on the geographical zone during the COVID-19 pandemic

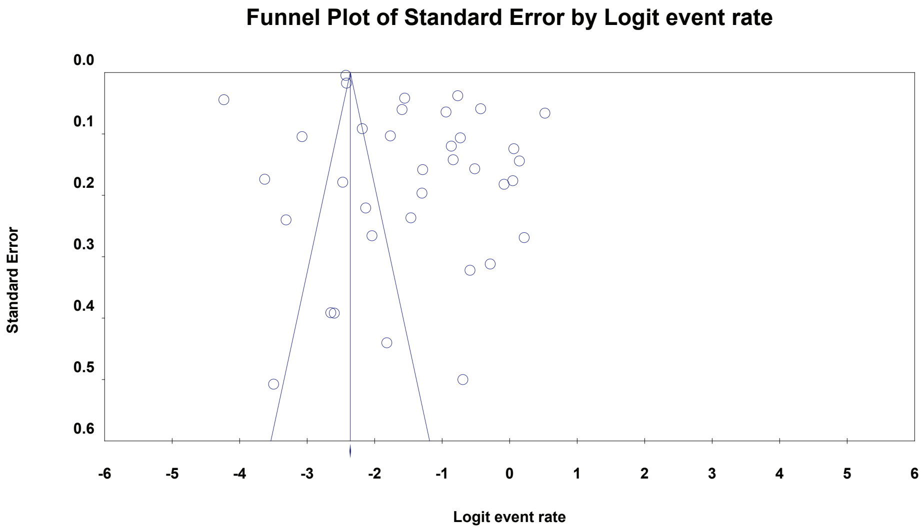

Figure 6. Funnel plot analysis of 36 studies

working and education, restricted industries, and factories activity, and the reduction of gatherings (e.g. weddings and mourning ceremonies) result in a decreasing need for mobility by motor vehicles.[38] In conclusion, reduced traffic congestion decreases the incidence of RTAs.[2]

Changing the mobility circumstances depends on the restriction status of each country. Thus, differences among road laws in different countries during the COVID-19 pandemic will affect the pattern of MVCs.[48] In the United States, the "stay at home" order has reduced motor vehicle utilization by 61% to 90%, so traffic accidents have reduced significantly.[9] While the Korean government had not yet imposed traffic restrictions, there was no change in the Korean traffic pattern and the prevalence of traffic accidents.[16] Although studies indicate a significant decrease in the total number of traffic accidents during the pandemic, different types of traffic accidents show different trends.[17] According to the studies, reducing the number of motor vehicles on the road during the pandemic has led to a reduction in multi-vehicle accidents (injured, fatal, damaged) while single-vehicle accidents (injured, fatal, and damaged) have increased,[32] which can be due to the increment of speeding on quiet roads, or the occurrence of risky driving behaviors due to lower road surveillance measures.[27] In hence, reducing the volume of traffic during the pandemic may affect the driver's perception of safety and lead to changes in driving behaviors.[25,48]

The present meta-analysis findings revealed that the lockdown period and mobility restrictions led to a decrease in the prevalence of road traffic injuries during the COVID-19 pandemic. Although traffic accidents are expected to be diminished during the COVID-19 pandemic, multiple studies reported different results.[27] In this regard, the new traffic pattern during the pandemic had potential to increase the rate of speed-related violations (e.g. careless driving, failure to stop at red lights, etc.) among drivers and endanger traffic safety.[11,25,37]

The number of traffic accidents is directly related to the amount of traffic flow. Therefore, reducing traffic flow could lead to a reduction in the number of traffic accidents, which is in line with the results of recent studies.[7,37] The reduction of traffic flow, in turn, caused the reduction of damage and/or mildly injured RTAs.[27] Although the number of traffic accidents is directly related to the traffic flow, some studies revealed an increment in the number of deaths from RTAs.[37] Increased fatal or severely injured RTAs can be due to speeding on quiet roads.[36] Given that the low traffic volumes provide the opportunity to drive at high speed, it would be the main cause of severe traffic accidents.[9,10,38,48]

Other factors such as less presence of police on the roads during the pandemic enhance risky behaviors among drivers.[9] Literature showed that quiet roads enhance some speed-related traffic violations among drivers, e.g. speeding, not stopping at a stop sign, passing a red light, etc. In Tokyo, the number of fines for speeding in 2020 has increased by 52% compared to 2019. Studies have indicated that speed-related violations are more likely to be committed during the lockdown period than before it.[25] Rising the speed of motor vehicles during the COVID-19 promote severe traffic accidents and injuries.[10] According to the evidence, alcohol consumption increased during the COVID-19 pandemic, which was directly associated with the risky behaviors (e.g. driving under the influence of alcohol).[27] Previous studies revealed that in addition to alcohol consumption, illegal drug-using, as a risk factor for RTAs, increased during the lockdown, resulted in severe RTAs.[41,48]

Notably, changing the sleep pattern during the pandemic along with the abnormal sleep quality can be considered a risk factor in favor of increasing RTAs.[48] On the other hand, the concerns in the case of economic situations and employment uncertainty during the pandemic likelihood can cause distraction-related traffic accidents. In addition, people who are worried about the health status of their relatives infected with COVID-19 can lead to traffic accidents by distractions.[45]

In the present study, Latin America and Africa were the most common areas for injury prevalence during the lockdown period, while South Asia and Africa had the highest injury prevalence before the lockdown. Therefore, traffic accidents during COVID-19 also noted different patterns under various conditions (different times and places, different demographic groups in terms of age, sex, and race.[34] Thus, multiple factors affecting the correlation between MVCs and COVID-19 led to a different pattern of traffic accidents during the COVID -19 pandemic.[39]

Strengths and limitations of the study

One of the major limitations of the study was excluding non-English studies due to the lack of expertise in translating other languages. Since the beginning of the pandemic was in China, probably we have missed some related Chinese studies.

Conclusion

This systematic review and meta-analysis provided a comprehensive overview of the prevalence of RTAs during the COVID-19 pandemic in the world. We have found that there is a relatively high prevalence of RTAs before COVID-19 when compared to the time during the pandemic. These data should be taken into consideration by health policymakers and top managers.

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Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethical Approval

This is a systematic review and there is no need for ethical approval, however, the study is approved by the ethics committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1400.1028).

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Supplementary Files

Supplementary file 1. Search strategy.

Supplementary file 2. Characteristics of included studies.

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