Pattern of Severity of Road Traffic Injuries among Pedestrians in Low and Middle-Income Countries: A Systematic Review

A Capstone Project submitted to
Johns Hopkins Bloomberg School of Public Health & IIHMR University
In partial fulfilment of the requirements for
The award of the degree of Master of Public Health

By

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October 2017

CERTIFICATE BY SCHOLAR

This is to certify that the Capstone Project titled **"Pattern of Severity of Road Traffic Injuries among Pedestrians in Low and Middle-Income Countries: A Systematic Review"** under the supervision of **Dr Mohan Lal Bairwa** for award of Master of Public Health embodies my original work and has not formed the basis for the award of any degree, diploma associate ship, fellowship, titles in this or any other institute or other similar institution of higher learning.

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List of Abbreviations

RTI-	Road Traffic Injury
LMICs-	Low and Middle-Income Countries
GNP-	Gross National Product
WHO-	World Health Organization
MICs-	Middle Income Countries
LICs-	Low Income Countries
MVCs-	Motor-Vehicle Collision
PVCs-	Pedestrian-Vehicle Collision
NOS-	Newcastle-Ottawa Scale

Acknowledgement

This MPH capstone project could not have been possible to complete without the support of my advisors and well-wishers.

I would like to sincerely thank my capstone advisor **Dr Mohan Lal Bairwa** (Assistant Professor, IIHMR University, Jaipur) for their continuous guidance, support, and patience. His mentorship has provided me great insights on designing and conducting this broad study in such a short time span with a huge learning experience.

I would like to give my special thanks to my faculty advisor **Dr Anoop Khanna** (Professor, IIHMR University, Jaipur) for being with me throughout this course and guiding and motivating me to perform my best.

I would like to thank our dear senior and MPH coordinator **Gowthamghosh B.** sir for their all -time valuable presence with us throughout the sessions and for inspiring and handholding in this MPH program.

Further, I would like to thank all the teaching and non-teaching staffs for their direct and/or indirect support.

Abstract

Background

Road traffic injury (RTI) is a challenging global health crisis especially in low-and middle-income countries (LMICs). LMICs contribute about 90% of total RTIs and deaths with high proportion of pedestrian-vehicle collision. In this area, to assess the injury severity and prediction of its outcome, various severity majoring scales are available but, there are no enough evidences available for pattern of severity of RTI among pedestrian in LMICs. This study will help to fill this gap.

Methods

In accordance with MOOSE guidelines we searched the electronic databases PubMed, CINHAL, Cochrane Library (CDSR), Web of Science, Scopus, EMBASE, ProQuest, and SciELO. Articles were eligible if they considered pedestrian road traffic injury in LMICs between 1997-2016. A metasummery was used for data analysis and 'Newcastle-Ottawa Scale' was used for quality assessment.

Results

Of the 5684 articles from the literature search, 12 articles from 9 LMICs were eligible for the study. The study participants were predominantly males (58 percent) with varying in age group pattern. MFISS, NISS, ISS, GCS, AIS were most commonly used severity majoring scales.

Conclusion

Our systematic review found a total of 12 articles that make up the evidence for pattern of severity of road traffic injury among pedestrian in LMIC settings. Pedestrians are most common group susceptible for such injuries with different pattern of severity. But, we are lacking behind in assessing and guiding new initiatives and policies for them due to lack of evidences. Further research should be performed in LMICs with patient-centered outcome to guide and serve the researchers and policymakers.

Pattern of Severity of Road Traffic Injuries among Pedestrians in Low and Middle-Income Countries: A Systematic Review

Introduction

Road traffic injury (RTI) is a challenging global health crisis especially in low- and middle-income countries (LMICs). The World Health Organization (WHO, 2013) anticipated that it will be the fifth leading cause of death globally by the year of 2030 if no urgent response is called for tackling it (1). The estimated cost of RTIs is approximately 2percent of the Gross National Product (GNP) of high-income countries, while this figure for middle-income countries (MICs) and low-income countries (LICs) is 1.5 percent and 1 percent, correspondingly. So, collectively MICs and LICs having the higher problem of motor vehicle collisions (MVCs) (2). LMICs contribute about 90 percent of total road traffic injuries and deaths (3). Among these injuries and deaths, pedestrian-vehicle collisions are over 33percent (4). These injuries have developed an epidemic share and are having an additional burden on available resources for healthcare (5).

Of the total pedestrian-vehicle collision (PVC) injuries and deaths, the commonest cause for death was traumatic brain injuries (6). A list of injury severity scoring systems have been developed and used for trauma care and research over last four decades. Quick assessment of severity of injury is required for the purpose of timely decision making for patient treatment need and to relate the quality of trauma care and conduct trauma related research. Most of them are classified under various categories like (a) Anatomical scoring systems [Abbreviated injury scale (AIS), Injury severity score (ISS), International Classification of Diseases 9 based injury severity score (ICISS), New injury severity score (NISS), Anatomical Profile (AP), Anatomical Index (AI)], (b) Physiological scoring systems [Glasgow coma scale (GCS),

Trauma score (TS), Revised trauma score (RTS), Prognostic Index, Acute Trauma Index, Triage Index], (c) Combined scoring systems [A severity characteristics of trauma (ASCOT), Trauma and injury severity score (TRISS), Harborview Assessment of Risk of Mortality (HARM)] (7)(8).

"The AIS was designed to stratify victims of motor vehicle crashes however, it doesn't design to provide any outcome prediction by itself". It's first description came in 1971 and the AIS-90 description has 1300 individual injuries. "It was divided into six scores of injury: AIS 1- Minor, AIS 2- Moderate, AIS 3- Serious, AIS 4- Severe, AIS 5- Critical, AIS 6- Unsurvivable" (9)(10).

"The MFISS method includes the three highest Maxillofacial Injury Severity Scores according to the AIS-90 standard and then it is combined with the injury severity scores for three maxillofacial functional parameters those are malocclusion, limited mouth opening, and facial deformity" (11).

The ISS is anatomically scoring system which is an ordinal scale. It has a range from 1 to 75. To compute it, six body regions are grouped from nine AIS body regions. Those six regions are head or neck, face, chest, abdominal or pelvic contents, extremities or pelvic girdle, and external. Than to calculate the score we have to sum the highest AIS scores are squared for the three most severely injured body regions (12). Whereas in NISS, the three most severely injured body regions are considered. Sum of squares is performed for the calculation of the NISS of three most severe AIS-90 injuries (12).

The GCS requires three different aspects of behavioral responses: motor response, verbal response, and eye opening. Each of them being evaluated independently and scores are

provided within 1-4 points for each section depends upon the victim's response. Then we sum all three section's points to get the GCS score of the victim (13)(14).

Despite development of many injury scores and their use for decades to assess the injury severity and the prediction of outcome, no enough evidences were available about pattern of severity and its determinants. This intrigued the authors to conduct the systematic review of the existing literature and compile the evidences. This study will provide evidences about pattern of severity among pedestrian related road traffic injuries; and will serve as a guide for future research for various safety measures especially for pedestrians. Hence, we did this systematic review to determine the pattern of severity of road traffic injuries among pedestrian according to various scales in LMICs.

Methods

Protocol and Registration

This systematic review is reported in accordance with the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) checklist, and is registered in the PROSPERO database (International Prospective Register of Systematic Reviews) under PROSPERO 2017: CRD42017073853 Available from http://www.crd.york.ac.uk/PROSPERO_REBRANDING/display_record.asp?ID=CRD42017073853. A MOOSE file is attached (See Appendix- 1)

Information Sources

We searched PubMed, CINHAL, Cochrane Library (CDSR), Web of Science, Scopus, EMBASE, ProQuest, and SciELO for articles published between years 1997 – 2016. Initial 200 pages of Google scholar were reviewed to supplement the search results. We were interested in the contemporary evidences because of industrialization and economic growth

both in numbers and speed of vehicles increased which may have an impact on pattern of severity of RTI among pedestrians so we examined publications from January 1997 through December 2016. All searches were done without any language restriction. We contacted with authors for further information which was not available in the relevant documents

Eligibility criteria

Study population

The population of interest was all age group pedestrian victims of road traffic accident. Victims of train, aircraft or other than road vehicles were not included in the study.

Outcome

The primary outcome was the assessment of severity of road traffic injury among pedestrians.

Study design

Studies were restricted by design and cross-sectional studies, cohort studies, registries, and the secondary data analysis of all mentioned studies.

Report characteristics

Searches were limited to peer-reviewed articles in all language. Abstracts of congress articles were included if the required information was available. There was no exclusion criteria regarding geography on the included studies but the editorials, letter to editor, errata and book chapter were not included.

Search strategy

A comprehensive database of all published studies was developed. It was addressing the aim of this systematic review. We listed indexing terms (like heading and subheadings) and other text words to describe concept clusters. The search was appeared in titles or abstracts only. The initial search was covering the keyword terms ‘Road Traffic Accident/Injury/Crash’ AND

'Low and Middle-Income Countries'. Than we looked for search with the help of experts and librarians, and from published strategies of other groups. Appendix-2 demonstrates the initial search strategy. We used the World Bank list of low and middle-income countries (Table-1) to identify the low and middle-income countries (15). However, we were not going to include LMICs directly into our search-key because there were chances of missing those articles where the mentioned study setting was any province or small area other than the country name. To overcome this problem, we cross-checked all the short-listed articles with the help of Rayyan software® (16). Further search was made in the reference lists of included articles for any additional sources of information.

Data management

We implemented the search strategies and imported all identified references to Rayyan software®. The search results from the different electronic databases were combined in a single library and the duplicate records from the same reports were removed. We screened all the articles by title, abstract, or full text to include or exclude the paper.

Data extraction

One reviewer (NS) extracted the relevant data from all eligible publications and saved it into a predefined Rayyan software® file which was created for this review. This was followed by the second reviewer (MB) to assess and ensure the quality of extraction. In this process of checking of all extracted data we were looking for the variables whether they are correctly included or not into the database. If there was any inconsistencies in between the reviewers, were sorted out by consensus, and arbitration by the review team (DKM and SDG) wherever needful. A PRISMA flow diagram of the study selection procedure was prepared to provide an overview of the decision that were made in the data collection process. (Appendix-3)

The extraction of variables for each study was based on: name of author(s), year of publication, geographic location, study period, study setting (hospital, registry, population based), source of data, participants, study design, and sample size. Furthermore, we extracted the name of the injury severity scale which was used to determine the severity of pedestrian injury. The studies whose full text was not available (congress papers) even after contacting the authors, we looked for relevant data from abstracts.

Data synthesis

Relevant data extracted from eligible studies. During the initial evaluation of the shortlisted articles it was difficult to pre-plan about a meta-analytical approach due to a high methodological variability (e.g. study designs, severity measure tool and their criteria's, study setting etc.). Therefore, first we used 'Meta-summery' which aggregated qualitative and quantitative findings from all the studies comprised in this review. Than we grouped the related findings into categories which was representing the study's objectives (17). Followed by the quality assessment with the help of an adapted 'Newcastle-Ottawa Scale' as per need of this systematic review to assesses the quality of studies was done (18).

Quality appraisal

The quality of studies was appraised using a adapted version of "modified Newcastle-Ottawa Scale (NOS)" (18). This adaptation was based on the types of studies shortlisted for the systematic review (The appraisal standards of NOS are shown in Appendix-4). We looked for each standard in the included studies. Whenever the standards were satisfied we provided the relevant score to that study. All seven criteria in studies with primary data and six criteria in studies with secondary data that could be related to the NOS were identified. Therefore, cross-sectional studies assigned maximum 10 score and studies based on secondary data analysis

assign maximum 9 score. The points were evaluated as very good (9-10), good (6-8), satisfactory (3-5), and unsatisfactory (0-2) for all the studies.

Ethics statement

Systematic review doesn't require approval by ethical committee as it used secondary data which is already in the public domain. Additionally, there was not unit level data where unique identifiers present.

Results

Twelve studies met the inclusion and exclusion criteria for in our systematic review. A summary of the characteristics of the 12 selected articles is shown in Table-2.

Study design and Geographical area

Five studies were based on primary data with cross sectional design (2)(19) (20)(21)(22)(23) and 7 were based on secondary data with cross sectional design (24)(25)(26)(27)(28)(29). The geographic areas included in the studies were Jordan, Korea, South Africa (2), Pakistan, China (2), Malaysia, Turkey, Philippines, Nigeria (2).

Characteristics of participants

The study participants were predominantly males (58 percent) of the selected 5 studies (19)(25)(20)(30)(22) (Table-3). Rest seven studies did not provide information on distribution of participants by gender. Most of the studies (10 of 12) included pedestrian from all the age groups. Whereas, two studies (30)(22) had specific age groups (aged up to 15 years and more than 16 years, respectively). We found 4 hospital based studies (19)(25)(20)(31), 4 population based studies (23)(30)(32)(22), one police record based (33), and 3 were registry based (2)(26)(27).

Injury severity

To fulfil the objective of the study, we presented a full account of pattern of severity using various injury severity scales. These studies included either one or two of the following scores: MFISS (19), NISS (25), ISS (20)(27), GCS (20)(25) (28) (30), AIS (22)(23), however, four studies didn't mention specific scale (2)(24)(26)(29). Most of the studies presented that pedestrians aged 20 years and above were at higher risk of injury than other age groups (2)(19)(20)(22)(24)(25)(27). Among them, elderly people aged 60 years or more were more susceptible to fatality (27).

Maxillo-Facial Injury Severity Score (MFISS)

Aladelusi et al (2014) used MFISS to assess severity among pedestrian RTIs of all age groups (19). The study found that more than 51percent of pedestrian RTI victims from age group of 1-20 years, and 83percent of those above 60 years had maxillofacial injuries. Most of the victims were students of their 1st and 2nd decades of life. The victims with highest MFISS were documented in the 11-20 years age group. Whereas, the least scores were in the age group of 71-80 years. More than 97 percent accidents were occurred in intra-city location. Vehicles involved in such accidents were dominantly car/minibus (65 percent) and motorcycle (30 percent).

Abbreviated injury scale (AIS)

Nie Jin et al (2010) and Zhao et al (2013) used AIS system to assess severity of injury. Nie Jin et al (2010) documented the proportion of minor (AIS score 1/2) and severe (AIS score 3+) injuries as 65 percent: 35 percent and 49.5 percent: 50.5 percent for minivan and sedan cars, respectively (23). There was a significant association of impact of speed with the risk of pedestrian AIS 3+ injury.

Zhao et al (2013) revealed that approximately 94 percent fatalities and 11 percent slight injuries involved a head AIS greater than or equal to 3. Females were twice as likely as males to suffer a head injury. The impact of speed played an important role in determining severity pattern as low speed (0-39 km/h) accounted for 44 percent and 6percent of mild and severe head injuries, respectively, whereas high speed (>70 km/h) accounted for almost half of severe head injuries.

Injury Severity Score (ISS)

Two studies, Nasrullah et al (2010) and Sonaike et al (2010) included the ISS system as severity scale (20)(27). Nasrullah et al (2010) reported that in the both age groups (1-15years and $\geq$ 16years), majority of victims (57 percent and 61 percent respectively) belonged to lower ISS which was ranged from 1 to 9, followed by higher ISS 10 to 19 (40 percent and 36 percent respectively). Head and neck were the more severe site for injury. Both anatomical sites injured more frequently as 56.9 percent and 55.1 percent cases in their respective 1-15 years and $\geq$ 16years age groups. Twenty one percent of injuries in male and female pedestrians were having significant difference (17 percent vs 38 percent; $p<0.01$). Majority of accidents occurred outside the house (85 percent).

Sonaike et al (2010) found that the elderly (65years and more age) had higher severity scores than young (less than 65 years age) population group (ISS 15, $p< 0.001$) injured than the young (under 65 years) (27). The elderly population was more than twice as likely to die than younger population. Mortality is an important measure of severity of injuries.

New Injury Severity Score (NISS)

Jung Soo lee et al (2016) showed that the mean value of NISS in pedestrian age group was 18.9 ± 15.5 (25). About 60 percent of the injury victims were males as compared to 40 percent of females. Head injuries were accounting about 32 percent of total injury cases. According

to study victims of minor injury group (NISS, 1-3) had 5±4.9 days of length of hospital stay, victims of moderate injury group (NISS, 4-8) had 8.9±5.9 days duration, victims of serious injury group (NISS, 9-15) had 15.5±11.2 days duration, victims of severe injury group (NISS, 16-24) had 24.7±17 days duration and the victims of critical injury group (NISS, 25-75) had 30.9±34 days in the hospital with statistically significant differences ($p<0.05$).

Glasgow coma scale (GCS)

Majority of included studies used GCS scale to assess the severity of injury during the hospitalization of RTI victims (20)(25)(34)(31). These studies reported that pedestrians with RTI, those who reported to hospital were mostly with score 13 or more ranged from 37-97 percent, 8-31 percent with GCS of 9-12, and 3-32 percent with GCS 3-8 points. (Table-4)

Jung Soo Lee et al (2016) documented that most of the victims (97 percent) had a GCS of 13-15 points at admission, while 3 percent victims had a GCS of 3-8 (25).

Nasrullah et al (2010) indicated that 82 percent victims had a GCS $\geq$ 13 (minor) while 11 percent had a GCS of $\leq$ 8 (severe) and only 7 percent had a GCS 9-12 (moderate) (20).

Solagberu et al (2014) mentioned that about 37 percent had a GCS $\geq$ 13 (minor), while 32.4 percent had a GCS of $\leq$ 8 (severe), and 30.6 percent had a GCS 9-12 (34).

Tokdemir et al (2009) indicated that 59.7 percent had a GCS $\geq$ 13 (minor), while 24.5 percent had a GCS of $\leq$ 8 (severe), and 15.8 percent had a GCS 9-12 points (31).

Other findings

Remaining four studies did not used any validated tool. However, the studies defined and classified the severity according various self-modified/developed scales (2)(24)(26)(29). Bashar et al classified the study participants as 73.5 percent victims with slight injuries, 18.7 percent with medium injuries, 5.1 percent of severe injuries and 2.7 percent of fatalities (24).

Nadesan-Reddy et al (2013) reported that the 9.9 percent were without injury , 63.1 percent with slight injury, 23.6 percent with serious injury, and 3.35 percent with fatal injuries collectively for Chatsworth and KwaMashu (2).

Olukoga et al (2008) mentioned that pedestrian constituted 24 percent casualties and 61 percent fatalities of the total road traffic injuries (26). Verzosa et al (2016) mentioned that about 96 percent victims were non-fatal whereas 4 percent were fatal cases.

Quality appraisal of selected studies

Based on Newcastle-Ottawa Scale, 9 of the 12 studies were of good quality (19)(25)(20)(23)(27)(29)(31)(22)(34) and the remaining 3 were satisfactory (2)(24)(26). Most studies with satisfactory scores were carried out before 2005 (Table-5). Inadequate sample size, failed to use secure records for the ascertainment of the exposure, and failed to use validated severity measuring tool for the assessment of the outcome were the few major reasons for the less score in those studies. However, description about the non-respondents wasn't mentioned by any of the included studies. Cumulative findings of such characteristics indicated that representativeness of the sample was 100 percent, justified/satisfactory sample size was 25 percent, description of non-respondent was 0 percent, ascertainment of the exposure was 44.44 percent, comparability between important factors was 66.67 percent, assessment of the outcome was 44.44 percent, and the description of statistical test was 58.33 percent.

Discussion

This systematic review studied the pattern of severity of pedestrian road traffic injuries in LMICs. We found 12 manuscripts of 9 LMICs among 139 countries from last two decades which indicates lack of attention on this area of RTIs (15). Pedestrian injuries belonged largely

to vulnerable sections of society including children, elderly, etc. This study revealed that different studies used various injury severity scales, namely, MFISS, AIS, ISS, NISS, and GCS. Some of the popular scales were not even used for this population group viz., TRISS, ASCOT, ICISS, combined method etc. These studies found various pattern of severity in different age groups, their gender based distribution. Few of them focused on injured body part as well in their analysis. Thus, this comprehensive review highpoints the limited number and poor quality of manuscripts on this topic and calls for more research on patient-centered outcomes of RTI among pedestrians in LMICs to inform the need of researchers and policy makers' priorities.

However, in the setting of the UN's Decade of Action for Road Traffic Injury Prevention 2010-2020 there is numerous calls for increased literature focusing on RTIs (35). Along-side, multiple journals has published calls for research (36), but still there is small increase in the literature based on the studies found by this review. Comparatively there is an abundance of literature available in High Income Countries (HIC) about the pattern of severity of pedestrian injuries. The proper utilization of such injury severity scores are still missing in LMIC settings. Once such initiatives will be under routine data collection procedures they let for prioritization that considers the inadequate infrastructure, implementation challenges, funding allocation at various locations and levels in these settings.

All the studies were of cross sectional design, however, some studies were based on primary data (19)(20)(22)(23)(34), and others were based on secondary data (2)(24)(25)(26)(27)(29)(31). The main sources of poor quality of studies found was un-justified or unsatisfactory sample size, non-description of non-respondents, and failed to mention about the severity scale. Most studies depend on police, hospital records, and trauma registries among which police and committee (Metro Manila Crash Reporting and Analysis

System, National Trauma Database, Road Traffic Accident Statistics) based trauma registry records have likelihoods of reporting information bias about the injury severity and public hospital records are likely to incomplete due to poor appliance. Performing a meta-analysis was not possible due to given numerous types of data sources, outcomes measured, and different scales used for assessing injury severity.

The results suggest that most common groups for such injuries were 1-20 years & >60 years age groups. The highest MFISS was recorded in 11-20 years whereas least scores were in 71-80 years of age group (19). Studies related to AIS scores describes that more the AIS more the severe outcome of the injury (22)(23). According to studies with ISS scales there is no significant difference between under 15 and above 15 age groups. Which indicates all the age groups are similarly under the risk of pedestrian injury. But elderly populations (65years <) were comparatively under more risk than young (20)(27). The length of hospital stay varies approx. 5 days to 2 months as the New Injury Severity Score increases (25). 84.07percent was the mean GCS > 13 (minor), while 9.68percent for the GCS of < 8 (severe) and only 6.25percent for the GCS of 9-12 (moderate) for all four studies (Table-4) (20)(25)(34)(31).

The heterogeneity of study settings (hospital based, registry based, police record based, and population based) and source of data (primary and secondary data) restricted us to pooling of the data and make further analysis in terms of meta-analysis. So, still there is a scope to do more research and publication of those studies which are assessing injury severity of pedestrians. This inadequate number of shortlisted manuscripts could be suggestive of the limitations in funding for implementation, evaluation, and publication about RTI initiatives.

There is need to develop consensus among researchers and healthcare providers about use of various severity scores that may provide sound body of evidences for use of the scales and

comparison of them to assess of the use of the scores. This will enable the researchers and health care providers to use them for prediction of outcomes and policy planners to improve and develop preventive measures for pedestrian road traffic injuries.

The limitations of this study must be considered when evaluating or using the findings of this study. The focused one is availability of limited studies from LMICs and among those heterogeneity which made the job more difficulty as point of pooling the data.

Conclusion

Our systematic review found a total of 12 articles that make up the evidence for pattern of severity of road traffic injury among pedestrian in LMIC settings. Pedestrians are most common group susceptible for such injuries with different pattern of severity. But, we are lacking behind in assessing and guiding new initiatives and policies for them due to lack of evidences. Further research should be performed in LMICs with patient-centered outcome to guide and serve the researchers and policymakers.

Reproducibility

For this review we developed a reproducible online dataset (17). This Dataset (in.csv format) and search keys are made available at our OneDrive repository. https://instituteofhealthmanagemtin-my.sharepoint.com/personal/neeraj_j16_iihmr_in/_layouts/15/guestaccess.aspx?folderid=151dde0eec6e94c789754344de9b68e02&authkey=ATPB1vq5Z8-900GdOMYBqAE

Competing interests

The authors declare that they have no competing interests.

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Appendix-1: MOOSE Guideline

MOOSE Guidelines for Meta-Analyses and Systematic Reviews of Observational Studies*

Title Identify the study as a meta-analysis (or systematic review)

Abstract Use the journal's structured format

Introduction **Present**

The clinical problem
The hypothesis
A statement of objectives that includes the study population, the condition of interest, the exposure or intervention, and the outcome(s) considered

Sources **Describe**

- Qualifications of searchers (example- librarians and investigators)
- Search strategy, including time period included in the synthesis and keywords
- Effort to include all available studies, including contact with authors
- Databases and registries searched
- Search software used, name and version, including special features used (example- explosion)
- Use of hand searching (example- reference lists of obtained articles)
- List of citations located and those excluded, including justification
- Method of addressing articles published in languages other than English
- Method of handling abstracts and unpublished studies
- Description of any contact with authors

Study Selection **Describe**

- Types of study designs considered
- Relevance or appropriateness of studies gathered for assessing the hypothesis to be tested
- Rationale for the selection and coding of data (example- sound clinical principles or convenience)
- Documentation of how data were classified and coded (example- multiple raters, blinding, and interrater reliability)
- Assessment of confounding (example- comparability of cases and controls in studies where appropriate)
- Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results
- Assessment of heterogeneity
- Statistical methods (example- complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated

Results **Present**

- A graph summarizing individual study estimates and the overall estimate
- A table giving descriptive information for each included study
- Results of sensitivity testing (example- subgroup analysis)
- Indication of statistical uncertainty of findings

Discussion **Discuss**

- Strengths and weaknesses
- Potential biases in the review process (example- publication bias)
- Justification for exclusion (example- exclusion of non–English-language citations)
- Assessment of quality of included studies
- Consideration of alternative explanations for observed results
- Generalization of the conclusions (such as- appropriate for the data presented and within the domain of the literature review)
- Guidelines for future research
- Disclosure of funding source

*Modified from Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA 2000; 283:2008–12.

Appendix-2: Search Key

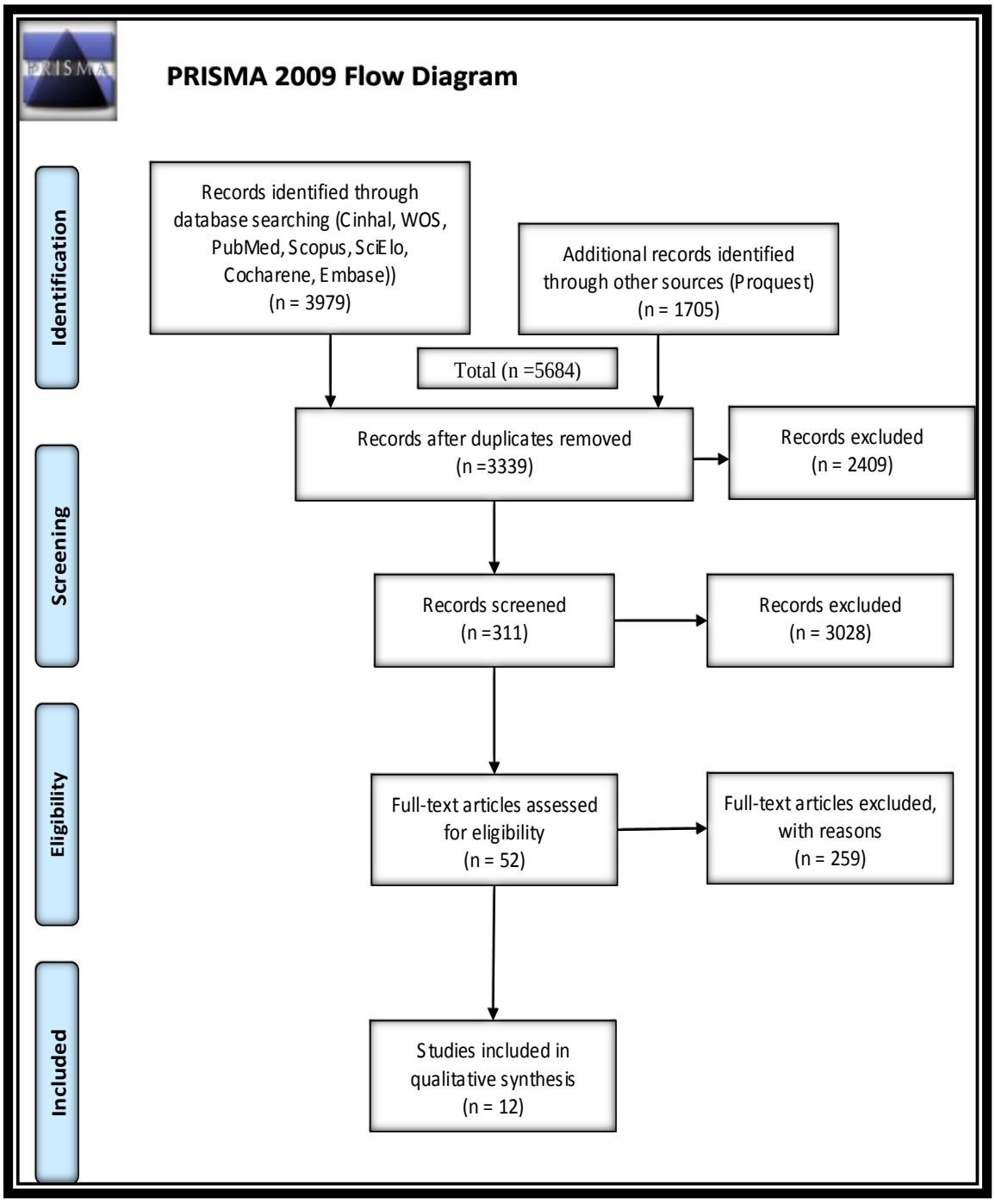
General Search Key

((road OR traffic OR transport OR unintentional OR vehic* OR motor*) AND (acciden* OR crash* OR injur* OR deaths OR collision OR fatal*) AND (pedestrian OR ("vulnerable Road" AND user*)) AND sever*)

For Scopus-

TITLE-ABS-KEY ((road OR traffic OR transport OR unintentional OR vehic* OR motor*) AND (acciden* OR crash* OR injur* OR deaths OR collision OR fatal*) AND (pedestrian OR ("vulnerable Road" AND user*)) AND sever*) AND PUBYEAR > 1996 AND (EXCLUDE (PUBYEAR , 2017))

Appendix-3: PRISMA Flow Diagram



Appendix- 4: Modified Newcastle-Ottawa Scale adapted for cross-sectional studies

Selection: (Maximum 5 stars)

1) Representativeness of the sample: (Maximum 1 star)

a) Truly representative of the average in the target population. * (all subjects or random sampling)

b) Somewhat representative of the average in the target population. * (non-random sampling)

c) Selected group of users.

d) No description of the sampling strategy.

2) Sample size: (Maximum 1 star)

a) Justified and satisfactory. * [Sample size calculated and it was adequate according to reviewer]

b) Not justified. [Rest all]

c) No description of the sample size calculation. [in cases of large multi-centric studies, it may be classified as (a)]

3) Non-respondents: (Maximum 1 star)

a) Comparability between respondents and non-respondents' characteristics is established, and the response rate is satisfactory. *

b) The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.

c) No description of the response rate or the characteristics of the responders and the non-responders.

4) Ascertainment of exposure: (Maximum 2 star)

a) Secured record (e.g. Hospital/Registry) **

b) Structured interview or questionnaire *

C) Written self-report

d) No description

Comparability: (Maximum 2 stars)

1) The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.

a) The study controls for the most important factor (Severity). *

b) The study control for any additional factor. * (Age, Sex, Residence-Urban/Rural)

Outcome: (Maximum 3 stars)

1) Assessment of the outcome: (Maximum 2 stars)

a) Validated measurement tool. **

b) Non-validated measurement tool, but the tool is available or described. *

c) No description of the measurement tool.

2) Statistical test: (Maximum 1 stars)

a) The statistical test used to analyze the data is clearly described and appropriate, and the measurement of the association is presented, including confidence intervals and the probability level (p value). *

b) The statistical test is not appropriate, not described, or incomplete.

We have not selected one factor that is the most important for comparability, because the variables are not the same in each study. Thus, the principal factors were identified for each study.

This study has maximum of 10* and minimum of 0*. We have categorized the quality of the studies as follows:

Very Good Studies: 9–10*

Good Studies: 6-8

Satisfactory Studies: 3-5

Unsatisfactory Studies: 0-2*

Table-1: Low and middle-income countries			
Afghanistan	Dominica	Liberia	Sao Tome and Principe
Albania	Dominican Republic	Libya	Senegal
Algeria	Ecuador	Macedonia, FYR	Serbia
American Samoa	Egypt, Arab Rep.	Madagascar	Sierra Leone
Angola	El Salvador	Malawi	Solomon Islands
Argentina	Equatorial Guinea	Malaysia	Somalia
Armenia	Eritrea	Maldives	South Africa
Azerbaijan	Ethiopia	Mali	South Sudan
Bangladesh	Fiji	Marshall Islands	Sri Lanka
Belarus	Gabon	Mauritania	St. Lucia
Belize	Gambia, The	Mauritius	St. Vincent and the Grenadines
Benin	Georgia	Mexico	Sudan
Bhutan	Ghana	Micronesia, Fed. Sts.	Suriname
Bolivia	Grenada	Moldova	Swaziland
Bosnia and Herzegovina	Guatemala	Mongolia	Syrian Arab Republic
Botswana	Guinea	Montenegro	Tajikistan
Brazil	Guinea-Bissau	Morocco	Tanzania
Bulgaria	Guyana	Mozambique	Thailand
Burkina Faso	Haiti	Myanmar	Timor-Leste
Burundi	Honduras	Namibia	Togo
Cabo Verde	India	Nepal	Tonga
Cambodia	Indonesia	Nicaragua	Tunisia
Cameroon	Iran, Islamic Rep.	Niger	Turkey
Central African Republic	Iraq	Nigeria	Turkmenistan
Chad	Jamaica	Pakistan	Tuvalu
China	Jordan	Palau	Uganda
Colombia	Kazakhstan	Panama	Ukraine
Comoros	Kenya	Papua New Guinea	Uzbekistan
Congo, Dem. Rep.	Kiribati	Paraguay	Vanuatu
Congo, Rep.	Korea, Dem. People's Rep.	Peru	Venezuela, RB
Costa Rica	Kosovo	Philippines	Vietnam
Cote d'Ivoire	Kyrgyz Republic	Romania	West Bank and Gaza
Cuba	Lao PDR	Russian Federation	Yemen, Rep.
Djibouti	Lebanon	Rwanda	Zambia
	Lesotho	Samoa	Zimbabwe

Table- 2: Characteristics of shortlisted studies

Authors-Year of Publication	Study setting/ Design	Severity scale	Salient Features
Aladelusi et al - 2014	Hospital Based/Cross sectional study	MFISS	• Forty-six participants (22.9% of all victims of road traffic crashes seen within the study period) were victims of pedestrian RTC. • Pedestrian RTC occurred in all age groups with almost 40% of the victims in their 1st and 2nd decades of life. • The most severe MFISS was observed in the 21 – 30-year age group while the least severe injury observed was in the 71 – 80 years age group. • Thirty participants (65.2%) were hit by a car or minibus while fourteen (30.4%) were knocked down by a motorcycle. • Two (4.4%) were hit by a truck. • Soft tissue injury was the most common maxillofacial injury and head injury was the commonest concomitant injury observed. • The median MFISS score of victims of motorcycle was 4.0 while the median scores for victims of car/minibus pedestrian RTC was 9.0. • The most severe maxillofacial injury was seen in victim of car/minibus pedestrian crashes. Seventeen percent (8) of the victims had a fatal outcome.
Bashar et al- 2013	Police record based/Retrospective study	Not mentioned	• The results of the study showed that the majority of pedestrian accidents have occurred at non-intersection locations, during clear and sunny weather, on dry surface, during daylight, and at low speed limits. • Also, more pedestrian accidents have occurred during the afternoons, on Thursdays, and during July. • The majority of involved drivers in pedestrian accidents were males, with private license type, driving private vehicles and committed the fault of "not giving priority to pedestrians". • The majority of pedestrian victims was males, children less than 15 years old, and hit by vehicles while crossing the road. • Pedestrian traffic accidents have resulted into 73.5% of slight injuries, 18.7% of medium injuries, 5.1% of severe injuries and 2.7% of fatalities.

Jung Soo Lee et al-2016	Hospital Based/Retrospective study	GCS & NISS	• The proportion of pedestrian traffic accident (TA) was the highest, followed by driver, passenger, motorcycle, and bicycle TA. • The mean NISS was significantly higher in pedestrian and motorcycle TAs and lower in passenger TA. • Analysis of differences in mean hospital length of stay (HLS) according to NISS injury severity revealed 4.97±4.86 days in the minor injury group, 8.91±5.93 days in the moderate injury group, 15.46±11.16 days in the serious injury group, 24.73±17.03 days in the severe injury group, and 30.86±34.03 days in the critical injury group (p<0.05).
Nadesan-Reddy et al-2013	Registry Based /Retrospective study	Not mentioned	• In Chatsworth, an average of 62% (pre- 331 v. post 291) of the PVCs were of minor severity while in KwaMashu two-thirds (pre- 74.2% v. post 66.7%) fell into this category. • Serious collisions accounted for >20% of the total in both areas (Chatsworth: pre- 132 v. post 101; KwaMashu: pre-37 v. post 29), while non-injury and fatal collisions accounted for the remainder. • The majority of PVCs occurred during daylight hours; more than two-thirds (pre-367 v. post 326) in Chatsworth and more than half (pre-90 v. post 59) in KwaMashu. • The 2 most common vehicle types involved in collisions in these areas were cars and minibus taxis.
Nasrullah et al-2010	Hospital Based/Cross sectional study	ISS & GCS	• The majority of them were males (80%; n=502), aged 21-40 years (63%). Road traffic injuries (RTIs) 65% (n=411) followed by gunshots (14%, n=85) were the most common types of injuries. • Upon arrival to hospital 82% (491/598) of patients had a Glasgow Coma Scale (GCS) ≥13. • The mean hospital stays and Injury Severity Score (ISS) of patients were 3.5 days (SD ±6.4) and 4 (SD ±5.2) respectively. • The head, neck and face were the most affected body parts (50%; n=276). • Three percent (n=17) were pronounced dead on arrival to the ED.
Nie Jin et al-2010	Population Based /Cross sectional study	AIS	• There is a significant correlation among the impact speed and the severity of pedestrian injuries. • The minivan poses greater risk to pedestrian than sedan at the same impact speed. • There is a significant correlation among pedestrian head AIS 3+ injuries and injury parameters (HIC, head linear acceleration, head angle acceleration, angle velocity).

Olukoga et al-2008	Registry Based/Retrospective study	Not mentioned	• Most of the casualties of road traffic accidents were drivers 4296 (46%) who accounted for 103 (17%) of the fatalities. • The majority of the fatalities were pedestrians 368 (61%) who were only 2241 (24%) of the casualties. • Passengers accounted for about the same proportion of the casualties and fatalities. • The two urban operational areas of South Central and North Central accounted for 37872 (73%) of the road traffic accidents, 8876 (69%) of the casualties and 358 (67%) of the fatalities. • But there were more fatalities per 100,000 populations in the two largely rural operational areas of North and South with 67 fatalities per 100,000 population and 35 fatalities per 100,000 populations respectively. • The percentage monthly distributions of the road traffic accidents, casualties and fatalities were very similar.
Solagberu et al-2014	Population Based /Cross sectional study	GCS	• Some 226 pedestrians (114 boys and 112 girls) comprising 42 children aged B4 years, 91 aged 5–9 years and 93 aged 10–15 years were seen with car collisions (83 pedestrians, 36.7 %), motorcycles (76, 33.6 %), buses (41, 18.1 %), others (15, 6.6 %) and 11 undetermined vehicles. • Injuries on the highways were 147 (65 %); inner-city roads 77 (34.1 %) and two undetermined roads. Crossing the road was responsible for 168 (74.3 %) pedestrian injuries; while three other mechanisms produced 58 (25.7 %) patients. • Regions injured were head (42.9 %), lower limbs (35.4 %) and others (21.7 %). Relatives, bystanders, and police/ambulance brought 186 (82.3 %), 31 (13.7 %) and eight (3.5 %) children, respectively; and within 6 h (43.4, 11.5 and 2.2 %) and after (38.9, 2.2 and 1.3 %). Nineteen deaths (10 brought-in-dead, nine SER deaths) occurred; 15 of them girls, 15 had severe head injury, 15 were brought by relatives. • However, fatality risks were truck collisions (OR 5.97), female child (OR 4.25), head injury (OR 4.18) and age B4 years (OR 3.7).

Sonaike et al-2010	Registry Based/Retrospective study	ISS	• Approximately 11% (8,275) of injuries involved patients older than 65 yrs of age. • There were significantly less men (53.3%) and more whites (65.5%) among the elderly than in younger pedestrian trauma patients (67.0% males, 46.7% whites). • The elderly is more severely injured than the young (39.4% above ISS 15, versus 27.8%, $p < 0.001$), and more likely to experience shock (10.0% vs 7.3%, $p < 0.001$). • In terms of patterns of injuries, the elderly is significantly more likely than younger patients to sustain fractures of all types, intracranial injury, pneumo-thorax, but less likely to sustain hepatic and splenic injuries. • The elderly is more than twice as likely to die than younger population (14.9% vs 5.9%, $p < 0.001$) and with longer lengths of stay (8.8 vs 6.7 days, $p < 0.001$).
Tokdemir et al-2009	Hospital Based/Retrospective study	GCS	• Five hundred thirty-two of the cases (386 male, 146 females, mean age: 26.8±20.3 years) involved in MV accidents experienced traumatic brain injuries, of which 299 were MV occupants and 233 were pedestrians. • The pediatric (≤16 years: 65.4%) and elderly (≥65 years: 64.7%) groups were frequently involved as pedestrians in MV accidents; adults 17–64 years of age were involved as pedestrians at a lower rate (25.4%, $p<0.001$). • The GCS values of the pedestrian victims were significantly lower than those of the MV occupants on admission ($p<0.001$).
Verzosa et al-2016	Population Based /Retrospective study	Not mentioned	• The results of the binomial regression analysis show that traffic crashes that involve heavy and multiple vehicles, and an elderly pedestrian (60 years old and above), as well as those that occurred during the evening (7 pm to midnight) and late at night (1 am to 5 am) have significantly higher odds of resulting in a fatal outcome; when the crash involves a female pedestrian and when the road surface is wet the odds of a fatal outcome are lower. • Moreover, by closely examining the environment of these roadways, the study finds that most pedestrian fatalities occur on high-speed, high-traffic-volume, multilane roadways, that are surrounded by land uses that generate a particularly problematic mix of heavy vehicular and pedestrian traffic. • The street level analysis also finds that fatal pedestrian crashes occur close to different types of transit stations.

Zhao et al-2013	Population Based /Cross sectional study	AIS	• A higher pedestrian fatality risk was associated with age over 46, impact speeds over 40 km/h, and higher likelihoods of the victim's head striking the windscreen frame/A pillar and of the victim sustaining a head injury. • Similarly, a higher risk of head injury was associated with being female, age over 60, impact speeds over 40 km/h, and a likelihood of the victim's head striking the vehicle rather than the ground. • Impact speeds of over 40 km/h and head contact site on O12windscreen frame/A pillar retained a strong association with severe head injury (AIS 5–6) rate.

Table-3: Gender wise distribution of targeted population

Authors-Year of Publication	Participants characteristics	Sample Size	Male	Female	Total
Aladelusi et al - 2014	RTC victims 24 (52%) males and 22 (48%)females.	46	24	22	46
Bashar et al-2013	Male drivers accounted for 97.5% of pedestrian accidents.	1130			
Jung Soo Lee et al-2016	Male 621 (59.3%) and female 427 (40.7%).	1048	621	427	1048
Nadesan-Reddy et al-2013		Chatsworth 588; KwaMashu 172; Total= 760			
Nasrullah et al-2010	Male 502 (80%)	411	333	78	411
Nie Jin et al-2010		79 Sedan & 31 Minivan= 110			
Olukoga et al-2008		2609			
Solagberu et al-2014	114 boys and 112 girls.	226	114	112	226
Sonaike et al-2010	Male= 53%, Female= 47%;	79307			
Tokdemir et al-2009		756			
Verzosa et al-2016	Male 56.80% & Female 43.20%;	7628	4333	3295	7628
Zhao et al-2013		285			
			5425	3934	9359
		Percentage	57.96	42.04	

Table-4: Glasgow Coma Scale

Authors	**Year of Publication**	**Mild (13-15 Points)**	Percentage	**Moderate (9-12 Points)**	Percentage	**Severe (3-8 Points)**	Percentage	**Total cases**
Jung Soo Lee et al	2016	871	97.10			26	2.90	897
Nasrullah et al	2010	322	81.73	32	8.12	40	10.15	394
Solagberu et al	2014	40	37.04	33	30.56	35	32.41	108
Tokdemir et al	2009	139	59.66	37	15.88	57	24.46	233
		1372	**84.07**	102	**6.25**	158	**9.68**	1632

Table-5: Quality Appraisal of shortlisted studies with Newcastle-Ottawa Scale

Authors-Year of Publication	Representativeness of the sample	Sample size	Non-respondenets	Ascertainment of the exposure	Comparability	Assessment of the outcome	Statistical test	Total
Aladelusi et al - 2014	1	0	0	2	2	2	0	7
Bashar et al- 2013	1	0	NA	0	2	0	0	3
Jung Soo Lee et al-2016	1	0	NA	2	1	2	1	7
Nadesan-Reddy et al- 2013	1	0	0	1	1	0	0	3
Nasrullah et al-2010	1	0	0	2	1	2	1	7
Nie Jin et al- 2010	1	0	0	1	1	2	1	6
Olukoga et al- 2008	1	1	NA	0	1	0	0	3
Solagberu et al-2014	1	0	0	1	2	2	0	6
Sonaike et al- 2010	1	1	NA	1	1	2	1	7
Tokdemir et al-2009	1	0	NA	2	1	2	1	7
Verzosa et al- 2016	1	1	NA	2	2	0	1	7
Zhao et al-2013	1	0	0	2	1	2	1	7
Total	12	3	0	16	16	16	7	70
Percentage	100.00	25.00	0.00	44.44	66.67	44.44	58.33	50.72

NA- Not applicable due to limitation (secondary data)