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Original Article

Prevalence and Overall Burden of Lower Limb Amputations in Patients with Severe Lower Extremity Injury Following Road Traffic Accidents: A Systematic Review and Meta-Analysis

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Abstract:
Lower limb amputation is a major public health challenge that significantly impacts the lives of affected individuals, their relatives, healthcare systems, and society at large. Road traffic accidents (RTAs) are responsible for a significant percentage of the cases of lower limb amputations. The aim of this research is to analyze the existing literature to determine the prevalence of lower limb amputations resulting from severe lower extremity injuries caused by RTAs, as well as to examine the impact that these amputations have on quality of life (QoL) and psychological consequences.
A thorough literature search was carried out across three databases (PubMed, ScienceDirect, and Google Scholar), and a total of six publications were included in this review. The pooled effect was evaluated in Comprehensive Meta-Analysis (CMA) software, employing a random effect model. Based on our analysis, the pooled prevalence of lower limb amputations as a result of RTA was 43.2%. Out of the six studies that were considered for inclusion in this review, only three of them reported on results that were related to psychological outcomes and quality of life. It is necessary to have rehabilitation programs that are all-encompassing and address both the physical and psychological components.

Keywords: Prevalence; Lower Limb Amputation; Road Traffic Accidents; Quality of Life; Psychological Outcome

Introduction

Amputation is a surgical intervention that involves the removal of a limb or part of the limb as a result of an injury, disease, or infection. This is typically done when alternative therapies are not possible [1]. A growing number of people around the world are becoming concerned about the effects of amputation, particularly those that involve the lower limbs [2]. Motor vehicle accidents contribute significantly to the cause of amputation, including lower limbs especially in areas with high incidence of road traffic accidents where the lower extremities are very severely injured [3].

Lower limb amputations have far reaching implications that transcend the direct impact on the health of the victims. In most cases, the healthcare systems and the entire society are indirectly affected. Individuals with life-long disabilities live with residual limiting effects on the overall quality of life, affecting their physical and mental health, social interactions and financial stability. Furthermore, worldwide morbidity and death rates are significantly impacted by the fact that road traffic accidents are a substantial contributing factor [4, 5].

However, it is important to note that the incidence and distribution of road traffic injuries vary across geographic locations and demographic groups, a factor that every epidemiological assessment must take into account. Globally, road traffic accidents account for about 1.19 million fatalities and between 20 and 50 million non-fatal injuries that are caused by road traffic accidents each year, according to the World Health Organization (WHO). Ninety-two percent of these fatalities occur in countries with low and moderate incomes. The younger, more active persons are disproportionately affected by these incidents in comparison to their older, less active counterparts. Additionally, vulnerable road users such as walkers, cyclists, and motorcyclists are also disproportionately affected by these accidents. These accidents are a leading cause of death for children and young adults aged 5–29. This high prevalence can be attributed to a number of factors, including a disregard for traffic laws, excessive speeding, and the presence of unsafe road infrastructure [6].

While the clinical characteristics of lower limb loss and its medical management are well documented, prevalence estimates of limb loss due to road traffic accidents vary widely across regions, and a comprehensive synthesis of this evidence remains limited. This paucity of research on prevalence rates across regions, healthcare systems, and traffic settings is a barrier to the global and regional impact of lower limb amputations in this context. The inability of policymakers to acquire accurate data makes it more difficult for them to distribute resources in the most effective manner and limits the development of preventive initiatives that have a significant impact.

Objectives and Research Question

The main objective of this study is to determine the prevalence of lower limb amputations resulting from severe lower extremity injuries due to traffic accidents, and to assess their impact on patients' quality of life and psychological outcomes.

The research question guiding this study was: "What is the prevalence of lower limb amputations following severe lower extremity injuries due to traffic accidents, and how do these amputations affect patients' quality of life and psychological well-being?"

The framework for the research question follows the PIO (Population, Intervention, Outcome) format [7]. Where;

Population (P): Patients with severe lower extremity injuries resulting from traffic accidents (e.g., motorbike, car, tricycle).

Intervention (I): Lower limb amputation (unilateral or bilateral) following these traffic accidents.

Outcome (O): The primary outcome is Prevalence of lower limb amputations while secondary outcomes are Psychological outcomes (e.g., depression, anxiety, PTSD), and quality of life (measured through scales like SF-36, WHOQOL-BREF).

Methodology

Study Design

This study followed the guidelines for meta-analysis outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [8].

Search Strategy

A comprehensive search was performed on PubMed, ScienceDirect, and Google Scholar. The following search terms were used: lower limb amputation, prevalence, traffic accident, road traffic, road accidents, quality of life, and psychological outcomes. This strategy aimed to capture all relevant articles from the year 2000 to the search date (July 24, 2025). The search results were refined with the application of Boolean operators "AND" and "OR" [9]. MeSH terms were also applied in searching PubMed which is the only database that features such terms [10].

The compiled search term: (lower limb amputation) AND (Prevalence) AND (traffic accident

OR road traffic OR Road Accidents) AND (quality of life OR psychological outcomes)

Eligibility Criteria

Studies were included if they were original research articles (cohort, cross-sectional, case-control, RCTs) published in English between 2000 to search date and reported on the prevalence of lower limb amputations following traffic accidents and/or provided quantitative data on prevalence, quality-of-life or psychological outcomes. Studies were excluded if they did not report on lower limb amputations as a result of traffic accidents or lacked primary data on the specified outcomes.

Data Extraction and Quality Assessment

After retrieving the relevant studies, the data extraction was conducted independently by two researchers and discrepancies were resolved through discussion. Key data extracted from the studies included information relating to study details, patient demographics, type of amputation, and reported outcomes.

The included studies were assessed for bias risk and methodological quality using the Checklist for Assessing the Quality of Quantitative studies [11]. This evaluation tool was chosen for its comprehensiveness and inclusion of all quantitative study evaluation criteria. The following criteria were used to score each item: 2 for "Yes", 1 for "Partial yes", 0 for "No".

The included studies were all observational, comprising mostly cohort and case-control studies. Questions five (5), six (6), and seven (7) of the evaluation tool were not scored since they were specific for interventional studies.

The bias risk analysis of these studies was done using 11 items. Lower scores indicate a higher risk of bias, while higher scores indicate lower bias risk. Zero (0) was the lowest possible bias score and 22 the highest possible score based on this assessment. However, the highest possible score for interventional studies according to this tool is 28.

Data Analysis and Statistical Methods

Data were analyzed using Comprehensive Meta-analysis (CMA) software version 4. A random-effects model was applied due to anticipated heterogeneity across studies. Heterogeneity was assessed using the I^2 statistic and Cochran's Q test. Sensitivity analyses were conducted to test the robustness of the results. Funnel plots were used to visually map publication bias.

Results

Search results and Study Selection

Following a systematic search in PubMed, Google Scholar and ScienceDirect 18521 records were retrieved (5 from PubMed, 17900 from Google Scholar and 616 from Sciencedirect). After applying appropriate filters, 16940 articles remained. Thereafter, 87 duplicate articles were removed. The remaining 16853 articles were subjected to title and abstract screening after which 16789 articles that did not meet the inclusion criteria were excluded. Additionally, the full text of 14 articles could not be retrieved for further screening. Following detailed eligibility assessment of the full text of 50 articles, 6 studies that met the inclusion criteria [12-17] were selected for analysis in this review. The literature selection process is illustrated in the PRISMA flow diagram as shown in Figure 1.

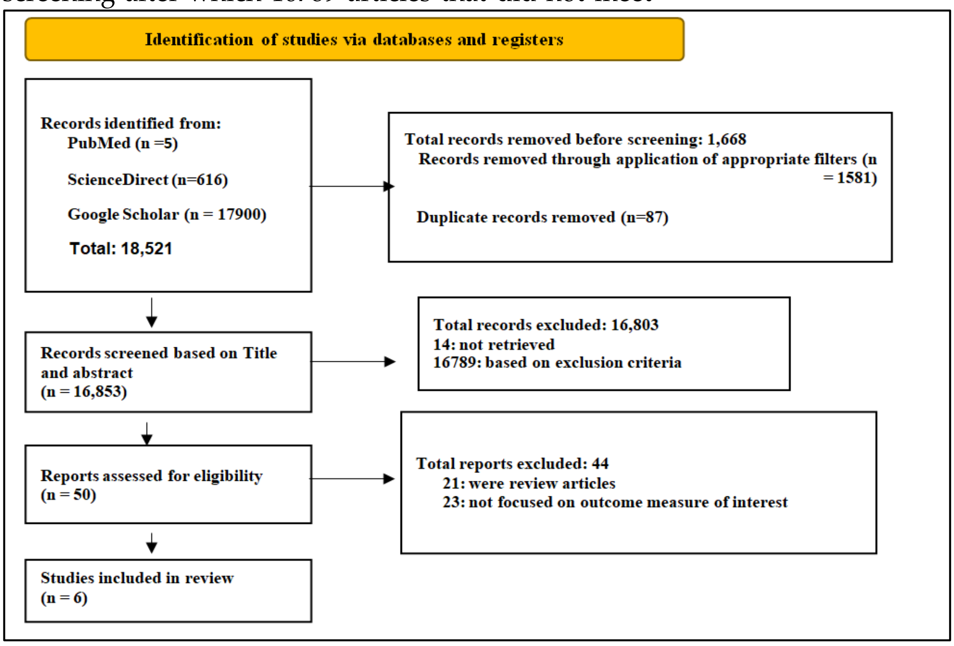


Figure 1: PRISMA Flow Diagram

Study Characteristics and Quality Assessment

The included studies encompass a wide range of geographical regions, methodological designs, and patient characteristics, contributing to the robustness and applicability of the findings. Table 1 provides a detailed summary of the study characteristics and participant demographics across the different studies. The studies were conducted in a range of trauma centers, with sample sizes ranging from 106 to 332 participants. Studies included in this review were conducted in India, Bangladesh, Iran, and the USA, with highest publication from India. Among the included studies, males had the predominant population. For example in each of the studies by Saini et al. (2020) [12] and Al Imam et al. (2019) [15] male participants were over 80% male, reflecting gender disparities in severe lower limb injuries from road traffic accidents. The participants were aged between 23 to 38 years. It is noteworthy that participants in Mackenzie et al. (2004) [14], Al Imam et al. (2019) [15], and Saini et al. (2020) [12] were mostly middle-aged, while Rouhani & Mohajerzadeh (2013) [13] featured younger participants (mean age of 23 ± 11 years).

Table 2 shows the prevalence of road traffic accident-related lower limb amputation reported in each of the studies included in this review. The highest prevalence (68.8%) was recorded in Deepak et al. (2023) [17], while Shankar et al. (2020) [16] reported the lowest prevalence (22.7%). This variability in reported prevalence across the included studies highlights the complex factors that affect amputation, such as socioeconomic status and healthcare availability.

As shown in Table 2, of the six studies included in this review, only three reported on outcomes relating to quality of life following trauma-related lower-extremity amputations. Mackenzie et al. (2004) [14] used Sickness Impact Profile (SIP) scale for assessment whereas Shankar (2020) [16] and Deepak et al. (2023) [17] used World Health Organization Quality of Life - BREF (WHOQOL-BREF) for assessment. Mackenzie et al. (2004) [14] reported mean (standard deviation) scores of 11.2 (± 15.7) and 12.5 (± 11.9) for the psychological domains and overall quality of life (QOL), respectively. Shankar et al. (2020) [16]reported 16.86 (± 4.55) and 78.73 (± 12.99), whereas Deepak et al., (2023) [17] reported 57.37 (± 20.46) and 53.79 (± 22.06).

Table 3 summarizes the quality assessment scores for each study, highlighting the strengths and areas of concern across the included literature. Table 3 reveals that Deepak et al. (2023) [17], Al Imam et al. (2019) [15], and Mackenzie et al. (2004) [14] received the highest total quality scores (22/22), indicating minimal risk of bias in their design and reporting. The study by Saini et al. (2020) [12], on the other hand, received the lowest score (19/22), mostly as a consequence of poor reporting in areas such as outcome measures, variance estimates, and confounding control.

Table 1: Study Characteristics and Study Participants

Study ID (Author, Year)	**Country**	**Study Design**	**Study Setting**	**Sample Size**	**Gender Occurrence**	**Mean Age of Participants**	**Socio-economic Class**	**Traffic Accident Features**	**Type of Lower Limb Amputation**	**Source (Journal)**
Saini et al., (2020) [12]	India	Cross-sectional	Level 1 Trauma Centre	125	97.5% Male, 2.4% Female	37.2 years	Not reported	Road Traffic Accidents (85.4%)	Unilateral transtibial (85.4%), Bilateral transtibial (4.9%)	Journal of Clinical Orthopaedics and Trauma
Rouhani & Mohajerzadeh (2013) [13]	Iran	Retrospective descriptive (files review; 2005–2010)	University Shohada Hospital, Tabriz (tertiar	146	80% Male, 20% Female	Trauma group mean age = 23 ± 11 years (the paper gives mean age for trauma	Lower to Middle class (implied)	Road Traffic Accidents (46%of 146)	Transtibial (below-knee): 115 (79%); Transfemoral (above-knee): 25	Archives of Bone and Joint Surgery

			y orthopaedic centre).			group). Use this for the RTA/trauma subgroup mean age.			(17%); Syme: 6 (4%)	
Mackenzie et al., (2004) [14]	USA	Cohort, Prospective	8 Level-I trauma centres (multi-institutional, US).	161	84% Male	35.2 ± 13.3 years	Lower to Middle class (implied)	Motor Vehicle (20%), Motorcycle (25%), Pedestrian (17%)	Below-knee (trans-tibial): 109 (≈67.7%); Above-knee (trans-femoral): 34 (≈21.1%); Through-knee: 18 (≈11.2%) (counts reported).	Journal of Bone and Joint Surgery
Al Imam et al., (2019) [15]	Bangladesh	Cross-sectional	Tertiary Rehabilitation Center	332	87.7% Male, 12.3% Female	37.5 ± 13.8 years	Lower to Middle class (implied)	Road Traffic Accidents (58.7%)	Unilateral (95.8%), Below knee (52.1%), Above knee (30.4%)	Disability and Rehabilitation
Shankar et al., (2020) [16]	India	Descriptive cross-sectional study	Armed Forces Medical College, Pune	150	73.3% Male, 26.7% Female	Not reported	Upper class (71.3%)	Road Traffic Accidents (22.7%), Railway (16.7%)	Above-knee 40%; Below-knee 60%; Right side 44.7%, Left 34.7%, Bilateral 20.6%	Medical Journal Armed Forces India
Deepak et al., (2023) [17]	India	Cross-sectional	Tertiary Rehabilitation Center	106	78.3% Male, 21.7% Female	Not reported	Not reported	Road Traffic Accidents (68.87%)	Unilateral Transtibial (Transtibial most common)	Cureus

Table 2: Outcome Measures

Study ID (Author, Year)	**Prevalence of amputated as a result of RTA (%) [event rate]**	**Psychological outcomes (mean ± SD)**	**QoL (mean ± SD)**
Saini et al., (2020) [12]	32.8% [41/125]	Not reported	Not reported
Rouhani & Mohajerzadeh (2013) [13]	40.4% [59 / 146]	Not reported	Not reported
Mackenzie et al., (2004) [14]	38.51% [62/161]	SIP psychosocial subscore — mean (SD): 11.2 ± 15.7 (reported).	SIP overall score — mean (SD): 12.5 ± 11.9 (reported).
Al Imam et al., (2019) [15]	58.7% [195/332]	Not reported	Not reported
Shankar et al., (2020) [16]	22.7% [34/150]	WHOQOL-BREF *psychological domain mean = 16.86 ± 4.55.*	WHOQOL-BREF overall mean = 78.73 ± 12.99
Deepak et al., (2023) [17]	68.87% [73/106]	WHOQOL-BREF *psychological domain mean* = 57.37 ± 20.46	WHOQOL-BREF overall mean = 53.79 ± 22.06

Table 3: Quality Assessment

Criteria	Deepak **et al. (2023) [17]**	**Saini et al. (2020) [12]**	**MacKenzie et al. (2004) [14]**	**Al Imam et al. (2019) [15]**	**Rouhani & Mohajerzadeh (2013) [13]**	**Shankar et al. (2019) [16]**
1. **Question / objective sufficiently described?**	2	2	2	2	2	2
2. **Study design evident and appropriate?**	2	2	2	2	2	2
3. **Method of subject/comparison group selection or source of information/input variables described and appropriate?**	2	2	2	2	2	2
4. **Subject (and comparison group, if applicable) characteristics sufficiently described?**	2	2	2	2	2	2
5. **If interventional and random allocation was possible, was it described?**	0	0	0	0	0	0

6. **If interventional and blinding of investigators was possible, was it reported?**	0	0	0	0	0	0
7. **If interventional and blinding of subjects was possible, was it reported?**	0	0	0	0	0	0
8. **Outcome and (if applicable) exposure measure(s) well defined and robust to measurement/misclassification bias? Means of assessment reported?**	2	1	2	2	2	2
9. **Sample size appropriate?**	2	2	2	2	2	2
10. **Analytic methods described/justified and appropriate?**	2	2	2	2	2	2
11. **Some estimate of variance is reported for the main results?**	2	1	2	2	1	2
12. **Controlled for confounding?**	2	1	2	2	1	1
13. **Results reported in sufficient detail?**	2	2	2	2	2	2
14. **Conclusions supported by the results?**	2	2	2	2	2	2
Total	22	19	22	22	20	21

Meta-Analysis Findings

Forest Plot Analysis

Figure 2 shows the prevalence rates of all the included studies in a forest plot of the meta-analysis. The event rate in the conducted investigations varied from 0.227 to 0.689. Each study's point estimates are shown by squares, and the 95% confidence intervals are represented by horizontal lines. A substantial incidence of amputations was observed in this pooled cohort.

As evidenced by the summary effect in the forest plot, the random effect model produced an overall event rate of 0.432 (95% confidence interval: 0.305–0.569). This indicates that patients with severe lower extremity injuries following RTAs have a moderate overall burden of lower limb amputations.

Meta-Analysis Statistics and Heterogeneity

As shown in Figure 3, the fixed effect model yields a point estimate of 0.460 (95% CI: 0.428, 0.492), slightly higher than the random effect model's estimate of 0.432 (95% CI: 0.305, 0.569). This disparity indicates a substantial between-study heterogeneity. The heterogeneity is evident based on the high Tau-squared (0.444) and I-squared (94.173) values. The heterogeneity may be related to variations in study design, patient demographics, and geographical locations.

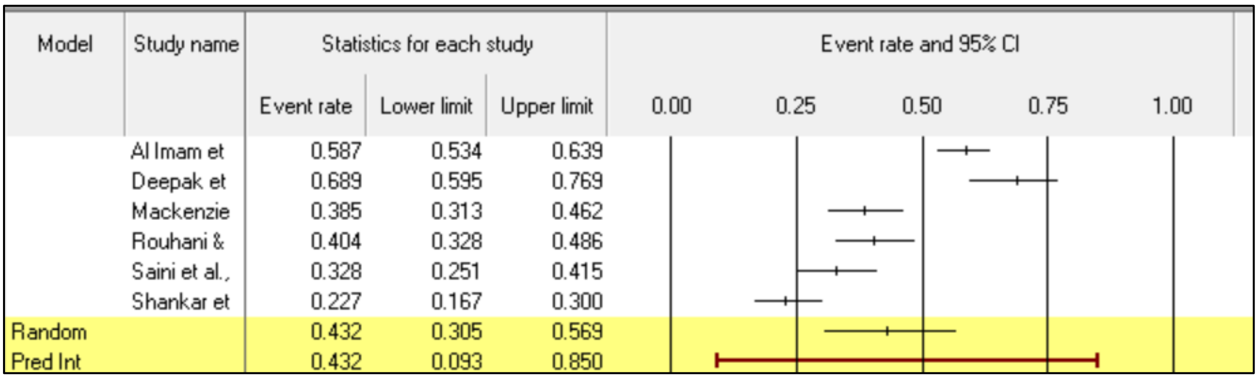
Distribution of True Effects

Figure 4 shows the distribution of true effect size of 0.43 (CI: 0.30, 0.57). Therefore, for a typical population of patients with severe lower extremity injuries as a result of road traffic accidents, lower limb amputations are expected to fall within this range.

The 95% prediction interval spans from 0.09 to 0.85, indicating that while the true effect in most similar populations is predicted to be near to the mean, each study's effect size is unknown.

Funnel Plot Interpretation

The publication bias of the study was evaluated using the funnel plot (Figure 5). There is no significant asymmetry in the funnel plot, which indicates that there is no publication bias in the papers that were investigated. The interpretations of publication bias in these circumstances need to be made with caution because funnel plots are less trustworthy when there are less than 10 studies involved [18].



Model	Study name	Event rate	Lower limit	Upper limit
	Al Imam et	0.587	0.534	0.639
	Deepak et	0.689	0.595	0.769
	Mackenzie	0.385	0.313	0.462
	Rouhani &	0.404	0.328	0.486
	Saini et al.,	0.328	0.251	0.415
	Shankar et	0.227	0.167	0.300
Random		0.432	0.305	0.569
Pred Int		0.432	0.093	0.850

Figure 2: Forest Plot

Model		Effect size and 95% interval			Prediction Interval		Between-study		Other heterogeneity statistics			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Lower limit	Upper limit	Tau	TauSq	Q-value	df (Q)	P-value	I-squared
Fixed	6	0.460	0.428	0.492					85.812	5	0.000	94.173
Random	6	0.432	0.305	0.569	0.093	0.850	0.666	0.444				

Figure 3: Meta-analysis statistics

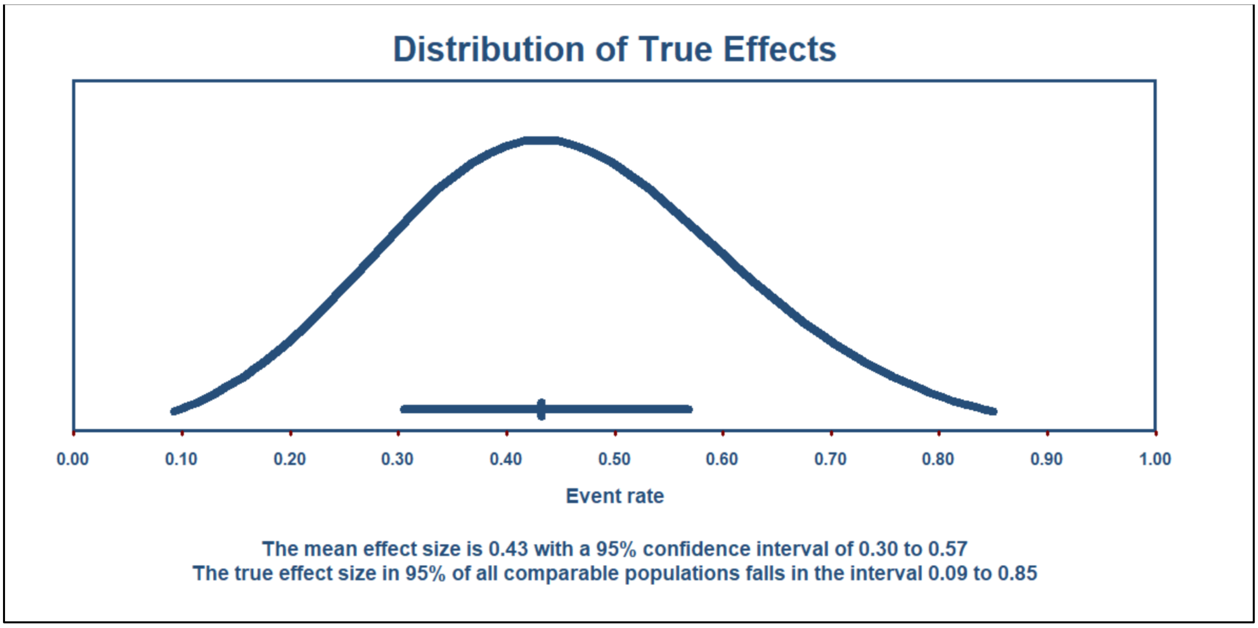


Figure 4: Distribution Plot of True effects

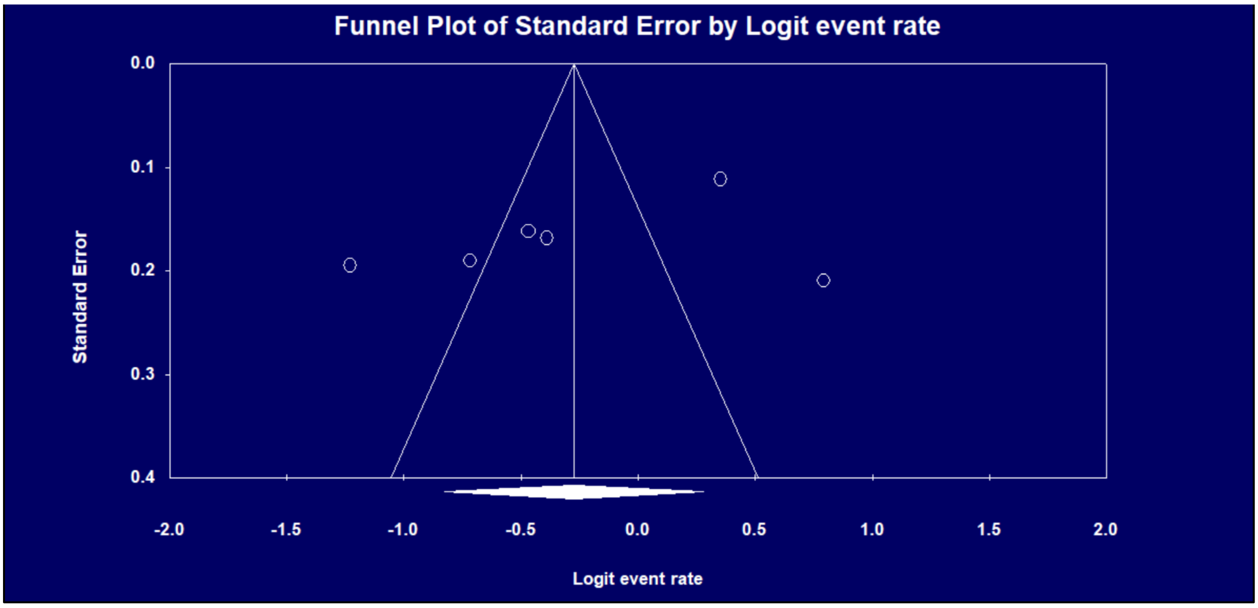


Figure 5: Funnel Plot

Discussion

Summary of Key Findings

The overall pooled prevalence rate of lower limb amputations due to RTA across the six studies was 43.2% (95% CI: 30.5–56.9%), demonstrating the global impact of RTAs. This rate is consistent with findings reported in previous studies, which indicate that road traffic accidents are a major cause of disability, particularly in low and middle income settings [19, 20]. The findings highlight the need for robust public health initiatives to prevent RTAs and enhance healthcare facilities dedicated to addressing such cases. The findings from our review are consistent with those of previous research which found significant amputation rates among RTA survivors [21].

This review found that patients with lower limb amputation experienced psychological distress, including depression, anxiety, and PTSD, with significant variability in psychological and Quality of Life, QoL outcomes. This is consistent with other studies that emphasized amputee mental health issues [22]. In studies like Deepak et al. (2023) [17], lower QoL scores illustrate ongoing adaptive challenges that patients face following RTA related amputation. These findings emphasize the necessity of psychological and physical support through rehabilitation for such patients, as their mental health and quality of life can be greatly impacted. Thus, comprehensive rehabilitation programs that include physical and psychological assistance are crucial to achieving improved long-term results for these individuals [23, 24, 25].

Recommendations

The long-term rehabilitation and psychological stress experienced by amputees contribute significantly to social and economic burdens. Early intervention and prevention, such as road safety education and traffic rule changes can significantly reduce RTAs and amputations.

Clinically, our study emphasizes early intervention and thorough care for severe lower extremity injuries. Timely amputations and individualized rehabilitation are crucial interventions that are prognostic to patient recovery and quality of life post event.

Consequently, this report recommends increased investment in RTA prevention techniques such as traffic safety rules, enforcement, and public awareness. Policymakers should also enhance amputees recovery and QoL by creating policies that will increase access to prosthetics and rehabilitation services.

Future Research Directions

Future research should focus on identifying specific risk factors for lower limb amputations in traffic accidents, such as the role of vehicle type, speed, and the presence of safety measures.

Limitations

The limited number of studies considered poses a significant constraint on the generalisability of the findings. The high level of heterogeneity in the study designs among the included studies limits the generalizability of the findings. Furthermore, the use of diverse measurement tools in outcome measures evaluation, particularly regarding psychological and quality of life, QoL scales, makes it challenging to compare outcomes across studies.

Conclusion

Given the pooled prevalence rate from this review 43.2% (95% CI: 30.5, 56.9%), there is a need for robust public health initiatives to prevent RTAs and improve healthcare infrastructure for managing severe injuries. Policymakers should invest in RTA prevention strategies, enhance prosthetic and rehabilitation services, and promote a multidisciplinary approach to care for lower-limb amputees.

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Conflict of Interest Statement: The authors declare that we have no conflicts of interest.

Ethics Approval Statement: This study involved secondary analysis of published data. Ethical approval was not required.

Authors Contribution: Author 1 and Author 2 conceptualized and designed the study. Authors 1, 2, and 3 conducted the literature search and data extraction. Author 2 and Author 4 performed data analysis and interpretation. Authors 4, 5 and 6 contributed to methodological appraisal and quality assessment of included studies. Author 1, 2 and 3 drafted the initial manuscript. Authors 2, 4, 5 and 6 critically revised the manuscript for important intellectual content. All authors read, reviewed, and approved the final manuscript.

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