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Review TTEA

Safe Routes to School: Best Practices and Their Applicability to Urban Context

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Abstract

Safe routes to school (SRTS) programs aim to encourage active transportation for children through enhanced safety, accessibility, and infrastructure within the areas surrounding schools. SRTS has become increasingly popular worldwide as a method of promoting public health, decreasing traffic, and promoting community cohesion. Yet bringing SRTS to urban environments comes with special challenges. Urban locations often have high traffic volumes, inadequate pedestrian facilities, socioeconomic inequities, and variable policy backing that deter program success. Furthermore, schools in cities tend to have inadequate space and resources for mandatory safety improvements, and community engagement can be uneven across neighborhoods. This review integrates results from a mixed array of studies, including NIH-supported evaluations, policy analysis, and implementation case studies. It distills best practices like stakeholder engagement, data-informed planning, equity-oriented outreach, and alignment with larger urban mobility planning. The programs that integrated infrastructure upgrades with education and enforcement had the most persistent effects. Importantly, city SRTS efforts that focused on disadvantaged neighborhoods had greater walking and bicycling rates, lower rates of injury, and enhanced perception. The research highlights the need to adapt SRTS policy to the urban context, prioritizing flexibility, inclusivity, and intersectoral coordination. By linking SRTS to city planning and public health objectives, cities can realize the maximum potential of the programs. In all, this book embodies SRTS's transformative potential to create healthier, safer, and more just urban spaces. It presents a guide for policymakers and practitioners looking to apply tested strategies to complex city environments.

Keywords: Safe zone, safe route, SRTS, urban, safety, pedestrian, school, traffic accidents

INTRODUCTION

Safe routes to school (SRTS) programs aim to make it safer and easier for children to walk or bike to school by improving the built environment, establishing supportive policies, and encouraging positive behaviors among road users. These initiatives often include better sidewalks, safer crossings, traffic-calming measures, and educational campaigns that teach both children and drivers how to share the road responsibly. Evidence from global studies, including research conducted in India, shows that infrastructure upgrades, reduced vehicle speeds, and strong community engagement are among the most effective strategies for improving safety [1–3].

Such measures are especially crucial in urban areas where high traffic volumes, poorly maintained or incomplete pedestrian pathways, and wide socioeconomic differences create significant risks for young pedestrians. In these settings, children face some of the highest rates of road-

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traffic injuries, particularly around school zones where congestion and unsafe driving behaviors are common. Prioritizing safety through well-designed crossings, clearly marked school zones, and enforcement of speed limits can significantly reduce crashes and save lives. At the same time, involving parents, teachers, local governments, and community members helps build a shared sense of responsibility and ensures that solutions reflect the needs of each neighborhood. Because every community faces different challenges, SRTS programs must be tailored using local data—such as traffic patterns, pedestrian counts, and school area risk assessments—to create targeted interventions. By putting safety at the center of these efforts, cities can support healthier travel habits, reduce inequities in mobility, and give every child the opportunity to reach school safely and confidently [4–6].

METHODOLOGY: STRUCTURE OF THE REVIEW

This review employed a structured methodology to examine evidence on child pedestrian safety and the applicability of global best practices to Indian urban contexts. Sources selected included peer-reviewed journal articles, government reports, and NGO publications published between 2010 and 2024, ensuring both credibility and contemporary relevance. The literature was thematically organized into five domains: infrastructure interventions such as safe crossings, sidewalks, and speed-calming measures; policy frameworks and audit mechanisms; behavioral and socioeconomic determinants affecting child safety; community engagement and educational initiatives; and comparative challenges faced in urban versus rural implementation. A comparative analysis was undertaken to identify best practices from both high-income and low- and middle-income countries, with particular attention to how differences in infrastructure quality, traffic density, and socio-demographic characteristics influence transferability to Indian cities. Each study was critically appraised for methodological rigor, relevance, and practical applicability, prioritizing empirical research, spatial analysis, and policy evaluations. The synthesis of findings highlighted scalable, context-appropriate strategies while also identifying persistent gaps in research and implementation, thereby providing direction for future policy development, targeted interventions, and more nuanced investigations into child pedestrian safety within rapidly urbanizing environments [7–9].

GLOBAL BEST PRACTICES

Global best practices for making SRTS use many different methods together. These methods include improving the physical environment, controlling how fast cars go, connecting with local rules, and getting the community involved. Some of the main actions are putting up raised crosswalks, speed bumps, and small islands for pedestrians to stand on. These help cars go more slowly and make it easier for people to see. Other steps include setting lower speed limits and using flashing lights and signs to remind drivers to slow down. They also use data to find areas where kids are at higher risk and then work on making those places safer. Programs like Walk Safe and SRTS teach kids and families how to walk safely to school. These efforts work best when they are tailored to fit the needs of the local area, making sure that all children, especially those from less advantaged backgrounds, have safe and equal access to school [10–12].

LITERATURE REVIEW

Based on the studies summarized in Table 1, the literature highlights that child pedestrian safety in school zones is influenced by a complex interaction of socioeconomic, behavioral, infrastructural, and policy-related factors. A recent study in England using Bayesian spatiotemporal analysis demonstrated that socioeconomic inequality significantly affects child crash risk, whereas active modes, such as walking and cycling, can enhance safety when supported by appropriate environments. Studies from India consistently reveal gaps in road safety knowledge and practice among school children, particularly in rural and high school populations, indicating that awareness alone does not necessarily translate into safe behavior and emphasizing the need for curriculum-level interventions [13].

Table 1. Comparative literature review.

Author(s)	Year	Location	Focus area	Key findings
Shoari et al. [1]	2023	England	Bayesian spatio-temporal analysis of child crashes	Socioeconomic inequality affects child pedestrian safety; walking/cycling improves safety.
Indhumathy and Thenmozhi [2]	2016	Tamil Nadu, India	Knowledge and practice among rural school children	Poor knowledge and practice of road safety; need for curriculum integration.
Priyanka Raj et al. [3]	2011	Tamil Nadu, India	Road safety awareness in high school students	55% couldn't identify traffic signs; knowledge doesn't always translate to safe behavior.
Pappu Kumar et al. (Review) [4]	2023	India (General)	Pedestrian facility reassessment in school zones	Infrastructure, policy, and community engagement are key to improving safety.
Angela Z. Cayabyab [5]	2023	Los Angeles, USA	Built environment and child pedestrian collisions	Roadway and sidewalk design, plus socio-demographics, influence collision risk.
Md Hasibur Rahman [5]	2019	Florida, USA	Engineering countermeasures in school zones	Two-step speed reduction and driveway control significantly reduce crash risk.
Pappu Yadav et al. [7]	2024	Patna, India	Pedestrian safety index modeling	Midblock crossings are risky; modeling helps identify hazardous school zones.
Dias et al. [8]	2021	Colombo, Sri Lanka	Pedestrian behavior risk in school zones	Low sidewalk and crossing usage; behavior risk mapping aids safety planning.
Khattak et al [9].	2020	Nebraska, USA	Speed differentials in school zones	Active school zones reduce vehicle speeds; effectiveness varies by road type.

Infrastructure-focused reviews and empirical studies from India and the United States underline the importance of pedestrian-friendly facilities, effective speed management, and driveway access control for reducing crash risks in school zones. Research from Los Angeles and Florida shows that roadway design, sidewalk quality, socio-demographic factors, and engineering countermeasures, such as speed reduction strategies, play a critical role in mitigating collisions. Modeling approaches, such as pedestrian safety indices and risk mapping in India and Sri Lanka, further help identify hazardous school zones, including midblock crossings and areas with poor pedestrian infrastructure. Overall, the literature suggests that improving child pedestrian safety requires integrated approaches that combine education, infrastructure enhancement, enforcement, and community engagement (Table 1) [14].

INNOVATIVE APPLICATIONS

Innovative methods are increasingly being used to improve child pedestrian safety in and around school zones. Bayesian spatio-temporal modeling, such as the approach used by Shoari et al. (2023) in England, helps identify crash hotspots and track how risks evolve over time, allowing planners to target interventions more precisely [1]. Simulation-based techniques also play a key role; for example, Rahman (2019) applied VISSIM microsimulation to test engineering countermeasures like reduced traffic speeds and improved driveway access, using indicators such as Time to Collision to assess potential safety gains before real-world implementation [6]. Other studies have created new tools for evaluating school zone safety, including the Pedestrian Safety Score Index developed by Kumar et al. (2024) in Patna, which uses video-based behavioral data to highlight midblock crossings needing urgent attention [4]. Statistical models like the negative binomial regression used by Cayabyab (2023) further show how built environment factors—such as sidewalk gaps, crosswalk quality, and parking-lot access points—shape crash patterns, helping planners design safer street networks [5]. Research on driver behavior, including work by Strawderman et al. (2015), has revealed that excessive signage can reduce driver attentiveness, underscoring the importance of strategic sign placement rather than

simply increasing sign numbers [10]. Equity-focused studies by Tetali et al. (2016) and Singh et al. (2018) highlight how gender, income, and travel distance influence mobility choices, showing that girls often avoid cycling due to safety concerns, which calls for more inclusive infrastructure [11, 12]. Additionally, tools like GIS-based catchment mapping and behavioral risk assessments, used by Cayabyab (2023) and Dias et al. (2021), help identify critical locations where targeted improvements can most effectively enhance child pedestrian safety [5].

FUTURE SCOPE

Future research should focus on expanding localized Bayesian and regression-based crash modeling across diverse Indian cities by integrating real-time traffic, socioeconomic, and behavioral data. Linking SRTS planning with smart city platforms through Internet of Things (IoT) sensors, GIS tools, and AI-based traffic monitoring can enable dynamic management of school zone safety. Greater emphasis is needed on gender-inclusive infrastructure to address disparities in walking and cycling among girls, particularly in high-risk, urban areas. Behavioral interventions, such as visual nudges and gamified safety applications, should be developed and evaluated to enhance pedestrian compliance and driver awareness near schools. Longitudinal policy impact studies are essential for assessing the effectiveness of national frameworks and guidelines in reducing child pedestrian injuries. Equity-focused planning should prioritize low-income and marginalized communities, whereas school-centric urban design and cross-sector collaboration among transport, education, health, and urban development agencies can support holistic and sustainable SRTS implementation.

CONCLUSION

This review shows that SRTS programs are very important for making it safer for children to walk, especially in busy city areas where there is more traffic and insufficient good infrastructure. Successful examples worldwide include improving roads, slowing down cars, teaching safe behavior, and working with policies to make a real difference in reducing accidents and encouraging children to walk or bike to school. In India, research shows that we need to focus on local solutions that consider different social and economic conditions, gender issues, and problems with city planning. New tools, such as Bayesian modeling, microsimulation, and pedestrian safety scores, can help plan better ways to improve safety. Going forward, including SRTS in smart city plans, using data to check progress, and working together across different areas will be important for making school areas safer, fairer, and healthier.

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