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Preventing Child Pedestrian Injury: A Guide for Practitioners

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Abstract

Each year, an estimated 270,000 pedestrians die from road traffic-related injuries, (worldwide) and children are among the most vulnerable. Child pedestrian injuries occur primarily in residential areas, often on the same street or in close proximity to the child's home, and 90% of injured child pedestrians are unaccompanied by an adult at the time of the injury. The cause of these injuries is a complex combination of factors related not only to characteristics of the child but also the built environment, the road configuration, features of the motor vehicle that might reduce injury, and driver behavior. Accordingly, effective interventions must incorporate education, technology, and improved infrastructure. The medical practitioner can not only provide the necessary education but can also be a powerful voice for changes in pedestrian infrastructure that make walking safer. This article explores the current state of childhood pedestrian injuries using examples from the United States and Australia. Pedestrian interventions and the role that primary care and lifestyle practitioners play in promoting safe pedestrian behaviors among their patients and their families are discussed.

Keywords

pedestrian; child; injury; lifestyle medicine

Walking is a basic and common mode of transportation in societies around the world.¹ Yet child pedestrian injury is one of the leading causes of death for children in Australia,² North America,^{3,4} the United Kingdom,^{5,6} and most highly motorized and rapidly motorizing countries.^{7,8} Globally, it is estimated that 270 000 pedestrians die each year from preventable injuries¹ and a significant proportion of these are children. There are several categories of interventions that have been proven to have a measurable and meaningful impact on child pedestrian injury rates. This article will demonstrate the size and scale of the pedestrian injury problem, how these interventions have been successfully implemented, and

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the critical role that lifestyle medicine practitioners can play in improving child pedestrian safety.

Child Pedestrian Safety

An estimated 262 000 children aged 0 to 19 die each year as a result of road traffic injuries.⁹ Among a group of 70 countries, most of which were middle- to high-income countries, pedestrian fatalities accounted for approximately 33% of road traffic crash deaths among children.⁹ To illustrate the epidemiology of pedestrian injuries among children in high-income countries, we describe injury patterns and trends seen in Australia and in the United States. In Australia, 270 children aged 0 to 14 years died as a result of injuries sustained in pedestrian–motor vehicle collisions and another 5216 were seriously injured from 2000 to 2010.¹⁰ In the United States, pedestrian injuries are the third-leading cause of injury-related death for both boys and girls ages 5 to 14. In 2010, 288 children ages 0 to 14 were killed as pedestrians.¹¹

While the age distribution of these fatal and nonfatal pedestrian injuries varies by country and region, within the United States, we know that among children 0 to 14 the greatest number of deaths occur in children under the age of 3 (Figure 1).¹¹ However, when considering fatalities among children aged 0 to 19, the greatest numbers are seen in teens ages 15 to 19, outnumbering children under 3. The number of nonfatal injuries treated in emergency departments increases by age group, with the greatest number of nonfatal injuries to children increasing as children get older (Figure 2). Similarly, the figure for nonfatal child pedestrian injuries in the State of Victoria (Australia) follow those of the United States.¹²

While child pedestrian injuries continue to be a leading cause of death for children ages 19 and under in the United States, the pedestrian deaths rates (Figure 3) and nonfatal injury rates (Figure 4) have been declining since 1995.¹³ The decline can be attributed to many factors including innovative education programs,¹⁴ greater enforcement of speed zones around schools and neighborhoods,¹⁵ and reduced exposure. The number of unaccompanied children walking to and from school and in other activities around roads has reduced dramatically in the last 30 years.¹⁶

We have seen a recent increase in the United States in the rate of pedestrian injuries among older children, particularly teenagers. One theory is that distraction by mobile technologies plays a role in these injuries; a multisite observational study of 34 000 students crossing in school zones found that 1 in 5 high school students were observed to be distracted by cellular phones or listening to music.¹⁷ An important role medical practitioners can play is identifying patients, or family members of patients, who regularly use mobile devices when walking and providing anticipatory guidance when needed.

Pedestrian Injury Causation

What are the circumstances that lead to pedestrian injuries, and how can they inform interventions? As described by Schwebel et al,¹⁸ important behavioral risk factors account for many child pedestrian injuries. A small number of scenarios account for more than 70% of injuries to child pedestrians.¹⁹ The most common (43%) is the “dart out” phenomenon,

wherein the child darts out into the street suddenly, frequently from between cars, to retrieve a toy or ball or to cross the street, and is struck by a passing motor vehicle. Dashing across an intersection is another common cause accounting for about 11% of incidents. These 2 scenarios primarily involve children aged 5 to 9 years and 5 to 14 years, respectively.¹⁹

By contrast, events in which a car reverses over a child are limited almost completely to very young children (children in the 1-2 year age group) who are small in stature, difficult to see, and physically unable to alert the driver. The proportion of these injury events varies between published reports with findings in the United States suggesting 5% to 7%²⁰ of child pedestrian deaths occur due to the car reversing over the child while approximately 3%¹⁰ of fatal child pedestrian injuries in Australia are driveway incidents predominantly involving sports utility or 4-wheel-drive type vehicles. Practitioners can caution parents with young children on these driveway and backover risks. Many new vehicles have reverse cameras and screens built-in to warn parents of objects in back of the vehicle.

Vehicle type is also an important contributor to pedestrian fatalities. When the risk of killing a pedestrian was measured as the number of pedestrian fatalities per billion vehicle miles travelled in the United States, compared with cars, buses were 11.85 times and motorcycles were 3.77 times more likely to kill children 0 to 14 years old.²¹ The risk of killing a pedestrian per vehicle mile traveled in an urban area was 1.57 times the risk in a rural area.²¹ Exposure to traffic is another important factor. Periods when children are most active in the streets, such as Halloween night in the United States, increase the risks of pedestrian injuries.²² These can be teachable moments during patient and family encounters.

Child pedestrian injuries occur primarily in residential areas.²³ A large proportion of these injuries occur on the same street or in close proximity to the child's home.²³ There is also a complex relationship between the speed and volume of traffic and the likelihood of injury. A child is at a greater risk of injury on roads that have few vehicles but where the vehicles are exceeding the speed limit—this type of road is typically found in residential areas. Another dangerous road environment consists of roads where there are many vehicles that are moving slowly. These roads might include roads with school busses picking up or dropping off children outside a school or parents dropping off children near shops, malls, and busy streets.²⁴

Besides the volume and speed of traffic, other environmental features such as on-street parking and semipermanent or permanent objects such as trash cans, telephone poles, trees, and mail boxes can hide a child who is walking beside the road and who might dart onto traffic. It is conceivable that a child's movement from their home to the roadside could be completely obscured by such obstacles, and it has been reported that obstacles along the roadside (or verge) can increase the likelihood of pedestrian injury 3-fold.²⁴ Practitioners can help parents assess roadside hazards such as these in the proximity of the dwelling and where children play.

The Challenge of Designing Effective Interventions

While children need to be encouraged to walk as a healthy and enjoyable activity, and as an alternate form of transportation (saving energy and the environment), walking also needs to be made as safe as possible.²⁵ With 90% of injured child pedestrians unaccompanied by an adult at the time of the injury,²⁶ a number of preventive strategies have focused on ensuring children under the age of 10 are accompanied by an adult when crossing the road. This strategy has value considering the developmental attributes that affect the behavior of children that may make them more likely to be struck by a vehicle.

There is now considerable evidence that developmental processes have a large impact on a child's ability to make safe decisions when crossing the road.²⁷⁻²⁹ While walking or running across a road is an easy task for a child, making a decision about when and how to cross is much more difficult. It requires that the child detect motion, ascertain if the motion is toward or away, and estimate the speed of the vehicle to forecast when the vehicle will arrive in the child's space. Execution of these tasks relies on figure-ground discrimination, distance depth cues, and the relative size of the vehicle and its velocity.^{28,30,31} The various cognitive tasks that must be completed before crossing takes place demand considerable abilities particularly for children younger than 10 years, and especially for children who might be developmentally delayed or have deficits in psychomotor skills. Not only may they be developmentally unable to navigate this skill, it may not be entirely trainable until an appropriate cognitive level has been reached.²⁰ Practitioners can help assess a child's developmental capability for pedestrian risk.

A child's developmental timetable alone, however, does not explain the high incidence of children in pedestrian injuries. The cause of these injuries is a complex combination of factors related not only to characteristics of the child but also the built environment, the road configuration, features of the motor vehicle that might reduce injury, and driver behavior.^{23,24} Accordingly, effective interventions must incorporate education, technology, and improved infrastructure.³² The medical practitioner can not only provide the necessary education but can also be a powerful voice for changes in pedestrian infrastructure that make walking safer.

Improving Child Pedestrian Safety Through Education

An array of child pedestrian safety education programs have been evaluated in relation to raising a child's knowledge and ability to cross a road safely.³³ Research has shown that it is possible to improve the pedestrian skills of children and to modify the abilities of parents to assess accurately the skills of their children in crossing streets.¹⁴ The key features of these programs are that they include cross-curricular education that integrates across subject matter; activities that increase practical road crossing skills; and importantly, they advocate that children are assisted by an adult when crossing a road until the age of 10 years.

A recent evaluation of a child pedestrian school safety program concluded that when a program is not cross-curricular and when the program is not well structured, the effectiveness of the program can be strongly influenced by individual teachers.³⁴ Similarly,

an entire classroom-based pedestrian safety education program that solely used a table-top to illustrate safe places for children to cross the road reported no measureable safe road crossing behaviors among children who had received the training compared with those children not receiving the program.³⁵ In contrast, programs such as the Australian Child Pedestrian Injury Prevention Project (CPIPP), which involved school and home-based activities focused on pedestrian skills training in a real road environment using school access and local traffic roads, reported enhanced road crossing behaviors among children who had received the program.¹⁴ The strategies used in the CPIPP were all cross-curricular and designed so they were student-centered, interactive, and involved parents. Similar cross-curricula school-based education programs have also found significant improvement in child pedestrian safety behaviors albeit self-reported behaviors.^{36,37}

Despite the consistent findings that high-quality child pedestrian safety education programs can increase child pedestrian safety knowledge and road crossing behaviors, the increasing demands being placed on school health education curricular leaves little time for child pedestrian education. Child pedestrian skills training, which has been shown to be a key component of such a curriculum, is a very minor focus in many school health education programs. When pedestrian education is included in schools, it must not be limited to teaching the curb drill, “Look right, look left, listen, then look right again, and, if the road is clear, cross the road.” While research has shown that 97% of children who are taught a curb drill “look right, look left, look right” can repeat the drill verbally, children do not necessarily understand how this translates to their behavior.^{38,39}

One solution to the aforementioned challenges is the use of computer simulation or “virtual reality” to enhance pedestrian training and decision making within a safe environment.^{18,40,41} A number of studies have highlighted the effectiveness of pedestrian safety education when virtual road environments are delivered in the classroom via a desktop computer.^{42,43} With time and fiscal constraints being imposed across most health education programs, the utility of virtual reality for child pedestrian safety education is increasingly becoming realized.

A more recent strategy to enhance children’s safe road crossing abilities while being supervised by an adult is the implementation of walking school buses.⁴⁴ The efficacy of walking school buses, a useful method for increasing children’s physical activity, has been mixed in relation to changing a child’s safe crossing behaviors.⁴⁴ Walking school buses require parent/adult supervision, and adult supervision has been reported to significantly enhance a child’s pedestrian safety.^{15,45} However, the type of parental supervision is important. A recent study found that children when accompanied by an adult committed multiple unsafe pedestrian behaviors, with aberrant pedestrian behaviors more prevalent among children not holding a parent/adult’s hand.⁴⁶ This highlights that the quality of parental/adult supervision may be compromised when the child is part of a walking bus and that the efficacy of parental/adult supervision is dependent on the parent/adult child dyad. Clearly more research is needed to find common risk factors and effective behavioral interventions that can be implemented in community settings.⁴⁷

Preventing Child Pedestrian Injuries With the Use of Technology

Increasingly, technologies are being applied to either minimize the injury sustained in the unlikely event that a pedestrian collides with a motor vehicle such as the recent installation of pedestrian airbags in the Volvo V40⁴⁸ or, following the theme of this article, technology has been developed to assist parents with the challenges of supervising a child's road crossing behavior. In relation to the latter, a phone application has recently been developed⁴⁹ that enhances pedestrian safety among school children aged 5 to 10 years (see <https://itunes.apple.com/au/app/walk-this-way/id560957401?mt=8>). The phone application (which interfaces with Google Maps and geographic positioning systems) is composed of a star-rating system for pedestrian walking routes (1 star least safe to 5 star most safe) that provides objective information about pedestrian risks on certain walking routes and directs the adult user of the phone application to safer walking routes. The star rating model takes account of 5 key factors associated with the risk of pedestrian injury:

1. The speed limit at the crossing point during the periods a child walks to and from school
2. The average number of vehicles per hour at the crossing point during the periods a child walks to and from school
3. The width of the road to be crossed to complete an individual crossing movement
4. The number and direction of conflicting traffic that must be assessed by a pedestrian crossing at the crossing point
5. Whether there is a formal crossing facility provided to facilitate the crossing maneuver

Increasing Pedestrian Visibility

Several interventions have focused on increasing the visibility of pedestrians and bicyclists on the road, including fluorescent materials in bright colors during the day and lights and retro-reflective materials at night. Results suggest that these interventions can improve drivers' detection and recognition, but there is insufficient evidence of the effect on pedestrian and crashes or injuries.⁵⁰ Practitioners can easily add these recommended practices to patients, families, and children who walk, to increase pedestrian visibility.

Building Environments That Enhance Pedestrian Safety

Ironically, in our efforts to create safer roads for our children, in some instances we have increased the risk of injury for children. For example, using a protected pedestrian crossing increases the likelihood of pedestrian injury 2-fold, and the roadway nearby or adjacent to a pedestrian crossing has been found to be the most hazardous for young children.⁵¹ However, it is unknown whether this is because children assume these areas are "safe zones" and approach them with less caution. Fortunately, recent research suggests that when appropriate signs and road markings are provided at greater distances from the pedestrian crossing, thereby alerting drivers to the pedestrian crossing sooner, a reduction in pedestrian motor vehicle conflict occurs.

Built environment strategies for preventing pedestrian injury include separating pedestrians from motor vehicles, installation of traffic signals, in-pavement flashing lights, 4-way stops, pedestrian overpasses, fences to inhibit street access, and sidewalks.⁵² Painting signs at the entrance of a crosswalk to alert walkers to look the right way for on-coming traffic (Figure 5), while not yet evaluated, is another innovative strategy.

Additionally, Pedestrian Safety Zones are increasingly being used as an effective strategy for separating vehicles from pedestrians (see Figure 6).⁵³ A safety zone is usually an area or space officially set apart within a roadway for the exclusive use of pedestrians. In countries like Germany and the Netherlands, where reduced vehicle speeds and the design of safety zones that separate motor vehicles from pedestrians are more prevalent, rates of pedestrian injury and death are much lower than in the United States.⁵⁴

Engineering measures designed to increase the visibility of pedestrians, such as increased roadway illumination and relocating bus stops to the far side of intersections, also decrease injury risk. Of the engineering measures to manage vehicle speed, small roundabouts on residential roads and 4-way stops at intersections are effective.⁵² For children, speed humps can reduce overall child pedestrian injuries in a neighborhood setting.⁵⁵ Additional environmental strategies to decrease pedestrian injuries can be found in the articles by Sleet et al⁵⁶ and Ewing and Dumbaugh.⁵⁷

It is important that environmental strategies be selected and carefully implemented based on their evidence of effectiveness, and as alluded to earlier, some environment modifications originally thought to decrease injury risk have been found to increase injury risk. Crosswalks without traffic signals located on busy streets and/or on streets with more than 2 lanes increase risk for all pedestrians.⁵⁸ Additionally, some promising designs need further research, including routing traffic away from residential settings, off-road trails for pedestrians, and area wide traffic calming.⁵⁹

Efforts to improve the built environment with a focus on the safety of pedestrians and bicyclists have increased in recent years (see Box 1). Approaches such as “New Urbanism,” “Smart Growth,” and “Active Living” have emerged that encourage the building of walkable communities where people can reach destinations without driving and without automobile traffic. Designing communities with the comfort, enjoyment, and safety of the pedestrian as a priority is an important aspect of these new movements (see www.newurbanism.org/pedestrian.html; www.smartgrowth.org; www.activelivingresearch.org). These and other urban pedestrian safety strategies can benefit from the advice of lifestyle practitioners.

In a major change for the US Department of Transportation in 2010, Secretary of Transportation Ray LaHood announced that the needs of pedestrians (and cyclists) will be considered along with those of motorists and that the automobile will no longer be the prime consideration in federal transportation planning. He emphasized that walking is an important component for liveable communities and that favoring motorized transportation at the expense of nonmotorized transportation would diminish. We can see this reflected in marketing home sales, which frequently cite a “walk score” to help buyers select walkable communities. As these programs and efforts grow, it will be important to ensure that they are

accompanied by features of the built environment that keep pedestrians safe so that the benefits of active transportation may be obtained with minimal injury risk.

Implications for Primary Care Practice

Primary care and lifestyle practitioners have the opportunity to reduce the pedestrian injury problem using a variety of strategies, including patient screening, anticipatory guidance, family counselling, patient education, public policy support, community consultation, and environmental change. Medical care practitioners can also strive to improve post-crash survival by supporting comprehensive trauma care systems, technology that can detect crashes and injuries as they occur, telemedicine expansion, and improved emergency medical services in rural areas.

What Can Lifestyle Medicine Do?

At the Individual Level

- Include pedestrian safety in all health promotion and disease prevention activities with patients.
- Set goals for patients to reduce the risk of pedestrian injuries by changing one behavior, such as children under 10 crossing the street with an adult, and teens abstaining from walking while texting. A list of safe pedestrian behaviors can be found at <http://www.safekids.org/tip/pedestrian-safety-tips>.
- Expand record keeping to collect and monitor patient risk factors that may contribute to a pedestrian injury (eg, chart reminders and notes about young children or teens in the family, neighborhood road environment risks).
- Talk to parents about their local walking environments, such as separating vehicle traffic from pedestrians, sidewalks, and crosswalks. Encourage walking on sidewalks or paths and cross at street corners, particularly controlled (signalized) street corners.
- Counsel on the importance of purchasing vehicles with 5-star pedestrian safety ratings.
- Support the improvement of trauma care for pedestrian injury, including rapid ambulance response time and EMS services for children.

At the Community Level

- Support efforts to strengthen road safety policy and enforcement in your state, county or local jurisdiction.
- Encourage changes in local roads that will improve pedestrian safety, such as increased lighting, signalized crosswalks, safe routes to school, and reducing roadside obstructions that may obscure a driver's view of children in the road.
- Ensure comprehensive evidence-based health education program is provided in elementary (primary) schools.

- Strengthen collaborative partnerships with local coalitions, such as Safe Kids, the National Safety Council, or the State Office of Highway Safety.
- Support pedestrian safety as an efficient means to reduce health care costs.
- Support research on risk factors and interventions to reduce child pedestrian injuries, including factors that can affect driver behavior.
- Be a strong voice for enhancements to the local road environment, including traffic calming and changes that reduce vehicle speeds on neighborhood streets.

Conclusions

Pedestrians should not be the price we pay for increased motorization. Lifestyle is inextricably linked to traffic crashes and injuries: it is the type of cars and trucks we choose, the speeds we drive, the use of mobile devices while we walk and drive, and the environments we allow our children to play in. It is the travel mode we choose, the places we walk, and our complacency with poorly designed roads and intersections, enforcement levels, and safety features in our neighborhoods.

The lifestyle medicine practitioner has an important role in reversing this trend. At least in some clinical practices, motor vehicle injury prevention counselling is a preventive service and part of the patient encounter. No single intervention is likely to prevent all child pedestrian injuries. To date, preventive strategies have consisted of various combinations of education programs focused on enhancing pedestrian knowledge and pedestrian skills training, parent education, legislation, environmental modifications, and changes to vehicle design. Through efforts to educate and change parent and child behaviors, promoting stronger community traffic safety legislation and enforcement, and encouraging transportation agencies to make more effective use of technology and engineering, lifestyle medicine can contribute to reducing pedestrian injuries and help promote a culture of safety.

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Box 1.**New York City**

New York City has set an ambitious target of reducing annual road traffic fatalities by 50% by 2030. Strategies have included installing pedestrian countdown signals at 1500 intersections citywide; creating 75 additional 20 mph (32 km/h) school speed zones; enforcing speeding laws along major traffic corridors; and using mass media campaigns to engage and inform the public. Depending on the intervention, these measures have already been credited with reducing pedestrian collisions and total crashes in New York City by 25% to 51%.

Pedestrian Resources

Safe kids Worldwide: <http://www.safekids.org/walkingsafelytips#sthash.DBdjPlos.dpuf>

National Highway Traffic Safety Administration: www.nhtsa.gov/Pedestrians

Pedestrian and Bicycle Information Center: www.walkinginfo.org

National Center for Safe Routes to School: www.saferoutesinfo.org

National Center for Bicycling and Walking: www.bikewalk.org

America Walks: www.americawalks.org

Association of Pedestrian and Bicycle Professionals: www.apbp.org

Federal Highway Administration. Pedestrian Countermeasure Policy Best Practice Report: http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11017/

Public Policies for Pedestrian and Bicycle Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan: <http://katana.hsrc.unc.edu/cms/downloads/PBSPolicyReview.pdf>

How to Develop a Pedestrian Safety Action Plan: <http://drusilla.hsrc.unc.edu/cms/downloads/howtoguide2006.pdf>

PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System: www.walkinginfo.org/pedsafe/index.cfm

A Resident's Guide for Creating Safe and Walkable Communities: <http://drusilla.hsrc.unc.edu/cms/downloads/residentsguide.pdf>

Child Pedestrian Safety Curriculum: <http://www.nhtsa.gov/ChildPedestrianSafetyCurriculum>

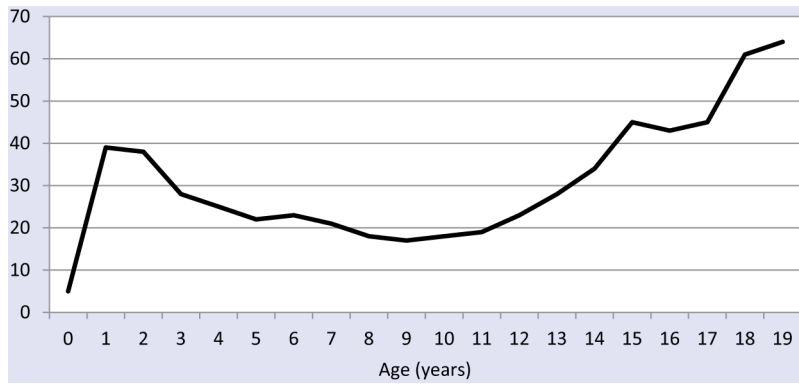


Figure 1. Average annual number of fatal pedestrian traffic injuries, by age 0 to 19, United States, 2003-2010.

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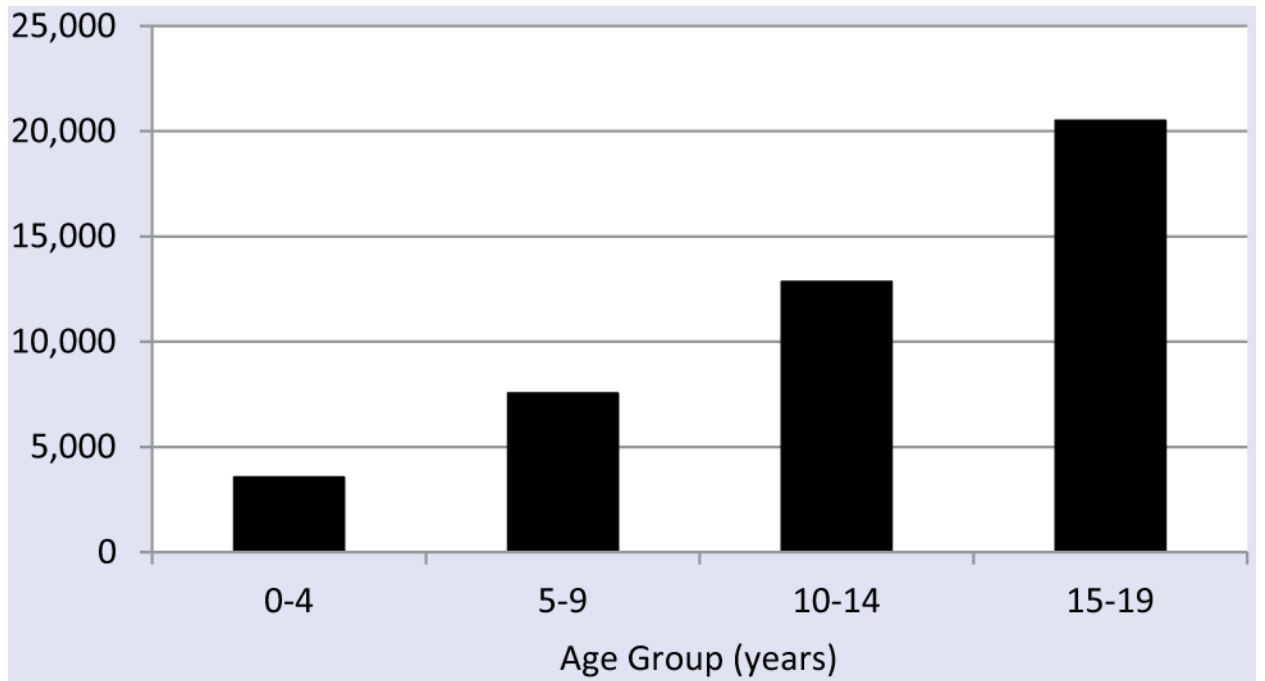


Figure 2. Average annual number of nonfatal pedestrian traffic injuries, by age 0 to 19, United States, 2009-2010.

Source: CDC NCIPC WISQARS. Data source: CPSC NEISS All-Injury Program.

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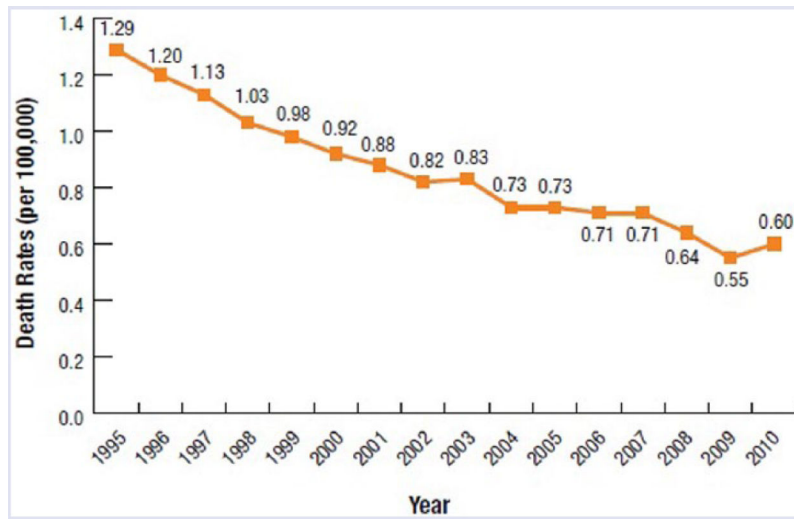


Figure 3. Trends in pedestrian death rates by year, United States, 1995-2010, children ages 19 and under.¹³

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Figure 4. Trends in child pedestrian estimated nonfatal injury rates by year, United states, 1995-2010, children ages 19 and under.¹³

Data Source: Safe Kids Worldwide.



Figure 5. A “prompt” for foreign visitors to “look right” (instead of left) before they step off the kerb—London, England.
Photo credit: David Sleet.



Figure 6. Safety zone for pedestrians in Kazernestraat, Den Haag, The Netherlands (November 2009).

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