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PREVENTION

REDUCING CHILDHOOD PEDESTRIAN INJURIES

SUMMARY OF A MULTIDISCIPLINARY CONFERENCE

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Reducing childhood pedestrian injuries

Summary of a multidisciplinary conference

Edited by Richard A Schieber, MD, MPH
and Maria E Vegega, PhD

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For the full Proceedings or a copy of the Recommendations please see:
http://www.cdc.gov/ncipc/pedestrian

Proceedings of a multidisciplinary conference

Reducing childhood pedestrian injuries

Edited by R A Schieber, M E Vegega

Dedicated to children walking, everywhere

Few news stories are as disturbing as that of a child killed while crossing the street. The photograph below (see fig 1), winner of the 1959 Pulitzer Prize, is still unsettling. Why did it happen? What could have prevented it? And why is it still happening, more than 40 years later?

It takes only a moment for lives to change. The young child in this photograph, trying to cross a busy street, was struck by a garbage truck as it rounded the corner. We can easily imagine the tremendous imbalance of momentum here—a truck weighing tons, striking a child weighing just pounds. No protective device, no safety gear could have eliminated that disparity.

By design, our society depends heavily on motor vehicle transportation. It sustains our economy and influences our culture profoundly. And yet, every day, each of us is a pedestrian who needs and deserves to share the road safely with motorists.

The right to walk safely seems fundamental, especially for children, yet each year for more than a decade, more than 700 children have died from injuries sustained while walking, over 500 of these in traffic. Although the fatality rate has declined somewhat for more than a decade, it could be attributable to improvements in pre-hospital and emergency medical care or to a decline in walking as a mode of transportation. As we encourage individuals to get out and walk to combat obesity and other health conditions, we must make sure that they have a safe environment in which to do so.

Many professionals and advocates have worked for years to reduce child pedestrian deaths in our country. Experts in motor vehicle safety, public health, city planning, school safety, child development, and engineering have wrestled with the problem, each approaching it from his or her specialty's point of view. But these approaches are limited because the entire solution does not rest within a single specialty. Child pedestrian safety is one of the most complex societal problems we face in injury prevention today.

Figure 1 Reproduced with permission (William Seaman/Minneapolis Star Tribune).

Effective solutions to the child pedestrian safety problem must be multifaceted and arise from a collaboration among experts from diverse fields. This need was the origin of the Panel to Prevent Pedestrian Injuries, an interdisciplinary conference held in September 1998 to focus on reducing childhood pedestrian injuries in the United States. Three organizations came together to spearhead the effort and support the conference—the Centers for Disease Control and Prevention, working to protect the nation's health; the National Highway Traffic Safety Administration, addressing road safety; and the National SAFE KIDS Campaign, advocating for the safety of our children. State-of-the-art position papers were commissioned on key topics in pediatric pedestrian injuries, including epidemiology, education, engineering, sociology, psychology, and research. These were the basis of discussion at the conference for the nearly 100 experts representing more than 25 professions from four high income nations (the United States, Canada, United Kingdom, and Australia). Conferees were charged with identifying key barriers to reduce pedestrian injuries and the appropriate next steps to overcome such barriers. This document summarizes their effort and puts forward the strategies and actions developed. Not all problems identified in the Executive Summary concluded with a recommendation. More than 100 recommendations arose from the conference, and it was necessary to be parsimonious in designing a workable set of recommendations.

This document is not intended to be a government plan of action, nor to provide recommendations to the United States government. Rather, these strategies are intended to be used by anyone interested in reducing pedestrian injuries among children, while encouraging them to explore their environment by walking. Although the conference was established to propose solutions for just the United States, they should be appropriate for other developed nations as well, after taking the special circumstances of each nation into account. We made no attempt to address possible pedestrian safety solutions for developing nations, since the traffic, environmental, educational, and administrative

milieu may be so different from that of developed nations as to warrant very different strategies not considered here.

Having sought your understanding of these limitations, we now urge you to review these deliberations and the consequent strategies, consider them, and implement them. We sincerely hope this document will inspire you to dedicate yourself to improving the safety of child pedestrians everywhere.

For a full hard copy of the either the Proceedings or the Recommendations, please see http://www.cdc.gov/ncipc/pedestrian

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EXECUTIVE SUMMARY

Reducing childhood pedestrian injuries

Edited by R A Schieber, M E Vegega

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EPIDEMIOLOGY

Motor vehicles are responsible for one of every five deaths among children 1–14 years of age in the United States, and pedestrian injuries account for one fourth of them.[1] Compared with occupant injuries, pedestrian injuries are more severe, with a fivefold higher likelihood of death among those injured.[2] In 1998, 726 child pedestrians were killed, and at least 30 000 children were non-fatally injured in traffic, which excludes those struck while in driveways, parking lots, or other non-traffic areas. Traumatic brain injury accounts for more than half the fatalities.[1]

The child pedestrian death rate has declined during the past several decades in the United States. This may be related more to reduced exposure than to a safer environment or better pedestrian skills.[3] Since walking is a major form of exercise for children, less walking may be partly responsible for the epidemic of obesity among American children.

Much research has been conducted concerning risk factors for child pedestrian injury. Overall, children are more likely to be struck in an urban area on a residential street in the late afternoon or early evening.[4] Walking at night or while drunk are risk factors for adult, but not child, pedestrians. Children put themselves at risk during midblock dart-outs, dashes across intersections,[5] and while alighting from buses. How and where a child is struck greatly depends on the child's gender and age.[6] Boys are more likely than girls to be injured, a matter that may be due more to differences in exposure to traffic than to any intrinsic factor.[7] Age is a major determinant, since it largely determines a child's degree of mobility and independence. Accordingly, solutions are also age dependent. For example, infants (less than 1 year old) are considered pedestrians when they are carried in arms or transported in a stroller, so that their risk is closely related to that of the caregiver, the locus of control. Toddlers (ages 1–2 years) sustain the highest overall number of pedestrian injuries. Their small size and limited traffic experience appear to be factors. Also, they are the most likely group to be injured in a *non-traffic* location, especially during driveway backovers. However, fatality statistics that are traffic based may under-report these events by as much as 50% in this age group, since driveways and parking lots are not classified as traffic areas.[8]

Preschool age children (ages 3–4 years) and younger elementary schoolchildren (ages 5–9 years) are most often struck as they enter the roadway at midblock, particularly if cars parked along the side of the road shield them from the view of drivers. According to some, they are at higher risk because their knowledge and key perceptual skills concerning traffic are not yet fully developed.[9 10] As a child's age increases, he becomes more mobile, has less supervision, and travels further from home independently. Play may divert his focus from traffic. As children mature into preadolescents and young adolescents (ages 10–14 years), they acquire more experience in traffic. A disproportionately greater number of such youth are injured on relatively busy streets, further from home.[11]

Some key risk factors are known. Parents of elementary schoolchildren often have unrealistic expectations of the street crossing ability of their children.[12] Other risk factors include the time when school ends, the proximity of school to home, family income, highest parental educational level achieved, employment status, crowding, ethnicity, family stress, and the child's road environment. Among these, high traffic volume, lower income, and younger age are most strongly related to child pedestrian injury.[13] Driver based risk factors include inattention, speed, risky driving habits, and the use of alcohol and illegal drugs.[14–16] However, because the focus of this conference was on child pedestrian behaviors and the environment, rather than driver related behaviors, these aspects were not explored in detail.

Surveillance systems that are crash based differ notably from those that are injury based, particularly with respect to case ascertainment and the environmental circumstances of a crash. Crash based surveillance systems of fatal and non-fatal injuries are reported to the United States Department of Transportation by the Fatal Analysis Reporting System and the General Estimates System, respectively. Unfortunately, neither of these two datasets captures children killed in non-traffic areas, such as driveways and parking lots, which account for many such injuries among toddlers and preschoolers. On the other hand, injury based surveillance systems (such as the vital statistics system of the National Center for Health Statistics and the National Electronic Injury Surveillance System) do tally the number of children killed or injured in both non-traffic as well as traffic areas. However, these systems do not capture many details concerning the cause or nature of the crash event. No surveillance system currently reports enough details of the crash or environment to suggest road engineering improvements at crash sites. Surveillance information is sorely needed that describes for each child injured the precise location and circumstances of the crash; the volume, complexity,

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Abbreviations: RCT, randomized controlled trials; RTOR, right-turn-on-red

speed, or density of traffic at the time, and the crossing distance attempted. Such information could substantially influence decisions concerning local road improvements and traffic control measures.

SOCIOLOGICAL FACTORS

A social paradigm exists in which pedestrian injuries result from social factors interacting together in a dangerous environment. The role of sociology is to define these social risk factors related to the family and peer groups at day care centers and schools. The family is the primary social group, through which the child is first introduced to social mores, norms, and conventions. It helps the child develop necessary coping skills, including safety. Several key factors define the family. These include socioeconomic status, a family based characteristic determined in large part by the parents' income and the highest educational level attained. Family income often determines the neighborhood of residence, type of housing unit, degree of dependence on walking for transportation, existence of fenced-in yards, characteristics of apartment complex play areas and its internal roads, and amount of supervision available to the child during play. Highest level of education achieved by a parent, perhaps at least as important as income, is a primary determinant of life style, which in turn determines many health related behaviors of the family. Some argue that better educated families, even more so than high income families, view the occurrence of injuries in a less fatalistic manner, and may more readily adopt positive safety practices. Race/ethnicity also may be important, even if only as a proxy for household income, since white children have lower rates of pedestrian injury than children of minority groups.

Many personal characteristics may have a social, rather than a biologic, basis for influencing the risk of pedestrian injury. Rather than being biologically predisposed to injury, boys may have a higher risk because they are given messages that they don't need to be as careful as girls, or because they are supervised less closely. This is important, because issues of social construction are theoretically amenable to educational and social change, whereas biologic differences are immutable. Even so, many social factors, especially income and educational level, do not change quickly. Direct approaches to enhance social cohesion in families or reduce stress are not easily available nor readily tolerated by families. Attempts to identify high risk behavior groups may be difficult, since behavioral problems among children may not be significantly associated with the occurrence of pedestrian injuries.[17 18]

Useful solutions originate in several realms, including public health, medicine, education, environmental planning and engineering, and regulation. The complexity of the pedestrian injury problem and the multitude of interactions among social and other factors suggest that prevention measures that emphasize parent education and supervision alone may be insufficient. It is unrealistic to expect a single working parent to walk her child to school every day. Instead, improving roadway and neighborhood design, modifying driver behavior, and instituting crossing guards at busy intersections should be considered. Both small and large scale changes are needed. The former includes educating and modifying school policies; the latter includes redesigning our cities to make them safer for pedestrians. Such major changes will require that many specialists in the fields of traffic safety, education, and public health work together effectively with government and community groups.

From an anthropologist's perspective, walking was an important evolutionary step in the development of the species. It occurred over millions of years, unlike man's adaptation to the dangers of motorized vehicles, which has occurred over the past century. An anthropologic or social approach considers the varying parental expectations of boys and girls, methods of child supervision across socioeconomic classes, and ways that communities could support busy families whose children are relatively less well supervised. Extending this further, one might consider that roadways and neighborhoods do not exclusively belong to adults or drivers, but also to the children who live there. Adopting this approach would shift the focus from the child and parent to the community environment. Instead of protecting children by restricting the type of range of children's physical activities, some believe that we should remodel our communities to make them more conducive for children to walk.

INDIVIDUAL FACTORS

Biopsychosocial attributes of the child, including gross motor, cognitive, perceptual, emotional, judgmental, and social skills, independently affect his or her ability to respond effectively to traffic. Physical attributes, including height, weight, and agility, affect the child's ability to see traffic and the driver's ability to see the child.[19] These consequently affect the relative degree of safety invoked by child strategies of crossing the road. An individual's experience in traffic of a certain intensity affects his or her later decisions in a similar environment.

Demographic characteristics of the child are the most consistent and powerful predictors of pedestrian injury. These include age, sex, race/ethnicity, social status, and community of residence.[20] The latter affects pedestrian risk by influencing the degree of neighborhood crowding, availability of parking and traffic controls, and degree of traffic law enforcement. Individual behaviors are also shaped by the child's emotional state at the time, in turn predicated on events of the immediate past (for example, a recent argument or fight), the anticipated situation in the immediate future, feelings towards any peers or supervisor walking alongside, and attitude towards the specific traffic situation at hand. After controlling for differences in demographic variables, some physical, personality and behavioral traits are not associated with increased risk.

Exceptional physical agility appears to increase risk, while physical limitations reduce it.[21] Cognitive developmental level determines the child's ability to focus attention, interpret traffic signs, and remember simple rules. Perceptual development determines the child's ability to locate sounds, judge the speed of an oncoming car, and attend to objects in peripheral visual fields.

Counterintuitively, personality and behavioral traits, including hyperactivity and impulsivity, do not appear to influence pedestrian injury risk, yet other individual level factors powerfully affect risk, especially age and developmental level.[17 21 22] Emotional instability also appears to be a causal factor in some cases.

Individual factors of the adult driver may influence risk, including the degree to which an adult driver understands normal child development, pertinent physical attributes of the driver (especially peripheral vision and response times), personality and habitual behavior patterns, past experience with child pedestrians in traffic, and ability to pay sufficient attention to children and traffic. Parents often do not accurately know their child's abilities and vulnerabilities in traffic. The overall style of adult supervision affects the risk of pedestrian injury.[23 24]

We do not sufficiently understand how well children at each developmental level can learn about traffic safety. While it is sensible and potentially important to tailor safety messages to a child's developmental level, does the resulting training reliably limit injury risk? Should we expect all children of a defined age range to respond in the same way to preventive measures? Could a program broadly aimed at teaching or training an entire population make traffic more risky for some children, such as those with severe impulsive disorders? Do children with accentuated levels of an individual factor, or the presence of several factors, have the same benefit (or detriment) from a given program? Theoretically, a program

could put a child at increased risk during street crossing if he becomes less supervised than before. And, if fewer children are injured now because they are walking less than in past decades, what will happen to injury rates if their mode of transportation shifts to favor walking? What is the proper role of the adult in supervising the child pedestrian? What are the key determinants of supervision, what patterns of supervising exist, and how these can be altered to increase pedestrian safety?

Strategies need to be developed to teach adults the normal expected capabilities and vulnerabilities of children in different demographic groups. Norms for child conduct and adult supervision in different traffic environments need to be prescribed. Countermeasures concerning the environment or better supervision have strong merit. Programs need to target subgroups at greatest risk, to enhance program efficiency and minimize undesirable effects on other groups. Special individual factors (for example, short stature) need to be considered.

Even so, strategies designed around the "average" child will not address those with special needs. Children with severe vulnerabilities, such as blindness or combinations of cognitive and physical disabilities, require an individual approach. Parents of children with special needs should learn the risks of walking for their children and how to reduce them through appropriate supervision and effective management of the child's conduct. This suggests a two level prevention strategy, one level aimed at high risk groups of normal children, the other aimed at individuals with special needs.

According to some, environmental modifications may have some benefit in reducing injuries.[20] However, these cannot set aside the need for supervision. And yet, even some important aspects of adult supervision are not well understood. For example, we do not know for how long and under what circumstances a child may be left without an adult, nor how or when parents should teach and train their children concerning road safety. Several issues need to be considered, including the value of physical activity in our society and the reality that multiple adults supervise a child, either directly or indirectly, during a day. Any subsequent guilt on the part of the supervisor that may arise as an unintended consequence after a child's injury needs to be minimized.

ENGINEERING FACTORS

Many existing engineering policies and practices are potentially detrimental to pedestrians, albeit inadvertently. In response to increasing motor vehicle demands, transportation agencies have emphasized designing and building roads. The result is the existence of multilane roadways that are designed to move heavy volumes of traffic, often at high speeds, between city centers and their suburbs. Such roadways, whether located in commercial or residential areas, may lack sidewalks or walkways, adequate shoulders, and medians or refuge islands. Their pedestrian crosswalks may be spaced one half mile apart, which encourages jaywalking. It may be difficult to retrofit a road built without sufficient considerations for pedestrian travel. For example, a safety problem created by building an intersection too wide for a child to cross in time cannot necessarily be remedied by painting a crosswalk or posting a pedestrian warning sign afterwards.

Intersections of arterial roads are commonly designed to accommodate high traffic volumes and allow large tractor-trailers to make right or left turns. To allow these large trucks to stay upright on the road without overriding the curb, a large turning radius is needed, particularly at speeds conducive to allow traffic to flow well. However, such geometry has the unintended consequence of substantially increasing the length of a crosswalk. To compound the problem, a right-turn-on-red (RTOR) is now allowed in all 50 states, with a few local exceptions. Although RTOR motorists are legally required to make a complete stop and then yield to pedestrians and cross street traffic, drivers may not stop completely. Further, while looking for gaps in traffic coming from their left, drivers turning right may not see pedestrians crossing in front of them from their right.[25]

Current timing of crossing signals may paradoxically increase some risks to pedestrians.[26] Virtually all pedestrian signals in the United States are timed to allow vehicles to turn right or left on a green light when the crosswalk light facing the same direction indicates WALK. This allows vehicles to drive through the pedestrian crosswalk at the precise time a pedestrian may be crossing there.

Children walking to school face special problems. The roads they use may be designed more for cars than pedestrians. Busy arterial streets often lack sidewalks. The route may require a child to cross a multilane, undivided road that lacks adequate traffic control devices or refuge islands. Adult crossing guards may be needed yet not provided. Bus stops may be improperly located, directing children to wait for the school bus on a busy street or intersection, rather than midblock or on a quiet residential street nearby. Parents driving their children to school may create excess traffic congestion at the school drop-off point, or make unsafe traffic maneuvers in that area.

Although children commonly play in their own neighborhood, many residential neighborhoods have been built strictly with cars in mind. Residential streets are commonly wide, straight, and provide for parking on both sides. This design encourages cars to drive at high speeds on local streets (including as drag races among teenage drivers), and can obstruct a motorist's view of children entering the street from between parked cars.

Other engineering problems that reduce pedestrian safety include the existence of work zones that encroach on sidewalks without providing adequate safe passage; poorly maintained sidewalks, walkways, and other pedestrian facilities that can result in falls; signal WALK time or green phase too brief to allow young children to cross the road; and lack of a shoulder or other provision for pedestrians along rural roadways.

Many good, specific engineering solutions exist. These include (1) maintaining sidewalks or walkways; (2) employing and training adults to be crossing guards; (3) posting supplemental warning signs; (4) establishing traffic signals or grade separated crossings where traffic hazards dictate; (5) selecting bus stop locations more carefully, such as on the far side of intersections or on residential streets; (6) establishing traffic calming measures, such as street narrowing, speed humps, and partial or full street closures; (7) building streets with tighter turning radii or with new, channelized right turn slip lanes; (8) increasing the "WALK" time of pedestrian signals to allow enough time for children to cross; (9) establishing more NO TURN ON RED intersections, with signs; (10) providing exclusive pedestrian timing signals that stop traffic in all directions for one interval during each signal cycle, allowing pedestrians to cross; (11) developing "intelligent" microwave or infrared pedestrian detectors to automatically extend the crossing time for children or other slower moving pedestrians; (12) reducing the number of lanes on arterial streets while adding sidewalks and bike lanes; (13) converting two way left turn lanes into raised medians with left turn pockets; (14) establishing pedestrian malls; (15) building multiuse paths; (16) removing sight obstructions such as parked cars near intersections; (17) providing safe walking areas in work zones; and (18) improving lighting on neighborhood streets.

Some engineering barriers presently thwart success. Any single type of road improvement does not fit all situations. Further, engineers and planners in one locale may not have used, or even be aware of, successful types of pedestrian facilities elsewhere. A huge network of roads has already been built in America without sufficient consideration of pedestrian needs, so that a great deal of retrofitting construction needs to

take place. And, guidelines for engineering and design of roads to meet pedestrian needs has only recently been created.

Some institutional barriers compound this problem. These include a lack of coordination between local and state engineers and planners, educators, law enforcement officials, and citizens to provide for child pedestrian safety; inadequate funding allocated for pedestrian improvements and safety research; and the low priority that elected officials place on walking as a mode of transportation.

Given these barriers, some general engineering recommendations include: (1) conducting evaluation research concerning the effectiveness of various types of pedestrian facilities and traffic calming measures; (2) encouraging citizen participation in transportation matters, particularly the selection of pedestrian facilities and improvements; (3) supporting the Partnership for Walkable America, a national coalition of partners concerned with improving pedestrian safety, mobility, and health; (4) aggressively funding and implementing the pedestrian objectives and action plan of the National Bicycling and Walking Study of the Federal Highway Administration[27]; (5) training state and local engineers, planners, and their students in pedestrian road treatments; and (6) urging metropolitan planning organizations, community traffic safety programs, and state and local transportation agencies to address pedestrian needs.

City and county transportation engineers and planners tend to identify the most practical problems. To them, these problems include the poor selection of sites for elementary schools which make them unconducive to walking, the ambiguous meaning of the flashing "WALK" and "DON'T WALK" signals, the high costs of redesigning a street once built, and remedying the problem of cut-through traffic on neighborhood streets.

EDUCATIONAL FACTORS

The key question concerning child pedestrian safety education is whether any existing educational program has substantially improved the street crossing behavior of children. Studies of the effectiveness of pedestrian education programs for children have been largely, although not universally, disappointing.[28 29] Most such education has taken place in the classroom, with the aim of increasing children's knowledge about traffic and their attitudes towards safety. The assumption is that, by building their knowledge of managing traffic and encouraging appropriate attitudes towards safety, children will be able to generalize what they learn in the classroom to real life traffic situations.

Since knowledge alone is not sufficient to result in road safety, other strategies, both educational and environmental, need to be developed. Road safety education programs should promote the development of skills and their application in a variety of traffic contexts. Unlike knowledge based methods which may (at best) change a child's attitude or ability to correctly answer questions about road safety, practical skills training methods lead to measurable changes in children's behavior in traffic. They improve judgment, increase their ability to cross at parked cars and intersections, help them learn to time crossings better and to plan safer routes, and reduce their roadside impulsivity. Although children's road crossing ability has historically been viewed within the Piaget construct of maturational readiness, this may not be the only useful paradigm. The fact that very young children can be trained in specific critical skills to cross residential streets as competently as older children indicates that maturationally readiness may not be the only important determinant. Parent participation is an important element of such training. Although most safety training and education in the United States occurs at school, programs that involve parents in training or reinforcing such lessons may be even more successful in changing behaviors.[30] However, parents may not know what to teach, or may overestimate a young child's ability to negotiate traffic.[12]

Driver education that addresses pedestrian issues is needed, particularly concerning the importance of yielding the right-of-way to pedestrians. Programs that combine public and school based education, improved signage at crosswalks, and police enforcement result in substantially more drivers yielding to pedestrians in targeted crosswalks and fewer pedestrians struck there.[31]

What is still needed? Parents and other caregivers need to better understand the developmental and behavioral characteristics that put young children at increased risk for pedestrian injuries. Before encouraging parents to take a leading role in road safety education, we need to assess their degree of proficiency in this area by asking key questions. How do parents currently prepare their children to deal with traffic safely? What materials and preparation might increase their effectiveness as a trainer? Are certain traffic skills better taught by professionals? What vulnerabilities do parents perceive their children to have? As with other topics, educational programs in traffic safety must be evaluated.

What should be done next? The classic view that, for maturational reasons, children cannot be expected to cope with anything but the most simple traffic environments, and cannot coordinate several variables at once, needs to be reviewed. A more comprehensive taxonomy of the skills and competencies children need to interact safely with traffic should be developed. Research should be conducted to identify skills that are trainable, their optimal training conditions, and target groups. Training objectives should be established on a scientific basis, considering the elemental components of each model behavior, how an experienced pedestrian might solve such problems, and the underlying skills needed. Approaches to activating parents, such as those used by the National SAFE KIDS Campaign and its many local coalitions, should be systematically evaluated. The manner in which parents teach and model behaviors needs to be understood better, so that experts can prepare information they need. Road safety education programs that incorporate traffic simulations need more rigorous evaluation. Little is known about parents' understanding of children in traffic and the methods they use to supervise them in traffic. A broad, multifaceted approach could help adult supervisors function more effectively. The relative value of educating drivers needs to be considered in tandem.

A RESEARCH AGENDA

Some experts attending the conference noted that we still do not yet have a clear understanding of the causal sequence linking poverty with pedestrian injuries. Some key associations between risk factors and pedestrian injuries have been demonstrated, including poverty, lack of adequate play space, residence near high speed and high volume roads, and less adult supervision. But precisely how poverty leads to pedestrian injuries is uncertain, whether it is due to poor adult supervision or some psychological state of the child. However, other experts have pointed out that, given sparse resources, we know enough about individual risk factors, yet do not know what type of intervention actually works well in most circumstances. For example, concerning education and training, proper program evaluation is needed to determine effectiveness and cost effectiveness of various educational and skills training programs at different ages.

Whenever feasible, randomized controlled trials (RCT) should be used to measure the degree of effectiveness. This study design is the gold standard for health care research and reduces the likelihood of bias. Using RCT methodology, two groups of people or two groups of existing roadways are created by random assignment. The groups are similar in

many ways, and have an approximately equal chance of experiencing the outcome of interest (pedestrian injury, in this case). The intervention is provided to only one group, after which the outcome of interest is measured and compared with the other (control) group. A wide range of environmental initiatives could be evaluated in this manner, and can take into account differences between the two groups in levels of walking, traffic noise, social networking, resident satisfaction, and perceptions of safety. A major challenge is to determine how to fund, coordinate, and conduct such research. Study designs other than the randomized controlled trial may be at times more practical and less expensive to evaluate the effectiveness of some community programs.

ADOPTING A NEW APPROACH

Although epidemiologic research clearly identifies a decline in child pedestrian deaths in the United States and Great Britain, this may be the result of less walking, rather than safer walking with fewer collisions or better health care of those injured.[3] Health benefits of walking are only one reason, and perhaps not the most important one, that this trend should be reversed. Walking reflects other aspects of societal health, and has direct implications concerning the degree of community coherence, social support, local crime and violence, and global environmental health. Thus, efforts should be made to promote safe walking for reasons other than just injury prevention. Advocating walking to improve the quality of life, community coherence and urban aesthetics is likely to be more appealing to a wide public audience than reasons that focus solely on prevention of injuries. Designing our cities and neighborhoods to match the needs of pedestrians, not just motorists, is a critically important long term goal.

EPILOGUE

The point of greatest dispute in the lively discussions of this conference was the relative value of education and training versus environmental modification in reducing pedestrian injuries to children. During the conference, spokespersons for each position acknowledged that neither education and training nor environmental modification was a sufficient solution by itself. Those favoring environmental change were concerned that educational programs had produced relatively small impact on behavior or outcome. Proponents of education countered that, in the past, education had been provided without skills training, an essential component. Even so, such proponents recognized that even the best education and skills training could not teach children to cope with all types of streets and intersections.

Proponents of education and training noted several other benefits of that course of action. Suppose that a particular child's neighborhood environment was made relatively pedestrian friendly and safe. Since those changes could never be accomplished quickly throughout the nation, that child would be at risk if he or she traveled to another neighborhood where such environmental modifications had not been made. To be safe, that child would need to have learned and mastered appropriate road safety skills. A second benefit concerns teaching children to properly use pedestrian road treatments. And before they become adults, children at some point need to be taught these skills, because without them, they are not likely to spontaneously understand traffic and know how to proceed safely.

We believe that the argument rests on two crucial issues. First, when a motor vehicle and a child collide, the margin of safety for the child is very small. Even though most child pedestrians who are struck are not fatally injured, a much worse outcome could have occurred with only a small change in crash circumstances or timing. Given this premise, an intervention to protect children from pedestrian injury needs to yield a high likelihood of success of protecting the child from being struck in the first place. Since child pedestrian behavior around traffic is frequently risky, any educational program or environmental modification needs to have a substantial benefit by preventing the collision. It should work the first and each subsequent time a child independently deals with a traffic threat. These are indeed stiff measures of effectiveness. They call for evaluation of what works in the field, followed by promotion of those interventions found to succeed by those criteria.

In the end, it is likely that a combination of educational and environmental measures will be needed, but the specific programs with the right mix to effectively reduce the risk to children may exist only as a prototype, if it exists at all. Much work remains to be done to protect child pedestrians, especially in light of the increasing complexity of traffic and roadways, other demands on driver behavior, and the active lives of today's children. The following paper lists the recommendations developed at this conference and begins to provide the necessary detail.

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RECOMMENDATIONS

Reducing childhood pedestrian injuries

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Goal

To enhance the wellbeing and safety of children by
(1) reducing their risk of injury while walking;
(2) increasing their physical activity level; and
(3) creating a more pedestrian-friendly environment.

RECOMMENDATION #1

Enhance public awareness about the need for improved safety for child pedestrians while promoting the health and environmental benefits of walking

Create coordinated national, state, and local public information campaigns that increase public awareness and understanding of:

(1) The interdependent relationship among personal health, safety, community livability, and environmental protection.

(2) Pedestrians as road users who, like motorists and bicyclists, need to be safe in traffic.

(3) The manner and degree to which engineering solutions can enhance pedestrian safety (for example, traffic calming, separation of pedestrians from motor vehicle traffic, better crosswalk controls).

(4) The usefulness and cost effectiveness of traffic law enforcement.

RECOMMENDATION #2

Modify the behavior and attitudes of both pedestrians and drivers to improve sharing of the road

(1) Develop and encourage strategies that improve sharing the road, and increase mutual respect of pedestrians and motorists by teaching both groups the rules of the road.

(2) Help the public understand the degree to which excessive speed increases stopping distances and thus increases the risk of pedestrian death.

(3) Encourage the public to support enforcement of posted speed limits (especially in school zones and residential areas), laws that prohibit passing of school buses, and yield-to-pedestrian laws. Support the development and use of innovative technologies, such as red light cameras to help enforce traffic laws.

(4) Develop, evaluate, and disseminate programs to educate parents and drivers about children's abilities and limitations as pedestrians in traffic. These programs should take into account different parenting styles and abilities. Encourage parents to supervise their children in traffic and teach their children age appropriate pedestrian safety rules.

RECOMMENDATION #3

Modify the physical environment to better support pedestrian traffic

(1) At the national level:

- Establish transportation policies that encourage local communities to integrate pedestrian access and safety into every phase of transportation planning.
- Foster collaboration among federal agencies and national professional groups to help develop and promote public policy that leverages resources to achieve the most effective programs without duplicating efforts.
- Develop road construction standards that are more conducive to safe walking.
- Compile and disseminate local "best practices" that foster pedestrian safety, especially those that emphasize the use of low cost solutions and new technologies.
- Help teach traffic engineers and engineering students how to retrofit streets and roads to make them safer. Develop and disseminate curricula, sponsor professional conferences, and assist with continuing education.

(2) At the state and local levels:

- Encourage state and local officials to revise laws, ordinances, and practices to promote the construction of sidewalks and traffic calming measures, such as roundabouts, speed humps, and other road designs.
- Encourage city planners, engineers, real estate developers, and landscape architects to consider pedestrian safety—particularly for children and persons with disabilities—when designing new communities or modify existing ones.
- Encourage local officials, designers, and planners to enhance pedestrian accessibility and safety when building or remodeling schools, recreational sites, and businesses.

RECOMMENDATION #4

Develop and conduct effective safe walking programs

(1) Ensure that programs to prevent child pedestrian injuries receive public and private program support sufficient to provide programs in all states. This may require corporate and Congressional champions and a national spokesperson.

(2) Encourage federal agencies responsible for road safety to make available effective pedestrian safety training activities for children. Encourage federal, state, and local departments of education to establish safe routes to school.

(3) Encourage states to develop statewide pedestrian safety plans that reflect community needs.

Encourage each state department of transportation to establish and adequately staff a pedestrian safety office to coordinate and conduct training programs, conduct public information and education campaigns, and develop local programs throughout the state.

(4) At the community level, create multidisciplinary coalitions to develop programs that emphasize safety aspects and the health and environmental benefits of walking. Encourage parents, teachers, school administrators, pediatricians, and other child care providers to identify and creatively solve local pedestrian safety problems. Such coalitions should seek to enroll non-traditional partners.

RECOMMENDATION #5

Conduct research to address gaps in knowledge and to translate research findings into effective programs and public policy

(1) Evaluate existing childhood pedestrian safety programs by using a systematic review process to determine which ones are effective and deserve widespread replication. Such programs include:

- Educational programs, such as Safe Routes to School, Walking School Bus, Willie Whistle, Keep on Looking, and others designed to reduce dart-outs and help children cross streets safely.
- Traffic calming strategies, such as roundabouts, speed humps, and other measures.
- Enforcement strategies, such as red light cameras and stricter ticketing of drivers who illegally pass school buses.

(2) Where sufficient data do not exist, use randomized controlled trials where feasible to measure intervention effectiveness.

(3) Conduct research to determine the cost effectiveness of promising programs.

(4) Fund research that links pedestrian safety to physical activity and a healthier environment.

(5) Identify behavioral indicators to help determine when a child is ready to cross the street independently. Assess the chronologic and developmental age, skill patterns, and teachable moments when children are most receptive to interventions.

(6) Determine what level of supervision children need at various levels of cognitive, social, skill, and behavioral development. Establish appropriate standards for such supervision.

(7) Develop, test, and evaluate programs that use teens to mentor young children in pedestrian safety.

RECOMMENDATION #6

Conduct surveillance to measure children's pedestrian injury rates, quantify the amount of walking children normally do, and identify risk factors for injury

(1) Identify and validate useful indirect measures that predict the occurrence of a child pedestrian injury. Use these to monitor program effectiveness.

(2) Develop and test community indicators of the prevalence of walking for transportation, the public's beliefs about the benefits and risks of walking, and the existence of environmental and social risks of walking.

(3) Define children's exposure to risk of pedestrian injury that includes, but is not limited to, factors related to the time the child spends in the street; traffic density, speed, and complexity; and road features such as the number of lanes and existence of marked or signed crosswalks. Develop and implement methods of collecting data on such exposure.

(4) Develop local risk factor surveillance systems to monitor how and why child pedestrians are injured, and to identify the environmental and behavioral modifications that could have prevented such injury. Establish linkages to other data sources, particularly emergency department data and police crash reports.

AIMS AND SCOPE

Injury Prevention is dedicated to the prevention of injuries among children and adults and offers the most comprehensive approach to injury prevention and control. Providing international and interdisciplinary coverage, each issue contains scientific reports, descriptions of local and national prevention programmes, review articles, commentaries and news.

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