

BALLS, BIKES, BEACHES, AND BURNS: PATTERNS OF CHILDHOOD INJURY

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ABSTRACT: *The risk of dying from injuries for children living in the United States is far higher than for their counterparts living in other industrialized countries. Injuries are often termed "accidents," a word which implies that unpredictable conditions caused the outcome. Yet many injuries occur under conditions that were predictable. It follows, then, that some environmental conditions can be manipulated to minimize these risks. This paper reviews the literature for four common causes of death from childhood injury: pedestrian, bicycle, fire, and water-related injuries. It offers suggestions for reducing environmental risks and calls for good planning measures to reduce child mortality associated with these causes.*

INTRODUCTION

Each year, about 16 million children ages 0 to 19 years are seen for injuries in emergency rooms across the United States, and more than 600,000 of those seen are injured seriously enough to warrant hospitalization. About 22,000 children will die from these injuries, and another 30,000 will incur serious permanent disabilities (Centers for Disease Control, Division of Injury Control, 1990). Childhood injuries are now recognized as a serious public health problem and preventing these injuries has become a high-priority public health issue in the United States (National Committee for Injury Prevention and Control, 1989).

Although preventing childhood injury deaths has become a national concern, the link between prevention and planning has not been well-established. Greenberg et al. (1994) noted that while planning and public health share many common concerns, the major journals in the field--the *Journal of the American Planning Association* and the *American Journal of Public Health*--suggest only minor overlaps. The authors suggest that these links be strengthened through a common literature, professional interaction, and increased cross-disciplinary education.

In an effort to begin building those linkages, this paper reviews both the public health and planning literature on childhood injury deaths

from four causes. Each section begins by noting the scope of the problem from the public health perspective. It then reviews the behavioral, environmental, and geographic circumstances that enable these tragedies to occur. Finally, suggestions from the planning literature are noted which can reduce or eliminate the conditions that contribute to these fatal outcomes. It is hoped that this cross-disciplinary effort will benefit both planners and public health professionals, broadening their understanding of these problems.

Why Study Only Injury Deaths?

Although population-based studies to estimate the incidence of childhood injuries in the United States exist, they are limited to small geographic areas (one hospital or HMO, or one city) and, therefore, subject to bias. Even the National Hospital Discharge Survey, which provides computerized data on a national probability sample of 200,000 hospital discharges annually, is not representative as it covers only one hospital in each community. In addition, case-control studies based on small numbers of cases are likely to be subject to recall bias. Injuries which are not severe enough to be seen in a hospital are unlikely to be reported at all. Even the National Health Interview Survey, which reflects self-reporting of injuries, suffers from recall bias. Those who report an injury are more likely to recall that injury if they sought treatment.

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If they did not, the injuries are unlikely to be reported.

On the other hand, there are a multitude of mortality studies using national data which provide us with information about which children and adolescents are at highest risk for death from injuries. These studies provide stable and unbiased results, allow for the determination of trends, and provide a clear picture of which groups are at highest risk for death from a variety of causes. Specifically, we know that adolescent males ages 15 to 19 years have overall injury death rates twice as high as adolescent females (National Center for Health Statistics, 1992). Children living in poverty have higher rates of death from drowning, fires, homicide, unintentional shootings, and motor vehicle accidents than middle- and upper-income children (Waller et al., 1989). Those living in urban areas face increased risks of death from violence, especially homicide (Ropp et al., 1992), and children living in rural areas are at increased risk of death from injury from machinery, especially tractors, trucks, and wagons (Woodward and Bolte, 1990).

Nor are these findings unique to U.S. children. Childhood injuries have been widely shown to be related to both local geographic and socioeconomic conditions, thereby placing some children at increased risk (Mazurek, 1994; Roberts, 1993; Roberts et al., 1993; 1994). Otherwise put, certain groups of children are at high risk for death from specific causes of injury because local environmental conditions and personal behaviors cross paths with deadly results. Four causes are reviewed below, selected as they are tied closely to prevention measures that can be achieved through good planning practices.

PEDESTRIAN DEATHS

The most common cause of serious trauma and death among young school-age children is pedestrian injuries, accounting for about 22 percent of all unintentional fatal injury deaths for those 5 to 9 years (about 2,000 American children per year) (National Center for Vital Statistics, 1988; 1992). In 1985, 1,434 white children and 418 non-white children ages 5 to 9 years died from pedestrian

injuries, with non-white children at greater risk (3.2/100,000) than white children (2.5/100,000) (Fingerhut and Kleinman, 1989). Male children are at greater risk for pedestrian injury deaths than female children by 2 to 1, regardless of race, with children living in poverty more likely to die of pedestrian injuries than children who live in families with higher incomes (Centers for Disease Control, Division of Injury Control, 1990; Rivara, 1990; Roberts and Coggan, 1994).

All of these epidemiologic findings make sense in the context of the environmental and behavioral conditions facing children as pedestrians. Children in the 5- to 9-year age group are beginning their school years and many walk to school without supervision for the first time. One study of parental attitudes about children as pedestrians showed that although 94 percent of parents assume their 5 and 6 year old children do not have the maturity to cross streets and walk to school alone, more than one-third of kindergarten students do so (Rivara et al., 1989). Children living in poverty are more likely to be walkers, whereas children living in families with higher incomes are more likely to be driven to school, either on a bus or by a parent. In other words, children in poverty have higher expectations placed on them to be responsible pedestrians (Rivara, 1990). They may also be exposed to higher traffic densities in inner-cities and live in areas with poor sidewalks, poor lighting, and few crossing guards.

The fact that male children have higher rates of death from pedestrian injuries also makes sense. Male children are more likely to play ball sports than female children. Female games tend toward jump rope and hopscotch, games which are likely to remain on the sidewalk. In contrast, errant balls often roll into the street where children chase them. This activity sequence accounts for many "dart-out" motor vehicle-pedestrian injuries, up to 70 percent of pedestrian injuries in the 1 to 4 year old group and up to 60 percent of injuries for those 4 to 9 years (Brison et al., 1988; Rivara, 1990). Pedestrian injuries are infrequent around schools and playgrounds, areas where crossing guards and teachers patrol activities. These injuries mostly occur during daylight hours when children are playing in their own neighborhoods or walking to school (Rivara, 1990).

The planning literature reflects legislation, environmental modifications, and some city planning applications that have been implemented in many states and localities in an effort to improve traffic safety and provide safe pedestrian pathways. The Burrall scheme, for example, called for multiple cul-de-sacs (Wynne, 1980) to remove through traffic from residential neighborhoods. A side effect of the scheme was to reduce risk to neighborhood children at play. The Radburn plan provided for walkways to link continuous park space (Eisner et al., 1993) so that pedestrians could move freely between public access areas without crossing streets. The risk to children at play in public parks was thereby reduced. Other efforts to adjust traffic flow and increase pedestrian safety, however, have turned out to be downright counterproductive from a child-as-pedestrian point of view. For example, right-turn-on-red legislation was widely adopted in the 1970s in an effort to conserve the gasoline burned while waiting for traffic lights to change. Child pedestrian injuries increased by 30 percent after it was adopted (Zador, 1984). Speed bumps have been demonstrated to increase bicycle and motorcycle injuries and are not considered effective for reducing vehicle speed except in purely residential areas (Rivara et al., 1989). Rumble strips have recently been studied by Grote et al. (1993) and found to be hazardous to both pedestrian and bicycle safety. Pedestrian overpasses and underpasses separate walkers from traffic but they are not effective in reducing pedestrian injuries because they are underutilized (Rivara, 1990). Overpasses often require the use of many steps, an impossibility for very young children, mothers with carriages or strollers, or children in the company of physically-challenged adults and elders. Underpasses are often considered unsafe because of poor illumination. Drainage in underpasses is also a problem, and flooding may make foot traffic impossible.

Painted crosswalks are also of questionable value for reducing pedestrian injuries. In fact, one study showed that pedestrians using marked crosswalks had twice the risk of injury as those using unmarked crosswalks (Highway Research Record, 1972). Experts on pedestrian injuries suggest that marking crosswalks gives children a sense of false security that traffic will stop if they are in the marked zone. Rather than reducing

childhood pedestrian injuries, they actually increase injury risk (Rivara, 1990). The marked crosswalk being less safe than an unmarked crosswalk seems to present a paradox. The explanation, however, is cultural. Anyone who has had the privilege of crossing streets in both Los Angeles and New York City can attest to the differences in driver response to a pedestrian in a marked crosswalk. In Los Angeles, traffic stops. In New York City, pedestrians need much more vigilance. Indeed, assuming a marked crosswalk is a safe zone is likely to yield tragic results. The cultural expectations in the two cities are simply different. Indeed, planners have demonstrated that pedestrian behaviors differ by city in the United States (Robertson and Carter, 1988), with compliance with signals far higher in the Southwest than in the Northeast. These regional and cultural differences should be taken into in the planning process.

Agran et al. (1994) have reported their findings of a case review of 345 children ages 0-14 years who suffered pedestrian injury in California. Eleven percent of the cases were injured in driveways, 8 percent in parking lots, 53 percent at midblock, and 28 percent at intersections. Events in driveways and parking lots involved children with a median age of 2 and 6 years, respectively, usually where vehicles were backing up. Events at midblock involved children with a median age of 6 where traffic was moderate to heavy. Accidents at intersections involved children with a median age of 10 where traffic usually had more than two lanes. To reduce these injuries among young children requires caretaker supervision. For older children, however, traffic controls and safe street crossing instruction, preferably in schools, can make a difference (Rivara et al., 1991).

The best way for communities to plan for minimal childhood pedestrian injuries is to provide well-maintained sidewalks and pathways, especially on school routes. This can be done by mandating that all new construction, especially that which is located in areas where children are required to walk to school, provide sidewalks that are separated from roadways, either by utilizing curbing and grass strips or other types of barriers. Urban areas should consider converting street traffic to one-way. This will increase driver vision of pedestrians and reduce pedestrian confusion.

Finally, those involved in traffic control and city planning would benefit from a superb reference on pedestrians and traffic-control measures from the National Cooperative Highway Research Program--*Pedestrians and Traffic-Control Measures* (1988). This monograph covers pedestrian behaviors (including children's behaviors) in urban and rural settings, type of pedestrian accident (such as dart-out, bus stop-related, ice cream vendor), and engineering and physical measures that can be instituted (such as lighting, one-way streets, safe routes). It provides clear guidelines for improving pedestrian safety, including child-as-pedestrian safety.

BICYCLE-RELATED DEATHS

There are more than one-half million bicycle injuries serious enough to be seen in a hospital each year, and about 80 percent of these injuries are to children 0 to 19 years of age. The cost of these injuries is staggering, estimated at well over \$1 billion, annually (National Electronic Injury Surveillance System, 1987). National Center for Health Statistics (1988; 1992) data show that more than 500 children and adolescents die each year from bicycle-related injuries. The most common cause of death from a bicycle-related injury is head trauma, and in more than 87 percent of these injuries, the head trauma resulted from a bicyclist colliding with a motor vehicle (Sacks et al., 1991). Males are twice as likely as females to be injured in a bicycle-related incident, regardless of age, accounting for 85 percent of all bicycle-related deaths due to head trauma (Fingerhut and Kleinman, 1989). Bicycle injuries occur to children in all socio-economic strata, with those in the lowest income group having a slightly increased risk (low income, 39 percent of injuries; high income, 30 percent of injuries) (Pless et al., 1989).

Efforts to change these statistics by manipulating both environment and behavior are currently underway. Many researchers have called for the implementation of bicycle helmet laws, stating that helmet use will reduce the number of deaths from bicycle injuries, especially those due to head trauma (DiGuiseppi et al., 1990). Sacks et al.,

(1991) estimate that universal use of helmets by bicyclists could prevent one bicycle-injury death every day and one head trauma every 4 minutes. These statistics have been taken to heart by several states which now have bicycle helmet legislation on their books: California, Connecticut, Georgia, Massachusetts, New Jersey, New York, Oregon, Pennsylvania, Tennessee, and several counties in Maryland (Centers for Disease Control and Prevention, 1995). Yet making bicycle helmets mandatory through state legislation will not eliminate all bicycle-related injury deaths in children. There are strong associations between high bicycle injury rates and environments with dense traffic, poorly designed intersections, and few bicycle paths (Guyer et al., 1985). Similarly, communities where urban planning takes bicycle safety into account by providing bicycle routes, bicycle paths, and barriers that separate bicyclists from traffic show fewer injuries (OECD, 1983).

Good planning for bicycle traffic begins with becoming familiar with the American Association of State Highway and Transportation Officials *Guide for the Development of Bicycle Facilities* (AASHTO, 1991). The document calls for communities to be creative, using sidewalks for one-way school routes or widening shoulders on roads to provide bike lanes. Routes need to be routinely checked for obstructions and impediments, such as unsafe storm grates or bridge decks, broken sidewalk or rough pavement, hidden driveways, and vegetation that impairs visibility. Parent groups can be enlisted to aid in this process. Traffic signals can be designed to be user-friendly for bicyclists, but local ordinances should still mandate that bicycles be walked across intersections on school routes.

Jones (1993) notes that two federal laws, the Clean Air Act and Intermodal Surface Transportation Efficiency Act are spurring bikeway planning across the country, and he recommends that a part-time bikeway coordinator position be created for all cities of over 30,000 persons. Communities that undertake good bicycle planning, enforce helmet laws, and provide bicycle safety programs, should effectively reduce their bicycle injury rates.

FIRE-RELATED DEATHS

Public health statistics show that more than 1,000 American children ages 0 to 14 die each year from fire- and burn-related injuries (National Center for Health Statistics, 1992). Fully 84 percent of childhood fire-related deaths are the result of a house fire and 45 percent of these are of children under four years of age. The percentage of injury deaths from fire then decreases to 12 percent for those ages 5 to 9 years and to 5 percent for those ages 10 to 14 years (McLaughlin and McGuire, 1990). This reduction in percent in the older group is explained by the fact that older children have more knowledge about how to escape a house fire and are more likely to be affected by other types of injury deaths. Cigarettes are responsible for 35 percent of all fatal fires in the United States and cause 14 percent of the fires that kill children (Rivara, 1994). Child experimentation with matches causes about one-third of fires that kill children under the age of 5 (Robertson, 1992). Three times more black children under the age of 10 years die from house fires than white children of comparable age. Native American children and those living in low socio-economic status are also at increased risk (Fingerhut and Kleinman, 1989). Explanations for these patterns are that black and Native American children are more likely to live in substandard housing where fires may spread more quickly and where fire extinguishers may not be available. Many also live in areas with reduced fire protection, either because they live in a remote area or because they live in areas where fire protection services have been cut. This means the fires that do start will burn longer and may be more difficult to put out (Munson, 1983).

There is a geographic pattern to house fire deaths of children. Rates are highest in the Southeast (except for Florida), in a band from South Carolina westward to Arkansas and Louisiana. Rates are also high in the middle Atlantic region (Delaware, Maryland, New Jersey and Pennsylvania) and the region around Lake Michigan (Illinois, Indiana, and Michigan). Lowest rates of childhood death from house fires are found in the Western states (Robertson, 1992). Explanations for this geographic variation include

regional differences in the amount of poor and older construction, the use of wood for heating, and regional differences in the use of smoke detectors.

Many child fire-related and burn injury deaths can be prevented. For example, research has shown that the risk of dying from fire-related injuries is cut in half when smoke detectors are installed. Yet only 67 percent of households with a child under 17 years of age have smoke detectors and these are more prevalent in non-central city areas and in the Midwest than in cities and the Northeastern, Southern, and Western regions of the United States (National Center for Health Statistics, 1994). Similarly, sprinkler systems are effective for controlling fires and saving lives, but they are not commonly found in dwelling units (Centers for Disease Control, Division of Epidemiology and Injury Control, 1987). Given that smoke detectors and sprinkler systems are highly effective early warning systems that prevent fire and burn-related injury deaths, it seems prudent that they be mandated through national legislation. Yet they are not. Fire codes and regulations for such devices are at the hands of local government. Community regulations regarding smoke detectors and sprinklers vary widely. Planners in communities without these regulations might consider working with their local building inspectors to mandate smoke detectors for all rental units and sprinkler systems for all newly-constructed multiple dwelling units.

More than a decade ago, Butcher and Pamell (1983) called for fire walls between newly-constructed residential units. To encourage owners to upgrade substandard construction, planners can work with their municipalities and tax assessors to create tax incentive programs for fire prevention improvements. Urban and regional planners might also consult with the professionals who design emergency response patterns for fire, police, and other emergency vehicles so that response to fire calls will not be impeded by new projects (Gartner, 1981). Finally, fire departments often institute window sticker programs which allow fire fighters to readily identify rooms where children are likely to be sleeping. This quick identifying mark on the exterior of a burning building can reduce the time necessary to search for and remove children at risk of death from fire and smoke inhalation. Nor should remote areas be neglected. In places where

fire response time is simply too long because of distance or travel obstacles such as mountain roads, regional planners might work with social service agencies and fire officials to support programs that provide residents with inexpensive smoke detectors and batteries in order to save lives, if not property. These simple actions hold the promise of cutting fire-related injury deaths in children substantially.

DROWNING

Drowning accounts for more than 2,100 deaths of American children ages 0 to 19 years, annually (National Center for Health Statistics, 1992). For the United States as a whole, drowning is the leading cause of injury death for children 0 to 4 years, now outranking motor vehicle occupant or pedestrian trauma in that age group (Wintemute, 1992). Males are more likely to drown than females, accounting for 78 percent of all child drowning deaths (Waller et al., 1989). After the age of 5, males account for 86 percent of child drowning deaths (Fingerhut and Kleinman, 1989). Wintemute (1990, p. 663) summed up the problem succinctly: "from birth through 19 years, 1 in every 1098 boys will drown, 1 in 301 will be hospitalized for a near-drowning, 1 in 75 will be treated in an emergency department and sent home, and 1 in eight--13% of all boys--will get in serious trouble in the water but avoid injury through timely intervention at the scene. For girls the comparable figures are 1 in 3333, 1 in 913, 1 in 228, and 1 in 23."

Fully 98 percent of all childhood and adolescent drownings take place in fresh water. Even in states with significant salt-water boating and beach recreation, such as Hawaii, Florida, and California, fresh-water drownings still predominate (Wintemute, 1992). This makes sense if we examine information about one group with very high rates of death from drowning--toddlers 1 to 3 years of age. A toddler at highest risk of drowning is most likely to be white and from a household with high socio-economic status (Rivara, 1994). It is apparent that households with high socio-economic status are more likely to have swimming pools, and toddlers with access to swimming pools in their own yards are at increased risk.

A second risk for drowning for children in the youngest age group is the bathtub. An Arizona study showed that while 85 percent of all drownings of children 4 years old and younger occurred in swimming pools, another 9 percent occurred in the bathtub. The remaining portion of drownings were associated with other sources of fresh water, especially buckets, toilets, and ponds (Flood et al., 1990). Among older children, fresh water drownings still predominate and males remain at higher risk than females. The association between drowning with swimming pools and bathtubs almost disappears in this older age group, replaced by beaches, canals, lakes, ponds, and rivers. Another difference in the older age group is that rates for blacks are about twice as high as for whites and are far higher among those living in households with lower socio-economic status (Wintemute, 1992). Explanations for this phenomenon include the fact that children living in lower socio-economic conditions may not have pool access, may not have been able to afford swimming lessons, and part of their summer recreation may center around swimming in dangerous water bodies. Among adolescents, there is evidence that alcohol becomes a factor in drowning incidents, with about 50 percent of male adolescent drowning victims under the influence at time of death (Robertson, 1992). Children with seizure disorders are also at high-risk regardless of age, race, or socio-economic status (Wintemute, 1992).

Drownings and near-drownings carry heavy costs, with many survivors having serious and permanent neurologic disabilities. For children 0 to 4 years, these costs were estimated at about \$650 million per year (in 1987 dollars), mostly for 24-hour nursing care (Zamula, 1987). In cases where the child did not survive, parental suicide from guilt and anger has been documented (Wintemute, 1992). Families often relocate after a drowning, in an attempt to leave the environment they associate with the event. Studies that follow families who suffer the loss of a child to drowning show divorce rates exceed 80 percent within a few years (Zamula, 1987).

As with pedestrian, bicycle, and fire injuries, environmental manipulation can help reduce the tragedy of childhood death by drowning. For example, although pool fencing for preventing

swimming pool drownings has been a major thrust of public health advocates for years, fencing regulations remain under the purview of municipal authority and many have no regulations that require restricting access to swimming pools. Community planners and activists need to work with government councils and building inspectors to mandate swimming pool fencing for all pools for their communities. Although fencing costs between \$600 (for chain link) and \$4,000 (for wrought iron) per average pool, fencing clearly save lives, especially for those 1 to 3 years old.

Planners should also become familiar with two excellent references with regard to the planning, design, and construction of pools. The first, *Public Swimming Pools: Recommended Regulations for Design and Construction, Operation and Maintenance*, is put out by the American Public Health Association (1981) and focuses only on public swimming pools. It covers planning considerations other than fencing, such as pool, deck, and walkway construction; lighting, ventilation, water, sewer and electrical considerations; as well as pool safety. The second, *Swimming Pools: a Guide to their Planning, Design, and Operation* by Gabrielsen (1987), is far more comprehensive, covering not only community pools, but those of voluntary agencies and schools; private residences; hotels, motels, apartment complexes and condominiums. Whenever new pool construction is being considered, these references are invaluable.

The problem of bathtub drownings is beyond the scope of public health and planning professionals, requiring caretaker vigilance rather than municipal ordinance or environmental manipulation. Good planning, however, can effect other types of fresh water drownings in the local environment. For example, public facilities, including wading pools and fountains, which allow free access to swimming are a hazard. Storm grates should be of small enough size so that children will not be tempted to crawl in to recover a ball. Storm drain outflow pipes should also be inaccessible to children tempted to go exploring. Bars or wire can serve as inexpensive entry barriers and also reduce animal habitation. Bridges and trestles are tempting for older children and adolescents to use as diving boards. Access needs to be restricted or in some way made inhospitable for this purpose. One

suggestion is to use wire caging along the lower three feet of the structure as this effectively eliminates diving. Higher cage barriers will also effectively eliminate fishing and other non-sanctioned uses of these structures.

Access points to bodies of water, such as lakes, rivers, and canals, need to be monitored or limited. Planners can work with local recreational departments to be sure that signs are posted that prohibit the use of alcohol in the area. Signs can be placed strategically reminding boaters and all non-swimmers that might be tempted to go wading of the requirement for life vests. Rivers, especially, are subject to strong currents and signs should warn swimmers not to swim without a buddy or a safety rope. As about 50 percent of fresh water drownings in teens are linked to alcohol, good lighting and police patrolling of public waterfront access areas are the best deterrent.

PLANNING PLACE AS A PUBLIC HEALTH MEASURE

The vast majority of health planners focus on access, facilities, new technologies, and emergency response times. Few are trained to focus on the environmental conditions in the community that impact public health. On the other hand, city, regional, and traffic planners routinely work to create attractive and functional environments. Most incorporate public safety considerations into their designs, but few are trained to consider childhood and adolescent behaviors that might interact with their planned environments to produce deadly results. With a bit of conscious effort, planners, along with parents, police, and concerned citizens, can make a difference in the injury rates of children in their communities (National Center for Health Statistics, 1994; Rivara, 1985; Wilson, 1995). In fact, planners are in a unique position to make an impact as they are the ones specifically trained to manipulate local environments--environments where even subtle changes can yield big results. Behavioral, city, health, social, traffic, and urban planners can encourage fine-tuning of their community environments that will reduce or prevent specific

types of childhood injuries. Local ordinances and community education can yield further improvements in reducing childhood risks, and the result will be that we will lose fewer American children to drowning, pedestrian, bicycle, and fire-related injuries.

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