Raising Safe Kids: One Stage at a Time

A study of child development and unintentional injury.

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I. Executive Summary

American children are needlessly suffering from unintentional injuries at an alarming rate. In 2007, an average of 12 children were injured every minute, resulting in more than 6 million reported unintentional injuries over the course of the year. The risks that children face go far beyond a sprained ankle or a skinned knee. Every 101 minutes, a child in the United States dies from an unintentional injury, such as a vehicle crash or a fire, making it the leading cause of death and disability for children ages 1 to 14 in the United States.

Injuries have a significant economic impact as well. Aside from the costly emergency department bills – which affect overall health care costs across the country – these nonfatal injuries are also associated with missed school days, lifelong disabilities, and limited future employment opportunities.

Since its establishment in 1987, Safe Kids USA has held an annual public education campaign called National Safe Kids Week. Focusing on a specific topic each year, National Safe Kids Week is designed to educate parents and caregivers, injury prevention professionals, policy makers and the general public on the steps that are needed to keep children safe from unintentional injury.

During our 22 years of work, we have seen the childhood injury death rate in the United States drop by 45 percent. This reduction not only demonstrates that the efforts of the injury prevention community have been effective, but it also underscores that more must be done. Children need help and protection from a world built by adults and for adults.

Last year, Safe Kids Worldwide was a participant in reviewing the content of the groundbreaking World Health Organization/UNICEF *World Report on Child Injury Prevention*, released in December 2008. The report prompted us to conduct an extensive literature review of the five leading unintentional injury risks in the United States across four developmental categories to determine how a child's stage of development impacts injury risk.

This report will help parents and caregivers understand a child's abilities and propensity toward serious injury. As infants and children go through a series of developmental stages, their different behavioral, cognitive, and physical capabilities can put them at increased risk for injury. In an environment designed for adults,

children have a poor understanding of risks and danger. Their natural curiosity and restricted ability to handle more than one stimulus at a time make them unable to make an informed choice to protect their safety. However, there are many things a parent and caregiver can do to prevent a child from being injured.

Using the available developmental research, Safe Kids USA has created a list of easy-to-follow safety recommendations, for each age group and risk area, which can help parents raise safe kids – one stage at a time.

II. Introduction & Methodology

To better understand the world that children live in, this report examines the cognitive, physical and behavioral limitations and abilities of children that increase the likelihood of five different types of injuries: falls, bicycle-related injuries, motor vehicle occupancy injuries, fire and burn injuries, and poisonings. Safe Kids USA reviewed many publications from the nation's leading epidemiologists, medical experts, developmental psychologists and pediatricians to create this report, which represents a critical review of the existing literature on the relationship between child development and injury prevention.

Knowing that one scientific study does not make up the entire body of knowledge, the overall objective was to move beyond the public's attraction from the latest published study to concentrate on the cumulative knowledge of decades of injury prevention research that has been subjected to rigorous and continuous peer review. The ultimate goal of this report is to help parents, caregivers, the general public and policy makers to better understand the injury risks facing the most vulnerable segment of our population – our children.

The Four Stages of Child Development

Child development is a different concept than growth. Growth usually describes an increase in the child's height and weight, whereas child development refers to how children learn and perform more complex tasks as they get older. This can include gross motor skills (using large muscles groups to keep balance, change positions, sit, crawl, stand, walk or run), fine motor skills (coordinating hands to draw, play or write), language skills (speaking, body language or understanding what others say), cognitive skills (thinking skills such as learning, problem-solving or reasoning) and social skills (interacting with others and developing relationships).

Unfortunately, as children get older, they encounter different risks for unintentional injuries based on their cognitive, behavioral, and physical development. It is during these growing years that a child's observations and experiences have a tremendous impact on his or her future behavior. This means that the care that infants, children and adolescents receive directly impacts their ability to lead an injury-free childhood.

Safe Kids USA has used four developmental stages to classify the injury risks to children in this report. While the corresponding ages were not completely consistent

across all of the research, the four developmental stages (and their corresponding ages) used here were the most commonly used systems of classification. They are:

- Infancy (children 0 to 12 months old)
- Early Childhood (children 1 to 4 years old)
- Middle Childhood (children 5 to 9 years old)
- Early Adolescence (children 10 to 14 years old)

III. Research Findings by Development Stage & Injury Risk

Infancy

Infants, children ages 0 to 12 months, are a vulnerable group for unintentional injury, as they are just beginning their development and are completely reliant on adults for their care and safety. Their small size and lack of strength and biological development put them at increased risk for many categories of injuries.

Infancy & Falls

From birth, children quickly become active learners who are constantly observing, making predictions about how things work and then testing these ideas. Through curiosity, infants acquire an increasingly accurate set of ideas about how the world works.[1] Unfortunately, the child's appreciation for risk is nonexistent and by the end of the first year of life, infants crawl or walk into off-limits places and reach for dangerous items in the name of learning.

In a recently published study of 990 infant injuries seen at an emergency department, falls accounted for 61 percent of all infant injuries. From the 605 reported fall injuries, the most frequent fall mechanisms were falls from furniture (37.9 percent), general falls (17.5 percent), falls from being dropped by an adult (15.2 percent), car seat falls (12 percent), fall down stairs (10.4 percent) and infant walker falls (6.9 percent).[2] When stratified by age group, falls by being dropped by an adult took place most often among newborns to 2-month old infants and falls off a piece of furniture, such as a bed or changing table, occurred most frequently among infants 3 to 11 months old.

Infancy & Motor Vehicle Occupancy Injuries

Children under 1 year of age are physically vulnerable and generally at greater risk for injury than older children who are more physically developed. The muscle and bone development of an infant's spine is a crucial consideration when determining and designing the proper restraint for a child this young.[3] Due to the vulnerability of infants during their first year of life, securing a children in rear-facing seats has proven to be the safest option to support their head, neck and back and prevent spinal cord injuries.[4]

Another hazard for infants as passengers arises from how they are positioned within the child restraint. Infants do not have adequate muscle control of their necks to prevent their heads from falling forward or slouching if they are seated in an upright position.

This can lead to a blocked airway and prevent the child from breathing properly. This is a particular danger for preterm infants.[5] [6]

Infancy & Non-fire Burns

Infants are naturally driven to explore their environment, often through touch or taste, with increasing mobility as they approach their first birthday.[7] The normal developmental sequence of learning motor skills begins at approximately 6 months of age and progresses from reaching for objects to crawling, walking, and climbing.[8] While children are developing physically, their cognitive skills are not advanced enough to recognize the risks associated with hot liquids or other items that can burn them,[9] such as hot pans, space heaters or curling irons. They also do not have the ability to control their impulses or understand the consequences of their actions.[10]

Additionally, infants are at greater risk of burn injuries because their skin is thinner than that of adults. An adult's skin can receive a third-degree burn in five seconds when exposed to water at 140 degrees Fahrenheit, but at 120 degrees Fahrenheit it can take five minutes.[11] [12] [13] The exact timing for a child's skin to burn is unknown, but the original model by Moritz and Henriques has been used by others to estimate the time it takes for skin to burn at various temperatures. According to a 1983 report, at temperatures higher than 54 degrees Celsius (130 degrees Fahrenheit), a child's skin can burn in approximately one-quarter the time it takes to burn an adult's skin. [14] [15] Thus, an infant placed in bathwater that is too hot will be more likely to be burned before the child can be removed as compared to an adult.

Hot beverages are also of concern given that they are normally served at 160 to 180 degrees Fahrenheit and infants are routinely carried or kept nearby an adult.[16] Therefore, an infant is much more likely to be burned by a spilled hot beverage than an adult.

Infancy & Home Fires

Along with being at a greater risk for non-fire-related burns, infants are at a great disadvantage in a fire. Because most of them cannot walk and many sleep in enclosed cribs, they cannot be expected to escape without an adult's assistance if a fire occurs. Since only 23 percent of households have practiced a fire escape plan in their home, infants are at an even higher risk of injury or death from a home fire.[17]

Smoke inhalation injuries are another significant risk to infants because of their smaller airways, resulting in mucus obstruction and higher respiratory rates.[18] An infant's respiratory rate is approximately 30 to 60 breaths per minute, compared to 12 to 16

breaths per minute for an adolescent.[19] Thus, infants are breathing in harmful gasses such as carbon monoxide more quickly.[20] All of these elements potentially increase the likelihood of smoke inhalation injuries.

Infancy & Poisonings

Newborns and infants are at increased risk of poisoning due to a number of factors including biological makeup. Infants under 6 months old are typically more sensitive to chemical toxicity because their developing systems allow hazardous levels of chemicals to stay in their bodies for prolonged periods of time,[21] making heavy metals, such as lead, a particular concern for this age group. Newborns also have slower digestion and increased stomach emptying, which further promotes absorption. In addition, newborns have kidneys and livers that have lower functioning capacity than adults, decreasing their ability to break down and eliminate chemicals.

Newborns also have less body fat and higher water concentrations than adults. [22] This type of body composition causes chemicals to concentrate at target organs, increasing the risk of organ toxicity.

Contact through the skin is another significant exposure route for newborns. Keratin, the hard protective top layer of skin, does not typically form until 3 to 5 years after birth. Due to this lack of protection, an infant's skin readily absorbs chemicals. [23] [24] Additionally, a newborn's skin surface area compared to their body weight is more than twice that of an adult.[25] This means that the dose levels for newborns will be much higher even if the exposure is identical to that of an adult.

Infants typically have higher respiratory rates than adults and as such will breathe more air than adults relative to their body weight. This means that while their exposure to airborne toxins will most likely be similar to an adult, the dose their body receives will most likely be greater, making the newborn more vulnerable to respiratory poisons such as environmental tobacco smoke and carbon monoxide. [26] [27]

Additionally, infants learn about the world using their senses as they are exposed to the world around them. At around 4 months of age, infants begin exploring with their mouths. By the sixth month, infants have greater muscle development and control, giving them more trunk stability.[28] They are able to hold on to toys without dropping them and are better able to complete hand-to-mouth movements. Children in this age group have been observed making 10 hand-to-mouth contacts per hour.[29] The infant's desire to put objects in his or her mouth, combined with increased time spent on the

ground, can result in increased ingestion of chemicals that collect on the floor's surface and on the child's toys such as pesticides, carpet and floor cleaners and lead dust.

Safety Recommendations for the Infancy Stage

Infants are vulnerable to many injury hazards because of their small size and lack of strength, experience and physical skills. It is the parent's or caregiver's responsibility to create a safe environment for infants.

Falls Prevention

- ✓ **Install stair gates.** Infants will begin to crawl, pull up to stand and take their first steps putting them at risk of falling down a staircase or wandering into areas of the home that are not child-safe.
- ✓ **Secure furniture to the wall.** Infants will begin walking around holding on to furniture for stability.
- ✓ **Do not leave your baby unattended on furniture.** Always place one hand on your baby to prevent him/her from rolling over or falling off a changing table, bed or piece of furniture.

Motor Vehicle Safety

- ✓ **Use a rear-facing, semi-reclined car seat until at least age 1 and 20 lbs.** This is the safest option to support an infant's weak head, neck and back and prevent spinal cord injuries. Use a rear-facing car seat longer if the seat has higher weight and height limits.
- ✓ **Never leave a child alone in a car.** When left in a vehicle, even on a cool but sunny day, a young child's core body temperature may increase three to five times faster than an adult's. This can cause permanent injury or even death.

Fire Safety

- ✓ **Install smoke alarms.** Infants breathe more quickly and this puts them at higher risk of breathing in harmful gasses at a faster rate.
- ✓ **Practice an escape plan with your family.** Protect infants from smoke dangers and fires since they cannot escape on their own.

Burn Safety

- ✓ **Set your water heater to 120 degrees or lower.** Test the bathwater with your wrist or elbow before placing your baby in it. An infant's skin will burn more deeply and quickly at lower temperatures than adult's skin.

- ✓ **Do not hold a baby while cooking or carrying hot foods and liquids.** An adult's skin can receive a third-degree burn in five seconds if the temperature of a liquid is 140 degrees. Since an infant's skin is thinner and most hot drinks are served at 160 to 180 degrees, a spill can burn a young child's skin even faster.
- ✓ **Never microwave a baby's bottle.** Drinks heated in a microwave may be much hotter than their containers. Instead, heat bottles with warm water and test them before feeding an infant.

Poisoning Prevention

- ✓ **Be safe when giving medicines to a baby.** Make sure to read labels and give babies the proper dosage as their metabolisms are faster and their slow rate of digestion increases their risk of poisoning.
- ✓ **Lock up poisons out of sight and reach.** Curiosity and the desire to put everything in their mouths place infants at higher risk for poison exposure than adults. At this age, infants also have more sensitive skin.
- ✓ **Install carbon monoxide alarms.** Carbon monoxide is an odorless and invisible gas that can kill or make children seriously ill in small doses that might not noticeably affect adults.
- ✓ **Learn the National Poison Control number: 1-800-222-1222.**

Early Childhood

Children in the early childhood stage, ages 1 to 4 years, are gaining a sense of independence and beginning to explore their surroundings. Their physical development and greater mobility is both a positive and a negative when it comes to unintentional injury. Children in this age group are curious but still lack basic decision-making capabilities.

Early Childhood & Falls

Children in this age group are at increased risk of falling due to their underdeveloped muscles and bones and limited sensory abilities. Children are still developing balance by learning to shift their body into a more stable position [30] to appropriately lift and place their feet to widen or narrow their stance,[31] or in the case of toddlers learning to walk, dropping from a standing position to a sitting position and using a nearby object for support.

Since social skills are not well developed, children have a propensity to imitate others through a developmental stage of social activity called parallel play, where children

play side by side without interaction. Children engaged in parallel play often imitate the actions of another child, but rarely cooperate in a task or engage in dramatic play or formal games with others. The underlying injury risk here is that children in parallel play may imitate older playmates or siblings and surpass their physical abilities for climbing or using playground equipment increasing the likelihood of an injury.

Early Childhood & Motor Vehicle Occupancy Injuries

Both behavior and a child's physical maturity can contribute to a child's risk of being injured in a vehicle. Children at this age sometimes resist being placed in a child safety seat and may become a distraction to the driver during car rides. In one focus group conducted in California, parents reported that some toddlers were so distracting to the driver that they ended up taking the child out of the car seat.[32] Parents in this study also reported removing the child from the restraint if the child became fidgety or if they fell asleep.

The article also states that between the age of 2 and 2½ years children begin to refuse their car seat, one reason being because they want to ride like older children using seat belts. A parent or caregiver who reacts to this type of behavior by taking a child out of his/her seat at any time validates the behavior and also sends a message to the child that restraint use is negotiable.[33] Other child-related behavioral hassles that were found in the focus group included resisting riding in a car seat, becoming bored or uncomfortable in the seat, getting out of the seat while the vehicle was moving, needing attention while the vehicle was moving, or that the child just did not like riding in the restraint.

While a child's behavior is one aspect of development that may influence the ability to ride in a vehicle safely, a child's physical maturity also has a significant impact. Generally, studies have shown that children of this age, due to their size and physical maturity, are safer in a back seat of a vehicle than in the front seat.[34] [35] The reason often cited is that children are at greater risk for injury from front airbags; however, studies that came out before airbags were prevalent show that the back seat of a vehicle is still the safer option for children under age 15, regardless of airbag proximity or restraint use.[36]

Early Childhood & Non-fire Burns

Children ages 1 and 2 are at the greatest risk for fire and burn-related injuries in this age group. As with infants, children who are 1 to 4 years old still have greater skin sensitivity to hot temperatures putting them at increased risk for non-fire burns.

In addition to having thinner skin, 1- and 2-year olds are more vulnerable to burns as they are still actively exploring their environment and have increased mobility. At the same time, their cognitive skills are not developed enough for them to recognize the danger of hot liquids and objects and control their impulses.[37] [38] A study by Schubert noted that standard kitchen countertops are within reach of 1- and 2-year olds, but they cannot see what is on them.[39] Children at this young age often want to stay close to their parents or caregivers so they are more likely to be in the kitchen when adults are cooking, increasing the chance that they will see something to grab or be in the path if hot food or liquid is spilled.[40]

As children grow into the preschool years, their burn injury rate declines significantly. This may be the result of their intellectual development in understanding the concepts of danger, cause and effect, and the consequences of their actions.[41] [42] [43] Most 3-year olds have the ability to control their impulses.[44] In addition, improvements in children's motor skills at this age may allow them to more easily avoid or escape from certain scald burn hazards, such as bathtub water or a tipping pot.[45]

While 3-and 4-year olds have a lower fire and burn injury rate than younger children, their rate is still higher than that of children ages 5 to 9. As children learn more about cause and effect relationships, they may begin to experiment with trying to get a cigarette lighter to work.[46] They also cannot generalize from an experience so if they burn themselves in one situation, they may be not able to link that experience to the next time they are near a hot object.[47]

Early Childhood & Home Fires

In addition to non-fire burns, young children are also at increased risk of death from home fires. As with infants, young children's lungs are potentially more vulnerable to the effects of smoke inhalation. They also generally do not have the cognitive skills to be able to escape a fire on their own. In a review of home fire deaths in the U.S. from 2002 to 2005, 15 percent of children under age 5 who died were deemed to be "unable to act" compared to 0 percent of older children.[48] For older children, a greater percentage were said to be "attempting to escape." Some young children have also been known to hide in their room or a closet during a fire.[49]

As children age they are also more likely to start fires with matches, lighters and other heat sources, which may cause injuries or death. There are generally two types of child-playing fires discussed in the literature. "Fireplay" is thought to be driven mostly by curiosity and fascination with fire and tends to be practiced by younger children.[50] "Firesetting" is when children use fire for purposeful action and tends to be more

prevalent among older children; however, this behavior has also been seen in this age group. [51] [52]

A preschooler's interest in fire is thought to reflect developmentally-appropriate curiosity about his or her environment.[53] Children in this age group are also at the developmental stage of wanting to role-play using adult tools and objects and control objects to see cause and effect.[54] Most children have only seen successful use of matches and lighters by adults, and the younger ones cannot appreciate the potential danger.[55]

A combination of behaviors may show children of this age lack a fundamental understanding of the risks and consequences of fireplay. Children can be very resourceful in gaining access to matches and lighters. In a survey of 57 parents of children ages 6 and under who had set at least one fire, more than 80 percent of parents said that they had spoken with their children about the dangers of fire.[56] However, most of the parents reported that their child had obtained the matches and lighters from out of reach locations such as on top of the refrigerator or kitchen cupboards, and 40 percent said that their child had climbed on something in order to obtain the matches or lighter to set the fire.[57] Children most likely know that they are not supposed to be using matches and lighters as 53 percent of child-playing fires occur in bedrooms.[58] The issue is compounded if children do not tell their parents or hide in a closet, in fear of punishment, when they have started a fire.

Early Childhood & Poisonings

As infants grow into toddlers they become more mobile and their risk for exposure to toxic substances increases. By age 1, most toddlers can walk with the aid of furniture and by 18 months they are completely mobile.[59] During this stage, children develop the ability to open cabinets, drawers and containers making it possible for them to access chemicals stored in low cabinets and medications that are left within their reach. While a child's language skills are rapidly improving, he/she still lacks the ability to fully understand or remember directions or rules. Additionally, the concept of cause and effect is new and young children have minimal impulse control.[60] At this age, children's curiosity about the world they live in combined with their mobility, lack of understanding of danger, and inability to control their behavior put them at increased risk of being exposed to poisons if not adequately supervised.

Children of this age group are far less susceptible to poisoning than infants because of the drastic changes in biology that occur between 5 and 12 months of age. However, toddlers still have larger surface area to body mass ratios resulting in a possible greater dose than an adult exposed to the same amount of a chemical.[61] [62] Their respiratory

rates are still higher than adults' and as their lungs continue to develop, the surface area for chemical absorption continues to increase.

Preschoolers can run and climb easily. They can also bend over without falling, allowing them to easily access unlocked cupboards and drawers where chemicals and medications are often stored.[63] A child's exposure to new environments expands through daycare and preschool, which can be significant sources for chemical exposures. Preschoolers are inquisitive and exploratory by nature and want to learn their environment.[64] In addition, their fine motors skills are advancing and they are capable of unscrewing and opening jars and lids allowing them to have access to medications and chemicals that are not properly stored.

Preschoolers spend more time walking upright making their breathing zone higher than younger children, though not as high as an adult's. That said, they still spend much of their playtime at ground level and as such the ground remains a source for exposure to toxins.[65]

Safety Recommendations for the Early Childhood Stage

As children grow from infants to toddlers to preschoolers, they become more mobile and curious. One of the most effective ways to prevent serious injuries is to keep hazards away from them.

Falls Prevention

- ✓ **Install stair gates.** A toddler's increased mobility and active lifestyle put him/her at risk of falling down a staircase or wandering into areas of the home that are not child-safe.
- ✓ **Do not place toys or tems that attract children on top of furniture.** Young children love to climb on furniture and use drawers and shelves as steps.
- ✓ **Place furniture away from windows and secure it to the wall.** Young children are at a high risk of falling through a window and having furniture tip over on them.
- ✓ **Actively supervise your children when they are on a playground and provide safe places to play.** Look for a playground that has 12 inches of shredded rubber, hardwood fiber/mulch or sand below the equipment. Children enjoy running, climbing and jumping, while still lacking balance, and these surfaces can reduce the severity of playground fall-related injuries.

- ✓ **Maintain separate play areas for children under age 5.** Young children will try to imitate older kids and play on equipment designed for older children putting them at risk of serious injury.

Motor Vehicle Safety

- ✓ **Use a forward-facing car seat until the harness no longer fits, and then move your child to a booster seat.** The five-point harness will protect small children and keep them in place.
- ✓ **Carry soft toys and books for children to use as long as they are properly restrained.** Children's behavior in the car may also become distractive to the driver because they want to ride like older children or get bored.
- ✓ **Hold a child's hand in driveways, parking lots and sidewalks.** Young children can walk and run well but are unaware of hazards around them.
- ✓ **Drivers should walk all the way around the car before getting in.** Young children are small and hard to see, and can easily be hidden in a car's blind spot.
- ✓ **Never leave a child alone in a car.** When left in a vehicle, even on a cool but sunny day, a young child's core body temperature may increase three to five times faster than an adult's. This could cause permanent injury or even death.

Fire Safety

- ✓ **Install and test smoke alarms.** Young children breathe more quickly putting them at higher risk of breathing in harmful gasses at a faster rate.
- ✓ **Practice an escape plan with your child.** Young children do not have the cognitive skills to escape a fire on their own. Instead, they may hide in a closet or under the covers.
- ✓ **Lock up matches and lighters out of their sight and reach.** Children are curious about their environment and may be attracted to matches and lighters. At this stage, they may begin to try to get a cigarette lighter to work to see what happens.
- ✓ **Teach young children not to play with matches or lighters.** Young children are more likely to set fires out of curiosity. Children will also try to imitate adults if they use these items for fun, especially toy-like lighters.

Burn Safety

- ✓ **Set your water heater to 120 degrees or lower.** Children's skin burns more deeply and quickly at lower temperatures than adults' skin.

- ✓ **Make the stove area a "kid-free" zone.** Children want to stay close to their parents, but their cognitive skills are not developed to recognize the danger of hot items.
- ✓ **Cook with pots and pans on back burners and turn handles away from the front of the stove.** As children grow in height, they may be able to reach the counter and front burners and pull hot items on themselves.
- ✓ **Place hot foods and liquids on the center of the table.** An adult's skin can receive a third-degree burn in five seconds if the temperature of a liquid is 140 degrees. Since most hot drinks are served at 160 to 180 degrees and children's skin is thinner, a spill can burn a child's skin even faster.

Poisoning Prevention

- ✓ **Use child-resistant packages.** While a child-resistant package does not guarantee that a child cannot open the container, it may be a deterrent or it may slow the child down long enough for an adult to intervene.
- ✓ **Lock up poisons out children's sight and reach.** A child's new ability to open drawers and cabinets and turn doorknobs gives him/her access to dangerous household items.
- ✓ **Keep products in their original containers.** Avoid confusing curious children.
- ✓ **Never refer to medicine or vitamins as "candy".** Referring to medicine as candy could cause a young child to think that it is harmless or pleasant to eat. Since children tend to imitate adults, avoid taking medications in front of them.
- ✓ **Install carbon monoxide alarms.** Carbon monoxide is an odorless and invisible gas that can kill or make children seriously ill in small doses that might not noticeably affect adults.

Middle Childhood

Middle childhood is a time of intense growth and adventuresome play. Children ages 5 to 9 are experiencing rapid development, both physically and mentally. Their decision-making skills are improving and peer pressure becomes a significant factor in their injury risk.

Middle Childhood & Falls

While there is not much research that links this developmental stage with the prevalence of falls, children ages 5 to 12 are approximately twice the height of 2- to 3-year olds and have over 8 times their grip strength, making them steadier than younger children. Since this age group is more likely to play in groups, they are more vulnerable

to peer pressure for participating in risky playground behaviors such as misuse of playground equipment and jumping from swings or parallel bars.

Middle Childhood & Bicycle Injuries

Bicycles and other recreational vehicles provide children with opportunities for physical activity but also increase their risk of injury. Bicycles become a common toy in the lives of children at this age. This is reflected in the 10-fold increase in the number of emergency department visits due to bicycle-fall injuries in children ages 5 to 14 versus children ages 0 to 4. In fact, bicycles are the most common sport/recreational product involved in injuries among 5- to 14-year olds.

Although bicycle and other recreational vehicle use increases during middle childhood and early adolescence, a child's sensory-motor skills are not fully developed. At this stage in life, children acquire adult-like reaching capabilities [66] [67] but do not have adult-like hand-eye coordination and obstacle avoidance abilities.[68]

Helmet use among children ages 5 to 9 was observed to be both affected by peer influence (bicycle, scooter and in-line skates) and parental role modeling (bicycles and in-line skates only).[69] Children whose parents or peers wore helmets matched the helmet use of their companions.[70] [71] Although the majority of research almost entirely focused on helmet use behaviors, specifically helmet use during cycling, this research emphasizes the importance of the association between a child's thoughts, social attachments and safety behavior.

Middle Childhood & Motor Vehicle Occupancy Injuries

Child behavior is another safety barrier for booster seat-aged children. One article reported that children who needed assistance buckling themselves into a booster seat resisted using it because they felt that since they could buckle themselves with a seat belt alone using a booster was a step backwards.[72] The same article stated that comfort also had a large influence on a child's behavior and willingness to stay in a booster seat. Also, resistance of the child to a booster seat was found to play a role in a parent's decision to transition the child to a seat belt. When a child showed enough resistance, parents reported prematurely moving the child to the adult lap and shoulder belt.

Middle Childhood & Non-fire Burns

The fire and burn-related injury rate for 5- to 9-year olds is much lower than that of younger children.[73] Since their skin can still burn more easily than adults' skin, this decreased rate is likely the result of even further improvement in their cognitive skills to recognize the danger associated with hot liquids and other hot items. In addition,

most children at this age are in school during much of the weekday and away from cooking activities happening at home where younger children could be exposed to danger.

Overall, children ages 5 to 9 are at a lower risk of fire and burn injuries than people ages 15 to 54.[74] However, children ages 5 to 14 are at a higher risk for cooking-related scald injuries, specifically from tableware and microwave ovens.[75] This may be the result of the height of the microwave and table in relation to a child's ability to reach and handle a container of hot food or drink and their still-developing cognitive skills.

Middle Childhood & Home Fires

Children ages 5 to 9 are at higher risk for residential fire-related death than teens and adults ages 15 to 39 and they are also less likely to wake up if a smoke alarm sounds while they are sleeping.[76] The lesser ability of children to awake from sleep may be related to the delay in prefrontal lobe development, which occurs mostly between ages 12 and 24 and is responsible for making judgments.[77] This could include making judgments while asleep, such as recognizing a smoke alarm sound and deciding it is important to wake up. In addition, deep sleep decreases with age and young children may experience deeper sleep overall than adults.[78] All of these factors could contribute to children waking less frequently to a smoke alarm.

In addition to being less likely to wake up to a smoke alarm, elementary school-age children also may not be able to effectively plan out an escape route if a smoke alarm sounds. Children at this age do not fully understand causal relationships and cannot be expected to develop detailed step-by-step plans.[79] If an alarm sounds, they may not be able to escape unless the route has been practiced before, which most families have not done.

In the 5- to 9-year old age group, fireplay continues to be a concern. In one study, 45 percent of 5- to 9-year old boys reported that they had engaged in fireplay.[80] While elementary school-age children are able to recognize the danger of fire, they still do not fully understand the high risk. One survey of children this age found that only 66 percent believed that one match could start a fire that could burn down a house.[81] In addition, 78 percent of children ages 6 to 14 reported that they could put out a small fire.[82]

Middle Childhood & Poisonings

At this stage, a child's biological make up is looking progressively more similar to that of an adult's, but differences still remain. Their skin exposure is still a concern as their

surface area to body mass ratio remains larger compared to adults.

Children in this group are also establishing their independence and are likely to spend periods of time participating in activities without adult supervision. At this stage, children have a strong sense of right and wrong and develop the ability to link their behaviors and consequences, possibly protecting them from some types of poisonings.[83]

Safety Recommendations for the Middle Childhood Stage

Teach children how to make good decisions in order to prevent injury during this time of intense growth and adventuresome play.

Falls Prevention

- ✓ **Make sure children use age-appropriate playground equipment for 5- to 12-year olds.** Children enjoy playing in groups and are more vulnerable to peer pressure for misusing playground equipment. Tell them what equipment is appropriate for their age levels.
- ✓ **Provide safe places to play.** Look for a playground that has 12 inches of shredded rubber, hardwood fiber/mulch or sand below the equipment. Children enjoy running, climbing and jumping, but still lack balance.
- ✓ **Teach children proper playground behavior:** no pushing, shoving or crowding**.**
- ✓ **Place furniture away from windows and secure it to the wall.** Children may pretend to be a flying superhero or may be influenced by older children to do dangerous stunts.

Bicycle Safety

- ✓ **Model safe behaviors and teach children the rules of the road.** Children are more likely to learn safe road crossing behaviors from adults.
- ✓ **Make sure children wear a helmet and protective gear every time**. Children are spending more time away from home where they may attempt dangerous tricks. They still have less coordination for pedaling, more trouble recognizing and avoiding obstacles and lack adults' hand-eye coordination abilities.

Motor Vehicle Safety

- ✓ **Talk to children about the need to use booster seats for a correct seat belt fit.**
- ✓ **Keep children in booster seats with the vehicle lap and shoulder safety belts until they pass the Safety Belt Fit Test.** A seat belt alone is not designed to suit the physical and developmental needs of young children. A booster seat is

recommended for children under 4 feet 9 inches tall and 40 to 80 or 100 lbs. Seat belts generally do not fit children until they are between 8 and 12 years old.

- ✓ **Walk all the way around the car before getting in.** Young children are small and hard to see, and can easily be hidden in a car's blind spot.
- ✓ **Never leave a child alone in a car.** When left in a vehicle, even on a cool but sunny day, a child's core body temperature may increase three to five times faster than an adult's. This could cause permanent injury or even death.

Fire Safety

- ✓ **Install and test smoke alarms.** Test smoke alarms at night to see if your child can awake to them. If he/she does not wake up, try using prerecorded-voice or strobe light alarms.
- ✓ **Discuss fire safety and practice an escape plan with your child.** Children at this age have a decreased ability to awake to smoke alarms and cannot perform an effective escape plan without practice.
- ✓ **Lock up matches and lighters and teach children not to play with them.** Children will try to do adult-like things so do not use these items for fun, especially toy-like lighters.

Burn Safety

- ✓ **Set your water heater to 120 degrees or lower.** A child's skin burns more deeply and quickly at lower temperatures than an adult's skin.
- ✓ **Do not allow children to use a microwave until they are tall enough to reach the items in it safely and understand that steam can cause burns.** Children at this age are now at higher risk of cooking-related scald injuries.
- ✓ **Place hot foods and liquids in the center of the table.** An adult's skin can receive a third-degree burn in five seconds if the temperature of a liquid is 140 degrees. Since children's skin is thinner, and most hot drinks are served at 160 to 180 degrees, a spill can burn a child's skin even faster.

Poisoning Prevention

- ✓ **Lock up poisons out of your child's sight and reach.** At this stage, children are more likely to spend periods of time without adult supervision and suffer poisonings from household cleaners.
- ✓ **Install carbon monoxide alarms.** Carbon monoxide is an odorless and invisible gas that can kill or make children seriously ill in small doses that might not noticeably affect adults.

Early Adolescence

The early adolescence years bring many changes, not only physically, but also mentally and socially. During these years, 10- to 14-year olds struggle for independence and control, and often are not supervised by adults. Also, peer influence and acceptance becomes very important. This age group's risk-taking behaviors and perceptions of invincibility and immortality put them at risk for injury.

Early Adolescence & Bicycle Injuries

Children ages 8 to 12 have less ability to avoid obstacles and prevent falls. This age group segments the process into two steps, obstacle recognition and execution of avoidance action, whereas older children and adults appear to have one integrated approach.[84] Children in early adolescence demonstrate less motor coordination for pedaling bicycles relative to older children[85] and differences in bone development show greater effect on motor skills and balance in these young adolescents.[86] Moreover, this age group's visual perception is less defined than that of older teens and they lack the ability to discern an object from within a visually noisy background. This is an important skill to have in order to identify oncoming cars in busy intersections.

Early Adolescence & Motor Vehicle Occupancy Injuries

Children mature at different speeds and hit growth spurts and milestones, such as puberty, at different ages. During this stage, children have a higher injury death rate as a motor vehicle occupant compared to younger age groups. Children of this age are likely to prematurely move from a booster seat to an adult lap and shoulder belt and are more likely to be completely unrestrained than younger children. In 2007, 32 percent of children ages 8 to 14 who were involved in fatal crashes were unrestrained, 8 percent more than children ages 4 to 7.[87] For all children ages 0 to 14, front passenger airbag presence has shown to have an impact on increased fatality risk when a child is seated in front of the airbag.

Physical development is key in determining when a child should use a booster seat or the adult seat belt. A seat belt is not designed to fit a child. A child who prematurely uses the adult lap and shoulder belt is at an increased risk for head injury and spinal damage in the event of a crash.[88] For optimal seat belt fit, the child's femur must be long enough so that he/she can sit against the back of the seat. The child must also be tall enough for the shoulder belt to fit over the collarbone and the pelvis should be developed enough to anchor the seat belt. When a child has not developed enough to properly fit in an adult lap and shoulder belt, he/she is at risk for abdominal injury, when the seat belt rides up on the child's stomach causing internal organ damage and

neck or face injury from the shoulder belt riding too high on the child's neck.

As children get older and begin to make decisions about their behavior they also become less likely to be properly restrained. Results from a 1990 study of inner city children show that lack of consistent seat belt use and non-use among adolescents may come from stress factors such as trouble with school or the law, lack of home support, or general depression.[89] Another study shows that children who said they were not likely to wear a seat belt were more concerned with the negative impact of wearing seat belts such as movement restriction and "overprotection" instead of focusing on the safety benefits such as protection from injury, being safe, and less worry about police.[90]

Another study with children ages 10 to 12, shows that defiant attitudes play a more critical role in decision making than knowledge about what is safest, leading to a decrease in safety practices despite awareness of risk.[91] These studies show that even if children are aware of what is safest, there are other influences that come from peers, and from life in general that hinder children from making the safest choices about their behavior.

Early Adolescence & Home Fires

Physically, a 10- to 14-year old's development progresses in terms of skin thickness and lung development, although it is less than that of an adult. With this age group, home fires are more of a concern than non-fire burns as their cognitive skills are better developed to avoid non-fire burns injuries. While this age group is at a much lower risk from actually dying in a fire, older children are more likely to intentionally set fires than younger children.[92] [93]

While firesetting may be intentional, the deaths and injuries that can result are often unintentional. A number of different behavioral and social science theories have been put forward as to why these children set fires. Among the theories are that the behavior is learned from others who set inappropriate fires, a way to attain power over other people or their environment, a cry for help, or a desire to gain acceptance from peers.[94] In some cases, children who set fires have been known to also have other behavioral issues, such as aggression, risk-taking, antisocial behavior, and substance abuse.[95] Firesetting may be more likely to be a repetitive or chronic behavior as compared to fireplay.[96]

Older children ages 10 to 14 are most likely to be injured by cooking equipment-related fires or candle fires.[97] In addition, candle fires are the second leading cause of fire-related deaths for this age group.[98] Children ages 10 to 14 start to experiment with

burning candles in their rooms and may practice less safe behaviors when using them. Around the time of puberty, adolescents show an increase in reward-seeking behavior, yet their capacity for self-regulation develops more slowly making them more vulnerable to risky and reckless behavior. This riskier behavior is seen across a wide array of activities such as reckless driving, irresponsible drinking and unprotected sex. In addition, many adolescents do not obtain enough sleep, which can cause lapses in attention, fatigue, and decreased motivation.[99] [100]

These behavioral aspects could also help explain why children ages 10 to 14 had the highest fireworks injury rate in 2007 among all age groups.[101] Another contributing factor to fireworks injuries could be an increase in adolescents' risk-taking behaviors in the presence of peers. In a study where participants were asked to play a video driving game, adolescents with a mean age of 14 displayed twice the risk-taking behavior in the presence of two friends in comparison to those who were alone. In comparison, an increase of 50 percent was seen for young adults with a mean age of 20 and there was no effect on risk-taking behavior for adults with a mean age of 34.[102]

Early Adolescence & Poisonings

Entry into adolescence introduces new behaviors and environments for possible chemical exposures. During early adolescence children begin puberty and various physical, mental and social changes. They are more independent, make most of their own decisions and are more likely to participate in activities without supervision. They also become more concerned with how they are perceived and are influenced by their peers.[103] Peer pressure and risk-taking behaviors associated with this age group might lead to experimenting with psychoactive substances such as inhalants or recreational prescription medication use.[104] [105]

Adolescents are more likely than adults to ignore or misjudge risks and explore "off-limit" environments, such as abandoned buildings or other contaminated sites. They may also have jobs or chores that could put them at risk of chemical exposure.

Biological differences seen in other age groups are no longer present by the end of this stage and all mechanisms (gastrointestinal, skin and lung absorption, metabolism, distribution and elimination) are fully mature.

Safety Recommendations for the Early Adolescence Stage

As growing children gain more confidence, their increased risk-tasking behaviors can

be dangerous. Adolescents should have reliable information and be empowered to make safe choices.

Bicycle Safety

- ✓ **Make sure children wear a helmet and protective gear every time.** Older children may not wear protective equipment because they think it does not look good or because their friends are not wearing it.
- ✓ **Model safe behaviors.** Set a good example for your children by wearing the right safety gear and obeying traffic signals.

Motor Vehicle Safety

- ✓ **Buckle up and be a role model. Require that all occupants use the appropriate restraints.**
- ✓ **Once your child passes the Safety Belt Fit Test, teach him/her to wear a seat belt every time.** Children using the adult lap and shoulder belt before they fit properly are at increased risk for abdominal injury, internal organ damage and neck or face injury.
- ✓ **Teach your child that all children under age 13 should ride in a back seat.** This is based on average weights, sizes, physical maturity and emotional maturity.
- ✓ **Talk to children about car safety.** Teach children to use booster seats and seat belts in a back seat in every vehicle, on every ride, whether or not a parent is there.

Fire Safety

- ✓ **Discuss fire safety with your child.** Older children are more likely to intentionally set fires.
- ✓ **Teach children to never use candles in their bedrooms.** Older children are more likely to be killed by candle fires than adults under age 65 and their lack of sleep may cause drops in attention.
- ✓ **Practice a fire escape plan with your family.**

Burn Safety

- ✓ **Teach children to never play with matches, lighters or fireworks.** If your child sets a fire intentionally, seek out counseling for him/her. Firesetting can be an indication of a mental health or behavioral issue that should be addressed.
- ✓ **Do not allow children to use a microwave until they are tall enough to reach the items in it safely and understand that steam can cause burns.** Children at this age are now at higher risk of cooking-related scald injuries.

Poisoning Prevention

- ✓ **Talk to your child about the dangers of poisonous items like gasoline, spray paint and medicines.** Peer pressure and risk-taking behaviors associated with this age group might lead to experimenting with inhalants or prescription medications.
- ✓ **Install carbon monoxide alarms.** Carbon monoxide is an odorless and invisible gas that can kill or make children seriously ill in small doses that might not noticeably affect adults.

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