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David C. Schwebel PhD & William Pickett PhD

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The Role of Child and Adolescent Development in the Occurrence of Agricultural Injuries: An Illustration Using Tractor-Related Injuries

David C. Schwebel, PhD
William Pickett, PhD

ABSTRACT. Agricultural settings are dangerous, especially for children. This article focuses on child and adolescent development, and how development might influence children's safety in the occurrence of pediatric farm injuries. The authors focus especially on one of the most traumatic causes of pediatric farm injury, those associated with tractor operation. The roles of physical, perceptual, cognitive, and social development are reviewed and discussed, as are relevant sociocultural factors. Following review of developmental risks for child injury in agricultural settings, the authors present a case study of a fatal youth tractor injury and provide illustrations of the child development factors that may have contributed to the death. The authors conclude with a discussion of the implications of developmental aspects of pediatric agricultural injury for behaviorally oriented intervention strategies, including public policy.

KEYWORDS. Adolescent development, agriculture, child development, farming, injury, pediatrics, rural health, safety, tractors

Agricultural settings are dangerous for children. Farms are both a unique occupational environment and a place of residence. On farms, children are routinely exposed to mechanized and other hazards starting from an early age. This occurs in both work and non–work-related contexts. Young children are often permitted on agricultural worksites while adults are working. Older children become exposed to traumatic risks as they begin to assume adult work roles and responsibilities. The consequences of these early occupational exposures are well documented, and include high rates of major trauma and unintentional injury.[1–6]

Tractors are a leading cause of trauma among all age groups on farms. Among preschoolers, many children are unintentionally killed when they are either run over as bystanders to tractors and related attachments, or run over after falling off moving tractors as passengers.[5,6] As children develop, a major source of traumatic injury relates to the early operation of farm tractors for production tasks. As children reach the teenage years, they contribute

David C. Schwebel is affiliated with the Department of Psychology, University of Alabama at Birmingham, Birmingham, Alabama, USA.

William Pickett is affiliated with the Department of Community Health and Epidemiology, Queen's University, Kingston, Ontario, Canada.

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Address correspondence to: David C. Schwebel, Department of Psychology, University of Alabama at Birmingham, 1300 University Blvd, CH 415, Birmingham AL 35294, USA (E-mail: schwebel@uab.edu).

to the farm as operators of tractors involved in many production-related activities.[7–9] Teens are at high risk for rollovers, often on machines that lack rollover protection structures (ROPS) and other basic safety features, as well as for falls from tractors and attached equipment during their operation.[7–9] These types of injuries are very serious, often resulting in death.[2–3,5,6,8]

Recently, social scientists have begun to investigate specific behavioral factors that might increase risk of pediatric injuries on farms, and how health and safety professionals might approach the reduction of injuries.[10–14] Agricultural injuries, like general child injuries, result from interactions between children and the environment in which they engage.[11,13,15,16] This article focuses on a key variable that moderates such relations between child and environment, the child's developmental stage, and how a youth's developmental stage might influence risk for injury. We chose to focus on risks for young people who operate farm tractors as an example of broader farm injury risk related to child development. We did this because of the obvious and known risks associated with tractor operation, and the potential opportunity to intervene.[11,17]

The article is divided into three sections. First, we briefly review aspects of child and adolescent development (physical, perceptual, cognitive, social, and also sociocultural factors) that might influence risks for pediatric injury associated with the operation of farm tractors. To bring this presentation to life, we offer a case study of a pediatric tractor-related fatality, speculating on developmental factors that might have contributed to the death. Finally, we discuss implications for intervention, policy, and future research that emerge from this developmental perspective, including several ways that the examples with tractors could be extended to broader risks to children in farm injury contexts.

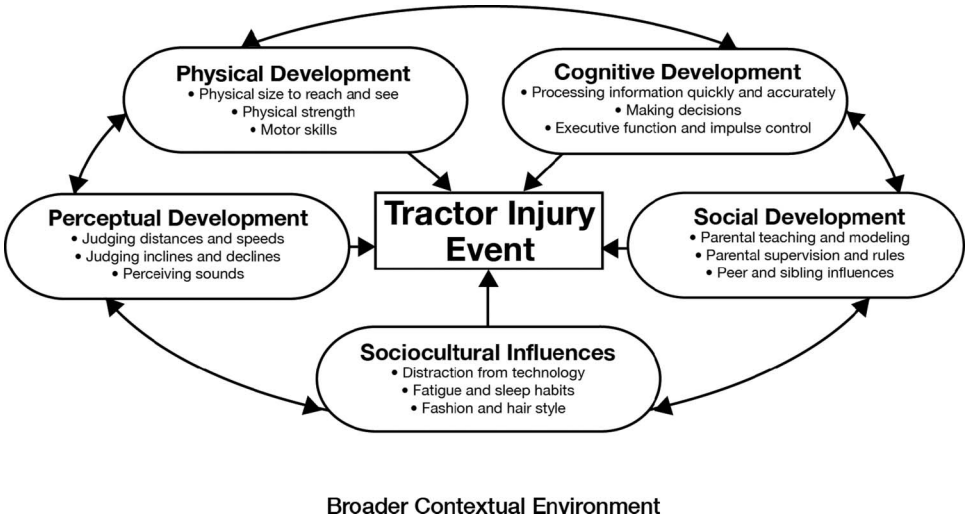
We use the term "development" in this article to refer to change that occurs throughout time, as a human being grows older. The term also refers to a level of change, or a set of skills that has been accomplished at a certain point of growth. We conceptualize child development and adolescent development to be on a continuum, and to overlap with each other. Therefore, we use the term "child development," but in doing so conceptualize the descriptor "child" to extend into the adolescent and teenage years. Similarly, we use terms like "children," "youth," and "adolescents" to refer to broad and purposefully ambiguous age ranges. We consider the term "children" as reaching older into the teen and adolescent years and for the term "youth" as extending younger into middle childhood. We deliberately do not refer to specific ages because children develop at different rates, and therefore age is a misleading barometer of development. One 8-year-old may have very different capacities than a different 8-year-old, for example.

Child Development and Child Agricultural Injury Risk

Figure 1 describes the various aspects of child development that might have an impact on safe tractor operation. We approach this discussion from the perspective of ecological theory, which suggests that multiple layers of context (e.g., the individual, the family, peers, schools, communities, and the broader culture) work together to influence individual development and behavior.[13,18,19] Our focus lies primarily in the more proximate layers of influence and especially on the individual child and how his or her development may influence risk of safe tractor operation and agricultural injury. In other words, we examine how the individual's developing mind and body may influence his or her ability to operate a tractor safely. We consider four overlapping aspects of development—physical, perceptual, cognitive, and social functioning—and how skills within those domains develop over time to create a more mature, skilled, and capable tractor operator. Underdeveloped functioning in any of the domains could influence safe operation, as detailed below.

Although not our emphasis, we also touch upon the impact of the broader contextual environment (e.g., community, culture) in our discussion.[18] In particular, we discuss the impact of sociocultural influences that may directly impact youth development and tractor safety.

FIGURE 1. Components of child development relevant to the occurrence of tractor injuries.



Physical Development

Physical development refers to the development of size, strength, and motor skills over time. With respect to farm tractors, at least three aspects of physical development might contribute to injury risks. These factors have each been studied using anthropometric data and non-living models, but not yet with actual samples of children.[10,20,21] First, to state the obvious, children have reduced reaching ability compared to fully grown adults. In one study of 45 of the most commonly used US tractors, for example, the hand throttle and gear shifts were too far for almost all 12- to 16-year-old drivers to reach; even critical controls such as the steering wheel were beyond the reach of most 12-year-old drivers.[20] Second, youth are physically weaker than adults. Inadequate strength to operate tractor controls, including the strength to do so over time and without fatigue, can contribute to unsafe tractor operation. Almost all tractors commonly used in the US require more sustained strength to operate than is typical of children aged 13 to 17 years.[10] Third, because of their shorter stature and smaller dimensions, children operating a tractor have a reduced field of vision. This is especially true for operational views directly in front and to the sides of operating tractors.[21]

Perceptual Development

Perceptual development refers to changes in children's ability to accurately perceive their environment. Perception and perceptual development play multiple roles in the risks experienced for pediatric injury, especially related to pedestrian injuries.[22–24] Laboratory-based research demonstrates that children overestimate their abilities to complete basic physical tasks such as reaching and stepping, with those children who overestimate more often also experiencing a higher rate of injuries.[22,25] Similar research in the pedestrian safety literature shows that children do not gain adult-level perceptual skills for detecting the distance or velocity of moving vehicles until adolescence.[26,27] With respect to farm tractor operation, a child's ability to accurately judge distances (e.g., distance from the tractor wheels in operation and a nearby ditch), the degree of an approaching incline/decline, and the proximity and meaning of sounds (e.g., approaching or retreating noise from moving vehicles) all play a role in the occurrence of injury events.

Cognitive Development

Broadly, cognitive development refers to the process of attending to relevant stimuli in the environment, considering and processing

perceived information, and making decisions about how to act. It overlaps somewhat with perceptual development, as most cognitive process rely on perception of environmental stimuli. Cognition is highly relevant to pedestrian[28,29] and driving-related tasks[30,31] and is likely to play a major role in tractor safety as well.

It is possible to subdivide the cognitive processes involved in operating a farm tractor into various segments. The youth must process information that is perceived within his or her environment. Sometimes this information must be perceived and processed rapidly to ensure safety. Youth have delayed processing speed compared to adults,[32] especially when stressed[19]; in related circumstances—such as when elementary school children judge when to enter a traffic gap to cross the street—slow cognitive processing of environmental cues is associated with compromised safety.[33,34]

Beyond information processing, drivers of farm tractors must make important operational decisions. Young children have a poor understanding of cause-and-effect, poor abilities to remember and follow directions and rules, and poor abilities to comprehend and consider safety risks.[35] By middle childhood, many of these skills have developed to reach adult maturity, but some cognitive skills may remain inferior. Of particular concern in late childhood and adolescence is underdeveloped *executive function*—the ability to plan, organize, and inhibit. Adult-level executive functioning does not emerge until early adulthood,[36] and may contribute to pediatric injury risks through underdeveloped impulse control, decision-making, and planning skills.[37]

One important component of executive function is impulse control—the ability to inhibit impulses to act when introduced to novel or desirable stimuli, or when instructed to do so.[38] Adult levels of impulse control may not emerge until several years post adolescence.[19,32,36,37,39] Impulsivity, sensation-seeking, activity level, and low inhibitory control are each related to risks for pediatric injury in a large body of existing literature.[40] A smaller body of literature supports these underdeveloped behavioral traits as potential factors in agricultural injury in particular.[13,41,42]

Social Development

Social development refers to the role of social interactions on children's growth, behavior, and thought. During the early years of development, of course, parents and other adults play a vital role in protecting the safety of children. Children develop strong attachments to parental figures and learn to trust them as guides and teachers. This teaching occurs through multiple pathways. One pathway surrounds the conscious effort of parents, who teach children safety-related rules and admonish children who behave in unsafe manners.[43] Some parental teaching is manifest in the development of logical thinking and decision-making skills rather than specific safety-related rules. Further, such teaching occurs through social modeling.[44] Children observe how their parents behave in various situations, and use those observations to determine how they will behave in analogous circumstances.[45] Parents who engage in safe behaviors on and around tractors might therefore have children who model their safe behavior.

A further role of parents in the social development of children is their actions in determining and enforcing safety-related rules on the farm.[43,46] This relates to the equipment that children may operate and at what age. Parents who permit children to operate farming machinery before they are developmentally capable of doing so may place their children at increased risks for injury. Of course, direct parent supervision of children also plays an important role in maintaining children's safety. As children learn to operate a tractor, for example, parents or other adults must provide close, attentive, and continuous supervision to teach children safe operating procedures.[47,8]

Along with parental influences, other children—especially peers and siblings—influence risk-taking behavior via modeling of risky behaviors, peer pressure to take risks, and other pathways.[32] Such influences become particularly relevant as children develop into the adolescent years. Peer influences have been well-documented for domains of adolescent risk-taking including alcohol use,[49,50] smoking,[51] sexuality,[52] and aggression.[53] Peer influences are likely to impact upon risk-taking

during tractor operation (including the cognitive processes involved in taking risks), although such specific influences have not been the subject of focused study.

Sociocultural Factors

Youth today grow up in a sociocultural environment very different than previous generations. Some aspects of that contextual environment may influence safe tractor operation. Below, we discuss three prominent issues.

First is the tendency of today's youth to be "connected" through technology and media. A recent report by the Kaiser Foundation[54] found in a nationally representative US sample that youth aged 8 to 18 spend an average of over 7.5 hours a day using media, including over 4 hours watching television, 2.5 hours listening to music, 1.5 hours using the computer, and over an hour playing video games. About two thirds of children aged 8 to 18 have their own cell phone, and over three quarters have a personal music-listening device. Beyond media use, youth in 7th through 12th grades also spend an average of 1.5 hours daily text-messaging and half an hour talking on their phone. Increased risk for injury due to distraction from phone conversations, text-messaging, and listening to music is well documented in the pedestrian and teen driving literatures.[55–58] Although empirical data are lacking, such distraction is likely also to influence safe tractor operation.

A second aspect of youth's sociocultural environment is fatigue and sleep habits. For a number of reasons, including the availability of appealing media and technology, early school start times, and biological circadian rhythms that promote late bedtimes in adolescence, today's youth get much less sleep than is recommended by experts.[59,60] Tired operators may fall asleep at the wheel, and even when awake may be less attentive, focused, or safe than well-rested operators.

Last, we mention fashion and hairstyle. As self-identity and self-concepts develop through adolescence, many youth prefer stylish attire and hairstyles.[61,62] When these styles create safety risks (e.g., loose/tattered clothing, draw-strings, untied long hair), some youth may jeopardize safety in deference to impressing peers or maintaining self-identity.

CASE STUDY: A COMMENTARY ON HOW CHILD DEVELOPMENT MIGHT CONTRIBUTE TO TRACTOR-RELATED INJURY

The following case study is presented as one illustration of how factors related to child development might affect risks for fatal injury related to tractor operation. This was abstracted from the National Institute for Occupational Safety and Health's (NIOSH's) *Fatality Assessment and Control Evaluation (FACE) Program* database. FACE cases of tractor-related youth deaths commonly involve rollover events where a youth operator loses control of a tractor that rolls, pinning the operator under the tractor and causing traumatic crush injuries. There is typically poor information about the exact circumstances leading to the injury as the victim is alone.

The case:

> *A 10-year-old boy died from injuries sustained when the tractor he was driving overturned. The victim was driving the tractor on a public highway, pulling a baler and a hayrack loaded with bales of hay. He was driving east on the public highway and attempted to make a right turn onto a gravel road. There was a slight downhill slope where the gravel road met the asphalt highway. When the rear wheels of the tractor left the asphalt surface and contacted the gravel road, the tractor began to slide. The momentum of the baler, hayrack, and the load of hay apparently caused the tractor to slide to the edge of the road and overturn. The tractor rolled 180 degrees to the side and came to rest in an inverted position at the edge of the road. The victim was pinned underneath the tractor as a result of the rollover. The father of the victim had been following his son and witnessed the incident. The investigating deputy sheriff felt excessive speed during the turn may have contributed*

to the crash. (from http://www.cdc.gov/niosh/face/stateface/mn/94mn041.html)

Neither the FACE investigators nor local law enforcement was able to determine with certainty what caused this injury event. Most likely, a range of factors contributed to its occurrence. Relevant factors undoubtedly included equipment issues (the tractor had no ROPS or seat belt; the boy was towing two implements) and parent behavior and decisions (the young boy was not being supervised closely and was permitted to drive the tractor while towing two implements). The child's developmental abilities also likely contributed. Below, we consider each salient developmental factor, as well as sociocultural environment factors, and how they may have contributed to this death. These observations, although speculative, are based upon established child development principles and research.

Physical Development

The average height of 10-year-old Caucasian boys in the United States is 55 inches.[63] Ergonomic data suggest that it is very unlikely that the victim could reach the steering wheel or brake pedal on the tractor he was operating quickly or comfortably.[20] It is also likely that the child victim had an impaired view of the terrain,[21] and may not have had sufficient strength to quickly depress the brake pedal to avoid an obstacle or risk.[10]

Perceptual Development

At age 10, the boy almost certainly had underdeveloped perceptual skill relative to an adult tractor operator.[22–27] He therefore may have misjudged the speed with which he was traveling, the distance from the gravel road, how soon he had to brake to slow the tractor, and the angle required for the tractor to successfully negotiate the turn. He also may not have recognized the importance of relevant aural cues (e.g., the sound of tires leaving an asphalt surface onto a gravel surface) or seen and accurately processed relevant visual cues (e.g., a short drop between the two road surfaces or the slight downhill slope where the gravel road met the asphalt highway).[22–27]

Cognitive Development

Several lapses in cognitive function likely contributed to this child fatality. First, the tractor was towing two implements. This load requires advanced problem-solving skills for the tractor to be operated safely. Second, it seems likely the boy was traveling at a speed that was inadvisable for the turn. It is unclear from the case if the rapid speed was motivated by a desire to get to a destination more quickly or to finish the task more quickly; if so, an individual with a more mature impulse control system may have decelerated further before entering the turn.[32,36,37,39]

A third set of decisions was made once the tractor began to slide. In such urgent situations, adults have the capacity to quickly appraise the situation and make split-second decisions.[19] Children have slower processing speeds and may be more likely to err in emergency situations.[19,32]

Two last aspects of cognitive development may be relevant to this case. We are not provided relevant information, but the boy may have been trained in tractor operation, perhaps by his parents or other adults. However, he may not have learned or retained all of the instructions received during his training.[43] He may also have had insufficient practice or training operating a tractor with the more complex circumstance of towing implements. Finally, the boy probably did not comprehend nor anticipate the consequences of his actions.[36,37] Speculatively, a reduced attention span may have left him inattentive or bored, and focused solely on finishing his work rather than maintaining safety.[64–66]

Social Development

The FACE database provides no definitive information about the boy's family. He may have parents who are risk-takers themselves, and therefore model risky behavior. They may or may not have provided strong instructions in the safe operation of a tractor. They may or may not have instituted rules to guide this work.

From the information available, it does not appear that social influences from other children were relevant to this incident. However, parental factors and supervision likely were relevant. The boy was followed at some unknown distance by his father, who witnessed the crash. Child injury prevention experts conceptualize supervision as having three facets: attention, proximity, and continuity.[47,48] Because we know the child was physically separated from his father, we can presume the father had potentially inadequate attention on his son's safety, very poor proximity to intervene in case of emergency, and poor continuity of supervision.

Sociocultural Issues

Because of limited information available in the FACE database, it is impossible to determine whether other factors may have contributed to this fatality. Possible sociocultural issues are many—for example, the boy may have been distracted while driving. He may have been looking elsewhere or daydreaming. He may have been talking on the phone, listening to music, or otherwise using technology to relieve the tedium of his work tasks. Further, the boy may have been fatigued, both physically and mentally, and this state left him at risk.

IMPLICATIONS

Implications for Interventions

Few existing agricultural safety interventions are based upon randomized trials or other empirical observations,[67–70] partly because such interventions are difficult to implement. One approach might be to reduce youths' risk-taking by addressing their decisions and behaviors. Unfortunately, *child development is hard to accelerate*. Dating to classic work by Vygotsky,[71] developmental psychologists have long recognized that some developmental change can occur early with appropriate adult encouragement (sometimes called scaffolding), but there are limits to the changes that are possible. From a neuroscience perspective, it is simply not possible to expedite the growth of the brain and the neural connections that form over time.[72]

One alternative approach is to teach children safety-related rules, and assume that they will follow them. This approach permits children to follow rules rotely rather than requiring them to make decisions requiring advanced skills they do not yet possess.[43,46] Thus, if driving the tractor is prohibited, and the child obeys that rule, then tractor-related operation injuries will be avoided. Institution and consistent monitoring and enforcement of safety-related rules is likely to be an effective strategy. It relies on processes that can be accomplished by most children at an earlier developmental stage, learning and following rules, rather than processes typically accomplished later in development, such as noticing and judging the risk of a situation and acting in response.

A second strategy is to focus preventive efforts on parents rather than children.[67] Because children may not always engage safely in their environments, even when rules are instituted and consistently enforced, parents must be encouraged to model safe behaviors and to supervise young children. Based in health-related behavior change theory,[73] we recommend three strategies. First, parents must be encouraged to recognize their children's vulnerability to injury.[74] If they do not believe their children might be injured, they are unlikely to make behavioral changes that would protect them. Second, parents must be open to change. They must be willing to recognize that child safety is an issue worthy of consideration and admit that making changes might be helpful.[75] Third, community norms must be redefined. Use of bicycle helmets among suburban American children provides a familiar example: as it became socially accepted and socially expected to wear helmets, more and more child cyclists used them.[76] Similarly, it must become normal in agricultural populations to expect children to begin driving tractors only when they are physically and cognitively ready to do so, based upon established child development principles. One example of an intervention to address this issue is the national "Keep Kids Away from Tractors" social media campaign launched in 2007 (see http://www.childagsafety.

org). Through the use of innovative public service messaging in print, visual, and audio formats, and involving the support and voice of major public figures, this campaign attempted to change social norms surrounding the acceptability of permitting young children to operate farm tractors. In short, developmentally appropriate activities must be recognized, enforced, and normalized.

A third strategy—and one that ideally would be implemented in conjunction with efforts to change child and parent behavior—is to focus on safety-related changes to the environment.[77] When individual-level active behavior change is ineffective or impractical, environment- and vehicle-level passive change may be more effective. Installation and use of ROPS and seatbelts on tractors provide an obvious example of such an approach. It does not appear, however, that any environmental strategy currently exists that would ensure 100% the safety of a child on a farm who has not reached requisite developmental milestones.

Implications for Public Policy

We believe there are at least four implications of this review for policy targeting agricultural injury prevention. First, the creation of new regulations should consider child development principles, including the fact that there are biological limitations to the speed with which neural development can occur.[72] For example, children should not be permitted to operate a tractor without requisite skills. This pertains both to field work in occupational situations and to operation of tractors on public roads and highways for other transport purposes. In addition, it is important that any tractor being operated by a youth meets basic criteria with respect to safety, maintenance, and the presence of protections such as ROPS and seatbelts that are appropriate for use by individuals with smaller stature such as children.[78]

Second, we need to reduce inconsistencies in the types of work that are considered hazardous under US child labor laws for general farmworkers, but are not considered hazardous for farm children.[4,79] Farm family members are currently exempt from these Hazardous Orders, and these inconsistencies could be informed by what we know about child development.

Third, we need existing resources used to assign farm work to children to be informed by current knowledge of child development and how it relates. This includes such resources as the North American Guidelines for Children's Agricultural Tasks (NAGCAT),[17,80] the American Academy of Pediatrics Position Statement on farm tractor use,[1] and the aforementioned Hazardous Occupational Orders for Agriculture.[79]

Last, there is a need for continued policy-oriented research to determine the pragmatic steps necessary to institute policies that will protect vulnerable young workers from being subject to hazardous work without appropriate protections. Farm safety is a challenging field at the best of times, and all recommendations need to be tempered by such pragmatic needs.

Implications for Research

Research needs are substantial; we mention a few priorities. First, correlational or longitudinal (e.g., cohort) studies could examine physical, cognitive, and perceptual development and how it relates to farm safety topics like tractor operation. Experimental studies could examine the influences of parents or peers on the behaviors of youth on farms. Research should consider development broadly, but also focus on particular aspects of development (e.g., attentional processes; perception of distances; executive function) and how those specific traits relate directly to critical parts of safe farm work in general, and tractor operation specifically.

One challenge to research in the field is identifying ways to study agricultural work and play ethically, without placing children at risk. The pedestrian, bicycling, and teen driving literatures have begun using virtual reality simulation as a strategy to conduct research ethically, without placing children at risk for injury.[34, 81–83] Simulation models such as those used in automobile safety research—for example, a virtual tractor environment—could be of immense value to research efforts.

CONCLUSIONS

Safe-engagement in agricultural settings is highly complex, and children lack multiple developmental skills required to maintain safety. Using tractor operation as an example, we have offered a description of the wide range of physical, cognitive, perceptual, and social skills required for safe tractor operation. Young children cannot operate tractors safely because they lack the developmental capacity to do so in many domains. As children mature, they slowly acquire obligatory skills for safe behavior on farms, including for tractor operation. Parents, employers, and policymakers must be aware of the role development plays on farm settings. Researchers should continue to explore how the development of physical, cognitive, perceptual, and social skills influence children's farm safety.

REFERENCES

1. American Academy of Pediatrics, Committee on Injury and Poison Prevention and Committee on Community Health Services. Prevention of agricultural injuries among children and adolescents. *Pediatrics.* 2001;108:1016–1019.

2. DeMuri GP, Purschwitz MA. Farm injuries in children: a review. *WMJ*. 2000;99:51–55.

3. Hard DL, Myers JR. Fatal work-related injuries in the agriculture production sector among youth in the United States, 1992–2002. *J Agromedicine*. 2006;11: 57–65.

4. Marlenga B, Berg RL, Linneman JG, Brison RJ, Pickett W. Changing the child labor laws for agriculture: impact on injury. *Am J Public Health*. 2007;97:276–282.

5. Brison RJ, Pickett W, Berg RL, Linneman J, Zentner J, Marlenga B. Fatal agricultural injuries in preschool children: risks, injury patterns and strategies for prevention. *CMAJ*. 2006;174:1723–1726.

6. Pickett W, Brison RJ, Berg RL, Zentner J, Linneman J, Marlenga B. Pediatric farm injuries involving non-working children injured by a farm work hazard: five priorities for primary prevention. *Inj Prev*. 2005;11:6–11.

7. Marlenga B, Brison RJ, Berg R, Linneman J, Zentner J, Pickett W. Evaluation of the North American Guidelines for Children's Agricultural Tasks using a case series of injuries. *Inj Prev*. 2004;10:350–357.

8. Pickett W, Hartling L, Brison RJ, Guernsey J. Fatal farm injuries in Canada. *CMAJ*. 1999;160:1843–1848.

9. Pickett W, Hartling L, Guersey J, et al. Surveillance of hospitalized farm injuries in Canada. *Inj Prev*. 2001;7:123–128.

10. Fathallah FA, Chang JH, Berg RL, Pickett W, Marlenga B. Forces required to operate controls on farm tractors: implications for young operators. *Ergonomics*. 2008;51:1096–1108.

11. Morrongiello BA, Marlenga B, Berg R, Linneman J, Pickett W. A new approach to understanding pediatric farm injuries. *Soc Sci Med*. 2007;65:1364–1371.

12. Morrongiello BA, Pickett W, Berg RL, Linneman JG, Brison RJ, Marlenga B. Adult supervision and pediatric injuries in the agricultural worksite. *Accid Anal Prev*. 2008;40:1149–1156.

13. Sudhinaraset M, Blum RW. The unique developmental considerations of youth-related work injuries. *Int J Occup Environ Health*. 2010;16:216–222.

14. Williams QL, Alexander BH, Gerberich SG, Nachreiner NM, Church TR, Ryan A. Child bystanding: a risk factor for injury and identifying its determinants on Midwestern agricultural operations. *Accid Anal Prev*. 2010;42:10–18.

15. Barton BK, Schwebel DC. A contextual perspective on the etiology of children's unintentional injuries. *Health Psychol Rev*. 2007;1:173–185.

16. Peterson L, Farmer J, Mori L. Process analysis of injury situations: a complement to epidemiological methods. *J Soc Issues* 1987;43:33–44.

17. Marshfield Clinic. North American Guidelines for Children's Agricultural Tasks (NAGCAT). Available at: http://www.nagcat.org/nagcat/. Accessed January 8, 2010.

18. Bronfenbrenner U. *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press; 1979.

19. Johnson SB, Jones VC. Adolescent development and risk of injury: using developmental science to improve interventions. *Inj Prev.* 2011;17:50–54.

20. Fathallah FA, Chang JH, Pickett W, Marlenga B. Ability of youth operators to reach farm tractor controls. *Ergonomics*. 2009;52:685–694.

21. Chang JH, Fathallah FA, Pickett W, Miller BJ, Marlenga B. Limitations in fields of vision for simulated young farm tractor operators. Ergonomics. 2010;53: 758–766.

22. Plumert JM. Relations between children's overestimation of their physical abilities and accident proneness. *Dev Psychol*. 1995;31:866–876.

23. Tabibi Z, Pfeffer K. Choosing a safe place to cross the road: the relationship between attention and identification of safe and dangerous road-crossing sites. *Child Care Health Dev*. 2003;29:237–244.

24. Whitebread D, Neilson K. The contribution of visual search strategies to the development of pedestrian skills by 4–11 year-old children. *Br J Educ Psychol*. 2000;70:539–557.

25. Schwebel DC, Plumert JM. Longitudinal and concurrent relations among temperament, ability estimation, and injury proneness. *Child Dev*. 1999;70: 700–712.

26. Hoffman ER, Payne A, Prescott S. Children's estimates of vehicle approach times. *Hum Factors*. 1980;22:235–240.

27. Salvatore S. The ability of elementary and secondary school children to sense oncoming car velocity. *J Saf Res*. 1974;6:118–125.

28. Demetre JD. Applying developmental psychology to children's road safety: problems and prospects. *J Appl Dev Psychol*. 1997;18:263–270.

29. Thomson JA. Negotiating the urban traffic environment: pedestrian skill development in young children. In: Allen GL, ed. *Applied Spatial Cognition: From Research to Cognitive Technology*. Mahwah, NJ: Erlbaum; 2007: 203–227.

30. Lees MN, Cosman JD, Lee JD, Fricke N, Rizzo M. Translating cognitive neuroscience to the driver's operational environment: a neuroergonomic approach. *Am J Psychol*. 2010;123:391–411.

31. National Research Council, Institute of Medicine, and Transportation Research Board. *Preventing Teen Motor Crashes: Contributions from the Behavioral and Social Sciences, Workshop Report*. Program Committee for a Workshop on Contributions from the Behavioral and Social Sciences in Reducing and Preventing Teen Motor Crashes. Washington, DC: The National Academies Press; 2007.

32. Boyer TW. The development of risk-taking: a multiperspective review. *Dev Rev*. 2006;26:291–345.

33. Pitcairn TK, Edlmann T. Individual differences in road crossing ability in young children and adults. *Br J Psychol.* 2000;91:391–410.

34. Plumert JM, Kearney JK, Cremer JF. Children's perception of gap affordances: bicycling across traffic-filled intersections in an immersive virtual environment. *Child Dev.* 2004;75:1243–1253.

35. Schwebel DC, Gaines J. Pediatric unintentional injury: behavioral risk factors and implications for prevention. *J Dev Behav Pediatr*. 2007;28:245–254.

36. Sowell ER, Thompson PM, Holmes CJ, Jernigan TL, Toga AW. In vivo evidence for post-adolescent brain maturation in frontal and striatal regions. *Nat Neurosci*. 1999;2:859–861.

37. Johnson SB, Blum RW, Giedd JN. Adolescent maturity and the brain: the promise and pitfalls of neuroscience research in adolescent health policy. *J Adolesc Health*. 2009;45:215–221.

38. Rothbart MK, Sheese BE, Posner MI. Executive attention and effortful control: linking temperament, brain networks, and genes. *Child Dev Perspect*. 2007;1:2–7.

39. Blakemore S, Choudhury S. Development of the adolescent brain: implications for executive function and social cognition. *J Child Psychol Psychiatry*. 2006;47: 296–312.

40. Schwebel DC, Barton BK. Temperament and children's unintentional injuries. In: Vollrath M, ed. *Handbook of Personality and Health*. New York: Wiley; 2006:51–71.

41. Carlson KF, Gerberich SG, Alexander BH, et al. Children's behavioral traits and risk of injury: analyses from a case-control study of agricultural households. *J Saf Res*. 2009;40:97–103.

42. Larson-Bright M, Gerberich SG, Alexander BH, et al. Work practices and childhood agricultural injury. *Inj Prev*. 2007;13:409–415.

43. Morrongiello BA, Midgett C, Shields R. Don't run with scissors: young children's knowledge of home safety rules. *J Pediatr Psychol*. 2001;26:105–115.

44. Bandura A. *Social Learning Theory*. New York: General Learning Press; 1977.

45. Page RM. Role of parental example in preadolescents' use of seat belts. *Psychol Rep*. 1986;59:985–986.

46. Cole R, Koulouglioti C, Kitzman H, Sidora-Arcoleo K, Anson E. Maternal rules, compliance, and injuries to preschool children. *Fam Community Health*. 2009;32: 136–146.

47. Morrongeillo BA. Caregiver supervision and child-injury risk: I. Issue in defining and measuring supervision; II. Findings and directions for future research. *J Pediatr Psychol*. 2005;30:536–552.

48. Saluja G, Brenner R, Morrongiello BA, Haynie D, Rivera M, Cheng TL. The role of supervision in child injury risk: definition, conceptual and measurement issues. *Inj Control Saf Promot*. 2004;11:17–22.

49. Martino SC, Ellickson PL, McCaffrey DF. Multiple trajectories of peer and parental influence and their association with the development of adolescent heavy drinking. *Addict Behav*. 2009;34:693–700.

50. Nash SG, McQueen A, Bray JH. Pathways to adolescent alcohol use: family environment, peer influence, and parental expectations. *J Adolesc Health*. 2005;37: 19–28.

51. Maurer TW, Brunson L, Pleck JH. Adolescent smoking behavior: the relative influence of parental and peer norms. *Adolesc Fam Health*. 2003;3:130–139.

52. Le TN, Kato T. The role of peer, parent, and culture in risky sexual behavior for Cambodian and Lao/Mien adolescents. *J Adolesc Health*. 2006;38:288–296.

53. Leadbeater BJ, Banister EM, Ellis WE, Yeung R. Victimization and relational aggression in adolescent romantic relationships: the influence of parental and peer behaviors, and individual adjustment. *J Youth Adolesc*. 2008;37:359–372.

54. Rideout VJ, Foehr UG, Roberts DF. Generation M2: media in the lives of 8- to 18-year-olds. A Kaiser Family Foundation Study. 2010. Available at:http://www.kff.org/entmedia/upload/8010.pdf. Accessed March 6, 2012.

55. Harvey AR, Carden RL. Driving error and anxiety related to iPod mp3 player use in a simulated driving experience. *Percept Mot Skills.* 2009;109: 159–167.

56. Hosking SG, Young KL, Regan MA. The effects of text messaging on young drivers. *Hum Factors*. 2009;51:582–592.

57. Seo DC, Torabi MR. The impact of in-vehicle cell-phone use on accidents or near-accidents among college students. *J Am Coll Health*. 2004;53: 101–107.

58. Stavrinos D, Byington KW, Schwebel DC. The effect of cell phone distraction on pediatric pedestrian injury risk. *Pediatrics*. 2009;123:e179–e185.

59. Gradisar M, Gardner G, Dohnt H. Recent worldwide sleep patterns and problems during adolescence: a review and meta-analysis of age, region, and sleep. *Sleep Med*. 2011;12:110–118.

60. Hanson M, Janssen I, Schiff A, Zee PC, Dubocovich ML. The impact of school daily schedule on adolescent sleep. *Pediatrics*. 2005;115:1555–1561.

61. Chittenden T. Digital dressing up: modelling female teen identity in the discursive spaces of the fashion blogosphere. *J Youth Stud*. 2010;13:505–520.

62. Phelan TW. *Surviving Your Adolescents: How to Manage—and Let Go of—Your 13–18 Year Olds*. Glen Ellyn IL: Parentmagic; 1998.

63. CDC growth charts. Available at: http://www.cdc.gov/growthcharts/cdc_charts.htm. Accessed March 6, 2012.

64. Couperus JW. Perceptual load influences selective attention across development. *Dev Psychol*. 2011;47: 1431–1439.

65. Smith AB, Halari R, Giampetro V, Brammer M, Rubia K. Developmental effects of reward on sustained attention networks. *NeuroImage*. 2011;56: 1693–1704.

66. Zhan J-Y, Wilding J, Cornish K, et al. Charting the developmental trajectories of attention and executive function in Chinese school-aged children. *Child Neuropsychol*. 2011;17:82–95.

67. Gadomski A, Ackerman S, Burdick P, Jenkins P. Efficacy of the North American Guidelines for Children's Agricultural Tasks in reducing childhood agricultural injuries. *Am J Public Health*. 2006;96:722–727.

68. Hartling L, Brison RJ, Crumley ET, Klassen TP, Pickett W. A systematic review of interventions to prevent childhood farm injuries. *Pediatrics*. 2004;114: e483–e496.

69. McCallum DM, Conaway MB, Drury S, Braune J, Reynolds SJ. Safety-related knowledge and behavior changes in participants of farm safety day camps. *J Agric Saf Health*. 2005;11:35–50.

70. McCallum DM, Conaway MB, Reynolds SJ. Evaluation of a farm safety day program: participants and non-participants over a one-year follow-up period. *J Agric Saf Health*. 2009;15:255–271.

71. Vygotsky L. *Mind in Society* [trans. M Cole]. Cambridge, MA: Harvard University Press; 1978.

72. Shonkoff JP, Bales SN. Science does not speak for itself: translating child development research for the public and its policymakers. *Child Dev*. 2011;82:17–32.

73. Rosenstock IM. The health belief model and preventive health behavior. *Health Educ Monographs*. 1974;2:354–386.

74. Gärling A, Gärling T. Mothers' supervision and perception of young children's risk of unintentional injury in the home. *J Pediatr Psychol*. 1993;18:105–114.

75. Larson-Bright M, Gerberich SG, Masten AS, et al. Parents' safety beliefs and childhood agricultural injury. *Am J Ind Med*. 2009;52:724–733.

76. Thompson NJ, Sleet D, Sacks JJ. Increasing the use of bicycle helmets: lessons from behavioral science. *Patient Educ Couns*. 2002,46:191–197.

77. Staunton CE, Frumpkin H, Dannenberg AL. Changing the built environment to prevent injury. In: Doll LS, Bonzo SE, Sleet DA, Mercy JA, eds. *Handbook of Injury and Violence Prevention*. New York: Springer; 2007:257–275.

78. National Committee for Childhood Agricultural Injury Prevention. Children and Agriculture: Opportunities for Safety And Health. A National Action Plan. Marshfield, WI: National Farm Medicine Center; 1996. Available at: http://www.marshfieldclinic.org/nccrahs/?page=nccrahs_reports. Accessed March 6, 2012.

79. Child Labor Requirements in Agricultural Occupations Under the Fair Labor Standards Act. Child Labor Bulletin 102. Washington, DC: US Department of of Labor; 2004. WH publication 1295. Available at: http://www.osha.gov/pls/epub/wageindex.download?p_file=F10862/WH-1295CHILDLABORBULLETIN102.pdf. Accessed February 28, 2011.

80. Lee B, Marlenga B, eds. *Professional Resource Manual: North American Guidelines for Children's Agricultural Tasks*. Marshfield, WI: Marshfield Clinic; 1999.

81. Schwebel DC, Gaines J, Severson J. Validation of virtual reality as a tool to understand and prevent child pedestrian injury. *Accid Anal Prev*. 2008;40: 1394–1400.

82. Schwebel DC, McClure LA. Using virtual reality to train children in safe street-crossing skills. *Inj Prev*. 2010;16:e1–e5.

83. Senserrick TM, Brown T, Quistberg DA, Marshall D, Winston FK. Validation of simulated assessment of teen driver speed management on rural roads. *Annu Proc Assoc Adv Automot Med*. 2007;51:525–536.