Brief Report: Unintentional Injury Risk among Children with Sensory Impairments

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Objective Pediatric injuries result from a multifaceted process involving a range of individual, interpersonal, and environmental influences. One risk that remains poorly understood is the role of children’s perception and perceptual disabilities. Methods Injury counts (parent-report of injuries requiring professional medical treatment over the past year) in three groups of children were compared: those without vision or hearing sensory impairments, those with deficits who use eyeglasses or hearing aids, and those with deficits who do not use aids as recommended. A national sample of 7391 5-year-olds in the National Head Start/Public School Early Childhood Transition Demonstration Study was studied. Results Injury counts over the past year were higher among children with sensory impairments, and higher still among children with sensory impairments who did not use prescribed sensory aids. Conclusions Awareness of increased injury risk among children with hearing and vision impairment could help professionals protect children from injury.

Key words glasses; hearing aids; injury; safety; sensory impairment.

Unintentional injuries are the leading cause of mortality for children in the United States (National Center for Injury Prevention and Control, 2009) and much of the world (World Health Organization, 2008). Pediatric injuries occur as a result of a multicontextual, multifaceted process that involves a wide range of individual cognitive and perceptual processes, interpersonal influences, and environmental factors, among others (Schwebel & Gaines, 2007). One factor that remains poorly understood is the role of perception, perceptual development, and perceptual impairments in child injury risk.

A number of studies suggest perception and perceptual development might play a role in children’s safety among nondisabled children (Plumert, 1995; Tabibi & Pfeffer, 2003; Whitebread & Neilson, 2000). In particular, poor perceptual abilities appear to reduce children’s safety in pedestrian settings, both in laboratory studies examining the effect of vision-related perceptual development on pedestrian decision-making (Tabibi & Pfeffer, 2003; Whitebread & Neilson, 2000) and in one case–control community-based study examining vision and hearing deficits on pedestrian injury incidence (Roberts & Norton, 1995).

It is also well established that children with broader physical disabilities have increased injury risk (Ramirez, Peek-Asa, & Kraus, 2004; Xiang et al., 2005) and that vision impairment increases risk of injury in adults, particularly for falls, motor vehicle crashes, and occupational injuries (see Legood, Scuffham, & Cryer, 2002, for a review). However, the extent to which children’s vision and hearing impairments might lead to increased risk of all unintentional injuries remains understudied. One might presume that such children would have increased risk due to an inability to accurately perceive and respond to potential risks in their environment. That risk might be increased dramatically when a child has a sensory impairment that is uncorrected because the child does not wear eyeglasses or hearing aids as prescribed.

The best existing evidence addressing the question of sensory deficits and child injury risk comes from two recent studies. The first, by Xiang et al. (2005), examined children with serious vision or hearing disabilities—those children whose disability caused them to either require the help of others for personal care or to require special education or early intervention services. Children with disabilities had a significantly higher rate of injury...
(OR = 1.74, 95% CI = 1.03–2.95) than children without severe disabilities. The second compared children with long-term hearing loss to age-matched controls (Mann, Zhou, McKee, & McDermott, 2007). Replicating results from Xiang et al. (2005), the children with hearing loss had a higher injury rate than the comparison group (RR = 1.98, CI = 1.71–2.30).

The present study was designed to examine risk of unintentional injury among children with more minor sensory impairments. Using a sample of 7391 kindergartners, we compared injury counts in children without any sensory impairment to those who had impairments but used eyeglasses or hearing aids to correct for them, and those who had impairments and did not use aids as directed. We also tested whether group-related differences would hold after controlling for demographic covariates. We chose to study kindergartners because it represents a developmental stage when children’s safety is not fully protected by adult supervisors, and children’s perception of environmental safety plays an increasingly important role in injury risk.

**Method**

**Data Source and Sample**

Data came from the National Head Start/Public School Early Childhood Transition Demonstration Study, a multi-site randomized longitudinal investigation examining the implementation of a comprehensive Head Start-like transition program (Ramey et al., 2000). The cross-sectional data used in the present report come from an assessment of the children in kindergarten. A sample of 7,391 was available without missing data points. The primary criteria for admittance into Head Start programs is the families’ income level, which must fall below federal guidelines for poverty based on family size. Thus, all children in the study were from low-income families. Many were extremely impoverished.

The sample was highly diverse racially, ethnically, culturally, and geographically and included children in both rural and urban settings. Children were recruited from 31 data collection sites across the United States (see Supplementary Table A online). When English proficiency was limited, assessments were conducted in the native language of the family. Seventeen of the sites administered interviews in Spanish for some families. Other languages used to interview some families included Vietnamese (two sites), Hmong (two sites), Cambodian (two sites), and Navajo (one site). The sample was 52.78% boys and had a mean age of 5.75 years (SD = 0.37). Mean age for mothers was 31.06 years (SD = 5.55).

**Measures**

**Demographics**

Mothers reported basic demographic characteristics.

**Sensory impairment**

In response to separate inquiries about vision and hearing, teachers reported whether the child required eyeglasses or hearing aids. They also reported whether the child regularly wore the aids, as recommended.

**Child hyperactivity**

Mothers reported whether a doctor had ever told them their child had a hyperactivity disorder.

**Health insurance**

Mothers reported whether they had health insurance coverage for their child or not. This variable was included because presence of health insurance might influence a parent’s decision to visit a medical professional following a child’s injury.

**Poverty level**

Family poverty was assessed through a poverty distribution ratio created by dividing the family’s annual income by a computed poverty level based on standardized tables published by the U.S. Department of Health and Human Services. These tables take geographic location, cost of living, and size of family into consideration. Lower numbers signify greater poverty, with values of 1.0 or lower indicating a family is at or below the poverty level.

**Injury**

Mothers reported whether children had experienced an injury in the previous year that required professional medical attention.

**Analytic Plan**

Analyses proceeded in three steps. First, we considered basic descriptive data: How many injuries were reported by the three groups of children (those without sensory impairment, those with sensory impairment who use aids, and those with sensory impairments who do not use aids)? Second, we computed bivariate Zero-Inflated Poisson (ZIP) regression models predicting injury counts based on impairment/use of aid as well as relevant covariates. ZIP models are considered the best statistical strategy to predict count variables with excess zeros, such as the typical distribution of medically attended injuries among children (Karazsia & van Dulmen, 2008). Preliminary
analyses supported the fit and interpretability of ZIP models to these data over alternatives such as Poisson, negative binomial, or zero-inflated negative binomial models. Third, we computed multivariate ZIP regression models predicting injury counts based on both impairment/use of aid and the relevant covariates.

**Results**

Supplementary Table B (online) lists descriptive data for all variables included in the analyses. Table I presents data on annual injury counts among children with no sensory impairment, those with impairment and use of an aid, and those with impairment but no use of an aid. As shown, the children without impairment had the lowest injury counts. Children who required eyeglasses or hearing aids, and used them as recommended, reported higher injury counts than those without impairment. Children who required eyeglasses or hearing aids and did not use them had the highest annual injury counts of the three groups.

Table II presents ZIP regression models predicting injuries requiring professional medical attention over the past year. All covariates emerged as statistically significant in the counts portion of ZIP bivariate models ($x^2$ for all models $> 10.00$, all $p < .01$). Boys, more hyperactive children, poorer children, and children with health insurance had higher counts of injury. There was a trend for older children to have fewer injuries. Gender also emerged as a predictor in the dichotomous portion of the ZIP model, with boys having more injuries than girls.

Bivariate models comparing children with and without sensory impairment confirmed trends in the descriptive data. Children who required and used sensory aids had

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bivariate models</th>
<th>Multivariate models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child gender$^a$</td>
<td>-0.33 0.08 -4.05**</td>
<td>-0.31 0.09 -3.65**</td>
</tr>
<tr>
<td>Child age</td>
<td>0.20 0.11 1.80</td>
<td>0.24 0.11 2.13*</td>
</tr>
<tr>
<td>Hyperactivity$^b$</td>
<td>0.15 0.11 1.26</td>
<td>0.04 0.12 0.30</td>
</tr>
<tr>
<td>Poverty level</td>
<td>0.10 0.06 1.63</td>
<td>0.09 0.07 1.34</td>
</tr>
<tr>
<td>Health insurance$^c$</td>
<td>0.03 0.18 0.15</td>
<td>0.06 0.18 0.34</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>Bivariate models</th>
<th>Multivariate models</th>
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</thead>
<tbody>
<tr>
<td>Requires and uses aid</td>
<td>-0.28 0.27 -1.04</td>
<td>-0.33 0.28 -1.16</td>
</tr>
<tr>
<td>Requires aid, but no use</td>
<td>0.69 0.24 2.87**</td>
<td>0.82 0.27 3.08**</td>
</tr>
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<table>
<thead>
<tr>
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<th>Bivariate models</th>
<th>Multivariate models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child gender$^a$</td>
<td>-0.12 0.06 -2.18*</td>
<td>-0.12 0.06 -2.17*</td>
</tr>
<tr>
<td>Child age</td>
<td>-0.26 0.07 -3.43**</td>
<td>-0.27 0.07 -3.77**</td>
</tr>
<tr>
<td>Hyperactivity$^b$</td>
<td>0.85 0.06 13.13**</td>
<td>0.84 0.06 13.04**</td>
</tr>
<tr>
<td>Poverty level</td>
<td>-0.22 0.04 -5.07**</td>
<td>-0.18 0.04 -4.33**</td>
</tr>
<tr>
<td>Health insurance$^c$</td>
<td>0.47 0.13 3.76**</td>
<td>0.42 0.12 3.43**</td>
</tr>
</tbody>
</table>

Note: The valences of the effects for the dichotomous outcomes in this table have been reversed from the SAS output, which models the probability of zero injuries. This reversal makes these dichotomous outcome results more consistent with the counts results to aid interpretation of results. All models now predict either presence of or greater likelihood of injury.

$^a$Coded as boys = 1, girls = 2.
$^b$Coded as presence of hyperactivity = 1, absence = 0.
$^c$Coded as presence of health insurance = 1, absence = 0.
$^d$Coded as presence of impairment = 1, absence = 0.
$p \leq .05$, **$p < .01$. 

**Table I. Annual Injury Counts among Children with and without Sensory Impairments**

<table>
<thead>
<tr>
<th>Vision impairment</th>
<th>Hearing impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M (SD)</strong></td>
<td><strong>M (SD)</strong></td>
</tr>
<tr>
<td>No impairment</td>
<td>0.38 (1.21)</td>
</tr>
<tr>
<td>Requires and uses aid</td>
<td>0.47 (0.89)</td>
</tr>
<tr>
<td>Requires but does not use aid</td>
<td>0.64 (1.54)</td>
</tr>
</tbody>
</table>

**Table II. Zero-Inflated Poisson Regression Models Predicting Injuries for Children with and without Sensory Impairment**
higher counts of injury than those without sensory impairments. Children who required and did not use glasses had an elevated risk of injury presence in the dichotomous outcome portion of the ZIP model.

Multivariate findings largely paralleled bivariate results. Overall, both models were statistically significant (vision impairment model, $\chi^2 = 320, p < .01$; hearing impairment model, $\chi^2 = 304, p < .01$). Children with hearing impairments who used aids still had elevated injury count risk, as did those with hearing impairments who did not use aids. Children who required glasses and used them had a higher injury count. Children who required glasses and did not use them were more likely to experience injury than other children, but actually experienced lower injury counts than other children who were injured. Male gender, younger age, hyperactivity, poverty, and presence of health insurance also emerged as predictors of injury counts, and male gender as a predictor of injury presence.

Discussion

As hypothesized, injury counts were higher among children with sensory impairments and were even higher still among children with sensory impairments whose teachers reported they did not use sensory aids (eyeglasses or hearing aids). This pattern of results held after controlling for covariates and suggests that children with sensory impairment tend to have increased risk of injury, particularly when they do not use aids as recommended.

Previous work suggests vision impairment increases both child pedestrian injury risk (Roberts & Norton, 1995) and broad injury risk in adults (Legood et al., 2002). Serious sensory disabilities were linked to child injury risk in one epidemiological study (Xiang et al., 2005), and chronic hearing loss to child injury risk in a second (Mann et al., 2007). This study offers initial evidence that children with even relatively minor vision and hearing impairments—those who were integrated into regular classrooms—might have increased risk of pediatric injury. Although socially somewhat less skilled than their nonimpaired peers (Brown, Remine, Prescott, & Rickards, 2000; Celeste, 2006), children with minor sensory impairments are likely to spend most of their time with nonimpaired peers and may engage in potentially risky situations they cannot accurately perceive.

Our results also produced several secondary findings of interest. All covariates emerged as predictors of injury counts. These findings replicate a large literature suggesting male gender, hyperactivity, poverty, and presence of health insurance are associated with higher pediatric injury rates. We also discovered both higher counts of injury and a greater range of injury frequency among the children with hearing impairment than the children with vision impairment. One might hypothesize that children with hearing impairments behave with wide variation in injury-risk situations. Some might become overly cautious, in an attempt to prevent themselves from injury, but others—a larger portion—might take risks, perhaps by socializing and engaging with peers who do not have impairments despite their sensory limitation to do so safely. Finally, representing the complexity of ZIP analyses, children with vision impairment who did not use glasses as recommended had a greater likelihood of experiencing injuries, but actually experienced a lower count of injuries compared to other injured children. Replication of this unusual result is warranted before positing substantive interpretations of the finding.

The findings have implications for injury prevention. First, they suggest the safety of children with sensory impairments increases when children use the aids prescribed to them. There are a variety of reasons why children do not use aids, including risk of social ostracization, discomfort from wearing the aids, their failure to actually improve hearing (particularly true in children with severe hearing loss), and limited family resources to purchase or maintain the aids (Flynn, Davis, & Pogash, 2004; Kawell, Kopun, & Stelmachowicz, 1988; Ryan, Johnson, Strange, & Yonovitz, 2006; Terry & Macy, 1991). Efforts to overcome these barriers are complex, but might include strategies used in other domains to reduce bullying and teasing, increase comfort of medical devices, and increase social services to improve the health of disadvantaged children. Ultimately, prevention of injuries among children with sensory impairment may take the form not only of traditional safety-related interventions but also of interventions designed to improve social situations and peer relationships, so that children are comfortable wearing the medical devices prescribed to them.

Second, parents, teachers, and other supervisors should be aware of the potential for children with sensory impairments to misperceive the environments they engage within. Children with hearing impairments may not hear alerts of oncoming risk (e.g., cries forewarning an errant foul baseball, a honking car turning left, or a teacher warning the child to stop before entering a roadway). In fact, the risks of failure to heed warnings match in some ways the risk of injury to children with Oppositional Defiant Disorder, who fail to heed adult warnings for different reasons and have increased risk of injury (Schwebel, Speltz, Jones, & Bardina, 2002).
Risks to children with visual impairments are somewhat different. Accurately perceiving the characteristics of one’s environment is critical to safety (Plumert, 1995; Whitebread & Neilson, 2000), and misperception could result in injury on playgrounds, road environments, athletic situations, and other locations. Psychologists considering injury risk from the perspective of ecological theory have argued, in fact, that accurate perception of the environment might play a particularly critical role in the safety of children as they develop (Plumert, 1995).

The results of this study should be considered in the context of limitations. Although parent recall of injuries is a standard measure in the literature, and recall bias is known to be slight (Cummings, Rivara, Thompson, & Reid, 2005), results would be strengthened by a replication that validates injury history through alternate assessment strategies. Similarly, we relied on teacher-report concerning whether children had sensory impairments and whether they were prescribed sensory aids. In most schools, teachers are highly aware of such issues among their students, but no information was available to validate sensory impairment diagnoses or aid prescriptions. Another risk stems from small cell sizes. In particular, despite the large sample size, there were comparatively few children with hearing impairments. Finally, the fact that sensory impairments were reported at the same time as injuries over the past year is limiting. Some injuries could conceivably have occurred prior to the diagnosis of the sensory impairment.

In conclusion, pediatric injury is caused by a tremendous range of cognitive, social, interpersonal, and environmental factors. Accurate perception of the environment is just one of those, but the present results highlight the fact that children who have greater risk of misperceiving their environment because of a sensory impairment may also have greater risk of unintentional injury. It also suggests children who use sensory aids as recommended are partially protected from injury compared to children who do not use sensory aids as recommended. Awareness of these risks could help professionals in a range of disciplines protect children from preventable injuries.

**Supplementary Data**

Supplementary data can be found at: http://www.jpepsy.oxfordjournals.org/.

**Acknowledgments**

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**References**


