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Understanding Infants' In-Home Injuries: Context and Correlates

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Abstract

Rationale Infancy is a time of elevated risk of injury. Past research has focused mostly on the type of injuries, leaving many gaps in knowledge about contextual information that could aid in injury prevention planning. **Methods** In this longitudinal study, a participant-event recording method was used in which mothers tracked their infants' home injuries through three motor development stages (sitting up independently, crawling, and walking). A contextual analysis elucidated where injuries occurred, their type and severity, the infant's and parent's behaviors at the time, if the infant had done the risk behavior before and been injured, the level of supervision, and the nature of any safety precautions parents implemented following these injuries. **Results** Injuries occurred as often in play as in nonplay areas and were due to physically-active nonplay activities more so than play activities; mothers were often doing chores. Bumps and bruises were the most common types of injuries. As infants became more mobile, supervision scores *declined* and injury severity scores increased. Infants had done the risk behavior leading to injury previously about 60% of the time, with higher scores associated with parents implementing *fewer* preventive actions in response to injury. When mothers did implement a safety precaution, greater injury severity was associated with more modifications to the environment and increased supervision; teaching about safety was infrequent. **Conclusion** Implications of these results for injury prevention messaging are discussed.

Key words: accidents and injuries; infancy and early childhood; longitudinal research; parents.

Introduction

Unintentional injuries are the leading cause of death in the United States for children under 5 years of age (National Center for Injury Prevention and Control [NCIPC], 2020). Approximately 1,400 children in this age range die annually from an unintentional injury, while an additional 1.7 million experience a nonfatal injury (NCIPC, 2020). For young children, injuries often occur in the home and result from youth engaging in unsafe behaviors and interacting with hazards (Dal Santo et al., 2004; Morrongiello et al., 2004a,b; Nouhjah et al., 2017; Reading et al., 1999). Past research on factors that influence injuries to young children has focused mostly on the toddler (2–3 years) and preschooler (4–5 years) stages, though infancy (<2 years) has been identified as a high-risk period for injuries (Xu et al., 2018). In past research, conducting a contextual analysis of injuries to toddlers and preschoolers provided a wealth of knowledge to guide messaging to prevent these events, including where injuries occur in the home, the types of behaviors leading to injury, and parent activities and supervision at the time of injury. For toddlers, for example, there is considerable information about the nature of their

hazard interactions (e.g., Morrongiello et al., 2014), as well as the injury precautions that their parents implement and why (e.g., Gaines & Schwebel, 2009; Morrongiello et al., 2004a,b; Peterson et al., 1990; Sleet et al., 2010). Similarly, for preschoolers, research has revealed that contextual factors related to parent and child behaviors elevate injury risk, including the parent inadequately watching the child (e.g., Landen et al., 2003; Schnitzer et al., 2015), overestimating the child's understanding of safety and ability to follow rules (Mayes et al., 2006; Morrongiello et al., 2001), and children engaging in unpredictable behaviors that increase hazard interactions (Morrongiello et al., 2012). However, notable gaps in knowledge exist with regards to contextual factors relevant to injuries during infancy and the safety practices that parents implement during this stage in development. This longitudinal study addressed these gaps in knowledge, applying a contextual analysis of injuries and parent safety practices over approximately an averaged 10-month period, as infants transitioned from sitting to crawling to walking independently.

With accumulating age throughout infancy there are corresponding increases in motor competencies. These emerging skills create the opportunity for infants to more fully explore their environment. At the same time, however, infants lack the ability to appropriately appraise danger and recognize injury hazards (Cole et al., 2016; Gill & Kelly, 2017; Longobardi et al., 2016). Hence, the rate of injury has been shown to increase concomitantly as infants become more physically capable, showing peaks after infants acquire new motor milestones, including sitting up, crawling, and walking (Agran et al., 2003). These injury patterns suggest that parents may not be implementing safety precautions that anticipate the infant's emerging motor capabilities and potential for hazard interactions.

Insufficient knowledge about home hazards can result in parents failing to realize the need for implementing a precaution (Gaines & Schwebel, 2009). In addition, research has revealed a number of additional factors that influence parents' safety practices as their children develop. Parents of young children often attribute injuries to bad luck and such attributions are associated with implementing fewer safety precautions to prevent childhood injuries (Morrongiello & Corbett, 2008). When they do implement precautions, parents of toddlers' report using three strategies to varying degrees: supervision, teaching the child rules about safety, and modifying the environment to reduce access to hazards (Gärling & Gärling, 1993; Morrongiello et al., 2004a,b). These strategies are differentially effective depending on how and when they are used (e.g., Dal Santo et al., 2004; Greaves et al., 1994; Morrongiello et al., 2008). For example, when parents focus their efforts on reducing children's access to hazards as a *substitute* for actively supervising, this can result in more injuries to toddlers (Morrongiello et al., 2004a,b). Similarly, applying teaching about safety as their primary strategy before a child is developmentally ready to learn such information also elevates injury risk for toddlers (Morrongiello et al., 2004a,b). Notably, although one might expect that an injury to the child might evoke a change in parent behavior to reduce risk of repeating the injury, the evidence indicates that this is seldom the case (Peterson et al., 1986, 1995). It was of particular interest, therefore, in this study of infants' injuries to examine the extent to which injuries evoked changes in parental safety practices.

Current Study

Building on past studies of childhood injuries, a participant-event recording methodology was used (cf. Peterson et al., 1995) in which parents tracked their infants' injuries beginning when the infant was just able to sit up independently and proceeding until the infant was able to walk independently, which spanned about 10 months; past research has validated accuracy in parent reporting of recent (past 2 weeks) minor injuries to their children (Curry et al., 2013). Epidemiological data provide summary information about the types of injuries experienced during infancy (e.g., poisoning, drowning, falls). The *aim* of this study, however, was to provide a contextual analysis of the injuries experienced during low (sitting independently), moderate (crawling, climbing, pull to stand), and high (walking independently) levels of motor skills. Thus, the focus was not only on the types of injuries that occurred but the behavioral history of the child (e.g., what behavior led to the injury, whether the child had done this before, and if s/he was injured doing so), the severity of injury, and the parent's reactions to the injury (e.g., did the parent implement safety precautions to reduce future risk of injury). In addition, information about where injuries occurred and what the infant and parent were doing at the time were also examined. Based on past research with older children, we hypothesized that decreased supervision might be associated with more frequent or severe injuries as infants developed motor skills. We also expected that parents' safety practices would be influenced by infants' past behaviors and/or their anticipated future behaviors, though we had no specific hypotheses about the direction of these relations given the paucity of past research.

Materials and Methods

Participants

A final sample of 127 parents (99% mothers) participated, including 62 having a son ($M = 6.91$ months at

first visit, $SD = 1.78$ months) and 65 having a daughter ($M = 7.01$ months at first visit, $SD = 1.88$ months). Note that only one father was included and his data looked similar to that of the mothers in the sample (e.g., completed all measures and on appropriate timelines as expected) so there was no basis for excluding his data. Nonetheless, we use the term "mothers" throughout because this most accurately represents the nature of the sample and those to whom the findings are generalizable. An additional 18 mothers discontinued participation after the first home visit and their data were excluded (12% dropout rate). All infants were reported by parents to be typically developing; the average age at time of walking was 14.90 months ($SD = 2.47$ months; range: 9–26 months).

Participants were recruited throughout the community (e.g., infant swim lessons, baby music classes) or randomly selected from an existing database of families interested in research on child development who had been recruited at the local hospital at the time of the infant's birth. All parents who participated were English speaking, 94% were currently married, and 13% were employed outside the home ($M = 29$ hr/week, $SD = 20$ hr). Parent education level for the sample showed the following distribution: 2% had some or completed high school; 60% had some or completed a University/College degree; and 38% had higher level credentials. The family income distribution was as follows: 6% earned $20,000—$39,999; 8% earned $40,000—59,999; 14% earning $60,000–79,999; and the remaining 72% earned over $80,000 per year.

Overview of Study

After recruitment, parents participated in a biweekly phone call in which they completed a measure of infant motor development status (Motor Development Checklist [MDC]—see below). Once the infant could sit up independently (i.e., without support), home visit 1 was scheduled. Data collection about injuries continued until a month after the child walked independently (i.e., at least three steps without assistance or support on more than one occasion) and then a second visit was scheduled to collect the data sheets.

Measures

Questionnaires

During the first visit, parents completed a Demographic Sheet about parent education and family income level, as well as their ethnic, marital, and employment status.

The MDC was developed by the authors and used to track infant motor status throughout the study's duration. This was a hierarchical rating system based on the integration of three popular measures of infant development: the Bayley Scales of Infant Development (Bayley, 2005), Ages and Stages Questionnaire (Squires & Bricker, 2009), and the Denver Developmental Screening Test (Frankenburg & Dodds, 1967). The MDC includes five levels of motor ability, with higher levels indicative of increasing mobility status (e.g. level 1 = *sitting up without back support* and level 5 = *independent walking)*.

Diary Forms

Parents were asked to complete an *Injury Diary Form* (cf. Morrongiello et al., 2004a,b) each time the target child experienced an injury at home, with injury defined (cf. Morrongiello et al., 2001) as tissue damage (e.g., cut, burn, bump, redness), including evidence suggesting internal (nonvisible) issues, such as symptoms indicating a negative reaction (e.g., vomiting) in response to the ingestion of a hazardous substance (e.g., poison). Past research comparing self-reports with observed parenting behaviors has found that parent self-reports are reliable and valid indicators of a variety of parenting behaviors, including supervision (e.g., Kochanska et al., 1980; Morrongiello & House, 2004; Morrongiello et al., 2006). There also is evidence that parents can give valid and reliable reports about injuries, including when using diary measures (Cummings et al., 2005; Curry et al., 2013; Pless & Pless, 1995).

On the Injury Diary Entry Form parents provided contextual information about the injury, including: what was the nature of the injury (e.g., burn, scrape); where the child and mother each were and what each was doing; and how serious the injury was [0= not at all serious (i.e., may have given the child a hug or kissed the area affected but did nothing at all to treat the injury), 1 = a little serious (parent did something minor to the injury but it was more for the purpose of helping the child calm down and/or feel better than because the injury required treatment, for example, gently rubbing the injury for a few minutes), 2 = somewhat serious (i.e., parent *needed* to do something small to treat the injury, such as cleaning the injury and applying a bandaid), 3 = fairly serious (i.e., parent needed to do something more sustained or involved to treat the injury, such as apply an icepack a few times or put on a tensor bandage and limit the child's movement), 4 = very serious (e.g., took the child to see a doctor or dentist)]. Parents also reported on the historical context (whether the child had done the behavior before and whether they had been hurt doing so), who was in charge at the time of injury (mom, partner/spouse, older sibling/relative/sitter, and no one) and the level of supervision in effect (proximity, attention and continuity of attention) at the time of the injury (*Proximity*: within or beyond reach of child, *Attention and Continuity*: constantly watching,

constantly listening, intermittently watching or listening). They also reported on whether they implemented any change in reaction to the injury to reduce the likelihood of injury recurrence and the nature of these changes (teaching about safety, environmental modification to reduce hazards, and improved supervision).

Procedure

During the initial home visit, parents were familiarized with how to complete the diary recording forms that were organized in a binder. Sample forms were reviewed and completed together to ensure that parents fully understood what was to be done. Participants were contacted by telephone biweekly to check in on the child's motor development level (MDL), remind them about recording injuries, and answer any questions that had arisen. Parents completed injury forms from the time the child was just able to sit up independently until a month after s/he could walk at least three steps independently on two or more occasions. At the conclusion of the study, an interviewer returned to the home to pick up the binder containing diary forms and give the mother pamphlets about child safety and a gift card as a thank you gift.

Data Coding and Reliability

Parents showed excellent compliance in completing diary forms (0.5% of missing data), therefore, no adjustments were made for missing data. Guidelines about coding schemes were consulted (Chorney et al., 2015) and applied in this study. Parents reported on *what the child was doing* that led to injury and these data were coded as follows: nonphysically active play (e.g., sitting on floor and playing with blocks); physically active play (e.g., walking after a truck); physically active nonplay behavior (e.g., climbing on the couch); inappropriate behavior that the mother reports the child should not have been doing (e.g., climbing on bookcase, pulling on lamp cord); or typical nonplay behavior (e.g., walking down or up the stairs). Reliability was established by having a second research assistant code 25% of these reports. Agreement between these scores and those of the primary coder was 91%. The data of the primary coder were analyzed.

Parents also reported on *what they were doing* when their child was injured, with these coded as: chore of some type (e.g., cleaning); activity with child (e.g., playing), activity with someone else (e.g., helping partner do something); and leisure or personal activity (e.g., showering, getting dressed). Reliability was established by having a second research assistant code 25% of these reports. Agreement between these scores and those of the primary coder was 94%. The data of the primary coder were analyzed.

Parent reports about *supervision* (proximity, attention and continuity in attention) were assigned a score ranging between 1 and 6, with higher numbers indicating greater supervision (1 = beyond reach + intermittent attention, 2 = beyond reach + constant listening, 3 = beyond reach + constant watching, 4 = within reach + intermittent attention, 5 = within reach and constant listening, and 6 = within reach and constant watching). Reliability was established by having a second research assistant code 25% of these reports. Agreement between these scores and those of the primary coder was 96%. The data of the primary coder were analyzed.

Analytic Approach

The primary focus of this report was on examining contextual factors relevant to injuries as a function of motor development capabilities of infants. Injuries were grouped by three levels of MDL: *low* (MDL = 1, sitting), *moderate* (MDL= 2 or 3 or 4, crawling, pull to stand, climbing), or *high* (MDL = 5, walking). Because of the low incidence of some types of injuries (i.e., drowning, choking, poisoning, strangulation, and suffocation—all summed to less than 2% of injuries), we excluded these and analyzed the remaining four types of injury: (a) burn related (e.g., food, scald); (b) cuts, scrapes, and puncture injuries; (c) bumps and bruises; and (d) multiple injury types. The incidence of injuries of each type within each MDL was converted to proportion scores for analysis; the exact same pattern of significant effects were obtained when the rates of injuries were analyzed, but proportion scores are more intuitively easy to interpret so they are reported herein. The average rate of injury per month for low, moderate, and high MDL was 0.68, 0.82, and 2.17 (SD = 3.79, 2.99, and 4.32), respectively.

Because injury scores were non-normally distributed and there was no transformation that remedied this issue, we used nonparametric analyses. The Friedman test of differences among means is comparable to a one-way Analysis of Variance test and was conducted initially as an omnibus test; note that this test precludes our controlling for age or other variables. A significant Friedman test was then followed-up with Wilcoxon Signed Rank tests to conduct paired comparisons and identify significant differences; a Bonferroni correction was applied when multiple paired-tests were conducted in following up a significant Friedman test. Mann–Whitney U tests were applied to test for sex differences in the frequency of injuries for boys and girls at each level of motor development and in the level of supervision, and there were no significant differences, $p > .05$. To streamline the reporting in the Results we do not report these nonsignificant effects throughout. Finally, to assess for associations between variables of interest, Spearman's Rho correlations were conducted.

Results

Where Did Injuries Occur?

Parents indicated the location of their child in the home at the time of injury, with these grouped into three options: (a) nonplay room (e.g., kitchen); (b) child play area (e.g., playroom); or (c) a non-room area (i.e., hall, stairs, basement). The proportion of injuries in each area at each MDL was analyzed and Friedman tests indicated significant variation in the location of injuries when infants had low, moderate, and high levels of motor skills, X^2 (2)= 36.81, 68.66, and 15.78, respectively, $p < .001$. Wilcoxon tests (Bonferroni correction) indicated the same pattern for injuries at all levels of MDL. Injuries occurred as frequently in rooms the child played in as in rooms s/he was not expected to play in, $p > .05$. Thus, the child being in a designated play area did not secure their safety any more than them being in a nonplay room. Not surprisingly, a greater proportion of injuries occurred in these nonplay rooms and play rooms than in non-room locations (low: $M = 0.50$, 0.46, and 0.04, SD = 0.42, 0.42, and 0.15, respectively; moderate: $M = 0.44$, 0.46, and 0.10, SD = 0.33, 0.34, and 0.20, respectively; high: $M = 0.42$, 0.36, and 0.21, SD = 0.37, 0.37, and 0.34, respectively), $p < .001$.

What Types of Injuries Occurred and How Serious Were These?

The proportion of injuries of each type (burn, cut/scrape/puncture, bump/bruise, and multiple) at each MDL (low = sitting, moderate = crawling, pull to stand or climbing, and high = walking) are given in Table I. A Friedman test revealed significant differences as a function of type of injury when infants' mobility skills were low [X^2 (3) = 89.52, $p < .001$], moderate [X^2 (3) = 198.79, $p < .001$], and high, X^2 (3) = 70.49, $p < .001$. Follow-up paired comparisons based on Wilcoxon tests (Bonferroni correction) revealed significant differences between all types of injury when MDL was low, $p < .05$. At moderate levels of motor skills, there were more bump/bruise injuries than any other type ($p < .05$), more cuts than multiple injuries ($p < .05$), and burns were infrequent and did not differ from the frequency of multiple injuries, $p > .05$. The same pattern of differences occurred when MDL was high except that multiple injuries were more frequent than burns, $p < .05$. Thus, bumps/bruises were the most common types of injury during infancy, followed by cuts. Other types of injuries were generally infrequent.

Comparing each type of injury across MDLs revealed no difference in the low incidence of burns across MDL, $p > .05$. A similar finding emerged for cuts, $p > .05$, bumps and bruises ($p > .05$), and multiple injuries, $p > .05$. Thus, throughout infancy the same ranking of type of injury was observed, with falls (resulting in bumps and bruises) being the most common mechanism of injury.

Table I. *Mean (SD) Proportion of Injuries of Each Type as a Function of Motor Development Level (MDL; Low = Sitting Independently; Moderate = Crawling/Climbing/Pull to Stand; High = Walking Independently)*

MDL	Type of injury			
	Burn	Cut	B/B	Multiple
Low	0.03 (0.02)	0.21 (0.30)	0.68 (0.38)	0.08 (0.27)
Moderate	0.02 (0.11)	0.19 (0.27)	0.74 (0.31)	0.05 (0.18)
High	0	0.23 (0.34)	0.70 (0.37)	0.07 (0.21)

Note. BB = bump/bruise.

For each injury, parents rated how serious the injury was, with higher numbers indicating greater severity (0–4 rating scale). These scores were then averaged for all injuries within an MDL to obtain one overall score for each participant for each MDL. A Friedman test comparing severity ratings across MDLs revealed injury severity varied with level of motor development, X^2 (2) = 17.89, $p < .01$. Wilcoxon paired-comparisons (Bonferroni correction) revealed the average severity ratings increased from 1.28 ($SD = 0.46$) when infants had low levels of motor skills to 1.55 ($SD = 0.41$, $p < .05$) when infants had moderate levels of motor skills and to 2.73 ($SD = 0.75$, $p < .05$) when infants reached high levels of motor development and could walk. Thus, as infants acquired greater motor skills during infancy the severity of their injuries increased.

What Was the Child Doing That Led to Injury and Had S/He Done This before?

The proportion scores for what the child was doing at time of injury are given in Table II. Friedman tests indicated significant variation at low, moderate, and high levels of motor skills, X^2 (4) = 50.01, 137.75, and 91.45, respectively, $p < .01$. Wilcoxon paired-comparison tests (Bonferroni correction) revealed that at low motor skills, more injuries resulted from Play-Nonphysically Active and Physically Active-Nonplay and Typical behaviors than either Physically Active play or Inappropriate behavior, which did not differ from each other. When infants had moderate motor skills, injuries most often resulted from Physically Active-Nonplay than any other actions, $p < .05$, with Typical behavior falling second and exceeding injuries during play and from Inappropriate actions (see Table II). Finally, when infants could walk well and were high in motor skills, injuries most often occurred from their being physically active when not playing, which exceeded all other causes of injury, $p < .05$.

Parents also reported on whether the child had done the injury-resulting behavior before. When infants were low on motor skills, about 64% reported

Table II. *Mean (SD) Proportion of Injuries Resulting From Different Types of Activities as a Function of Motor Development Level (MDL; Low = Sitting Independently; Moderate = Crawling/Climbing/Pull to Stand; High = Walking Independently)*

MDL	PL-PA	PL-Not PA	PA-Non PL	INA	Typical
Low	0.07 (0.22)	0.34 (0.41)	0.32 (0.38)	0.01 (0.07)	0.25 (0.38)
Moderate	0.11 (0.22)	0.09 (0.16)	0.54 (0.34)	0.05 (0.11)	0.21 (0.28)
High	0.20 (0.34)	0.03 (0.09)	0.52 (0.40)	0.05 (0.15)	0.20 (0.32)

Note. PA = physically active; PL = play; INA = inappropriate.

the child to have done this before, with 52% saying the child had been previously hurt in this way. When infants had moderate motor skills, about 63% had done the injury-resulting behavior before, with 41% of them having gotten hurt before. When infants had a high level of motor skills, about 58% had done the injury-resulting behavior before, with 51% of these having gotten hurt before. Thus, across MDLs, for about 40–50% of injuries the child did something they had not done before. However, the remaining 50–60% of injuries presumably could have been anticipated, given the child had done the behavior previously and was often hurt doing so.

Correlations revealed that the child having done the behavior before was associated both with parents' ratings of injury severity and their likelihood of implementing safety precautions in reaction to the infant being injured, and these associations varied with the infant's MDL. Specifically, the more the child did the behavior in the past, the more the parent downplayed the seriousness of the injury for infants high in motor skills, r (85) = −.25, $p < .05$; this association was not significant when infants had fewer motor skills. Additionally, the more the child had previously done the behavior that led to injury, the fewer preventive actions were implemented in reaction to the child being injured, and this was true when infants had low, moderate, and a high level of motor skills, r (121) = −.27, −.19, and −.33, respectively, $p < .05$.

What Was the Parent Doing at the Time of Injury?

What the parent was doing at the time of injury is shown in Table III. A Friedman test revealed significant variation in parent activities at the time of injury when children had low, moderate, and high motor skills, X^2 (3) = 23.58, 82.74, and 39.14, respectively, $p < .001$. Wilcoxon tests (Bonferroni correction) revealed that when infants were able to sit, injuries were as likely to happen when the parent was doing chores as when the parent was engaged in a leisure activity or doing something with the infant ($p > .05$). In contrast, when infants could crawl and walk, injuries occurred when parents were doing chores more than any other activity ($p < .05$). At moderate levels of motor skills, doing something with the child exceeded engaging in leisure activities, whereas when infants were walkers, injuries were as likely to occur when the parent was engaged in a leisure activity as when they were doing something with the infant (see Table III). At all stages of motor development, significantly fewer injuries occurred when parents were doing something for someone else compared with any other activity, $p < .05$.

Who Was Supervising and How?

The person in charge at the time of injury was typically the mother (low: 81% of injuries; moderate: 80%; high: 71%) rather than the other parent (low: 12%; moderate: 15%; high: 20%), older sibling/caregiver (low: 3%, moderate: 1%, high: 5%), or no one in particular which effectively meant the child was not being supervised (low: 4%; moderate: 4%; high: 4%). All Friedman tests confirmed the proportion of maternal supervisors exceeded all other types, X^2 (3) = 123.96, 225.10, and 132.92, respectively, $p < .001$. In terms of supervision at the time of injury, supervision scores declined with increasing motor development (M = 4.59, 3.65, and 3.53, SD = 1.55, 1.36, and 1.61, respectively), X^2 (2) = 19.86, $p < .05$. When infants were low in motor skills, supervision was greater than when they were at a moderate and high level of motor capability.

To assess parental beliefs about the preventability of the injury that had occurred, parents were asked to give a rating to indicate their extent of agreement with the statement that "the injury could have been prevented if the infant had been more closely supervised" (range 1–6; 1 = disagree strongly, 4= agree a little, 6 = agree completely). There were no differences across MDL, with parents disagreeing (M = 2.33, SD = 1.56), $p > .05$. Thus, parents did not believe in the preventability of injuries during infancy, regardless of the child's level of motor skills.

Did Parents Implement Precautions to Prevent Injury Recurrence?

For each injury, parents reported on if they had taken any preventive action to reduce risk of injury recurrence. With increasing motor development, parents implemented *fewer* preventive actions in reaction to their baby experiencing an injury. Specifically, they implemented a preventive action in response to 40% of injuries at low, 27% at moderate, and only 20% of the time when infants were independently mobile. For

Table III. *Mean (SD) Proportion Scores Showing What Parent Was Doing at the Time of the Infant's Injury as a Function of Motor Development Level (MDL; Low = Sitting Independently; Moderate = Crawling/Climbing/Pull to Stand; High = Walking Independently)*

MDL	Chores	Activity with child	Activity with others	LP
Low	0.29 (0.37)	0.37 (0.36)	0.09 (0.24)	0.25 (0.37)
Moderate	0.44 (0.33)	0.29 (0.28)	0.07 (0.18)	0.20 (0.26)
High	0.39 (0.37)	0.30 (0.35)	0.07 (0.17)	0.24 (0.35)

Note. LP = leisure or personal activity.

times when they implemented a preventive action, they were asked to allocate 100 tokens to reflect how much of the time they implemented each type of strategy in reaction to the child's injury: supervise more, teach about safety, environmental change to reduce hazards. These scores were then averaged to obtain an overall score for how much they did each preventive action in response to injuries when their infants were at low, moderate, and high motor development stages. A Friedman test revealed significant variation in prevention strategy at each motor development stage, X^2 (3) = 37.02, 76.10, and 51.11, respectively, $p < .001$. Wilcoxon-paired tests (Bonferroni correction) revealed the same pattern of significant differences when infants had low and moderate motor skills, with environmental modifications being the most frequent precaution compared with the others ($p < .05$) and supervision exceeding teaching, $p < .05$. When infants were high in motor skills, environmental change also was the most frequent precaution implemented ($p < .05$), but supervision was now as *infrequent* as teaching, $p > .05$.

Correlations were conducted to determine if injury severity was associated with any particular injury prevention action (supervision, teaching, and environment modifications) at different levels motor development. For environmental modifications, greater injury severity ratings were associated with more parent actions to reduce infants' access to hazards when infants had moderate and high levels of motor skills but not when infants had limited motor skills, r (34) = .45 and .30, respectively, $p < .05$. Similarly, for supervision, more severe injuries were associated with greater reactionary supervision when infants had moderate and high levels of motor skills but not when they were at a low MDL, r (63) = .18 and .39, $p < .05$. No significant correlations emerged between injury severity and parents' reacting to injury by increasing teaching about safety, $p > .05$ (Table IV).

Discussion

Epidemiological data highlight that infants are at high risk for unintentional injuries and many of these occur in the home (Nouhjah et al., 2017; Reading et al., 1999; Xu et al., 2018). This longitudinal study examined such injuries in depth, yielding the data needed to execute a contextual analysis of in-home injuries experienced over an ~10-month period as infants transitioned from just sitting up alone to crawling or climbing or pulling to stand and then being fully independent walkers. Although the injuries reported herein by parents were minor ones that did not necessitate a visit for treatment by a health professional, the study of minor injuries can advance our understanding of more severe injuries. Peterson et al. (2002), for example, found that for 72% of 2,483 injuries children experienced at home over a 6-month period judges rated the potential for the injury to be significantly more severe. In a study of 2 and 3 year-olds, Morrongiello et al. (2004a) found a strong positive association between minor injuries during a 3-month period and serious injuries that the children had experienced during the 6 months prior to the study. Similarly, minor injuries to children in grades three through six showed significant concurrent associations with their rate of medically attended injuries (Karazsia & van Dulmen, 2010). Even research with adolescents reveals good predictive validity of minor injuries to medically attended ones (Karazsia & van Dulmen, 2011). Thus, the evidence suggests that minor injuries are reasonable proxies for more severe injuries and the study of these can advance our understanding of factors that contribute to medically attended injuries. The results of this study provide a number of insights that have implications for parents' safety practices to prevent injuries to infants in the home.

Some aspects of injuries were similar across MDLs and other aspects showed meaningful differences. The most common types of injury throughout infancy were bumps and bruises. The fact that two-thirds of injuries were due to bumps and bruises when infants have limited motor skills (e.g., only able to sit up) highlights that they can still manage to fall in early infancy and they apparently do so often. Falls are a leading cause of nonfatal hospital visits *throughout* childhood until 14 years of age (Taylor et al., 2017; Wang et al., 2013), and infants suffer more severe injuries than older age children (Unni et al., 2012), with these often

Table IV. *Mean (SD) Proportion Scores Showing the Extent to Which Parents Implemented Each Type of Safety Precaution in Response to Infants' Injuries as a Function of Motor Development Level (MDL; Low = Sitting Independently; Moderate = Crawling/Climbing/Pull to Stand; High = Walking Independently)*

MDL	Supervise more	Teach safety	Environment change
Low	0.29 (0.44)	0.07 (0.24)	0.64 (0.45)
Moderate	0.27 (0.36)	0.13 (0.29)	0.59 (0.40)
High	0.14 (0.28)	0.11 (0.27)	0.75 (0.38)

occurring to infants when at home (Haarbauer-Krupa et al., 2019). Surprisingly, however, research suggests that parents do not consider falls a cause for concern (e.g., Morrongiello & Kiriakou, 2004; Morrongiello et al., 2011). They do not seem to realize that head-heavy infants are at particular risk for experiencing severe injuries from falls (Unni et al., 2012). The specific ways that infants behave that lead to falls varies with motor skill level: rolling is more likely for pre-mobile infants, whereas climbing occurs more frequently for mobile infants who can walk (Haarbauer-Krupa et al., 2019). Nonetheless, drawing on the current findings to emphasize to parents how common falls are *throughout* infancy may create greater readiness for them to implement precautions to prevent these events, including changing their own behaviors (e.g., parents were often doing chores at the time of injury). This messaging may be particularly effective if concussion risk and potential long-term negative impacts on learning are emphasized because parents are increasingly familiar with concussions and they are very concerned about injuries that can produce longer-term learning impacts (Morrongiello et al., 2009b).

Though the type of injury did not vary with motor skill level, as infants acquired greater motor abilities the severity of injury increased. Consistent with this, more injuries resulted from infants being motorically active, whether playing or not. Thus, it seems that infants' expanding behavioral repertoire with age is associated with more serious injuries though not necessarily with different types of injuries. Interestingly, throughout infancy, regardless of motor skill level, about 25% of injuries occurred when the child was doing routine activities of daily living (e.g., eating). Previous research has found that young children's behavioral unpredictability is a risk factor for injury because parents do not anticipate these actions and are not supervising in a manner to intervene and moderate this unexpected injury-risk behavior (Morrongiello et al., 2008). Consistent with this, about 40% of injuries in this study, averaged across MDLs, resulted from infants doing something they had not done before. To prevent injury when infants do unexpected things, being within arms' reach and sustaining full attention is likely to be critical. The importance of these dimensions of supervision has been previously established through studies of injuries to toddlers and preschoolers (e.g., Pollack-Nelson & Drago, 2002; Morrongiello et al., 2004a,b; Schnitzer et al, 2015). The current results extend this conclusion to lower ages and suggest that proximity and continuity in attention are important for injury prevention *throughout* infancy, even when infants have limited motor skills and can only sit up independently.

Notably, about 60% of injuries resulted from infants doing something they had done before, and at least half the time they had previously been injured doing so. Parents presumably could have anticipated the likelihood of these behaviors and children's risk of injury. However, they only initiated a preventive action in response to an injury 40% of the time when infants were able to sit, and this steadily declined to reach only 20% by the time infants were able to walk without supports. Hence, as infants gained in their motor capabilities throughout the study, which would allow them to engage in *more* risk behaviors, parents did not increase their efforts to initiate precautions to prevent injury recurrence but actually *decreased* these efforts. Peterson and Tremblay (1999) and Peterson et al. (1986) also noted in their longitudinal studies of injuries to toddlers and to school-age children that parents did not often implement a preventive action in response to their child's injury. Possibly, this pattern of findings reflects the fact that parents do not rate injury preventability as high, which is evident not only in this study but also in previous studies of parental beliefs about injuries (see Morrongiello & Corbett, 2008, for review). Convincing parents that injuries are preventable and not "accidents" is a recognized challenge in the injury prevention field (Yanchar et al., 2012). Nonetheless, intervention research with parents of preschool children demonstrates that messaging that increases parents' perception of the potential severity of resulting injuries, including the possibility of longer-term effects on the child's cognitive functioning (e.g., memory, learning), can be effective to enhance parents' injury-prevention practices (Morrongiello et al., 2009b). Some aspects of the current data suggest similar processes may be operating for parents of infants. Specifically, greater injury severity was positively associated both with parents implementing more environmental modifications and increasing supervision, which are both strategies that could reduce a child's risk behaviors and interactions with hazards. Emphasizing injury severity risks for falls among head-heavy infants, therefore, may be particularly effective to motivate parents of infants to implement safety precautions in their home.

It is of interest to note that there were no sex differences in the incidence of injuries at any motor development stage in this study which concluded when infants

were ~18 months of age. Previous longitudinal studies of in-home injuries among 2-year olds have noted similar results (e.g., Morrongiello et al., 2004a,b, 2006). By the time children are 3–4 years of age, however, studies have found that boys engage in more risk taking and experience more frequent and severe injuries than girls' (e.g., Ginsburg & Miller, 1982; Rosen & Peterson, 1990). This emergence of sex differences in risk taking and injuries is believed to reflect both biological-based differences as well as socialization effects (see Morrongiello & Dawber, 1998, 1999, for discussion). Suffice it to say, the pattern of these developmental findings suggests that injury prevention messaging to promote safety practices by parents can be broadly applied whether they have an infant son or daughter. However, tailoring these messages to emphasize the particular vulnerability that sons experience beyond infancy may be warranted to increase effectiveness and impact on parents' safety practices. Boys have been found to be faster in hazard interactions, more persistent in doing so, and more resistant to parent efforts to redirect them away from hazards (Morrongiello & Dawber, 1998). Parent proximity, therefore, may be particularly important to secure the safety of young boys.

In terms of prevention strategies, parents reported using teaching, supervising, and hazard removal to varying degrees. The level of teaching about safety was relatively low throughout infancy, which is appropriate given infants have a limited understanding of danger. Generally, parents emphasized removing access to hazards more so than teaching about safety or supervising. Surprisingly, however, when infants transitioned to being independently mobile (i.e., faster to locomote, stronger to climb), parent supervision declined and hazard removal increased, which suggests that parents considered removing access to hazards as a reasonable alternative to supervising by attending and remaining proximal to their infant. Previous research with toddlers 2 years and older has revealed that hazard removal is *not* an adequate substitute for supervision to prevent injuries—in fact, doing so increased children's frequency of in-home injuries (Morrongiello et al., 2004b). Throughout early childhood, therefore, parents seem to have the mistaken belief that reducing access to hazards is a reasonable alternative to actively supervising by watching and staying proximal (Greaves et al., 1994). Messaging that counters this belief may be necessary so that supervision remains a key strategy used by parents for injury prevention *throughout* infancy and even as they take action to remove hazards.

Limitations and Future Research Directions

Despite the insights gained from this study there are some limitations to be acknowledged and a number of important questions to be addressed in future research. First, the sample was fairly homogeneous, being predominantly white, well educated, and middle-high income. Including a more diverse sample in future research is essential to determine if the current conclusions are generalizable to parents having more varied demographic attributes. An income gradient exists for injuries such that youngsters in low-income families experience a disproportionately high rate of injury (Birken & Macarthur, 2004). Hence, research studying parental safety efforts in lower-income families and factors that influence these practices is sorely needed. Utilizing cell phones with software that enables asynchronous interviews so that respondents can complete these at their convenience could reduce barriers to participation and enhance inclusion of a more diverse sample in future research. Second, there was only one father included in the sample, so the findings essentially represent only the views of mothers. Although some research indicates similarities in how mothers and fathers supervise very young children (Morrongiello & Dawber, 1998; Morrongiello et al., 2009a), other research has found that fathers and mothers of older children differ in their tolerance of children's risk taking, with fathers being more tolerant than mothers (e.g., Brussoni & Olsen, 2011). Thus, there may be meaningful differences in how mothers and fathers react to children's injuries that have implications for injury prevention programming targeting parents. Further research is needed to examine this issue and determine if different messaging is needed to impact the safety practices of mothers versus fathers. Finally, although parents were asked to record injury events, it is possible that they underreported these due to social desirability and wanting to portray a positive image as a parent. Although their reports indicate that for about 4% of the injuries there was no supervisor, which suggests openness and honesty in reporting, one cannot be certain of the accuracy of parental reports. Incorporating an observational component to assess parental safety practices directly when hazards are present in the home (e.g., Morrongiello et al., 2015) would greatly enrich our understanding of parental efforts to keep their infants safe.

These findings leave several important questions unanswered that are relevant to injury prevention planning. First, past research has shown that parents extend differential efforts to prevent injuries depending on the *type of injury* threat, with different injury beliefs (vulnerability, severity, and preventability) motivating different injury-specific prevention practices (Morrongiello & Kiriakou, 2004; Peterson et al., 1990). Examining parent safety beliefs and practices as a function of type of injury threat as infants age might elucidate particular beliefs to address depending on the type of injury one is working to prevent. Second, findings from this and other studies focusing

on older children indicate that parents sometimes respond to injuries by doing nothing to prevent recurrence. Hypothesized explanations for this include that with repeated injuries parents come to believe that these events are not preventable (Peterson et al., 1990), that there is desensitization and reduced worries with accumulating minor injury experiences by their child (Morrongiello & Dawber, 2000), and that parents may anticipate benefits to injury outcomes such as their child learning risk avoidance over time (Morrongiello & Corbett, 2008). Suffice it to say, our limited understanding of this phenomenon is a barrier to our prevention efforts. Research to elucidate the factors that influence whether parents make this decision, and if/how these factors vary with children's developmental status, is sorely needed so that injury prevention strategies can effectively promote parents' consistently responding to children's injuries by taking preventive actions. Finally, most research focuses on parents' current or recent safety practices and how these influence children's risk of injury. However, during infancy when there are frequent and dramatic developmental changes in motor competencies the ability to *anticipate* their child's emerging behavioral competencies is particularly important for injury prevention. Hence, research is needed to study parents' expectations about their infants' emerging behaviors in the upcoming months and if they anticipate the need to modify their home-safety practices in response. Relating these parental judgments to infants' injuries over time could suggest additional factors to focus on in injury prevention messaging for parents.

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