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Abstract

Objective The present study used a case-crossover design to investigate the association of caregiver alcohol consumption and supervision to children's injury occurrence and severity.
Method A community sample of 170 mothers of toddlers was interviewed biweekly about their children's daily injuries for a period of 6 months. **Results** Proximal caregiver-reported alcohol use predicted higher likelihood of injury occurrence and higher injury severity, whereas caregiver-reported supervision predicted lower likelihood of injury occurrence and lower injury

severity. **Conclusion** Even at low levels, proximal caregiver alcohol use may contribute to higher risk for childhood injuries and more severe injuries. The combined effect of supervision and drinking on injury likelihood warrants further exploration.

Unintentional injuries are the leading killer of 1- to 4-year-old children in the United States (Martin, Kochanek, Strobino, Guyer, & MacDorman, 2005). Although several studies have found that alcohol use in adults is related to increased risk for injury (Cherpitel et al., 2003; Vinson, Maclure, Reidinger, & Smith, 2003; Watt, Purdie, Roche, & McClure, 2004), few investigators have considered the effect of caregiver alcohol use on the children who are in their care.

As noted in Bronfennbrenner's (1979) social–ecological model of child development, children's environments impact their growth and development. Caregiver alcohol use, an important aspect of children's environments, has been found in previous studies to have a negative impact on children's development (Bijttebier, Goethal, & Ansoms, 2006; White, Johnson, & Buyske, 2000), including an increased risk for unintentional injuries (Bijur, Kurzon, Overpeck, & Scheidt, 1992). Bijur et al. (1992) conducted one of the only studies to examine the effect of caregivers' (both mothers and fathers) alcohol use on children's serious injuries. Using a large (n = 12,360) nationally representative sample, they found that children (younger than age 18) of problem drinkers and alcoholics were more likely than other children to sustain medically attended injuries. However, this study only investigated distal adult drinking (i.e., overall pattern of drinking behavior) and did not examine the relation between parents' proximal alcohol use (i.e., drinking occurring at a particular point in time) and children's risk for injury. Yet, recent research regarding injuries in adults

suggests that proximal exposure to alcohol is a better predictor of personal injury than is drinking pattern, and that risk increases acutely even with low levels of alcohol intake (Vinson et al., 2003).

Another limitation of the Bijur et al. (1992) study is that it used a between-subject design which does not control for interindividual third variables, such as impulsivity in the parent or child. A within-subject, event-based analysis is a powerful approach that can be used to rule out the effects of between-subject confounders in research on alcohol and injury (Vinson et al., 2003). Without such a design it is difficult to disentangle the effects of proximal caregiver behaviors (i.e., drinking while supervising a child) from stable caregiver characteristics (i.e., alcoholism).

While caregiver alcohol use has been found to be related to higher risk of childhood injury, several researchers have found that caregiver supervision may reduce the risk for childhood injury (Morrongiello & House, 2004; Morrongiello, Midgett, & Shields, 2001; Morrongiello, Ondejko, & Littlejohn, 2004; Schwebel & Bounds, 2003; Wills et al., 1997). Recent research has also found that maternal supervision may be protective for children who possess injury risk factors (e.g., externalizing behavior). Indeed, Schwebel, Brezausek, Ramey, and Ramey (2004) reported that the amount of time parents had available to be with their children (a potential proxy for supervision) mitigated the effect of child hyperactivity on children's injury frequencies. Maternal supervision may also mitigate the effects of other social–ecological risk factors, such as maternal drinking. For example, Bijur et al. (1992) suggested that caregiver drinking may be related to children's injuries because of children's exposure to higher risk situations (e.g., a lake or pool). Increased caregiver supervision, then, might moderate the effects of risky situations on children's injuries because

caregivers who are supervising closely could easily intervene to stop injuries from occurring (e.g., telling a child to stay away from the water).

Given the limited research on caregiver drinking and children's injuries, the primary goal of the present study was to examine whether proximal caregiver alcohol use predicted child unintentional injury outcomes (i.e., injury occurrence and injury severity). A secondary goal was to examine the role of supervision in the relation between alcohol and injury outcomes. Accordingly, we examined whether caregiver supervision would moderate the effect of caregiver alcohol use on child injury outcomes.

Methods

Participants

Data for the present investigation were drawn from a larger study investigating unintentional injuries in young children (Peterson, DiLillo, Lewis, & Sher, 2002). For this larger study, mothers with singleton toddlers were recruited from a mid-size midwestern community through flyers distributed to day care centers and parent groups, weekly advertisements in the local newspaper, and telephone calls to patients from a pediatric clinic list. Families were ineligible for participation if (a) they had more than one child at home, unless the child was >10 years older than the target child, (b) the child had a developmental disability, (c) the child had been hospitalized overnight for a previous injury, and (d) English was not the mother's primary language. Criterion (a) was used to ensure that the mothers' injury prevention practices did not differ based on child birth order, and criteria (b) and (c) were used to prevent differences in mothers' supervision due to unusual child characteristics or experiences (i.e., serious injuries). Criterion (d) was used to ensure that mothers could easily participate in the interview

process. The original sample consisted of 181 mothers; however, 11 mothers dropped out of the study before it was completed, resulting in a final sample of 170 mother–child dyads. There were no significant differences on demographic variables between mothers who completed the study and those who dropped out. Child participants were between 15–18 months and 33–36 months of age, with approximately equal numbers of boys (54%, n = 92) and girls (46%, n = 78). Mean child age was 24 months, (SD = 7 months); 44% of children were between 15 and 18 months, and 56% were 33–36 months old. Mothers were predominately Caucasian (91%), married (83%), in their mid-to-late 20s (M = 28.8, SD = 4.43), college educated (80%), and earned >$30,000 yearly (78%).

Procedure

Consent was gathered from mothers before their participation, and mothers were notified that their data would be kept confidential. Exceptions to confidentiality were explained, including circumstances involving child maltreatment and potential harm to self or others. Mothers monitored and recorded the antecedents and consequences of minor injuries to their children for a period of 6 months using the Participant Event Monitoring method (PEM; Peterson, Brown, Bartelstone, & Kern, 1996). Study interviewers instructed mothers to record detailed information about child injury occurrences, so that the mothers could recall the details of the events during structured interviews. Mothers were also instructed to gather detailed data about injuries that occurred under the supervision of other caregivers (i.e., fathers) when mothers were not the primary supervisors. To compare child and caregiver behaviors in situations in which injuries occurred to those in which no injuries occurred, mothers were also instructed to record data about their child's activities and surroundings during times when no

injuries occurred (i.e., control conditions). To make the control conditions similar to the circumstances surrounding injuries, control conditions were matched to days and times in which previous injuries had occurred. Specifically, during each biweekly interview, interviewers chose each child's most severe injury, and instructed the mother to record information about the child's behavior and location during the same day and time for the following week. For example, if the child's most severe injury occurred on Tuesday at 10 a.m., the control condition would be the following Tuesday at 10 a.m, and the mother would be instructed to record the child's activity and surroundings at that time. If the child had not sustained any injuries during the 2-week period, the interviewers randomly selected a day and time for the next control condition.

Unintentional injuries were defined as an outcome of an unintentional event that could be seen (e.g., bruise) or felt (e.g., muscle pain) by the child or other for at least 24 hr after the event. During the interview, mothers were asked whether the child's injury was intentional (e.g., from another child) or unintentional. A small number of injuries were intentional (4.4%, n = 57); these injuries were excluded from the analyses because the focus of the study was on unintentional injuries. Postcollege research assistants who were extensively trained in the PEM method interviewed mothers in their homes biweekly for a period of 6 months to gather injury data. Although mothers were interviewed about all of their children's injuries, they were caregivers for only 70% of the injury or control events. Fathers were the primary caregivers for 14% of events. If someone other than the mother was identified as the primary caregiver during the injury, mothers gathered information from the other caregiver and reported it during the interviews. Given the fact that mothers' second-hand reports of other caregivers' drinking and supervision may be less accurate than reports of their own

behaviors, we conducted the analyses below in two ways; we first examined data for events in which either mothers or fathers were supervising and then examined the data using only instances in which mothers were supervising. We excluded the 16% of observations in which caregivers other than mothers or fathers (e.g., daycare providers) were the primary supervisors because we were concerned that these reports were even less likely to be accurate than mothers' second-hand reports of fathers' behaviors. Mothers' responses to questions related to supervision, alcohol use, and child injuries were used to construct the variables of interest.

Measures

Caregiver-reported Alcohol Consumption[1]

Caregiver alcohol consumption was assessed by first asking mothers, if at the time of their child's injury, they or the caregiver at the time of the injury had used any alcohol in the past 24 hr. Their answers were coded as "yes" or "no." If the mother answered "no," a 0 was recorded for the number of drinks. If the mother answered "yes," then they were asked to indicate how many and what type of drinks the caregiver had consumed (the exact time of the alcohol consumption was not recorded). One drink was defined as 12 ounces of beer, six ounces of wine, or one ounce of hard liquor.

Caregiver-reported Supervision

Caregiver supervision levels were assessed by coding mothers' responses to a question about how closely the caregiver was supervising at the time of each injury event. Specifically, mothers described what the caregiver was doing at the time of the injury event, whether or not the caregiver was engaged in an activity with the child, and how many feet the caregiver was from the child. This information was then coded by the interviewer on a 7-

point Likert scale (1 = caregiver and child were <6 feet apart, with the caregiver not engaged in any other activity, to 7 = caregiver had no visual or auditory contact and could not have reached the child within 30 s). These scores were reverse coded for the present analyses so that "7" was the highest level of supervision and "1" was the lowest. The average pairwise coding reliability for all six interviewers was excellent (r =.90). Mothers were questioned about supervision prior to reporting the amount of alcohol that the caregiver had consumed to reduce the chances that their answers would be influenced by social desirability; however, the authors are aware that questioning the mothers about their or other caregivers' supervision use after asking about the injury may also have resulted in socially desirable responses.

Minor Injury Severity Scale

The Minor Injury Severity Scale (MISS; Peterson, Heiblum, & Saldana, 1996) is a reliable measure used to evaluate the actual tissue damage incurred from injuries. Trained coders used descriptions of the injuries obtained from PEM data to rate injuries on a 0 (no tissue damage) to 6 (a disabling injury or death) scale. During the PEM training, mothers were instructed to draw life-size pictures of each injury that their child sustained, and indicated the location of each injury on front and back view pictures of a child's body. Interviewers also gathered data specific to certain types of injuries (e.g., blood loss and size of injury). This detailed information allowed raters to score each injury based on information such as size, shape, depth, amount of blood loss, and location on the body. Interclass correlations for pairs of raters ranged from.61 to.82. Injury severity could only be coded for injury events and could not be coded for control conditions because no injuries occurred during the control conditions.

Results

Descriptive Data

Two different approaches to data analysis were used for the present study. When examining injury occurrence, we used a sample of 2,154 events that were divided into injury events that were matched to an approximately equal number of noninjury (i.e., control) events to permit the use of a within-subject, case-crossover analysis (see below for more detail; Maclure, 1991). Thus, this data set included both injury events and control conditions.

The data set used for examining injury severity was slightly smaller than the other (n = 2,056) because, although we included data for all injury events (including those that were not matched to control conditions), we did not include control conditions. Descriptive statistics were similar for both samples and consequently results from the matched injury/no injury (n = 2,154) sample will be reported below. Descriptive statistics reported by gender are also shown in Table I.

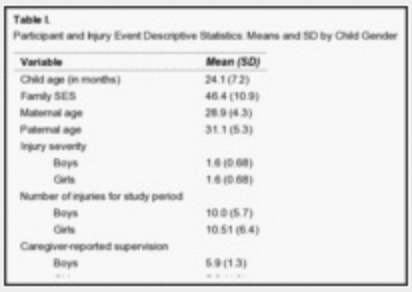

Table I.
Participant and Injury Event Descriptive Statistics: Means and SD by Child Gender

Variable	Mean (SD)
Child age (in months)	24.1 (7.2)
Family SES	46.4 (10.9)
Maternal age	28.9 (4.3)
Paternal age	31.1 (5.3)
Injury severity	
Boys	1.6 (0.68)
Girls	1.6 (0.68)
Number of injuries for study period	
Boys	10.0 (5.7)
Girls	10.51 (6.4)
Caregiver-reported supervision	
Boys	5.9 (1.3)

See full table

Table I. Participant and Injury Event Descriptive Statistics: Means and SD by Child Gender

The mean number of drinks that caregivers reported consuming while supervising their children was less than one drink (M = 0.06, SD = 0.38), and the maximum was 12 drinks. Zero drinks were reported on the majority (96%) of occasions. On those 74 occasions when caregivers did report

drinking, caregivers reported consuming only one drink or less during 41 (i.e., 55%) of those times and two drinks on 19 (26%) of occasions. On the remaining 19% of drinking occasions caregivers reported drinking 3–12 drinks (3 drinks on 5.4%, 4 drinks on 8.1% of, 6 drinks on 1.4%, 10 drinks on 2.7%, and 12 drinks on 1.4% of occasions). The number of drinks per drinking occasion that caregivers reported did not differ as a function of child age group ($F [1, 2,086] = 1.11$, $p = .29$) or sex ($F [1, 2,086] = 0.72$, $p = .40$). Mothers tended to report high levels of supervision ($M = 5.9$, $SD = 1.24$), and this was especially true for those with younger children ($M = 6$, $SD = 1.23$) compared to older children ($M = 5.8$, $SD = 1.34$; $F [1, 2,152] = 16.78$, $p < .0001$). No significant gender differences were found with regard to supervision ($F [1, 2,152] = 0.42$, $p = .52$).

Bivariate Correlations

We examined bivariate associations between caregiver-reported alcohol use (i.e., number of drinks per occasion), caregiver-reported supervision, injury severity, and injury occurrence. Three demographic variables [i.e., child gender, child age, family socioeconomic status (SES)] were also included because these variables have been found to be related to child injury rate and severity (Bradbury, Janicke, Riley, & Finney, 1999; Faelker, Pickett, & Brison, 2000; Rosen & Peterson, 1990). Each family had several variables that were measured repeatedly (i.e., caregiver-reported supervision, number of drinks, injury risk, and injury severity) and several that were not (e.g., child gender). It is difficult to correctly calculate correlations between repeated and nonrepeated variables; therefore, we attempted to provide the most accurate estimations by weighting each observation by the inverse of the family's total number of observations (1/x). Results can be seen in Table II. In both data sets (i.e., injury only and matched data), child age was

negatively related to caregiver-reported supervision and caregiver reported number of drinks. Family SES was also positively related to caregiver supervision and negatively related to caregiver-reported number of drinks and child gender (i.e., higher SES was associated with male children). Caregiver-reported drinking was not related to caregiver-reported supervision in either data set. In the matched injury/no injury data set, injury occurrence was positively related to caregiver-reported number of drinks and negatively related to caregiver-reported supervision. Correlations with injury severity were not examined for the matched data set because injury severity was not coded for the non-injury events. In the injury only data set, injury severity was negatively related to family SES and caregiver-reported supervision.

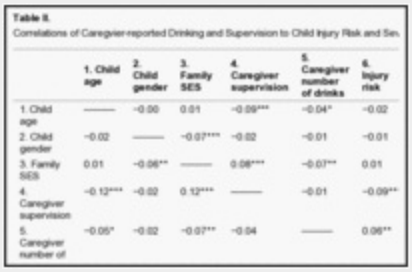

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Table II. Correlations of Caregvier-reported Drinking and Supervision to Child Injury Risk and Severity

Predicting Injury Occurrence

Injury occurrence is defined as children's odds of receiving an injury in a given situation. To obtain information about children's injury occurrence, a case cross-over analysis using conditional logistic regression was conducted (Maclure, 1991). Children's injury events were matched with their own noninjury events (control conditions) to estimate whether there was an increased likelihood of an injury occurring at differing caregiver-reported amounts of drinking and levels of supervision. One of the advantages of case-crossover analysis, as opposed to case–control analyses, is that subjects

serve as their own controls. Thus, between-subject confounding is controlled and effects of interest (e.g., increased odds of injury) cannot be attributed to unmodeled between-subject confounders (e.g., alcoholism, psychopathology; Maclure, 1991; Maclure & Mittleman, 2000). Similar analytical procedures have been used in alcohol and injury research with adults (Vinson et al., 2003). Because child age, child gender, and family SES are controlled for by use of the case-crossover analyses, we did not add these variables to the model.[2]

The first analyses in this section examine events in which either fathers or mothers were the primary supervisors of the children. Given that mothers provided second-hand information about fathers' supervisory and drinking behaviors, we were concerned that these observations may be less accurate than mothers' reports of their own behaviors; therefore, we also examined the data while only including observations for which mothers were the primary supervisors.[3] Due to the low frequency of injury events in which caregivers reported drinking more than four drinks, we combined occasions for which caregivers reported drinking four or more drinks. In addition, there were two occasions on which caregivers reported consuming 0.5 drinks, and we combined that with occasions on which caregivers reported consuming one drink. We also deleted observations in which supervision was equal to 1 or 2 because caregivers reported supervising at a level of 3 or higher on 99% of occasions.

Analyses Including Mothers and Fathers as Supervisors

Using a case-crossover model, we examined the main effects of caregiver-reported supervision, caregiver-reported alcohol use, and the interaction between caregiver-reported supervision and caregiver-reported alcohol use on children's injury occurrence. As can be seen in Table III, caregiver-

reported supervision negatively predicted likelihood of injury occurrence, and caregiver-reported number of drinks positively predicted injury occurrence. The interaction between supervision and number of drinks was not significant.

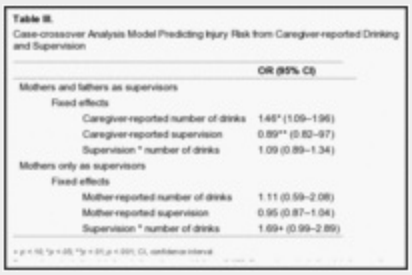

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Table III. Case-crossover Analysis Model Predicting Injury Risk from Caregiver-reported Drinking and Supervision

Analyses Including only Mothers as Supervisors

Next, we conducted the same analyses but limited the sample to occasions in which only mothers were the primary supervisors (1,509 events). Mothers reported drinking 0 drinks on 97.5% of occasions, 0.5 or 1 drink on 1.6% of occasions, and 2 or more drinks on 0.87% of occasions. In this smaller data set, there were few occasions in which mothers reported consuming more than two drinks; therefore, we collapsed the data to 0, 1, or 2 or more drinks. As shown in Table III, the main effects of alcohol and supervision were nonsignificant, but number of drinks marginally interacted with maternal supervision. In order to probe this interaction, we examined the effect of mother-reported drinking at three levels of supervision. Specifically, we used the main effect coefficients of alcohol use and supervision to calculate odds ratios (ORs) for the interaction term of supervision × number of drinks at three values of supervision (3, 5, and 7) and three values of number of drinks (0, 1, and 2). The ORs were then converted to probabilities and graphed. As can be seen in Fig. 1, a higher number of drinks predicted higher injury probability only at high levels of supervision (i.e., when

supervision was centered at seven). At lower levels of supervision (i.e., supervision centered at three and five), mother-reported number of drinks did not appear to be a risk factor for injury occurrence. In fact, children were at higher risk for injury at lower levels of drinking. It is important to note, however, that these analyses are based on 43 instances in which mothers consumed one or more drinks, and some of the cells have few instances of drinking.

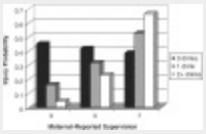

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Figure 1. Injury probability as a function of the interaction of mother-reported supervision and number of drinks. The mean probability of injury is.5 because half of the events in the data set were injuries. A supervision score of 3 = mother and child > 6 feet apart, no visual contact but there is auditory contact; 5 = mother and child > 6 feet apart, child has mother's full attention; 7 = mother within 6 feet of child, not engaged in other activity.

Predicting Injury Severity

Due to the clustered nature of the data (i.e., many child injury events within each family), a multilevel model was used to examine the effect of caregiver-reported drinking and caregiver-reported supervision on injury severity (Raudenbush & Bryk, 2002). Multilevel modeling is an appropriate technique to use with clustered data (i.e., several injury events within each family) because such clusters violate the ordinary least squares regression assumption of independence among error terms.

Analyses Including Mothers and Fathers as Supervisors

We first examined the predictive effect of caregiver-reported alcohol use, caregiver-reported supervision, and the interaction of alcohol use and supervision on children's injury severity. We controlled for the effects of child age, child gender, and family SES because these variables have been

found to be related to child injury rates (Bradbury et al., 1999; Faelker et al., 2000; Rosen & Peterson, 1990). Results can be seen in Table IV. Higher caregiver-reported supervision predicted lower injury severity, and there was a marginally significant predictive effect of caregiver-reported alcohol use on injury severity. Reported number of drinks did not interact with caregiver-reported supervision to predict injury severity.

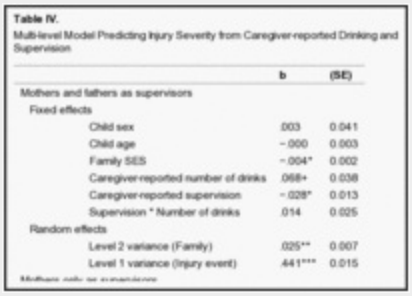

Table IV.
Multi-level Model Predicting Injury Severity from Caregiver-reported Drinking and Supervision

	b	(SE)
Mothers and fathers as supervisors		
Fixed effects		
Child sex	.003	0.041
Child age	−.000	0.003
Family SES	−.004*	0.002
Caregiver-reported number of drinks	.068+	0.038
Caregiver-reported supervision	−.028*	0.013
Supervision * Number of drinks	.014	0.025
Random effects		
Level 2 variance (Family)	.025**	0.007
Level 1 variance (Injury event)	.441***	0.015

[See full table]

Table IV. Multi-level Model Predicting Injury Severity from Caregiver-reported Drinking and Supervision

Analyses Including only Mothers as Supervisors

The same analyses as above were conducted but were limited to occasions in which only mothers were supervising the children (n = 1,636 injuries). As can be seen in Table IV, the results were the same as they were when occasions in which fathers were supervising were included in the analyses, except that number of drinks significantly predicted injury severity rather than only being a marginally significant predictor.

Discussion

Although acute alcohol use has been shown to be related to increased risk of proximal injury in adults (Vinson et al., 2003), little research has examined whether the children who are in the care of drinking adults are at greater risk for injury. Previous studies have reported that caregivers' overall alcohol use patterns were associated with higher child injury rates (Bijur et al.,

1992). However, due to methodological limitations of these studies, it cannot be discerned whether increased child injury rates are due to other stable caregiver or child characteristics (e.g., maternal alcoholism and child hyperactivity), or to proximal caregiver alcohol use. To address this gap in the literature, we examined whether acute caregiver-reported alcohol use predicted child proximal injury occurrence and severity. Furthermore, to examine whether supervision would mitigate the effect of caregiver drinking on children's injury occurrence and severity, we examined whether caregiver-reported supervision and alcohol use interacted to predict injury occurrence and severity.

As expected, when analyzing instances in which either mothers or fathers were supervising their children, we found that caregiver-reported number of drinks predicted a higher likelihood of children sustaining an injury. In addition, there was a trend toward caregiver-reported number of drinks predicting higher injury severity. These results provide evidence that acute caregiver alcohol use, even in small amounts, may be a risk factor for children's injury occurrences as well as for sustaining more severe injuries. Consistent with past research (Morrongiello & House, 2004; Schwebel & Bounds, 2003), we also found that higher supervision predicted lower likelihood of sustaining an injury and lower injury severity. Moreover, given our use of case-crossover analyses, we were able to demonstrate the link between time-specific instances of supervision and injury risk.

When analyzing times in which mothers reported only on their own (and not their spouses') supervision and drinking, we found a different pattern of results for predicting injury occurrence. There was a marginally significant interaction for mother-reported alcohol use and supervision such that alcohol use was associated with increased probability of an injury

occurrence, but only during times of close supervision, ironically undermining the potential protective effects of closer supervision. As noted, we did not find this interaction when examining times in which both mothers and fathers were supervising. These discrepant findings bring into question whether the effect of drinking on injury occurrence is conditional on supervision or unconditional. Although we expected that mothers' own self-reports would be more accurate than their second-hand reports of their spouses' behavior, their responses may be more prone to social desirability bias because mothers may have been more embarrassed to report high levels of drinking or low levels of supervision for themselves. The interaction results may also be unreliable because they were based on only 43 occasions in which mothers reported drinking, and some of the interaction cells contained very few observations (e.g., for moderate supervision and high drinking). Moreover, the interaction effect was only marginally significant, further bringing its robustness into question. Therefore, it appears that the main effect results that were based on times in which either fathers or mothers were supervising are more reliable than are the interaction effects that emerged when only mothers were supervising. Further research is needed using a larger sample size and additional measures of maternal drinking and supervisory behavior (i.e., other than self-report) to better clarify the nature of the relation between drinking, supervision, and injury risk for mothers.

Results from the present study support Bronfenbrenner's (1979) model of child development by indicating that factors in children's environments (i.e., caregiver drinking and supervision) impact children's developmental outcomes (i.e., injury risk and severity). These findings also add to the extant literature suggesting that both caregiver alcohol use and low levels of supervision are related to higher injury occurrence and severity among

young children. This information may be beneficial in educating caregivers about the potential negative effects of alcohol use on their children's safety, as well as the importance of close supervision for reducing injury occurrence and severity in children. The current study also provides more direct evidence for significant associations between caregiver behaviors (i.e., drinking and supervision) and injury outcomes than most injury investigations, as we focused on proximal influences on children's everyday injury events (e.g., number of drinks consumed and supervision at the time of the injury event) rather than distal influences (e.g., caregiver alcoholism and supervisory style). Demonstrating the impact of proximal alcohol use is important because it suggests a causal role for acute intoxication beyond general risk associated with caregiver drinking style. For example, heavy drinkers tend to be characterized by a range of traits that could presumably be related to childhood injury through either lax supervision (e.g., low conscientiousness) or engaging in risky activities (e.g., novelty or sensation seeking; Sher, Bartholow, & Wood, 2000). In addition, characteristics such as risk taking appear to be heritable risk mechanisms (Sher, Trull, Bartholow, & Vieth, 1999; Slutske et al., 1999, 2002), and the children of individuals who drink frequently may also be characterized by behavioral traits that are likely to put them at higher risk for injury. Matched case–control and other between-subject designs cannot completely control for a range of these types of confounders. Our case-crossover analyses address this limitation because both caregiver and offspring individual differences are held constant by the within-subjects nature of the analysis.

Although this study makes clear contributions to the field of injury prevention, some limitations of the current study bear mention. First, when interpreting these findings it is important to note that the analyses including data from mothers and fathers were based on only 74 occasions (4% of

injury and control events) in which caregivers reported drinking, and some of these occasions may have been from the same caregiver. Moreover, the majority of caregivers who drank in this sample only consumed 1–2 drinks. It is possible that relations between supervision, drinking and injury may differ in a group of caregivers who drink more heavily, and it would be important for future research to conduct similar analyses with such parents.

Second, we only collected self-report data about caregivers' or their spouses' alcohol use and supervision levels, and these data may be subject to social desirability bias. It is difficult to collect longitudinal repeated measures of caregiver supervision levels and child injury rates without using caregiver report. However, in future research, self-reports of supervision may be supplemented by using observational measures or instruments that have been found to correlate with observational measures of supervision, such as the Parent Supervision Attributes Profile Questionnaire (Morrongiello & House, 2004). Further, we were not able to collect data on the time at which caregivers consumed alcohol and therefore we could not calculate blood-alcohol content. Indeed, a caregiver who drank alcohol an hour prior to an event is more likely to be intoxicated than someone who drank the same amount the night before an injury occurred. However, use of self-report data is common practice in the field of alcohol research, either via retrospective paper-and-pencil measures or through self-monitoring tasks (Kivlahan, Marlatt, Fromme, Coppel, & Williams, 1990; Miller et al., 2002; Simpson, Kivlahan, Bush, & McFall, 2005). Furthermore, the fact that we found a significant effect for alcohol use, despite our measurement limitations and potential social desirability, suggests that our analyses may serve as a conservative test of the effect of caregiver alcohol use on injury occurrence and severity. Despite this, future research using a definition of proximal alcohol consumption that is based on

the amount of time that it typically takes to metabolize alcohol or by gathering enough information to calculate blood-alcohol level might clarify the relation between caregiver alcohol use and child injury risk. Researchers may also wish to use newer alcohol use assessment technologies that have been developed to avoid retrospective reporting biases, such as electronic diaries (Piasecki, Hufford, Solhan, & Trull, 2007) or ecological momentary assessment (Hufford, Shields, Shiffman, Paty, & Balabanis, 2002).

A third limitation of the present study is that the majority of our sample was Caucasian and upper middle-class, making our findings less relevant for families who do not fit within this demographic group. It is important to note that the case-crossover analyses control for the effects of family-level variables, such as SES. However, additional research is needed with more racially and economically diverse samples to assess the generalizabilty of these findings, as substance use and/or supervision levels (e.g., see Mulvaney & Kendrick, 2004) might differ in a sample with a more diverse racial or socioeconomic class composition. Obtaining data from families of low SES is particularly important, given research suggesting that children from such families are at higher risk for injury (Faelker et al., 2000; Haynes, Reading, & Gale, 2003; Hippisley-Cox et al., 2002). In the present study, we attempted to recruit a more diverse sample by using a patient list from a clinic that serves both low- and middle-income families and by providing a large financial incentive for families to participate. Unfortunately, however, these efforts did not result in a more diverse sample. Our lack of success may be partially due to the high participant burden associated with our study.

Fourth, our injury sample contained mostly minor injuries; only 22 injuries received medical attention. Yet, serious injuries are a low base-rate

phenomenon, and injury researchers have argued that minor, everyday injuries can be used as a proxy for studying the behavioral antecedents of severe injuries (Peterson et al., 2002). Indeed, Morrongiello et al. (2004) found a correlation of.68 for the amount of minor injuries that were reported during their study and moderate to severe injuries that were reported for the prior 6-month period.

Despite these limitations, our findings highlighting the potential role of both caregiver proximal alcohol consumption and supervision in children's injury occurrence and severity represent an important contribution to the study of childhood injury. Our results suggest that medical epidemiologists attempting to estimate the morbidity and mortality burden associated with alcohol consumption should begin to pay more attention to the possible effects of caregiver alcohol consumption (even in small amounts) on the health outcomes of those in their care. In addition, although further research is necessary to clarify the associations among caregiver drinking, supervision, and child injury risk, our study results may have implications for public health initiatives. Our findings that children of caregivers who drink even small amounts of alcohol are at increased risk for injury (as opposed to just the children of parents who drink heavily) may suggest the need for universal (i.e., directed at the entire population) education about the risks of caregiver drinking. However, replication of these findings may be warranted before pursuing such programs.

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Footnotes

1. We conducted the same analyses using two other indicators of substance use, including the amount of drugs that mothers had used and mothers' subjective level of intoxication; we found similar results for these other indicators.

2. We conducted analyses using two event-specific contextual covariates (i.e., number of children present and number of adults present); however, these variables were not significant predictors and did not alter the results. Thus, we omitted them from the final analyses.

3. There were very few observations in which only fathers were supervising in the matched injury/no injury data set to reliably predict child injury occurrence. However, results of analyses predicting injury severity using only instances in which fathers supervised were the same as the results from analyses in which observations from both mothers and fathers were included.

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Table I.

Participant and Injury Event Descriptive Statistics: Means and SD by Child Gender

Variable	Mean (SD)
Child age (in months)	24.1 (7.2)
Family SES	46.4 (10.9)
Maternal age	28.9 (4.3)
Paternal age	31.1 (5.3)
Injury severity	
Boys	1.6 (0.68)
Girls	1.6 (0.68)
Number of injuries for study period	
Boys	10.0 (5.7)
Girls	10.51 (6.4)
Caregiver-reported supervision	
Boys	5.9 (1.3)
Girls	5.8 (1.3)
Number of caregiver-reported drinks	

Boys	0.08 (0.50)
Girls	0.06 (0.59)

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Table II.

Correlations of Caregvier-reported Drinking and Supervision to Child Injury Risk and Severity

	1. Child age	2. Child gender	3. Family SES	4. Caregiver supervision	5. Caregiver number of drinks	6. In risk
1. Child age	———	−0.00	0.01	−0.09***	−0.04*	−0
2. Child gender	−0.02	———	−0.07***	−0.02	−0.01	−0
3. Family SES	0.01	−0.06**	———	0.08***	−0.07**	0.0
4. Caregiver supervision	−0.12***	−0.02	0.12***	———	−0.01	−0
5. Caregiver number of drinks	−0.05*	−0.02	−0.07**	−0.04	———	0.0
6. Injury risk	– – –	– – –	– – –	– – –	– – –	——

7. Injury severity	−0.03	0.01	−0.06**	−0.08***	0.03	– –

*p <.05; **p <.01; ***p <.001.

Correlations above the diagonal used the matched case–control data set (n ranged from 2,082 to 2,156 due to missing data). Correlations below the diagonal used the injury only data set (n ranged from 1,979 to 2,058 due to missing data).

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Table III.

Case-crossover Analysis Model Predicting Injury Risk from Caregiver-reported Drinking and Supervision

		OR (95% CI)
Mothers and fathers as supervisors		
Fixed effects		
drinks	Caregiver-reported number of	1.46* (1.09–1.96)
	Caregiver-reported supervision	0.89** (0.82–97)
	Supervision * number of drinks	1.09 (0.89–1.34)
Mothers only as supervisors		
Fixed effects		
drinks	Mother-reported number of	1.11 (0.59–2.08)
	Mother-reported supervision	0.95 (0.87–1.04)
	Supervision * number of drinks	1.69+ (0.99–2.89)

+ p <.10; *p <.05; **p <.01; p <.001; CI, confidence interval.

For analyses including data from both mothers and fathers n = 2,072. For analyses including data from mothers only n = 1,788. Interaction variables are centered to their mean. Supervision was measured on a 1–7 scale, in which 7 was the highest level of supervision. 7 = mother within 6 feet of child, not engaged in other activity; 6 = mother within 6 feet of child, engaged in other activity; 5 = mother and child > 6 feet apart, child has mother's full attention; 4 = mother and child > 6 feet apart, child does not have mother's attention; 3 = mother and child > 6 feet apart, no visual contact but there is auditory contact; 2 = no visual or auditory contact with child, could reach child within 30 s; 1 = no visual or auditory contact, could not reach child within 30 s.

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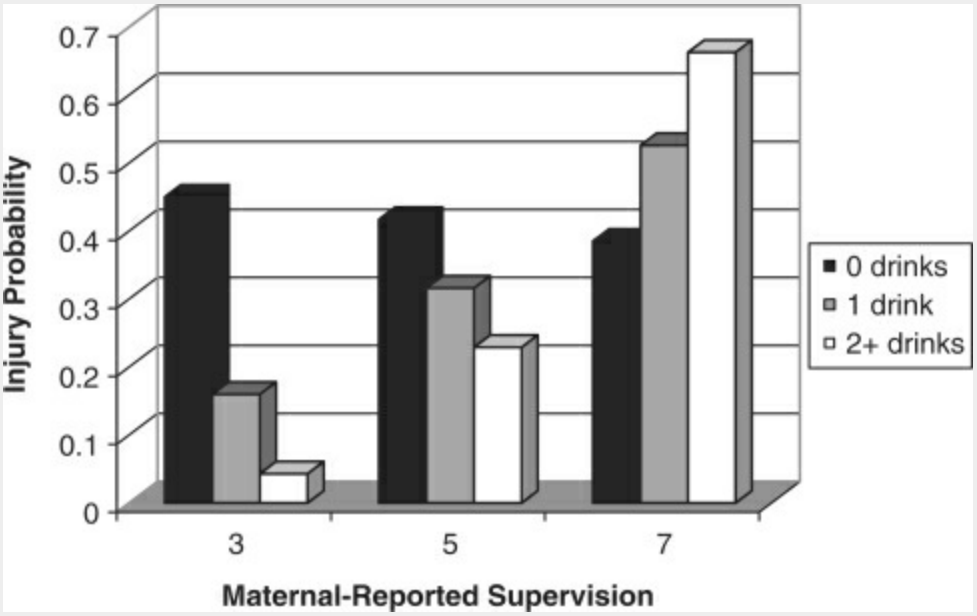

Figure 1.

Injury probability as a function of the interaction of mother-reported supervision and number of drinks. The mean probability of injury is.5 because half of the events in the data set were injuries. A supervision score of 3 = mother and child > 6 feet apart, no visual contact but there is auditory contact; 5 = mother and child > 6 feet apart, child has mother's full attention; 7 = mother within 6 feet of child, not engaged in other activity.

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Table IV.

Multi-level Model Predicting Injury Severity from Caregiver-reported Drinking and Supervision

		b	(SE)
Mothers and fathers as supervisors			
Fixed effects			
	Child sex	.003	0.041
	Child age	−.000	0.003
	Family SES	−.004*	0.002
	Caregiver-reported number of drinks	.068+	0.038
	Caregiver-reported supervision	−.028*	0.013
	Supervision * Number of drinks	.014	0.025
Random effects			
	Level 2 variance (Family)	.025**	0.007
	Level 1 variance (Injury event)	.441***	0.015
Mothers only as supervisors			
Fixed effects			

Child sex	−.014	0.043
Child age	−.001	0.003
Family SES	−.003	0.002
Mother-reported number of drinks	.112*	0.048
Mother-reported supervision	−.039**	0.014
Supervision * Number of drinks	−.015	0.031
Random effects		
Level 2 variance (Family)	.021**	0.008
Level 1 variance (Injury event)	.441***	0.017

+ p <.10; *p <.05; **p <.01; ***p <.001.

For analyses including data from both mothers and fathers Level 2 N = 160, Level 1 n = 1,915. For analyses including data from mothers only Level 2 N = 158, Level 1 n = 1,561. Interaction variables are centered to their mean. Supervision was measured on a 1–7 scale, in which 7 was the highest level of supervision. 7 = mother within 6 feet of child, not engaged in other activity; 6 = mother within 6 feet of child, engaged in other activity; 5 = mother and child > 6 feet apart, child has mother's full attention; 4 = mother and child > 6 feet apart, child does not have mother's attention; 3 = mother and child > 6 feet apart, no visual contact but there is auditory contact; 2 = no visual or auditory contact with child, could reach child within 30 s; 1 = no visual or auditory contact, could not reach child within 30 s.

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