ORIGINAL ARTICLE

Influence of safety gear on parental perceptions of injury risk and tolerance for children's risk taking

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Objectives: Risk compensation theory has been shown to relate to how individuals behave in areas such as traffic safety and consumer product safety. The present study examines whether risk compensation theory applies to parents' judgments about school age children's permissible risk taking under non-safety gear and safety gear conditions for seven common play situations. The extent of the child's experience with the activity and parental beliefs about safety gear efficacy were examined as possible moderators of extent of children's risk taking allowed by parents.

Method: A telephone interview was used to obtain each parent's ratings of permissible risk taking by their child (for example, speed at which child is allowed to cycle, height allowed to climb to on a climber) under safety gear and no gear conditions, and ratings of child experience and gear efficacy.

Results: Results confirmed risk compensation operated under all seven play situations, resulting in parents reporting they would allow significantly greater risk taking by their children under safety gear than non-safety gear conditions. Children with more experience with the activities were to be allowed greater risk taking, even when not wearing safety gear. Parents who believed more strongly in the efficacy of the safety gear to prevent injuries showed greater risk compensation. No sex differences emerged in any analyses.

Conclusion: Results highlight the need to communicate to parents that safety gear moderates injury risk but does not necessarily guarantee the prevention of injury, particularly if children are allowed greater risk taking when wearing safety gear.

Unintentional injuries are the leading cause of death and disability for children beyond 1 year of age.[1–3] It has been estimated that one in four children in the United States experience a medically attended injury each year,[4] and that as much as 15% of all money spent on medical costs for youth ages 1 to 19 goes for treatment or rehabilitation related to unintentional injury.[5] Increasing awareness of the personal and economic costs of unintentional injuries to youth, coupled with the realization that many injuries are preventable, have resulted in greater efforts to understand how such injuries occur and to devise ways to prevent these events from happening.

Epidemiological research reveals that many injuries to youth happen during activities that would be considered normative and age appropriate. For example, bicycling related injuries have been estimated to result in 400 000 emergency room visits each year for children under 15 years of age,[6] and to account for as many as 5% of all injury related hospital admissions for children in Canada.[7] Drowning ranks second as a cause of unintentional injury death among Canadians from birth through 24 years of age, with over 6% of all youth who die of injury related causes drowning.[8 9] Fall related injuries are a leading cause of hospitalization for youth, accounting for more than 25% of all injury related hospitalizations.[10] Furthermore, more recently a variety of other popular recreational activities have been found to pose significant threat of injury for young people, including: in-line skating,[11] trampolines,[12 13] and sledding.[14] The picture that emerges from these data is that children are often at risk of unintentional injuries when engaging in activities that provide for other health benefits, serve as an important basis of social interaction with peers, and that most parents would encourage them to pursue. Efforts to manage injury risk for these activities therefore has turned to product design and environmental modifications, with a primary focus on the development and marketing of safety gear to reduce injury risk during these activities.

A number of studies have documented the efficacy of at least some safety gear to reduce the incidence and/or severity of certain types of injuries among youth. For example, bicycle helmet usage has been shown to reduce the risk of head trauma by as much as 80%[15] and wrist guards, elbow and knee pads, and helmets substantially moderate injury risk for in-line skaters.[16] The proven effectiveness of safety gear has resulted in widespread publicity and targeted interventions to convince parents and youth to utilize such gear. There has been little consideration given, however, to the impact these messages have on parents' and children's perceptions of injury risk. Specifically, what if such messages lead parents to assume that injuries are completely preventable when safety gear is worn, which results in parents having greater tolerance for children's risk taking? This is the premise behind "risk compensation" theory, and the question addressed in the present study.

In general terms, risk compensation refers to the notion that in reaction to environmental or product design changes that serve to decrease injury risk individuals will behave in ways that increase risk of injury (see Hedlund[17] for a full elaboration of the theory). Hence, the development of airbags that automatically inflate upon car impact with another vehicle will presumably result in more "risky" driving behavior because the driver believes himself or herself to be protected from injury due to the airbags (see Peterson *et al*[18]). Not surprisingly, introduction of the notion of risk compensation has created much controversy among professionals concerned with injury control and risk management, particularly those who favor product design and environmental modification as a primary means of curtailing injury risk. A number of investigators have criticized fundamental premises of risk compensation theory, as well as those outlined in risk homeostasis theory, which is a related theory that proposes that individuals behave in ways to maintain a constant level of risk (see Evans,[19] McKenna,[20] and Wilde[21]).

Table 1 Activities, safety gear, and risk taking measures

Activity	Risk taking measure	Safety gear
(1) Water play in a pool	Depth (feet)	Life jacket
(2) Sledding down a hill	Speed of travel (mph)	Helmet, heavily padded snowsuit
(3) Bicycling on a concrete surface	Speed of travel (mph)	Helmet
(4) In-line skating on a concrete surface	Speed of travel (mph)	Helmet, wrist guards, elbow/knee pads
(5) Climbing at an indoor playground	Height on climber (feet)	Safety padding on the floor
(6) Jumping on an indoor trampoline	Height of trampoline (feet)	Safety padding on the floor
(7) Running outside	Speed of travel (mph)	Lush, thick, soft grass

What evidence there is to support the notion of risk compensation comes mostly from studies of driving behavior (see Peterson *et al*,[18] Potvin *et al*,[22] Simonet and Wilde,[23] and Streff and Geller[24]). In addition, there is some evidence in the area of product safety that is consistent with what one would predict based on risk compensation theory. For example, Viscusi and Cavallo examined the effects of cigarette lighter safety mechanisms in the households of families having children.[25] They found that after the introduction of the safety mechanisms on lighters, parents reduced precautions with respect to lighters and fire safety (see also Viscusi[26 27]).

Building on these few studies involving parents, the purpose of the present study was to examine risk compensation theory as it relates to parents' judgments about school age children's permissible risk taking in situations wearing or not wearing safety gear for each of seven common play activities (bicycling, swimming in a pool, in-line skating, sledding, jumping on a trampoline, climbing on a playground climber, and running while playing outside). The specific question addressed was whether safety gear influences what mothers think about their child's risk of injury and results in greater permissible risk taking under safety gear, as compared to no gear, conditions. Additional factors that were explored as possibly relating to permissible risk taking included the child's level of experience with the activity (see Johansson[28]) and the parent's belief about the efficacy of the gear to prevent injury (see Viscusi and Cavallo[25]).

METHOD

Subjects

Participants included 54 mothers having a child in the 7 to 9 age range, with an equal number (nine) of males and females at 7, 8, and 9 years. These participants were randomly selected from the database of the Child Development Research Unit at the University of Guelph which comprises a list of families in the Guelph and surrounding areas who are interested in participating in research on child development. Families are recruited from the local hospital at the time of a child's birth and they vary considerably in ethnic background, education level of parents, and economic status.

Materials

The questionnaire, delivered over the telephone as an interview, asked about seven different activities: swimming in a pool, climbing on a playground climber, sledding, bicycling, in-line skating, playing tag outside, and jumping on a trampoline. Each activity had both a non-safety gear condition and a safety gear condition for which the parent rated the extent of permissible risk taking by their child; the importance of using a within-subjects design has been confirmed in prior research on risk compensation theory.[24] Table 1 provides a list of the safety gear and risk taking measure for each activity. For example, parents were asked to assume their child was ascending a climber at an indoor playground and report how high they would allow their child to climb if there was (and was not) thick safety padding on the floor beneath the climbing structure. The child's experience with the activity was then rated on a six point Likert scale ranging from 1 "none/not much" to 6 "extensive". Parents' beliefs about the efficacy of the safety gear was rated on a six point Likert scale ranging from 1 "not effective at all" to 6 "completely effective" to prevent injuries.

Procedure

Subjects were contacted by phone and a future time for the 15 minute interview was arranged. Parents were asked to rate the extent of permissible risk taking by their child for both wearing and not wearing safety gear situations for each of the seven activities, with the no gear and gear conditions randomly ordered for each activity. If the no gear situation received a risk behavior rating less than the safety gear situation, then a question was asked to probe their reasons why (for example, "Can you help me understand why you would let your child go faster if he/she is wearing a helmet?"); these data were gathered to gain greater insight into how parents conceptualize injury risk and interpret safety gear as this relates to injury risk. Following the ratings of each activity, further questions were then asked to obtain ratings of the child's experience with the activities and the parent's beliefs about safety device efficacy.

RESULTS

Risk compensation was measured by taking the difference between mothers' ratings for the gear and no gear situations, with numbers exceeding zero indicating risk compensation.

Parents' ratings of risk compensation

To assess for risk compensation, one sample *t* tests (with a Bonferroni correction applied) were conducted comparing the difference score for each activity to a score of 0 (that is, no difference). For each activity, averaged over boys' and girls' scores, the magnitude of the difference score significantly exceeded zero, indicating that risk compensation was operating ($p<0.01$). Furthermore, a multivariate analysis of variance (MANOVA) confirmed that there were no sex differences in the magnitude of risk compensation shown ($p>0.05$), although type of activity affected the amount of risk compensation, $F(6, 364) = 15.44$, $p<0.01$).

The average difference scores as a function of activity can be seen in table 2. It is evident from these data that risk compensation was shown for all activities. However, one can also observe a great deal of variation in the magnitude of risk compensation, with some difference scores as low as 1.27 and others as large as 11.39. Follow up tests, with a Bonferroni correction applied, comparing between activities in the magnitude of risk compensation revealed significantly greater risk compensation for sledding and cycling than the other activities, and significantly less risk compensation for jumping on a trampoline and water play as compared to the other activities, with the magnitude of risk compensation shown for in-line skating, climbing, and running falling at intermediate levels between the two other activity groupings. Thus, wearing a life jacket resulted in greater permissible risk taking than not wearing one, but this difference score was small relative to

Table 2 The average difference scores (safety gear minus no-gear ratings for permissible risk taking) for boys and girls as a function of activity. Standard deviations are indicated in parentheses. Difference scores did not significantly vary with sex, only with activity

	Activity						
	Swim	Sled	Cycle	Skate	Climb	Jump	Run
Boys	0.85 (2.6)	10.19 (19.0)	10.03 (7.2)	6.03 (5.2)	3.60 (3.5)	1.95 (1.5)	2.48 (2.6)
Girls	1.69 (2.2)	12.59 (13.1)	9.07 (8.1)	5.53 (4.1)	3.73 (8.7)	1.62 (1.0)	3.70 (2.8)
Overall	1.27 (2.4)	11.39 (16.2)	9.56 (7.6)	5.78 (4.6)	3.67 (6.6)	1.78 (1.3)	3.09 (2.7)

Note: scores exceeding 0 indicate risk compensation.

Table 3 The average ratings for boys' and girls' experience (range 1–6) as a function of play activity. Standard deviations are indicated in parentheses. Experience did not significantly vary with sex, only with activity

	Activity						
	Swim	Sled	Cycle	Skate	Climb	Jump	Run
Boys	3.70 (1.6)	4.37 (1.3)	4.37 (1.3)	3.00 (1.9)	4.56 (1.2)	0.59 (1.8)	3.11 (0.50)
Girls	4.19 (1.4)	4.11 (1.4)	4.11 (1.4)	2.59 (1.4)	4.48 (1.1)	0.52 (0.51)	3.37 (1.2)
Overall	3.94 (1.5)	4.24 (1.3)	4.24 (1.3)	2.80 (1.7)	4.52 (1.1)	0.56 (0.50)	3.24 (1.2)

Table 4 The average ratings of safety gear efficacy (range 1–6) given by parents of boys and girls for each activity. Standard deviations are indicated in parentheses. Efficacy ratings did not vary with sex, only with activity

	Activity						
	Swim	Sled	Cycle	Skate	Climb	Jump	Run
Boys	4.78 (1.0)	3.37 (1.1)	4.33 (1.3)	4.15 (.72)	3.30 (1.1)	2.70 (1.1)	3.52 (1.2)
Girls	4.33 (1.2)	3.19 (1.2)	3.67 (1.4)	3.78 (1.1)	3.44 (1.3)	2.78 (1.2)	3.44 (1.1)
Overall	4.56 (1.1)	3.28 (1.1)	4.00 (1.4)	3.96 (.91)	3.37 (1.2)	2.74 (1.2)	3.48 (1.0)

that shown for wearing a helmet when cycling or sledding, both of which resulted in substantial increases in permissible risk taking.

Influence of child experience on permissible risk taking

To determine whether the parent's ratings of their child's experience with the activity (score range: 1–6) varied as function of sex or play activity a MANOVA with sex (2) as a between-subjects factor and activity (7) as a within-subjects factor was performed. Results revealed that boys and girls had comparable levels of experience with the seven activities ($p>0.05$). However, level of experience varied with play activity, $F(6, 364) = 62.03$, $p<0.01$, as can be seen in table 3. Follow up tests, with a Bonferroni correction applied, comparing between activities in the magnitude of child experience indicated comparable high levels of experience with swimming, sledding, cycling, and climbing, as compared to the remaining three activities, with the least experience indicated for jumping on a trampoline, and comparable intermediate level experience for in-line skating and running outside. Hence, experience ratings showed the sort of systematic variation one might expect for the particular activities surveyed herein.

To determine whether children's experience with the activities influenced mothers' tolerance for risk taking, a Pearson correlation was conducted. Results revealed a significant positive relation between experience and the risk taking scores when no gear was worn (r (54) = 0.24, $p<0.05$). Hence, mothers who believed their children had a high level of experience with the activities, allowed their child greater risk taking even when not wearing safety gear.

Parent's beliefs about safety gear efficacy

To assess whether parent's beliefs about safety gear efficacy (score range: 1–6) varied as a function of sex or play activity a MANOVA with sex (2) as a between-subjects factor and activity (7) as a within-subjects factor was applied to the data. Although no effect for sex was found, results indicated that parents' perceptions about the efficacy of safety gear to prevent injury varied with activity type, $F(6, 364) = 14.73$, $p<0.05$, as seen in table 4. Pairwise comparisons, with a Bonferroni correction applied, indicated that the magnitude of the difference varied across play activity. Specifically, parents judged gear to be more efficacious to prevent injury for swimming, cycling, and in-line skating than for the remaining activities, with no differences within each of these two groupings of activities. Hence, parents had the greatest confidence in the efficacy of safety gear to prevent injury for the gear that has been most widely acknowledged and publicized, namely gear for bicycling, swimming, and in-line skating.

When beliefs in gear efficacy scores were correlated with the magnitude of risk compensation scores it was found that mothers who believe in the efficacy of the safety gear showed greater risk compensation, swimming (r (54) = 0.21, $p<0.05$), bicycling (r (54) = 0.23, $p<0.05$), in-line skating (r (54) = 0.29, $p<0.05$), jumping on a trampoline (r (54) = 0.32, $p<0.05$), and running outside (r (54) = 0.47, $p<0.05$). And,

mothers who believed in the efficacy of safety gear indicated a greater tolerance for risk taking by their children when the safety gear was used, swimming (r (54) = 0.43, $p<0.05$), cycling (r (54) = 0.31, $p<0.05$), in-line skating (r (54) = 0.26, $p<0.05$), and jumping on a trampoline (r (54) = 0.55, $p<0.05$). Hence, in general, a belief in the efficacy of safety gear to moderate injury risk resulted in greater tolerance for children's risk taking by their mothers, resulting in greater risk compensation.

Finally, to explore mothers' spontaneous explanations for why they would allow greater risk taking under gear than no gear conditions their comments were examined. Coding of these fell into two categories: comments emphasizing an interpretation of the gear in terms of absolute risk (that is, the ability of the gear to completely prevent injury) and those emphasizing an interpretation of the gear in terms of relative risk (that is, the capacity of the gear to reduce injury risk and/or severity but not necessarily to eliminate injury risk completely). Scores were converted to proportions (that is, number of explanations that fell into each category of all those given by a mother) and separate analyses of variance were conducted for each activity, with explanation (two types) as a within-subjects factor. Results revealed significantly more absolute risk explanations than relative risk explanations for a number of activities. Specifically, absolute risk explanations predominated for swimming ($M = 0.82$, $F(1, 44) = 13.54$, $p<0.05$), sledding ($M = 0.76$, $F(1, 64) = 6.36$, $p<0.05$), cycling ($M = 0.91$, $F(1, 104) = 30.89$, $p<0.05$), and in-line skating ($M = 0.81$, $F(1, 102) = 22.26$, $p<0.05$). Hence, for those play activities for which safety gear are well known and publicized, mothers adopt an absolute risk framework and assume the gear will fully protect their child from injury, which probably explains their willingness to allow their child to engage in greater risk taking when wearing safety gear.

DISCUSSION

The present study examined whether safety gear influences what mothers think about their child's risk of injury and results in their intending to allow their child greater risk taking. Comparing the mother's ratings of permissible risk taking by their child when wearing safety gear to ratings when not wearing safety gear provided support for the notion of risk compensation: for all seven activities mothers intended to allow their child to engage in riskier behavior when safety gear was being used. Mothers of sons and daughters behaved similarly, showing comparable levels of risk compensation. Hence, the present findings confirm those obtained in studies examining how product safety influences parents' behavior,[25–27] namely, that product design and environmental modifications to promote child safety can lead parents to erroneously assume that there is now no risk at all of injury, resulting in parents allowing greater permissible risk taking by their children. Obviously, such practices by parents may temper or offset potential gains from enforcement of these safety measures, making it difficult to achieve the maximum benefit of such measures.

Two additional findings in this study provide further insights into factors influencing parental tolerance of children's risk taking. First, children who parents believed to have greater experience with the activities were allowed greater risk taking even when not using safety gear. Parents obviously assume that experience confirms a child's ability to effectively manage injury risk. However, this may not be true, particularly for boys. Prior research indicates that boys are less likely than girls to report injury experiences to parents, they are less likely to learn from injury experiences, and are more likely therefore to repeat behaviors that led to injury.[29 30] Taken together, these findings suggest that parents may be elevating their child's risk of injury, particularly for boys, by allowing greater risk taking for children having more experience with an activity, without careful consideration of the child's actual ability level *per se* and their history of even minor injuries experienced during the activity.

The second finding of relevance to our understanding of children's risk taking relates to parents' beliefs in the efficacy of the safety gear to prevent injury. Parents who rated gear as highly likely to prevent injury allowed children greater risk taking when using the gear. Moreover, the majority of parents judged the gear as an injury prevention measure, as opposed to a safety promotion or risk moderating measure. Hence, they failed to realize that injury risk is not absolute but relative, with the extent of risk determined by an interaction of environment and behavioral factors.

The problem of parents assuming absolute protection from safety gear, rather than relative protection, may contribute to explain why there are such high rates of improper usage of infant safety seats and improper fitting bicycle helmets being worn by children. Possibly, use of these safety devices may lead parents to assume protection is assured, resulting in a failure of parents to attend to the detailed information that ensures proper usage. Obviously, there needs to be greater emphasis in communicating to parents the difference between absolute and relative risk and the potential limits of safety gear to prevent injury to children and/or to constrain the severity of injuries, particularly when the gear is not properly used.

Limitations and future research

The present results provide important information about factors influencing parents' perceptions of child injury risk. None the less, there are some limitations to this study that need to be acknowledged, and there are a variety of outstanding issues that merit attention in future research. First, what parents report may not accurately reflect their behavior. Although it seems reasonable to assume that social desirability concerns by parents (for example, wanting to appear safety conscious and protective of their children) would have predicted a failure to find evidence of risk compensation in this study, it is still important to confirm that self reports showing risk compensation relate directly to parents' behavior. Second, it is also essential to establish whether children themselves show risk compensation as evidenced by increased risk taking under safety gear conditions and/or in reaction to skill development training with respect to recreational activities (for example, Canbike course) or injury management (for example, first aid course). Finally, although it may be difficult to study relations between risk compensation and child injury (rates, severity), such research is sorely needed. There is clear evidence that use of safety gear (for example, bicycle helmets) is associated with a reduction in serious injuries, such as head trauma (see Rivara *et al*[31] and Scuffham *et al*[32]). However, this does not necessarily imply that risk compensation is not operating at all. The difficulty in using injury statistics alone to establish whether risk compensation operates when safety gear is worn is that one has to estimate *what might have been*, that is, how much greater the reduction in injury might have been if children wore a helmet *and* they did not engage in increased risk taking. It may prove more productive for purposes of linking risk compensation to injury outcomes to adopt a multimeasure and longitudinal study strategy that includes observational measures of actual risk behavior, interviews to explore beliefs about personal injury vulnerability, and tracking of injury and near injury data. Obviously, more systematic research on risk compensation is needed before debates on this important issue (contrast Thompson *et al*[33] and Adams and Hillman[34]) can be resolved.

IMPLICATIONS FOR PREVENTION

Evidence of risk compensation among parents highlights the importance of communicating more than just a "Wear the Gear" message to parents. The present findings suggest that

Key points

- Use of safety gear can lead parents erroneously to assume that the chance of injury is completely eliminated, resulting in parents showing greater tolerance for children's injury risk behaviors when the gear is worn
- "Wear the Gear" messages to parents may produce the greatest effects to moderate injury when supplemented by messages that call attention to the continuing need for supervision and reasonable limits on children's risk taking.

focusing on safety gear utilization alone may be too narrow a strategy to maximize injury prevention and control among school age children. A message about the importance of safety gear needs to be balanced with one that emphasizes that gear is not a substitute for supervision and the importance of maintaining high standards limiting their children's risk taking behaviors.

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