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Young driver risk in relation to parents' retrospective driving record

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Abstract

Problem: Parents are an important potential influence on the driving safety of their children. This study examined the relationship of parental driving record on male and female offspring's at-fault collision risk. *Method:* Drivers aged 16–21 on the date of full licensure were selected from driver records and a matching process was used to identify putative parents in two-parent households. Poisson regression models were developed to predict at-fault collisions of male and female youth in the three years following full licensure from parents' at-fault collisions, speeding offenses, and other moving offenses in the four years prior to children's licensure. One set of models examined the relative risk associated with increasing numbers of maternal and paternal at-fault collisions and offenses. Other models examined the joint versus separate maternal and parental contributions. *Results:* Controlling for region of residence, both mothers' and fathers' at-fault collisions were associated with an increased risk in both male and female youth at-fault collisions. Mothers' and fathers' speeding offenses were also associated with increased relative risk of at-fault collisions for both sons and daughters, while fathers' other moving offenses increased collision risk for sons but not daughters. *Discussion:* Further research is required to identify how parental driving risk is transmitted to children. *Impact on Industry:* (a) Parents of young children should be informed of their role in influencing their children's future driving risk; (b) The results identify risk factors that could be of interest to licensing authorities and the insurance industry.

Keywords: Young drivers; Crash risk; Parents; Children; Driving records

1. Introduction

Young drivers are at elevated risk of collision per unit distance traveled up to the age of about 30 (Williams, 2003). The problem is particularly serious among young drivers in their first year of unsupervised driving (Preusser & Leaf, 2003). In British Columbia, one in five new drivers was involved in a crash in their first two years following full licensure (Wiggins, 2003).

On the other side of the coin, many young drivers remain collision-free, or at least are not responsible for their collision involvements. Much research has been devoted to the identification and measurement of characteristics that render some youths higher risks than others (e.g., Beirness & Simpson, 1988; Gregersen & Bjurulf, 1996; Jessor, 1987). The present study investigates the role of one of these potential factors that has received only recent attention: the influence of parental driving history. This relationship is important from both a theoretical and practical perspective given the importance of parents in the socialization process, as role models, and in later adolescence, their direct influence on the education, monitoring, and control of their children's driving.

A number of studies have examined the characteristics associated with youth driving risk. From these studies several classes of variables emerge as predictors or correlates of young driver collisions and/or violations. These include: lifestyle factors such as alcohol and other substance use, and unhealthy sleeping habits (Beirness & Simpson, 1988; Jessor, 1987); personality factors such as sensation-seeking, depression, and personal maladjustment (Wilson & Jonah, 1988); as well as low school grades and educational achievement (Carlson & Klein, 1970; Murray, 1998) and

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delinquency (Jessor, 1987). Much of the research in this area has been conducted in the context of problem behavior theory (Jessor, 1987). The theory postulates that risky driving among adolescents is part of a syndrome of problem behavior that tends to be in opposition to conventional legal and social norms.

In a longitudinal study, Begg, Langley, and Williams (1999) studied a wide variety of factors measured at age 15 or 18 that predicted involvement in four outcomes at age 21. The outcomes were: any collision, an injury collision, a non-injury collision, or a serious non-traffic injury. Outcomes were based on self-reports of events from the last 3 years. Prediction models were developed separately for males and females. These authors found only partial support for problem behavior theory, with high substance use and possession of a motorcycle licence being the only variables that consistently predicted collision involvement. Begg et al. (1999) found that injury and non-injury collisions were predicted by different factors, as were collisions of males and females. Of interest to the present study is the finding that low involvement with family predicted males' injury collisions. Males with low family involvement were three times more likely to have been in an injury collision.

Other recent research also points to an important role of parents and parenting style in mediating the driving behavior of children, from adolescence through young adulthood. In a longitudinal study that followed new drivers from the age of 16 through age 23–24, Shope, Waller, Raghunathan, and Sujata, (2001) found that the degree of parental monitoring, nurturing, and family connectedness reduced the risk of serious collisions and offenses. Conversely, negative parental influence (low scores on these same factors) increased young drivers' risk of serious collisions and violations, as well as risk of substance use. Higher substance use predicted higher collision risk — however it was not the principal mediator. The risk factors of high substance use and low parental influence were additive, but positive parental influence had a greater effect on lowering collision risk than did low substance use.

Bianchi and Summala (2004) investigated the relationship between self-reported driving behavior of Brazilian youth and their parents, evaluated by means of the Manchester Driving Behaviour Questionnaire. They found that parents' self-reported driving errors and violations predicted those of their children, but parents' tickets and collisions did not explain the respective measures in their children. One reason for the lack of correlation of the latter could be the small sample size (111 pairs) and the tendency of the self-report method to underestimate tickets and collisions. Children's aggressive driving was predicted more by children's lifestyle and family connectedness than by parents' aggressive driving. Taubman–Ben-Ari, Mikulincer, and Gillath (2005) report associations between parents' and children's driving styles, as measured by the Multildimensional Driving Style Inventory (Taubman–Ben-Ari, Mikulincer, & Gillath, 2004). Both mothers' and fathers' driving styles influenced those of both sons and daughters, although parents had differential influence depending on the gender of their offspring. For example, a careful driving style by a father was correlated with a careful driving style in both sons and daughters, whereas a parent's reckless driving style was transmitted only to a same-gender offspring (fathers to sons and mothers to daughters).

Very few studies have linked official driving records of parents with those of their offspring to measure the relationship of driving collisions or convictions. An early study (Carlson & Klein, 1970) compared only fathers' and sons' driving records and reported a positive correlation for traffic offense convictions, but not for collisions. Fathers' convictions and collisions were examined for a five-year retrospective period. The authors note that collisions were not reliably reported across the state, and therefore records may have been incomplete. The only published study to use a large sample size and to examine children and parents of both sexes was conducted by Ferguson, Williams, Chapline, Reinfurt, and De Leonardis (2001). Because this study used a methodology very comparable to the present one, it will be described in some detail.

Ferguson et al. (2001) selected driving records of over 300,000 currently licensed drivers, aged 18–21 from North Carolina Motor Vehicle Department files, and matched 47% of them with at least one putative parent. To maximize the chances that children were matched to their correct parents, only drivers with the same last names and addresses were used. Furthermore, parents were required to be between 36 and 65 years of age. The authors then modeled the likelihood of police-reported collision involvement for the young drivers as a function of child gender, combined parent collisions, combined parent convictions, and whether the child was matched with one or both parents (presumed single vs. two-parent household). Thus the study considered the sum of all parent collisions and the sum of all parent convictions, but did not distinguish between maternal and paternal contributions. The results showed that in both single- and two-parent households, parents with poor driving records were more likely to have children with poor driving records. Parents' collisions were more predictive of children's collisions than were parent's violations, and parents' violations were better predictors of children's violations than were parents' collisions. The model predicted a 7% increase in the likelihood of a child collision involvement for each additional parental collision. Children's expected violations increased by 13% for each additional parental violation.

The present study is a replication, extension, and refinement of the pioneering work of Ferguson et al. (2001). The primary aim was to confirm the earlier study's principal finding and to further investigate the impact of parents' driving history in terms of collisions and different types of offenses on the collision rate of young drivers in

their first three years after full licensure. It follows the approach of Ferguson et al. (2001) but with some notable differences and enhancements. The study uses liable (at-fault) collisions as the outcome measure, rather than total collision involvements. Liable collisions are a more direct indicator of risky or error-prone driving than total collisions, as the latter include those that the driver was unable to avoid. Collisions reported to the Insurance Corporation of British Columbia (ICBC) were used rather than police-reported collisions because ICBC has a monopoly on basic automobile insurance in the province and therefore has a record of all collision claims. Crashes reported to the insurer outnumber police-reported crashes by about 5 to1, and include a determination of liability for all crashes, whereas fault is not specified in police reports. Although the concepts of "liability" and "fault" are not identical, liability was the only consistently available indicator of fault and was considered sufficient for the purpose of the present study. Parental offenses were grouped into two classes, speeding and other moving offenses, in contrast to the earlier study that grouped all parental violations together. Furthermore, the study differentiates between male and female parents, thereby allowing the separate measurement of maternal and paternal contributions to the risk of their children. Because single parent households could not be reliably distinguished from two-parent households, only probable two-parent households were used in the analyses. The most important difference is that the present study related parental driving behavior *before* the child was licensed to children's driving record in a subsequent time period. Ferguson et al. (2001) chose the same time period for both parents and children, corresponding to the most recent 5 years of historical data. Their time period was not tied to date of licensure, and not all children had been licensed for the full five years. The present study used the driving record of parents in the four years *prior* to their children's date of first licensure to predict children's crashes in the three years following licensure. The parent window would thus correspond to the years when children were, in most cases, aged 12–17. These pre-licensure years correspond to a period when children are dependent on their parents as drivers and would likely have ample opportunity to observe and be aware of parents' driving behavior or styles.

Neither the present study nor its predecessor included a measure of amount of driving. However, the present study did distinguish parents' geographic region of residence as a potential contributor to children's collision experience, since both likely live in the same region and may experience similar qualitative or quantitative exposure correlated with region. Households in the heavily populated Lower Mainland region around the city of Vancouver were distinguished from households in the rest of the province. Vehicles registered in this region are known to have substantially higher collision claims experience than in other areas.

2. Method

2.1. Sample selection and matching

The sampling process was conducted in a series of steps. First, all of the young drivers who met the age criterion of 16–24 as of December 31, 1997 and had three full years of licensure within the province of British Columbia on that date were selected as potential candidates (N = 297,737). This date was chosen to avoid any potential impacts of the introduction of a graduated driver licensing program in 1998. The requirement of three full years' licensure effectively limited the young drivers' age range to 19–24 on December 31, 1997. Working backwards in time, the age range of the sample at date of full licensure was 16–21. The distribution of the final sample within this range was: 53% aged 16, 34% aged 17, 9% aged 18, 3% aged 19, 1% aged 20, and less than 1% aged 21. Thus the latest possible date of full licensure was December 31, 1994 and the earliest possible date was December 31, 1989. The final sample was about equally distributed by year of licensure for the years 1990–1994, with only 8% getting licensed in 1989.

Next, a matching process was undertaken to identify other members of each young driver's household likely to be the young driver's parents. Only young drivers with at least two possible parents were used in the study. To improve the chances of a correct match, household members were required to share the same surname and home address as the young driver on the date of the driver's full privilege licensure. A parent was defined as a household member, at least 18 years older and no more than 45 years older than the driver (for putative mothers) and no more than 50 years older (for putative fathers). In households with more than one resident qualifying as a possible mother or father (5% of selected households), the first eligible name was selected. The matching process identified 58,950 young drivers with a two-parent match. This final sample included 32,120 young males and 26,830 young females.

2.2. Extraction of offenses and collisions

The driving records of the parents in the four years prior to the child's full privilege licensing date were then examined and counts of offenses determined for each putative parent. Offenses were grouped into two types: (a) speeding violations, and (b) all other moving violations. Initially, alcohol-related offenses and non-moving violations were also examined, but due to low frequencies in each category, they were dropped from the models.

A list of the moving offences other than speeding with counts greater than 10 is provided in Table 1. More than 70% of the "other moving" category involved disobeying traffic signals or stop signs.

Table 1
Description and frequency of specific "other moving" offenses by mothers and fathers

Description	Fathers	Mothers	Total
Disobeying traffic sign or signal	1,946	916	2,862
Red light at intersection	1,444	662	2,106
Disobeying stop sign	1,358	741	2,099
Yellow light at intersection	953	471	1,424
Disobeying traffic control device (general)	745	277	1,022
Failure to yield to vehicle	387	364	751
Unsafe lane change	393	153	546
Following too closely	336	184	520
Passing on right, unsafe passing on left	300	99	399
U-turn prohibited or unsafe	251	96	347
Crossing solid double line	243	59	302
Improper right turn at intersection	206	112	318
Failure to yield to pedestrian	171	147	318
Failure to stop at railway crossing	103	18	121
Failure to keep to right side	62	43	105
Driving over highway divider	25	11	36
No turn signal	23	11	34
Failure to stop for school bus	10	13	23
Improper left turn not at intersection	8	3	11
Other (count <10 each)	29	7	36
Total offenses in "other moving"class	8,993	4,387	13,380

Parent at-fault collisions were identified from the ICBC Business Information Warehouse. This is a large data repository that combines data from several primary databases including: driver records, police reported collisions, vehicle records, and insurance claims. An at-fault collision is defined in this study as one for which the driver was assigned 50% or more of the liability by a claims adjustor. In 94% of drivers' at-fault collisions, assigned liability was 100%; thus drivers tend to be judged totally liable or not liable. When the matching and data linkage processes had been completed, personal identifiers were deleted from the linked files to ensure that they could not be traced back to individuals.

Household region of residence was included in the models to control for regional differences in collision likelihood. Given that all the children selected were living in the same household as their parents on the date of their full licensure, and most were likely in the same geographic region even after they left the parental home, residence could be a confounder with parental crash and violation frequency. Geographic region was determined from the "territorial rating" of the vehicle policies listed for a household on the date of the child's full licensure. The "territorial rating" is applied by the insurer to reflect regional differences in loss experience, of which collisions are the major determinant. The Lower Mainland is the territory with the highest loss experience. Vehicles registered to owners in this region experience more collisions than in other regions of the province due to heavy urbanization and commuting. Half of the households in the sample fell within the Lower Mainland territory. As all other territories experience fewer crashes, they are grouped together as "rest of province."

2.3. Statistical analysis

For each young driver, at-fault collision involvements were counted for the 3 year period commencing from full privilege licensure. This count is the dependent variable for the models used in the study. Models using total collisions were also tested but are not reported because they tended to yield similar but weaker effect sizes to the at-fault only models. Poisson regression analysis, appropriate for use with dependent count measures, was used to test for differences in the at-fault collision involvement rates of the young drivers. All analyses were conducted using SAS statistical software, Version 8.

In one set of models, maternal and paternal influences were separated and ordered to allow the estimation of each one on male and female children's at-fault collision risk. Parents' collision involvements were categorized into three levels: (a) no 'at-fault' collision involvements, (b) one 'at-fault' collision involvement, or (c) two or more 'at-fault' collision involvements. A similar categorization was used for parents' offenses. The zero count always served as the reference group. After testing initial models, some levels of offenses were collapsed in order to improve the parsimony of the model and increase cell sizes.

A second set of models assessed the joint influence of parental driving history by classifying each young driver household based on the number of parents with at least one at-fault collision (or offense type). Thus parental at-fault collision involvement was classified as: (a) neither parent had any collision involvements, (b) only the mother had a collision, (c) only the father had a collision, or (d) both parents had at least one collision each. The reference group was parent pairs with zero at-fault collisions. Household offense history was classified in a similar manner for each class of offenses. These models did not take into account multiple incident involvement by each parent, as did the previous set of models, but were designed to determine how the combined influence of both parents in the household compares to that from either parent alone.

3. Results

Table 2 provides counts of the number of young male and young female drivers according to level of parental involvement in at-fault collisions and in each of the offense categories.

The distributions of male and female youths according to parental driving history were very similar, indicating consistency in parent samples. Only small percentages fell into the groups characterized by the highest levels of parental involvement. For example, less than 1% had mothers who were involved in more than one at-fault collision during the 4-year period preceding the young driver' full privilege licence date, while the corresponding number for fathers was 2%.

Table 2
Frequency of at-fault collisions and offenses by parents of male and female young drivers

	Males (n=32,120)				Females (n=26,830)			
	Mothers		Fathers		Mothers		Fathers	
	n	%	n	%	n	%	n	%
At-fault collisions								
>1	250	0.8	709	2.2	206	0.8	555	2.1
=1	2,928	9.1	4,033	12.6	2,449	9.1	3,384	12.6
Zero	28,942	90.1	27,378	85.2	24,175	90.1	22,891	85.3
Speeding offenses								
>1	1,372	4.3	4,277	13.3	1,163	4.3	3,378	12.6
=1	4,978	15.5	7,431	23.1	4,302	16.0	6,164	23.0
Zero	25,770	80.2	20,412	63.6	21,365	79.6	17,288	64.4
Other moving offenses								
>1	244	0.8	775	2.4	229	0.8	638	2.4
=1	1,798	5.6	3,111	9.7	1,545	5.8	2,573	9.6
Zero	30,078	93.6	28,234	87.9	25,056	93.4	23,619	88.0

The 58,950 young drivers included in the study were involved in a total of 28,544 at-fault collisions during their first three years of post-learner driving (19,340 for males and 9,204 for females). Thus the 3-year estimated rate for the entire group was 484.2 at-fault collision involvements per 1,000 young drivers. As expected, females had a much lower 3-year collision rate than males (343.1 vs. 602.1 at-fault collisions per 1,000 drivers). The distribution of collisions was as follows: among females 72.2% had zero collisions, 22.3% had one collision, 4.6% had two collisions, and 0.9% had three or more collisions. Among males 58.0% had zero collisions, 28.9% had one collision, 9.4% had two collisions, 2.8% had three collisions, and 1.0% had four or more collisions throughout the 3-year period. The highest number was 6 for females and 9 for males.

Table 3 shows the relative risks of an at-fault collision derived from the Poisson regression models, for male and female youths. For males the deviance ratio (deviance/degrees of freedom) was 1.16 and for females, 0.92. Both algorithms converged, indicating reasonably good model fit.

Region of parental residence had a large influence on children's crash risk. Living in the heavily populated Lower Mainland was associated with an increased crash risk of 32% for males and 38% for females. Relative risks reported for other sources of parental influence thus account for this important variable. Removing residence from the models (not shown) resulted in somewhat higher relative risks associated with parental at-fault crashes, indicating a correlation between these variables. Removal of residence had a smaller effect on the relative risks associated with parental offenses.

Both mothers' and fathers' at-fault collision involvement had a strong influence on children's at-fault collision involvement. The pattern of this effect on male and female children was highly comparable and maternal collisions had a very similar influence to paternal collisions. A mother with two or more collision involvements increased the relative risk of collision involvement for sons by 20% and for daughters by 34%. A father with two or more collisions increased the relative risk for sons by 25% and for daughters by 28%. Parents with only one at-fault collision involvement increased their children's relative risk of an at-fault collision by 10–13%.

Table 3
Relative risk of involvement in at-fault collision in first three years of licensure based on mothers' and fathers' driving history

	Sons		Daughters	
	RR	95% CI	RR	95% CI
Mother's at-fault collisions				
>1	1.20 *	1.04, 1.37	1.34 **	1.10, 1.61
=1	1.13 ***	1.07, 1.18	1.13 **	1.06, 1.21
Zero	1.00	–	1.00	–
Father's at-fault collisions				
>1	1.25 ***	1.15, 1.36	1.28 ***	1.13, 1.45
=1	1.12 ***	1.07, 1.16	1.10 **	1.04, 1.17
Zero	1.00	–	1.00	–
Mother's speeding offenses				
>1	1.23 ***	1.15, 1.31	1.23 ***	1.12, 1.35
=1	1.12 ***	1.08, 1.17	1.15 ***	1.09, 1.22
Zero	1.00	–	1.00	–
Father's speeding offenses				
>1	1.09 **	1.04, 1.13	1.13 **	1.06, 1.20
=1	1.06 **	1.02, 1.09	1.06 *	1.01, 1.12
Zero	1.00	–	1.00	–
Mother's other moving offenses				
>Zero	1.04	0.98, 1.10	1.00	0.92, 1.08
Zero	1.00	–	1.00	–
Father's other moving offenses				
>1	1.15 **	1.06, 1.25	1.06	0.93, 1.20
=1	1.07 **	1.03, 1.12	1.03	0.96, 1.10
Zero	1.00	–	1.00	–
Residence				
Lower Mainland	1.32 ***	1.28, 1.36	1.38 ***	1.32, 1.44
Rest of BC	1.00	–	1.00	–

* p<.01.
** p<.005.
*** p<.0001.

The pattern of influence of parents' offenses on children's relative risk of an at-fault collision appears somewhat more differentiated. Children of mothers with two or more speeding offenses had a higher relative risk of an at-fault collision, compared to mothers without speeding offenses (23% higher for both sons and daughters). The relative risk was also significantly elevated for children of mothers with only one speeding offense (by 12% and 15% for sons and daughters, respectively). Fathers' speeding offenses were associated with lower, but still significant, relative risks for both sons and daughters. Furthermore, fathers with two or more speeding offenses did not impart a higher relative risk to sons than fathers with only one speeding offense.

Quite a different picture emerged for other (non-speeding) moving offenses. Fathers with two or more other moving offenses increased the relative risk of sons' at-fault collision involvement by 15%, while fathers with one other moving violation increased sons' relative risk by 7%. The relative risk of fathers' other moving violations on daughters' at-fault collisions was not significantly different from one. To maximize power, mothers with other moving offenses were collapsed into one level. However, even with this modification, there was no measurable impact on the relative risk of sons or daughters from such mothers.

Table 4 shows the impact on youth risk of an at-fault collision when two parents in the household have a history of at least one at-fault collision or one offense compared to that of just one parent alone or when both parents are collision or offense free. As in the previous model, these effects were examined accounting for the impact of living in a high-risk region of the province. Clearly the influence of two parents with incident-positive records is greater than that of either mother or father alone. In fact, the influence appears to be multiplicative for most variables. For example, either a mother or father with an at-fault collision increases a son's relative risk of an at-fault collision by 12–13%, but if both the mother and the father have an at-fault collision, the son's relative risk rises by 35% compared to a household where parents have zero at-fault collisions. In the case of other moving offenses, a son having two parents, each with at least one other moving offense, increases his relative risk of an at-fault collision by 21%, compared to only 9% for father only and not significantly for mother only. For daughters, neither the maternal nor paternal influence alone of having had a moving offense was significant, but if both parents had an offense on record, the daughter's relative risk of an at-fault collision was increased by 27%. A similar pattern was found for speeding offenses, but in this case the contribution of maternal speeding is more evident than that of fathers.

Table 4
Relative risk of involvement in at-fault collision in first three years of licensure based on joint parental driving history

	Males		Females	
	RR	95% CI	RR	95% CI
Parents with at-fault collision				
Both parents	1.35***	1.23, 1.47	1.32***	1.16, 1.51
Mother only	1.12***	1.06, 1.18	1.15***	1.07, 1.24
Father only	1.13***	1.08, 1.18	1.13***	1.06, 1.20
None	1.00	–	1.00	–
Parents with speeding offense				
Both parents	1.23***	1.17, 1.29	1.28***	1.20, 1.38
Mother only	1.15***	1.10, 1.20	1.17***	1.09, 1.25
Father only	1.07***	1.04, 1.11	1.09**	1.04, 1.14
None	1.00	–	1.00	–
Parents with other moving offense				
Both parents	1.21**	1.08, 1.35	1.26**	1.08, 1.46
Mother only	1.03	0.97, 1.10	0.94	0.86, 1.03
Father only	1.09***	1.04, 1.14	1.01	0.95, 1.09
None	1.00	–	1.00	–
Residence				
Lower Mainland	1.32***	1.28, 1.36	1.38***	1.32, 1.44
Rest of BC	1.00	–	1.00	–

*p<0.01, **p<0.005, ***p<.0001.

4. Discussion

The present study confirmed and extended the findings of Ferguson et al. (2001) that youth collision risk is related to both parental collisions and offenses. Whereas Ferguson et al. demonstrated a concurrent association (youth and parental records examined over the same time period), the present study found that parental records four years prior to youth licensure influenced youth driving risk in the three-year period following licensure.

The collision risk of youth increases with each increment in at-fault collisions of each parent's driving history in the four years prior to youth licensure. The increase in youth risk associated with parental collisions was even stronger in the present study than that of Ferguson et al. (2001) – possibly because the present one focused on at-fault collisions rather than total collisions. The earlier study reported relative risks of 1.08 and 1.06 for males and females, respectively, for parents with one crash, which compares to 1.13 and 1.14 for the present study, and would be close to the lower end of the 95% interval. The present study included a partial control for type of driving exposure by distinguishing households in a high-risk geographic region. Inclusion of this variable reduced the odds ratios associated with parent crash history somewhat, but was not the principle mediator of parental influence. The earlier study did not address geographic variations in collision risk. Given the differences in methodology between the two studies, the results can be considered consistent.

There was very limited support for a greater influence of same-gender parent, as suggested by the Taubman–Ben-Ari et al. (2005) study on driving styles. This could be related to cultural differences (Israel vs. Canada), sampling differences, types of measures (driving style vs. collisions and offenses), and methods of data collection (self-administered questionnaire vs. record search). Both male and female

youths in the present study were influenced in an analogous manner by parental history of at-fault collisions and speeding offenses. The only indication that young males' and young females' responses to parental offenses may be differentially affected according to parent gender was the finding of increased crash risk for young males, but not females, associated with other moving offenses of the father. Mothers' other moving offenses had no detectable influence on either sons or daughters, except when they occurred in combination with a father's other moving offense (second model). These types of driving offenses, which include disobeying traffic signals and following too closely, may be more reflective of driving style than are the more ubiquitous speeding offenses. Furthermore, the lack of a detectable influence on females of either parent's other moving offenses could be due in part to lack of sensitivity, as indicated by the confidence intervals. Sensitivity is an issue among the females because they have far fewer collisions than the young males.

One suggestive finding is that mothers' speeding offenses are more highly associated with increased relative risk among offspring of both genders than are fathers' speeding offenses. Speeding is a more normative behavior among fathers than among mothers, as evidenced by the fact that 36% of fathers had at least one speeding offense compared to 20% of mothers. Thus a mother with speeding offenses imparts a risk to her offspring and this risk increases with multiple offenses, while the relationship appears less strong in the case of fathers. This finding needs to be confirmed, but it does suggest a need for further research to determine if the motivations and correlates of speeding differ between males and females.

The study shows very clearly that among two-parent families both the mother's and the father's driving behavior plays a role in influencing their children's collision risk. These findings are even more notable when one considers that the start date of the window for examining parents' driving incidents pre-dates that of the youth by four years.

Furthermore, the driving risk associated with each parent appears to be multiplicative or even synergistic when both parents exhibit the negative characteristic. This finding suggests that one low-risk parent helps to balance the influence of a high-risk parent, but when both parents exhibit the high-risk behavior, the child is missing a protective influence. A positive influence from both parents results in the lowest risk level for the children.

Ferguson et al. (2001) reported that parent collisions were a better predictor of children's collisions than were parent violations, while parent violations were a better predictor of children's violations. Similarly, Ferguson et al. (2001) did not find a differential effect on sons versus daughters. Since Ferguson et al.'s measure included undifferentiated violations by both parents combined, speeding offenses were likely the major component (and fathers' speeding violations the larger proportion of the latter). The present study indicates the advantage of differentiating violations and parent gender. It reports higher associations between parental offenses and children's collisions than the earlier study, and suggests that some sources of parental offenses are more predictive of children's collisions than are others.

There are several mechanisms whereby parental driving could influence children's driving. One is directly, through behavior modeling or social learning. Children, throughout their childhood, have ample opportunity to observe the driving habits of their parents, and could emulate them when they themselves become licensed. However, parental influence on driving could also be indirect. Bad driving habits among parents may be associated with other problems (e.g., alcohol or drug abuse), personality traits (e.g., sensation-seeking), or attitudes (e.g., disregard for laws and societal norms) as suggested by Jessor (1987) in a theoretical paradigm developed for adolescents, but extended to adults (Wilson & Jonah, 1988). Propensity to commit traffic offenses may reflect a general disregard for laws, negligence or lack of self-restraint — characteristics that could be transmitted to children. For example, Rowe and Farrington (1997) have shown a high predictability of criminality among the children of parents with criminal records. These authors rule out imitation of delinquency as a likely explanation since the parent-offspring correlations were equally high for parents that committed their offense before the birth of their son compared to those who committed a crime after the birth. These authors also provided some evidence that parental supervision and child rearing practices explained some additional variance in the sons' criminal convictions, not explained by parental criminal convictions alone.

There may also be an association between parents' driving and parenting practices. Parenting practices are related to youth driving risk (Shope et al., 2001) so one reasonable hypothesis is that parents with bad driving habits also provide lower nurturing and monitoring of their children. This relationship has not been studied directly, but the findings of Shope et al. (2001) are suggestive, since these authors found low parental nurturing, monitoring, and connectedness were associated with higher substance use by youth.

The present study, like its predecessor (Ferguson et al., 2001) is an epidemiological study that measures strength of relationships. It provides little in the way of clues as to the explanations for those relationships. Studies are needed to examine how parents influence the driving behavior of their children. Ideally, longitudinal studies should incorporate driving behavior measures along with sociological, psychological, and health indices to attempt to explain what degree the transmission of high-risk driving may be cultural/genetic or mediated indirectly through non-driving-related parental behaviors or characteristics.

The study findings could have significant implications for driver education and public awareness. If future research determines that the primary mode of transmission of parental driving risk to offspring is through social learning, then

parents need to be made aware of their roles as models long before their children reach licensing age — the earlier the better. The most suitable venue for such education may be pre-natal classes! A second point of contact would be during their children's driver education. By involving parents in teen driver education, there may an opportunity to "undo" past negative behavior modeling, or conversely to reinforce positive modeling. Parents are interested in the safety of their teen drivers. However, they may not see the connection between their own driving behavior and their child's future risk as a driver. This knowledge could be used to motivate safer driving on the part of parents. It will be essential for future research to confirm the pathways and mechanisms of familial transmission of driving risk before embarking on such programs. The study findings may also be of interest to licensing authorities and insurance companies.

Finally, some of the study's limitations will be highlighted. The study sample is limited to young drivers living with a parent pair who share the same surname on the date of their first license. This would exclude many young drivers living in single parent households, with two parents who do not share the same surname, or on their own. Thus the results cannot be generalized beyond the two-parent, opposite gender household. Secondly, the matching process may have resulted in the identification of putative parents who were in fact other relatives (grandparents, aunts, uncles). Finally, the study calculates the strength of relationships, based entirely on data from official records. The results would be enhanced by the collection and analysis of supplementary data, such as those collected through survey questionnaires, focus groups, observation or instrumented recording of driver behavior to explore the nature of the relationships.

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