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**Does Gender Moderate the Relationship between
Driver Aggression and its Risk Factors?**

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Abstract

Aim: The current study assessed gender as a potential moderator of the relationship between self-reported driver aggression and various demographic variables, general and driving-related risk factors.

Method: Using data from a general-population telephone survey conducted from July 2002 through June 2005, two approaches to binary logistic regression were adopted. Based on the full dataset ($n=6259$), the initial analysis was a hierarchical-entry regression examining self-reported driver aggression in the last 12 months. All demographic variables (i.e., gender, age, income, education, marital status), general risk factors (i.e., psychological distress, binge drinking, cannabis use), and driving-related risk factors (i.e., driving exposure, stressful driving, exposure to busy roads, driving after drinking, driving after cannabis use) were entered in the first block, and all two-way interactions with gender were entered stepwise in the second block. The subsequent analysis involved dividing the sample by gender and conducting logistic regressions with main effects only for males ($n=2921$) and females ($n=3338$) separately.

Results: Although the prevalence of driver aggression in the current sample was slightly higher among males (38.5%) than females (32.9%), the difference was small, and gender did not enter as a significant predictor of driver aggression in the overall logistic regression. In that analysis, difficulty with social functioning and being older were associated with a reduced risk of driver aggression. Marital status and education were unrelated to aggression, and all other variables were associated with an increased risk of aggression. Gender was found to moderate the relationships between driver aggression and only three variables: income, psychological distress, and driving exposure. Separate analyses on the male and female sub-samples also found differences in the predictive value of income and driving exposure; however, the difference for psychological distress could not be detected using this separate regression approach. The secondary analysis also identified slight differences in the predictive value of four of the risk factors, where the odds ratios for both males and females were in the same direction but only one of the two was statistically significant.

Conclusions: The results demonstrate the importance of conducting the gender analysis using both regression approaches. With few exceptions, factors that were predictive of driver aggression were generally the same for both male and female drivers.

Keywords: driver aggression, gender, drink-driving, alcohol, cannabis, population survey

1. Introduction

Driver anger and aggression are frequent occurrences in our everyday lives (Neighbors et al., 2002; Underwood et al., 1999). In Ontario, Canada nearly half of survey respondents reported that they had been shouted at, cursed at, or had rude gestures directed at them in the past year, and about 8% of respondents reported having had another driver threaten to hurt them or to damage their vehicle (Mann et al., 2004; Smart et al., 2003). A smaller but still substantial proportion of drivers reported being a perpetrator of aggression, with a third of drivers reporting that they had shouted at, cursed at, or made rude gestures at another driver, and approximately 2% of drivers admitting to having threatened to hurt another driver or damage another driver's vehicle. Research worldwide has consistently shown that driver aggression is a primary contributor to the risk of motor vehicle collisions (Lawton et al., 1997; Mann et al., 2007; Mesken et al., 2002; Wells-Parker et al., 2002; Xie and Parker, 2002).

Gender may be an important factor in driver anger and aggression. Male drivers engage in more risk-taking on the roadways, commit more driving violations, receive more traffic citations, and are involved in more motor vehicle collisions than female drivers (Åberg and Rimmö, 1998; Arnett et al., 1997; Blockey and Hartley, 1995; Lawton et al., 1997; Parker et al., 1995). However, the literature examining gender differences in driver anger and aggression has not been as definitive.

There have been indications that male and female drivers do not differ in the overall level of anger they experience in response to roadway frustrations (Deffenbacher et al., 1994, 2003, 2004; Lajunen et al., 1998; Lonczak et al., 2007). Some results have suggested that male and female drivers differ in what offensive driver behaviors they find most anger-provoking (Deffenbacher et al., 1994) but these gender differences have not been found consistently

(Björklund, 2008; Deffenbacher et al., 2000; Lonczak et al., 2007). Further, several studies have failed to report gender differences in the behavioral response to driver anger (Hauber, 1980; Hennessy and Wiesenthal, 1999; McGarva and Steiner, 2000). However, there is evidence that gender can moderate the relationship between driver aggression and various individual difference or personality variables. Hennessy and Wiesenthal (2002a, b, 2005) found that gender moderates the relationship between driver aggression and both a vengeful attitude and willingness to commit violations. Lajunen and Parker (2001) found that males and females differ in the strength and the pattern of the relationship between general trait aggression and driver-specific aggression. Lonczak et al. (2007) found that sensation-seeking was associated with more traffic citations, but particularly so for women. Krahé and Fenske (2002) found that “macho” personality (i.e., an exaggerated endorsement of the male stereotype) was a predictor of men’s aggressive driving; however, a subsequent study by Krahé (2005) found that masculinity was unrelated to women’s aggressive driving. Instead, greater femininity predicted lower driver aggression in a sample of female drivers.

Some variables, although associated with driver anger and aggression, have not previously been associated with gender. Driver stress (which can be a consequence of traffic congestion or other driving-related frustrations) is strongly related to incidents of driver anger and aggression (Hennessy and Wiesenthal, 1999). The minimum threshold needed for an emotional and/or behavioral response to another driver’s offensive behavior is likely reduced by driver stress. In a field study that assessed state driver stress *in vivo* by interviewing commuting drivers over cellular telephones, no gender differences in state driver stress were found (Hennessy and Wiesenthal, 1999; Hennessy et al., 2000).

Gender differences have been identified in other high-risk behaviors and conditions related to driving, which may in turn impact the likelihood of road rage perpetration. For example, psychological distress and depression have been found to be related to high-risk driving and collision involvement (Mann et al., 2010a; Selzer et al., 1968; Selzer and Vinokur, 1975), and females are at greater risk for depression (Weissman et al., 1993). Alternatively, problem drinking, cannabis use, and driving after drinking or after using cannabis have been found to be associated with driver anger, aggression, and collision involvement (Butters et al., 2005; Laumon et al., 2005; Lonczak et al., 2007; Mann et al., 2004, 2010b, c; Wells-Parker et al., 2002), and these high-risk behaviors are more prevalent among males (Begg et al., 2003; Greenfield and O'Leary, 1999; Naimi et al., 2003). However, it may also be the case that although the prevalence of these high-risk behaviors is less among women, those female drivers who do engage in these high-risk behaviors may pose an even greater risk of road rage perpetration (see Impinen et al., 2010). These high-risk activities may represent more deviant and destructive health behaviors in females than they do in males, and thus may be more strongly associated with road rage perpetration and other negative outcomes, including increased mortality, among female drivers (Mann et al., 1993). The current study considered each of these possibilities by examining the role of gender as a potential moderator of the relationship between demographic, as well as general and driving-related risk factors, and driver aggression.

Lonczak et al. (2007) has examined the moderating effect of gender on the relationship between alcohol-related risk factors and driving outcomes such as driving anger, traffic citations, and traffic-related injuries. They found that gender moderated the relationship between driver anger and both frequency of consumption and number of drinks typically consumed. Specifically, more frequent drinking was associated with more driving anger, but this was

particularly true for women. Interestingly, a greater number of drinks typically consumed was associated with less driving anger, which was also particularly true for women. The authors suggested that this latter finding may reflect a tendency by women to drive less after having consumed several drinks in a single session, and thus be less likely to experience driving anger relative to men. No other moderating effects of gender were found.

The current study extends the findings of Lonczak et al. (2007) by considering a more diverse set of behavioral risk factors and focusing specifically on self-reported driver aggression. Specifically, we assessed gender as a moderator of the relationship between self-reported driver aggression and demographic variables (i.e., age, income, education, marital status), general risk factors (i.e., psychological distress, binge drinking, cannabis use), and driving-related risk factors (i.e., driving exposure, stressful driving, exposure to busy roads, driving after drinking, driving after cannabis use). The use of a large, representative sample of adult drivers permitted a more powerful assessment of the association of gender with driver aggression than possible in most previous research.

2. Method

2.1 Sample

The Centre for Addiction and Mental Health (CAMH) conducts a repeated cross-sectional telephone survey of Ontario adults aged 18 years and older. The survey, the CAMH Monitor, is administered by the Institute for Social Research at York University. The CAMH Monitor uses regional stratification and consists of independent monthly samples with approximately 200 completions each (response rate 56% to 61%; see Ialomiteanu and Adlaf, 2006 for sampling design details). The current sample is derived from data collected in the CAMH Monitor between July, 2002 and June, 2005 when a series of items designed to measure

perpetration of driver aggression were included in the survey. Data from this time period were merged into a single dataset and screened to include only the respondents who had held a valid driver's licence in the previous 12 months and who had driven in the previous 12 months ($n=6274$).

2.2 Outcome variable

Four items from the CAMH Monitor were used to determine the occurrence of perpetrated driver aggression: During the past 12 months, how many times have you (1) shouted, cursed, or made rude gestures at a driver or passenger in another vehicle?, (2) threatened to hurt a driver or passenger in another vehicle, or threatened to damage their vehicle?, (3) intentionally damaged or attempted to damage another driver's vehicle?, (4) intentionally hurt or attempted to hurt a driver or passenger in another vehicle? Respondents who replied never to all questions were coded as 0. Respondents who reported at least one experience of perpetrating driver aggression in the past year were coded as 1.

2.3 Predictor Variables

Demographic variables included gender (coded 1=female, 2=male), age (coded 1=18-34 years, 2=35-54 years, 3=55+ years), income (coded 1=<\$30,000, 2=\$30,000-49,999, 3=\$50,000-79,999, 4=\$80,000+, 5=not stated), marital status (coded 1=not married, 2=married or common law), and education (coded 1=less than high school, 2=completed high school, 3=some post-secondary, 4=university degree).

Measures of general risk factors included binge drinking, lifetime cannabis use, and psychological distress. Binge drinking was measured by a single item: About how often during the past 12 months would you say you had five or more drinks at the same sitting or occasion? (coded 0=less than once per month/non-drinker, 1=at least monthly). Lifetime cannabis use was

also assessed by a single item: Have you ever in your lifetime used marijuana or hash? (coded 0=no, 1=yes). The 12-item General Health Questionnaire (GHQ-12; Goldberg et al., 1997) has been used widely in general populations as a screening instrument for non-psychotic mental illness and psychological distress (e.g., Banks, 1983; Goldberg et al., 1997; Hardy et al., 1999; Mann et al., 2011; Pevalin, 2000) and was also included in the present study. Several studies of the GHQ-12 have identified two factors or sub-scales within the measure: (1) mixed depression and anxiety, and (2) social functioning (e.g., Politi et al., 1994; Schmitz et al., 1999; Wells-Parker et al., 2006). The latter sub-scale reflects difficulty with social interactions or performing social duties. A four-point Likert scoring method was used and items were summed to determine scores on the depression-anxiety and social functioning sub-scales. Higher scores reflected greater depression-anxiety and social difficulties. Respondents were required to respond to all items in order for a sub-scale score to be computed.

Measures of driving-related risk factors included distance driven, stressful driving, busy roads, driving after drinking, and driving after cannabis use. Respondents were asked to indicate how many kilometers they drive in a typical week (continuous variable), how much of their driving in the past 12 months was stressful (coded 0=none of the time, 1=at least some of the time), and how much of their driving in the past 12 months was on busy roads (coded 0=none of the time, 1=at least some of the time). Driving after drinking was measured by a single item: During the past 12 months, have you driven a motor vehicle after having two or more drinks in the previous hour? (coded 0=no, 1=yes). Driving after cannabis use was also measured by a single item: During the past 12 months, have you driven a motor vehicle within an hour of using cannabis, marijuana, or hash? (coded 0=no, 1=yes).

2.4 Analyses

The data were screened such that “don’t know” responses and refusals were excluded from analyses. The weighted sample size was used when reporting percentages, and these are considered representative of the population surveyed. All analyses were conducted using SPSS 15.0 software. Data on prevalence of driver aggression by demographic factors and risk factors were examined through chi-square and *t*-test analyses. Logistic regression analysis was used to assess the impact of the various risk factors on driver aggression when controlling for demographic factors. In the initial analysis, all demographic variables and risk factor variables were entered in the first block of the regression. In order to examine possible interactions with gender, all two-way interactions with gender were entered stepwise into the second block using the likelihood ratio (LR) test and a backward deletion procedure. The LR test is considered to be the most accurate stepwise method (Garson, 2010). A *p*-value of .05 was set for inclusion in the model and a *p*-value of .10 was set for exclusion from the model. Subsequent logistic regression analyses were conducted to more fully comprehend significant two-way interactions with gender. The data were separated into two individual samples: females (*n*=3338) and males (*n*=2921). All main effects were assessed in separate logistic regressions for each gender sample.

3. Results

Table 1 presents self-reported driver aggression for each gender, as a function of demographic characteristics, general risk factors, and driving-related risk factors. The overall prevalence of perpetrated driver aggression was greater for males (38.5%) than females (32.9%). Shouting, cursing, and making rude gestures was the most common form of driver aggression for both males and females, as virtually all respondents who reported driver aggression confessed to engaging in this more mild form of perpetration. Less than three percent of males and less than

one percent of females reported engaging in any of the other more aggressive categories of perpetration.

Demographic variables found to be significantly related to driver aggression were generally consistent across gender. A significant effect of age was found for both males and females, such that younger drivers (18-34 years) reported the highest prevalence of perpetrated driver aggression (47.3% for females, 54.5% for males), whereas the oldest drivers (55+ years) reported the lowest prevalence of perpetrated driver aggression (15.1% for females, 20.9% for males). For both male and female drivers, those who were unmarried reported a greater prevalence of driver aggression (37.3% for females, 45.9% for males) than those who were married (30.7% for females, 35.4% for males). The prevalence of driver aggression varied significantly by income. For both males and females, the highest income earners reported the highest prevalence of driver aggression (41.2% for females, 43.7% for males) and those not stating their income reported the lowest prevalence of driver aggression (22.5% for females, 29.7% for males). The prevalence of driver aggression also varied by level of education. For females, driver aggression was most prevalent among drivers with a university degree (37.1%) and least prevalent among those drivers who had not completed high school (21.5%). For males, driver aggression was most prevalent among those with only some post-secondary education (42.2%) and, as with females, least prevalent for those without a high school degree (31.7%).

The general risk factor variables significantly associated with perpetrated driver aggression were also relatively consistent across gender. For both males and females, driver aggression was more common for drivers who reported more depression-anxiety, reported consuming 5+ drinks at least monthly in the last year, and reported using cannabis in their lifetime. The only general risk factor to produce a different univariate result for male versus

female drivers was poor social functioning. For females, the poor social functioning score was greater among those who reported driver aggression versus those who did not. For males, no such difference was found.

The driving-related risk factor variables significantly associated with perpetrated driver aggression were entirely consistent across gender. For both males and females, a higher number of kilometers driven per week was estimated by drivers who reported driver aggression versus those who did not. Also for both males and females, driver aggression was more prevalent for drivers who reported that driving is stressful at least some of the time, that they drive on busy roads at least some of the time, that they have driven after drinking in the past year, and that they have driven after using cannabis in the past year.

Table 2 provides the logistic regression model of self-reported driver aggression using the full sample. Missing cases were deleted listwise, resulting in a lower sample size for the multivariate analysis. Adopting Field's (2005) recommendations, markers for multicollinearity were examined and the results of this analysis were indicative of an absence of multicollinearity. The Hosmer and Lemeshow test for the model was not significant, indicating good fit.

Of the demographic variables tested, age and income contributed significantly to the model. Relative to young drivers (18-34 years), middle-aged and older drivers had a reduced risk of engaging in driver aggression ($OR=.61$ for middle-aged drivers, $OR=.34$ for older drivers). Relative to those earning less than \$30,000 annually, those earning more had an increased risk of engaging in driver aggression (ORs ranging from 1.50 for those earning \$30,000 to \$49,999 up to 1.88 for those earning \$80,000+).

Controlling for demographic variables, all risk factors contributed significantly to perpetrated driver aggression. The GHQ-Social Functioning scale was the only risk factor to

reduce risk of perpetrated driver aggression ($OR=.96$). All other general risk factors, including the GHQ-Depression-Anxiety scale ($OR=1.11$), binge drinking ($OR=1.21$), and lifetime cannabis use ($OR=1.80$), increased risk of perpetrated driver aggression. Further, each of the driving-related risk factors, including driving exposure (i.e., number of kilometers driven per week, $OR=1.001$), experiencing stressful driving ($OR=1.92$), driving on busy roads ($OR=1.91$), driving after drinking ($OR=1.42$), and driving after cannabis use ($OR=1.61$), were also observed to be associated with a heightened risk of perpetrated driver aggression.

Only three of the two-way interactions with gender were retained in the model. These were interactions between gender and income, GHQ-Depression-Anxiety score, and number of kilometers driven weekly. In this analysis, interactions between categorical variables and gender are best understood as differences in the ratio of male-to-female perpetrated driver aggression at each level of the interacting variable. Essentially, an interaction term in a logistic regression is “a ratio of odds ratios” (Simon, 2008). In the case of income, the ratio of male-to-female perpetrated driver aggression in the reference group reveals that male drivers earning less than \$30,000 annually are at a greater risk of engaging in driver aggression than female drivers at that income level. Female drivers earning between \$30,000 and \$49,999 annually are at greater risk of engaging in driver aggression than male drivers in that income bracket. For drivers earning \$80,000 or more, males are at greater risk of perpetrating driver aggression compared to females, but this difference is not as great as the difference among male and female drivers earning less than \$30,000 annually.

The interaction between gender and the GHQ-Depression-Anxiety score indicates that depression-anxiety is associated with an increased risk of engaging in driver aggression for both males and females, but this association is particularly true for female drivers. The interaction

between gender and driving exposure indicates that a greater number of kilometers driven weekly is associated with a greater risk of driver aggression, but again, this is particularly true among female drivers. Although the odds ratio reported for this latter interaction is 1.000, values for kilometers driven varied from 0 to 7000, which suggests that the number of decimal places needed to demonstrate an odds ratio greater than or less than 1 should be very high. However, the confidence interval for this interaction was .999 to 1.000, confirming this interpretation of the gender by driving exposure interaction.

A secondary analysis was conducted to more fully comprehend the few significant two-way interactions with gender. The dataset was split into female ($n=3338$) and male ($n=2921$) respondents. All main effects were assessed in separate logistic regressions for each gender sample. Again, missing cases were deleted listwise, resulting in a lower sample size for each analysis. In both cases, the Hosmer and Lemeshow test was not significant, indicating acceptable fit of the model. Both of these secondary logistic regression models are presented in Table 3.

As with the overall model, the demographic variables of age and income significantly contributed to the prediction of perpetrated driver aggression for both male and female respondents. For both gender groups, relative to the youngest drivers, middle-aged and older drivers had a reduced risk of engaging in driver aggression. Although the effect of income was significant overall for both males and females, significant differences for levels of the income variable were significant for female respondents only. Specifically, relative to female drivers earning less than \$30,000 annually, those earning more had an increased risk of engaging in driver aggression. It should be noted, however, that this effect only approached significance in the case of female drivers earning between \$30,000 and \$49,999 annually ($OR=1.48$, $p=.06$). As

with the logistic regression of the full sample, relative to other female drivers, those earning \$80,000+ had the highest risk of perpetrated driver aggression ($OR=1.77$).

In examining the general risk factor variables, there were slight differences between the male and female regression models. In the case of male drivers, the results were very similar to those of the regression for the overall sample. All of the general risk factors were associated with the risk of perpetrated driver aggression; however, only the GHQ-Social Functioning scale was associated with a reduced risk of perpetration ($OR=.95$). The GHQ-Depression-Anxiety scale ($OR=1.07$), binge drinking ($OR=1.32$), and lifetime cannabis use ($OR=1.67$) were all associated with increased risk of driver aggression among male drivers. Among female drivers, only the GHQ-Depression-Anxiety scale ($OR=1.10$) and lifetime cannabis use ($OR=1.96$) were statistically significant.

The driving-related risk factor variables also produced a slightly different pattern of results for the male versus female drivers. Driving a greater number of kilometers each week was associated with a greater risk of perpetrated driver aggression ($OR=1.001$ for females, $OR=1.000$ for males), although the effect only approached significance in the male regression model ($p=.06$). This finding confirms the interpretation of the gender by driving exposure interaction found in the regression model of the overall sample. Experiencing stressful driving and driving on busy roads were associated with increased risk of engaging in driver aggression for both males and females. The odds ratio for driving on busy roads was greater for male than female drivers. Driving after drinking was significantly associated with increased risk of perpetrated driver aggression for male drivers only. Finally, driving after cannabis use was associated with increased risk of perpetrated driver aggression for female drivers only; however, the effect approached significance for male drivers ($p=.07$).

4. Discussion

Previous research has produced mixed results regarding gender differences in driver aggression. In a large, representative sample of adult drivers in Ontario, the current study used a yes-no dichotomous variable that examined any form of aggressive actions, ranging from shouting, cursing, and gesturing to purposefully injuring another road user or damaging a vehicle. The findings revealed that while the prevalence of self-reported driver aggression was greater for male (38.5%) than female (32.9%) drivers, this difference was not significant in the logistic regression conducted on the full dataset. This finding is surprising in view of other studies that demonstrate gender differences on driving-related measures such as risk-taking, number of violations, and collision involvement (e.g., Åberg and Rimmö, 1998; Arnett et al., 1997; Blockey and Hartley, 1995; Lawton et al., 1997; Parker et al., 1995).

The univariate and multivariate analyses presented here are consistent with previous research which has found that younger drivers are more likely to drive recklessly or aggressively, to be involved with cases of road rage, and to be involved in collisions (Hauber, 1980; Lajunen and Parker, 2001; Lawton et al., 1997; Wells-Parker et al., 2002). However, it is predominantly young *male* drivers who are over-represented among aggressive and risky driving and collision statistics (Centers for Disease Control and Prevention, 2010). It is perhaps surprising that the logistic regression conducted on the full dataset did not identify a significant interaction between gender and age. However, this is consistent with other studies that have also not found a significant gender-by-age interaction (Lonczack et al., 2007; Stradling and Meadows, 2000).

Consistent with previous findings (Mann et al., 2004; Shinar et al., 2001; Smart et al., 2003; Stradling and Meadows, 2000), higher income and education in the univariate analyses were associated with a greater prevalence of driver aggression among both male and female

motorists. It has been suggested that high income earners may have more business and social engagements and thus may experience more time urgency (Smart et al., 2003). Another possibility is that high income earners may be less deterred by the risk of fines should their driving violations be detected by the authorities (Smart et al., 2003; Wickens et al., 2011). Similar to the univariate analyses, the logistic regressions identified income as a significant predictor of self-reported driver aggression. As with the univariate analyses, high income earners were at increased risk for driver aggression. However, education did not enter as a significant predictor of driver aggression in any of the logistic regressions. This may be due to income and education accounting for common variance.

Interestingly, gender was found to moderate the relationship between income and self-reported driver aggression. Specifically, the logistic regression of the full dataset revealed that the gender difference in prevalence of driver aggression was less among those earning \$80,000+. Moreover, the standard gender difference in prevalence of driver aggression was reversed among those earning \$30,000-\$49,999; that is, the prevalence of perpetration was greater among females than males within this income bracket. The logistic regressions conducted on the single-gender samples found that although income overall was a significant predictor for both male and female respondents, gender differences emerged in the individual income categories. For female respondents, those earning more than \$30,000 were at increased risk of engaging in driver aggression. No individual income categories were significant predictors of self-reported driver aggression among male respondents. These results suggest that effects of income on driver aggression may be most relevant to female drivers.

Consistent with previous findings of other negative driver behaviors (Hemenway and Solnick, 1993; Turner and McClure, 2003), univariate analyses revealed that the prevalence of

self-reported driver aggression was greater among those who were currently unmarried or had never been married compared to those drivers who were presently married. However, also consistent with previous findings (Hemenway and Solnick, 1993; Turner and McClure, 2003), none of the logistic regressions identified marital status as a significant predictor of self-reported driver aggression. The relationship between marital status and driving behavior is often confounded by age, and the effect of marital status on various driving behaviors has often disappeared in multivariate analyses that included several demographic and risk factors associated with driving behavior.

4.1 General risk factors and driver aggression

Difficulty with social interactions or performing social duties, measured by the social functioning sub-scale of the GHQ-12, was found to be significantly higher in female aggressive versus non-aggressive drivers. However, there was no difference in social functioning between male perpetrators and non-perpetrators of driver aggression. Interestingly, the multivariate analyses of the full dataset and of male respondents separately found that difficulty with social functioning was associated with a *reduced* risk of perpetrated driver aggression. The multivariate analysis for female respondents identified a similar but non-significant trend. Motorists who experience difficulty with social interactions may be less willing to respond aggressively in response to frustrating roadway events. Further review of the dataset revealed that these motorists report driving fewer kilometers per week. Interestingly, previous research has failed to find a significant relationship between the GHQ-Social Functioning scale and collision involvement (Mann et al., 2010a) or driving after drinking (Stoduto et al., 2008).

Regardless of gender, univariate analyses revealed that scores on the depression-anxiety sub-scale of the GHQ-12 were significantly higher among aggressive drivers than non-

aggressive drivers. These results were mirrored in the multivariate analyses, both on the full dataset and on the single-gender samples. Drivers experiencing greater psychological distress were at greater risk of engaging in driver aggression. Previous research has found a significant relationship between the GHQ-Depression-Anxiety scale and both collision involvement (Mann et al., 2010a) and driving after drinking (Stoduto et al., 2008).

Interestingly, gender was found to moderate the relationship between depression-anxiety and driver aggression. Specifically, the difference in GHQ-Depression-Anxiety scores between perpetrators of driver aggression and non-perpetrators was greater for females than males. This suggests that psychological distress may play a greater role in predicting aggression in female drivers than male drivers, which may be a reflection of the higher rates of depression among women than men (Weissman et al., 1993).

According to the univariate analyses, binge drinking was associated with an increased risk of driver aggression among both male and female respondents. The multivariate analyses of both the overall dataset and the sub-sample of male drivers mirrored this effect. Binge drinking was not significantly related to driver aggression among female respondents; however, the odds ratio suggested that the relationship was in the same direction, and thus it may be that the strength and not the nature of the relationship differs between males and females.

Regardless of gender, univariate analyses indicated that lifetime cannabis use was associated with increased prevalence of driver aggression. Each of the logistic regressions found similar results, which are in line with those of previous research (Butters et al., 2005, 2006). Although the prevalence of cannabis use is known to be greater among males than females (Greenfield and O'Leary, 1999), this did not seem to impact the relative value of this risk factor as a predictor of driver aggression for males versus females.

4.2 Driving-related risk factors and driver aggression

Differences in exposure to the roadway environment were controlled in the present study by asking respondents to estimate the number of kilometers driven in a typical week. Univariate analyses revealed that, regardless of gender, perpetrators of driver aggression reported more mileage than non-perpetrators. This same finding was revealed by the logistic regression conducted on the full dataset. However, gender was found to moderate the relationship between driving exposure and driver aggression. Specifically, the difference in mileage between perpetrators and non-perpetrators of driver aggression was greater for female than male drivers. The logistic regressions conducted on the single-gender samples support this interpretation. For females, a greater number of kilometers driven was associated with an increased risk of driver aggression. For males, this relationship only approached significance ($p=.06$). Thus, weekly mileage may have more predictive value for driver aggression among women than men.

The nature of respondents' driving exposure was also controlled in the present study by including measures of exposure to busy roads and stressful driving. Consistent with a large body of previous research (e.g., Hennessy and Wiesenthal, 1999, 2001; Hennessy et al., 2000; Neighbors et al., 2002; Shinar, 1998; Wickens and Wiesenthal, 2005) the findings indicated that exposure to busy roads and experiencing stressful driving were positively related to self-reported driver aggression. A hypothesis to account for these findings is that driver stress, often a consequence of traffic congestion, reduces the minimum threshold at which motorists will retaliate in response to another driver's offensive behavior.

The final driving-related risk factors, driving after drinking and driving after cannabis use, were found by univariate analyses and the logistic regression conducted on the full dataset to be significantly associated with an increased prevalence of perpetrated driver aggression for both

male and female drivers. Although the prevalence of both driving after drinking and driving after cannabis use have previously been found to be greater among males than females (Begg et al., 2003), the interactions between these risk factors and gender were not significant, suggesting that gender differences in the prevalence of these risk factors did not impact their relative value as predictors of driver aggression for males versus females. Interestingly, however, in the logistic regressions conducted separately for each gender group, driving after drinking was identified as a significant predictor of driver aggression among males only. The odds ratio of this risk factor was larger for the female group than the male group, but was only significant in the latter case. In terms of driving after cannabis use, this risk factor was significant for females only, although it approached significance for males ($p=.07$). Moreover, the odds ratio for driving after cannabis use among females was nearly double the odds ratio for males, suggesting that although fewer women engage in this high-risk behavior, those who do may pose a greater risk of driver aggression.

4.3 Limitations

It is important to recognize some of the limitations of the current research. First, the use of self-report measures may have led to a social desirability bias in the dataset; however, previous studies have found self-report measures of alcohol and drug use at least to be valid in general population samples (Harrison, 1997). It is also possible that participants failed to recall all incidents of perpetrated driver aggression, driving after drinking, driving after cannabis use, or other behaviors used as predictor variables that occurred over a 12-month period; however, the impact of truncated estimates was minimized for most variables by converting respondents' estimates to binary responses that reflect any incidence versus no incidence of the behavior. Second, because these results are based on a cross-sectional survey, they do not permit drawing

cause-and-effect conclusions. Nonetheless, the current analysis suggests that there are important associations between various risk factors and driver aggression that can be observed in a general population sample. Third, it is impossible to determine whether non-respondents to this cross-sectional survey would have responded the same way as did respondents. However, previous research has established that non-respondents in studies of substance use and driving behavior are likely to be heavier substance users (Mann et al., 2003), suggesting that any bias introduced by non-response would be conservative. Finally, the use of a telephone survey methodology unavoidably excluded certain groups from participation in the study. Ontario residents who were in prisons, hospitals, and military establishments, the homeless, and those who rely exclusively on cellular telephones were not included in the target population. Although the potential for bias of the dataset exists, the size of the excluded group should be small relative to the total population of Ontario. For example, at the end of 2005, only 4.1% of Ontario households did not have a landline telephone (Statistics Canada, 2006).

4.4 Conclusion

The prevalence of overall driver aggression appears to be similar across genders. Although the prevalence of driver aggression in the current sample was slightly higher among males than females, the difference was small, and gender did not enter as a significant predictor of driver aggression in the logistic regression of the full dataset. Gender was found to moderate the relationships between driver aggression and only three variables: income, psychological distress, and driving exposure. The results of the subsequent analyses on the male and female sub-samples also found differences in the predictive value of income and driving exposure; however, the difference for psychological distress could not be detected using this side-by-side separate regression approach. The secondary regression analysis also identified modest

differences in the predictive value of social functioning, binge drinking, driving after drinking, and driving after cannabis use, where the odds ratios for both males and females were in the same direction but only one of the two was statistically significant. The fact that a few differences were found in the predictors of male and female driver aggression that were not reflected in a significant interaction with gender in the regression analysis of the full dataset demonstrates the value of conducting the analysis using both statistical techniques.

It is possible that gender differences in aggressive driving may emerge when examining more extreme forms of driver aggression (Butters et al., 2006; Hennessy et al., 2004). Hennessy and Wiesenthal (2001) failed to find a gender difference on a measure of mild driver aggression (e.g., horn honking out of frustration, swearing/yelling, purposeful tailgating, hand gestures, etc.), but found that males scored higher than females on a measure of driver violence (e.g., verbal or physical confrontations, chasing other vehicles, throwing objects, etc.). Subsequent studies and analyses found that driver violence was more prevalent among male drivers who exhibited a more vengeful attitude (Hennessy and Wiesenthal, 2002a), in combination with both elevated levels of mild driver aggression (Hennessy and Wiesenthal, 2002b) or willingness to commit violations (Hennessy and Wiesenthal, 2005). This same trend was generally not found among female drivers.

With few exceptions, we found that factors that were predictive of driver aggression were generally the same for both male and female drivers. This suggests that intervention strategies designed to reduce aggressive driving behavior could generally be targeted to *both* male and female drivers and still maximize the potential for behavior change. This is an important finding in light of the limited financial resources available for driver safety initiatives. It is also interesting in light of other research which has found gender differences in perceived concern for

driver safety and attitudinal support for driver safety legislation, suggesting that strategies for changing *attitudes* toward driver safety (versus changing the behavior itself) should be tailored by gender (Butters et al., submitted for publication). The few gender differences identified in the current study also provide guidance for future driver safety efforts. Educational campaigns targeting high-income earners or higher-mileage drivers may be more effective for female drivers within these subgroups. As well, the impact of depression and other mental health disorders on driver performance has received very little research attention from the scientific community (Wickens et al., in press, submitted for publication, in preparation). The results of the current study suggest that any future research examining depressed drivers should consider possible gender differences.

In general, our knowledge of gender differences in anger and aggression is limited, particularly in terms of the moderating role played by gender in the relationship between predictor variables and driver aggression. The current study sheds light on the role of gender as a moderator. Future research should examine the moderating role of gender for other variables related to driver anger and aggression, and also consider if gender differences may be larger when considering more extreme forms of aggression.

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Table 1

Any Perpetrated Driver Aggression for males versus females by demographic, general risk, and driving-risk measures: Ontario CAMH Monitor, July, 2002 – June, 2005.

	Females		Males	
	<i>n</i>	Any Perp ^a Yes (%) ^b	<i>n</i>	Any Perp ^a Yes (%) ^b
Total^c	3338	32.9	2921	38.5
Control variables:				
Age		***		***
18-34 years	807	47.3	715	54.5
35-54 years	1409	35.4	1316	38.8
55+ years	1032	15.1	849	20.9
Income ^d		***		***
<\$30,000	530	25.1	337	32.3
\$30,000-49,999	575	33.6	514	30.1
\$50,000-79,999	764	34.6	698	43.7
\$80,000+	845	41.2	969	43.7
Not stated	623	22.5	403	29.7
Marital status		***		***
Not ever/not currently married	1302	37.3	1009	45.9
Married/partner	2004	30.7	1893	35.4
Education		***		***
< High school	402	21.5	429	31.7
Completed high school	788	30.1	688	39.6
Some post-secondary	1238	35.1	960	42.2
University degree	874	37.1	813	36.8
General risk factor variables:				
GHQ - Social Functioning				
Mean (SD)		*		
Any Perp ^a Yes	980	6.11 (1.92)	1039	5.71 (1.91)
Any Perp ^a No	2253	5.95 (1.68)	1756	5.71 (1.68)
GHQ - Depression-Anxiety				***
Mean (SD)		***		
Any Perp ^a Yes	990	3.68 (3.26)	1042	3.02 (2.95)
Any Perp ^a No	2267	2.68 (2.69)	1782	2.35 (2.56)
Five+ drinks monthly -last 12 months		***		***
Less than monthly/non-drinker	2693	30.0	1817	32.5
At least monthly	636	44.1	1082	48.6
Cannabis use-lifetime		***		***
No	2160	23.7	1511	28.1
Yes	1158	50.4	1378	50.6

Driving risk factor variables:				
Km driven-typical week				
Mean (SD)		***		***
Any Perp ^a Yes	893	243.32 (352.82)	1037	472.01 (643.43)
Any Perp ^a No	2006	152.40 (213.91)	1770	374.78 (563.60)
Driving is stressful				
None of the time	1445	21.2	1265	28.7
At least some of the time	1652	42.4	1506	46.8
Driving on busy roads				
None of the time	357	15.9	167	20.0
At least some of the time	2733	35.2	2615	39.8
Driving after drinking				
No	3219	32.2	2526	36.3
Yes	100	58.0	372	54.6
Driving after cannabis use				
No	3289	32.4	2779	37.1
Yes	33	69.4	119	66.9

^a In the last 12 months.

^b Percentages reported are based on weighted sample size.

^c Drivers who (1) currently hold a valid driver's license or have held a valid driver's license in the last 12 months and (2) have driven a motor vehicle in the last 12 months.

^d Canadian dollars.

* Chi-square statistical significance, $p < .05$.

** Chi-square statistical significance, $p < .01$.

*** Chi-square statistical significance, $p < .001$.

Table 2

Logistic regression model of Any Perpetrated Driver Aggression: Ontario CAMH Monitor, July, 2002 – June, 2005.

	Perpetrated Driver Aggression ^a (<i>n</i> =5030)
<i>Control variables</i>	OR ^{b,c}
Gender (ref. = female)	1.45
Age (ref. = 18-34 years)	***
35-54 years	.61***
55+ years	.34***
Income ^d (ref. = <\$30,000)	**
\$30,000-49,999	1.50*
\$50,000-79,999	1.53*
\$80,000+	1.88***
Not stated	1.35
Marital status (ref. = not married)	1.04
Education (ref. = < high school)	
Completed high school	.98
Some post-secondary	.96
University degree	.86
<i>General risk factor variables</i>	
GHQ – Social Functioning	.96*
GHQ – Depression-Anxiety	1.11***
Five+ drinks monthly (ref. = less than monthly/no)	1.21**
Cannabis use-lifetime (ref. = no)	1.80***
<i>Driving risk factor variables</i>	
Kilometers driven-typical week	1.001***
Driving is stressful (ref. = none of the time)	1.92***
Driving on busy roads (ref. = none of the time)	1.91***
Driving after drinking (ref. = no)	1.42**
Driving after cannabis use (ref. = no)	1.61*
<i>Interactions with gender</i>	
Income ^d X Gender (ref. = <\$30,000)	*
\$30,000-49,999	.56*
\$50,000-79,999	.84
\$80,000+	.61*
Not stated	.86
GHQ – Depression-Anxiety X Gender	.96*

Kilometers driven-typical week X Gender	1.000*
Constant	.16***
Hosmer and Lemeshow test	7.28 _(8df) $p=.51$

Predictor variables have been centered by subtracting the weighted mean.

Ref. = reference category.

^a In the last 12 months.

^b Odds ratio.

^c Based on weighted sample size.

^d Canadian dollars.

* Wald statistical significance, $p<.05$.

** Wald statistical significance, $p<.01$.

*** Wald statistical significance, $p<.001$.

Table 3

Logistic regression models of Any Perpetrated Driver Aggression for males versus females:
Ontario CAMH Monitor, July, 2002 – June, 2005.

	Perpetrated Driver Aggression ^a	
	Females (n=2597)	Males (n=2433)
<i>Control variables</i>	OR ^{b,c}	OR ^{b,c}
Age (ref. = 18-34 years)	***	***
35-54 years	.68***	.56***
55+ years	.31***	.35***
Income ^d (ref. = <\$30,000)	*	*
\$30,000-49,999	1.48	.86
\$50,000-79,999	1.46*	1.32
\$80,000+	1.77**	1.20
Not stated	1.35	1.17
Marital status (ref. = not married)	.97	1.08
Education (ref. = < high school)		
Completed high school	1.08	.94
Some post-secondary	1.13	.89
University degree	.99	.80
<i>General risk factor variables</i>		
GHQ – Social Functioning	.97	.95*
GHQ – Depression-Anxiety	1.10***	1.07***
Five+ drinks monthly (ref. = less than monthly/no)	1.06	1.32**
Cannabis use-lifetime (ref. = no)	1.96***	1.67***
<i>Driving risk factor variables</i>		
Kilometers driven-typical week	1.001**	1.000
Driving is stressful (ref. = none of the time)	2.04***	1.84***
Driving on busy roads (ref. = none of the time)	1.56*	2.44***
Driving after drinking (ref. = no)	1.49	1.38*
Driving after cannabis use (ref. = no)	2.83*	1.47
Constant	.17***	.20***
Hosmer and Lemeshow test	13.78 _(8df)	9.83 _(8df)
	p=.09	p=.28

Ref. = reference category.

Predictor variables have been centered by subtracting the weighted mean.

^a In the last 12 months.

^b Odds ratio.

^c Based on weighted sample size.

^d Canadian dollars.

* Wald statistical significance, $p < .05$.

** Wald statistical significance, $p < .01$.

*** Wald statistical significance, $p < .001$.