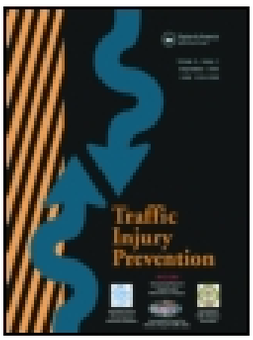

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# Self-reported Driving Under the Influence of Alcohol and Cannabis Among Ontario Students: Associations with Graduated Licensing, Risk Taking and Substance Abuse

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**ABSTRACT**

**Objective:** This paper describes the patterns of self-reported driving under the influence of alcohol (DUIA) and driving under the influence of cannabis (DUIC) among licenced Ontario students in 2009, and examines their associations with graduated licencing, risk taking, and substance use problems for understanding DUIA and DUIC behaviours. Ontario's graduated

 

licencing system requires new drivers to hold a G1 license for a minimum of 8 months, and a G2 licence for a minimum of 12 months before a full and unrestricted G license can be obtained. Among other restrictions, G1 drivers must maintain a 0 Blood Alcohol Content (BAC), have an experienced driver in the passenger seat, not drive on any high-speed expressways and not drive between the hours of midnight and 5 a.m. A G2 licence is more similar to a G licence, with fewer restrictions. .

**Method:** This study analyzed data from the 2009 Ontario Student Drug Use and Health Survey (OSDUHS). The OSDUHS is a biennial population-based survey of students (grades 7 to 12) in Ontario, Canada.

**Results**: The results showed that 16.3% of licensed students in Ontario reported DUIC while 11.5% reported DUIA during the past year. After controlling for the effect of age, type of licence emerged as robust predictor for both DUIA and DUIC behaviour, as students with a G2 and full licence were significantly more likely to report DUIA and DUIC than drivers with a G1 licence. Multivariate analyses suggested that risk seeking behaviours were more important for understanding DUIA behaviour than for DUIC behaviour. Elevated problem indicators for alcohol and for cannabis were associated with DUIA and DUIC, respectively.

**Conclusions:** While much attention has been paid to drinking and driving among adolescents, this research shows that more Ontario students now report driving after cannabis use than after drinking alcohol. The results identify important correlates of both behaviours that may be useful for prevention purposes.

Keywords: Teenagers – DUI – drugs – risk taking – graduated driver licensing

 

## INTRODUCTION

Young and inexperienced drivers are the most likely to be involved in motor vehicle collisions (MVCs) (Shope 2006) . There are many factors that are associated with increased collision risk among young drivers (e.g. Audet et al. 2001), including driving inexperience, challenges with difficult road conditions, higher tendencies to take risks and being more likely to drive erratically (Asbridge et al. 2005; Shope 2006). It has been known for many years that driving under the influence of alcohol (DUIA) impairs driving skills and increases the likelihood of MVC involvement (e.g. Beirness and Davis 2007, Macdonald and Mann 1996; Mann et al. 2001; Peck et al. 2008). Research on the impact of cannabis on collision risk has been more controversial, with some studies finding that cannabis use increases collision risk (Asbridge et al. 2012; Asbridge et al. 2014; Li et al. 2013; Li et al. 2012; Mann et al. 2007, 2008) while others suggest that cannabis may not increase collision risk (Compton and Berning, 2015; Romano et al. 2014). The risk of collision involvement increases exponentially with increasing Blood Alcohol Content (BAC; Mann et al. 2001; Peck et al. 2008). However, the nature of the relationship between increasing cannabinoid levels in the body and collision risk has not yet been clearly established (Asbridge et al. 2012). In Canada, DUIA and DUIC have become major traffic concerns, especially among young and inexperienced drivers (Fischer et al. 2006).

Understanding DUIA and DUIC among young drivers are thus important road safety and public health priorities (O'Malley and Johnston 2011). DUIA and DUIC increase collision risks among all drivers, and there is evidence that the effects of alcohol may be greater among young drivers (e.g. Hellinga et al. 2010, Peck et al. 2008). Factors that predict DUIA among young adults include aggressive behavior, low constraint, high levels of emotionality, high levels of

 

substance use, and juvenile delinquency (Begg et al. 2003) . Gender and socio-economic factors are also associated with DUIA and driving after use of other substances. Davison et al. (2012) found that, among young people, being male, living in rural areas, and being from disadvantaged families predicted driving while impaired (Davison et al. 2012). In recent years, evidence suggests that DUIC has become more common than DUIA among young drivers (O'Malley and Johnston 2011; Adlaf et al. 2003).

By definition, substance abusers participate in heavy and potentially hazardous rates of substance use. Substance abuse measures are also significantly associated with collision involvement and associated mortality (e.g. Callaghan et al. 2013; Haberman 1987). The impact of substance abuse on driving and collision risk may differ with age. Mann et al. (2010a) observed that those 18-34 years of age who reported a binge-drinking pattern (consumption of five or more drinks on one occasion regularly) were significantly more likely to report past-year MVC involvement. Furthermore, the alcohol dependence and the alcohol problem subscales of the Alcohol Use Disorders Identification Test (Saunders et al. 1993) were both associated with increased collision risk in a large sample of adults (Mann et al. 2010b). While substance problem measures appear to affect collision risk, very little assessment of their impact among adolescent drivers, including frequency of DUIA and DUIC, has been reported.

Graduated licensing systems (GLS) were designed to reduce collisions among young and new drivers by separating them from important collision risk factors during the period when they are acquiring driving-related skills (Mayhew and Simpson 1990; Waller 2003). Evidence suggests that GLS programs have been successful in reducing collision rates (Vanlaar et al. 2009). Ontario implemented a GLS in 1994 (Boase and Tasca 1998; Mann et al. 1997).

 

Ontario's GLS applied to all new drivers under 21 years of age, and consisted of G1 and G2 stages. Following successful completion of both stages, a full G license was obtained. In the G1 stage, that lasts a minimum of 12 months (8 months if the driver completes an accredited driver training program), driving must occur only while under the supervision of an experienced fully licensed driver. Other restrictions include no driving at night or on 400-series highways (expressways) and maintaining a 0 BAC. Drivers with a G2 license are allowed to drive without supervision by an experienced driver and are allowed to drive at night and on expressways, but must maintain a 0 BAC. While GLS systems do reduce collisions, additional research is needed to understand how they may be made more effective and to further reduce adolescent collision risk (Brookland and Begg 2011). For example, some authors have questioned the impact of GLS programs on driving after drinking among adolescents (e.g., Carpenter 2006). No studies have assessed the impact of GLS on DUIC among adolescents.

Risk-taking propensities have been linked to increased collision risk and hazardous driving behaviours (Jonah 1986; Jonah, Theissen and Au-Yeung 2001; Vingilis et al. 2013). Risk-taking propensity has been measured in a number of ways, ranging from self-report scales to self-reported behaviours (Jonah 1986; Vingilis et al. 2013). Sensation seeking is a personality construct identified by Zuckerman (2001) as the tendency to seek out novel and exciting experiences, and has been associated with risk-taking and hazardous driving (Jonah et al. 2001; Yildirim-Yenier et al. 2016). Self-reported behavioural indicators of risk-taking with regards to driving include self-reported driving violations and risky driving behaviours (Yildirim-Yenier et al. 2016; Vingilis et al. 2013). Some research has linked risk-taking propensity to DUIA (Jonah et al. 2001) but its link to DUIC among young drivers is less well understood.

 

DUIA and DUIC both increase the risk of collision involvement, and understanding factors that influence these behaviours is thus an important road safety priority (O'Malley and Johnston 2011). In this study we assess the factors that affect the likelihood of these two risk behaviours in a large, representative sample of adolescents in Ontario, Canada. In particular, we assess the extent to which DUIA and DUIC are affected by demographic factors, risk taking propensity, substance problem measures, and the type of license held.

## METHODS

### Survey and Participants

The data used in this study were derived from the 2009 cycle of the Ontario Student Drug Use and Health Survey (OSDUHS). The data for the multivariate analyses were based on a random half-sample of the licensed drivers who were asked about their risk-taking and alcohol and drug-use behaviors ($n$ = 1124, representing 144,300 students).

The OSDUHS is a stratified (region and school type), two stage (school, class) cluster sample design that is representative of Ontario students in grades 7 through 12. Post stratification weights were calculated for the sex-by-grade distributions within each regional stratum separately to ensure that the respondents in each region were proportionate to the population structure. The student participation rate for the survey was 65%. Further information on the OSDUHS, including the sampling procedures and weighting of data is available in Paglia-Boak et al. (2009).

The 2009 cycle of the OSDUHS survey was administered to Ontario students between November 2008 and June 2009. In elementary schools, two classes (one 7$^{th}$ grade class and one 8$^{th}$ grade class) were randomly selected, while in secondary schools, four classes were selected at

 

random (one in each of grades 9 to 12). Students completed the questionnaires anonymously. All students under the age of 18 were required to have signed parental consent, and all students were required to provide signed assent before they could participate. The Institute for Social Research at York University conducted the fieldwork for the survey.

**Measures and Variables**

The OSHUHS asked all students how many times, in the last 12 months, they had driven within an hour of drinking two or more drinks of alcohol (DUIA) and also driven within an hour of using marijuana or hashish (DUIC). These two variables were coded as binary measures with no=0 and yes=1, and were used to estimate the prevalence of DUIA and DUIC during the past year for licensed students. They also formed the two dependent variables in the multivariate analyses for the random half-sample of students who were asked about their risk-taking and substance use behaviors.

**Independent Variables**

Independent variables examined in the current study included demographic factors, risk taking behaviors, and substance-related problems. Age was classified as a continuous measure ranging from 16-20 years of age, and sex was classified as a dichotomous measure (female=0, male=1). Type of license was classified as a dichotomous measure (G1=0, G2/Full=1). Since G2 and full licences have relatively few differences in comparison to G1 licences, the small number of full licence holders in the sample (26) were included with the G2 holders. Those with a G1 license served as the reference group for all multivariate analyses. Ontario introduced a 0 BAC requirement for all drivers up to and including the age of 21 the year following the collection of these data.

 

**Risk taking behaviors**. The OSDUHS includes questions related to the risk taking attitudes and behaviours among students. The 4-item Brief Sensation Seeking Scale (BSS4), a measure of risk-taking and novelty seeking that has been validated with adolescent populations (Stephenson et al. 2003), was included in the survey. Students were specifically asked to rate their agreement with the following statements: (1) I like new and exciting experiences, even if I have to break the rules; (2) I prefer friends who are exciting and unpredictable; (3) I like to explore strange places; (4) I like to do frightening things. The items were summed creating a scale ranging from 0-12 with higher scores reflecting a higher degree of sensation seeking. Among the random half sample of licensed drivers, the sensation seeking scale possessed an acceptable level of internal consistency (Cronbach's alpha=.80).

In addition to the BSS4, students were also asked about risky driving behaviors including street racing and joyriding. Students were specifically asked if, during the past 12 months, they had (1) driven a car/truck in a street race, and (2) taken a car without permission. These variables were coded as binary variables, with no=0 and yes=1 for each question.

**Substance problems**. The OSDUHS includes the Alcohol Use Disorders Identification Test (AUDIT), which was developed by the World Health Organization (Saunders, et al. 1993). This 10-item instrument is designed to detect problem drinking behavior, and each item was scored on a 4-point scale to create a summed scale ranging from 0-40. The scale demonstrated acceptable levels of internal consistency among the random half sample of licensed drivers (Cronbach's alpha =.82). Respondents with a score of 8 or more (out of 40) are considered to be drinking at a hazardous or harmful level (hereafter referred to as hazardous drinking).

 

The Severity of Dependence Scale (SDS) is a validated 5-item scale used to screen for cannabis dependence in adolescent populations (Martin et al. 2006). Each item was scored on a 4-point scale, and the individual items were summed into a scale ranging from 0-15. The scale demonstrated acceptable internal consistency for the subsample of licensed Ontario students (Cronbach's alpha=.81), and a total score of 4 or more (out of 15) represents a potential cannabis dependence problem.

**Analytic Strategy**

Because the sampling design employs complex sampling methods and unequal probabilities of selection, all confidence intervals (CIs) were corrected for characteristics of the sampling design (i.e., stratification, clustering and weighting) using Stata 13.1 and applying Taylor series methods. The analysis was based on a design with 19 strata (region * school type), 181 primary sampling units (schools), and 9,112 total students. All analyses examined the random half-sample of licensed students who were asked about their risk taking and substance use behaviors. In order to maximize comparability between the different multivariate models, listwise deletion was not used, and all multivariate models were nested with the same sample size ($n$=1124) using the markout add-on command available in Stata (Long and Freese 2014). All estimates utilized the weighted data, and all multivariate analyses used binary logistic regression models correcting for the survey design. These binary logistic regression models were assessed at the $p<0.05$ level of significance.

**RESULTS**

**Characteristics of the Sample and Prevalence of DUIA and DUIC among Ontario Students**

 

The characteristics of the sample by license type are summarized in Table 1. Among the students with a driver's license in the sample, 46.6% were female and 53.8% were male, with an average age of 17.0 years. The most common type of license held was a G1 license (53.2%), followed by a G2/Full license (46.8%) .The average score on the BSS4 was 7.4, 10% reported participating in street racing in the past year, and 13.4% reported participating in joy riding in the past year. A large portion of the sample scored in the hazardous drinking range on the AUDIT (39.6%) while 3.4% showed evidence of cannabis dependence as measured by the SDS. Overall, 11.5% of student drivers in Ontario reported DUIA (95% CI: 9.8%-13.6%) and 16.3% of student drivers in Ontario reported DUIC (95% CI: 13.7%-19.3%) during the 12 months prior to the survey. These numbers represent approximately 33,400 students and 47,300 students in the province respectively, and suggest that DUIC is a more common behavior among licensed drivers in secondary schools in Ontario than is DUIA.

**Driving Under the Influence of Alcohol (DUIA)**

Table 2 presents the results from a series of multivariate weighted and nested logistic regressions predicting DUIA during the past year for licensed students in Ontario. Model A in Table 2 examines the role of background characteristics. Neither age nor sex was significantly related to DUIA for licensed drivers in Ontario. However, the type of license did significantly predict DUIA. In Model A in Table 2, Ontario students with a G2/Full license were 4.5 times more likely to report DUIA during the past year. It is important to note that this model controlled for the effect of age, suggesting that the odds of having a G2/Full license on drinking and driving behavior cannot be explained by the fact that older adolescents report more drinking and driving behavior. Type of license continued to exert a significant influence on DUIA in the

 

multivariate context (Table 2, Model D), as Ontario students with a G2/Full license were 3.8 times more likely than Ontario students with a G1 license to report DUIA during the past year. Even though G1 and G2 licenses among Ontario students under 22 years of age both have a 0 BAC requirement, those with a G2 license are able to drive without the supervision of a fully licensed driver. This lack of supervision may be a major reason those with a G2 and full license are more likely to drink and drive.

Model B in Table 2 examines the role of risk taking in predicting DUIA. All three measures (BSS4, street racing, and joy riding) were significantly associated with DUIA. They remained significant in the multivariate context (Model D). Every one-unit increase in the BSS4 scale increased the odds of drinking and driving by 18% ($p<0.01$) in the multivariate context, suggesting that risky attitudes are important for understanding drinking and driving behavior. In addition, youth who reported participating in street racing were more than 2 times more likely to report DUIA ($p<0.05$), and youth who reported joyriding in a vehicle without permission were 3.5 times more likely to report DUIA ($p<0.001$) in the multivariate context (Model D).

Model C in Table 2 examines the role of substance use problems in explaining student DUIA. While both hazardous drinking (AUDIT) and cannabis dependence symptoms (SDS) were significant in Model C, in the final multivariate context (Model D) only hazardous drinking was significant, as students who met the criteria for hazardous drinking were 3.5 times more likely to report DUIA in the past year ($p<0.001$).

**Driving Under the Influence of Cannabis (DUIC)**

Table 3 examines the results from a series of weighted hierarchic logistic regressions predicting DUIC during the past year for the licensed drivers. Model A in Table 3 examines the

 

role of background characteristics. Age was not significantly related to DUIC, but an effect of sex was seen, with males 1.68 times more likely to report DUIC in the past year ($p<0.05$). However in the multivariate context (Model D) sex was no longer significant.

The type of license the students report having significantly predicted DUIC among Ontario students. In Model A, students with a G2/Full license had more than quadruple the odds of DUIC behavior relative to students with a G1 license. Just as with DUIA, the effect of the type of licensing on DUIC cannot be explained by the fact that older students report more cannabis use and driving behavior, as this model controlled for the effect of age. When controlling for all other variables in the multivariate context (Model D), the effect of having a G2/Full license remained significant, as students with a G2/Full license a were 5.4 times more likely to report DUIC relative to students with a G1 license.

Model B in Table 3 examines the role of risk taking in predicting the cannabis and driving behavior of Ontario students. The BSS4, street racing, and joy riding all had a significant independent effect on DUIC in Model B; however, the impact of these variables diminished somewhat in the multivariate context (Model D). In other words, after controlling for the type of license and substance abuse, the effect of risk taking measures appeared to become less important.

Model C in Table 3 examines the role of substance use problems as measured by the AUDIT and SDS in explaining DUIC among Ontario students, and both were significantly associated with DUIC. In the multivariate context (Model D), licensed Ontario students classified as hazardous drinkers were 2.9 times more likely to report DUIC behavior ($p<0.001$),

 

while students who met the criteria for cannabis dependence (SDS) were 13 times more likely to report DUIC ($p$<0.01) behavior during the 12 months preceding the survey.

A comparison of results from the two multivariate models of DUIA and DUIC (Model D in Tables 2 and 3) suggests that system of graduated licensing in Ontario had a significant effect on both DUIA and DUIC behaviors among licensed students. Compared to those with a G1 license, those with a valid G2/Full license were 3.4 times ($p$<0.001) and 5.3 times ($p$<0.001) more likely to report DUIA and DUIC respectively. The effect of graduated licensing remained after controlling for age, suggesting that the effect of having a G2/Full license is not accounted for by age differences. Having a G2/Full license appears to afford students with opportunity and lack of supervision, which facilitates both DUIA and DUIC.

There are also important differences in factors that predict DUIA and DUIC among Ontario students. First, while all three risk taking variables exerted an effect in the multivariate context for DUIA, the impact of these variables was less pronounced in the multivariate analyses predicting DUIC. These findings therefore suggest that risk taking may be more important for understanding the drinking and driving behavior of Ontario students than it is for understanding their cannabis use and driving behavior.

The effect of substance use problems also differed depending on the outcome considered. For adolescents who reported DUIA, reporting harmful or hazardous drinking behavior as measured by the AUDIT increased the odds of drinking and driving by a factor of 3.5 ($p$<0.001). However, probable cannabis dependence did not exert a significant multivariate effect. For those who reported DUIC, hazardous drinking had a significant multivariate effect ($OR$=2.86, $p$<0.001), although the effect of probable cannabis dependence was much stronger ($OR$=13,

 

$p<0.001$). These findings suggest a consistency between the type of substance problem and the type of substance used when driving, but also that hazardous drinking may be a factor in both DUIA and DUIC.

**DISCUSSION**

The main purposes of this paper were to measure the prevalence of DUIA and DUIC among Ontario students using data from the 2009 Ontario Student Drug Use and Health Survey (OSDUHS), to examine the variables associated with DUIA and DUIC, and to compare the risk factors for these two behaviors. Importantly, among Ontario students with a driver's license, more students with a driver's license reported cannabis use and driving (16.3%) than report drinking and driving (11.5%). These findings are consistent with other recent observations from Ontario and other provinces (Adlaf et al. 2003; Asbridge et al. 2005). The proportion of Ontario student drivers reporting DUIA has decreased substantially over the past 30 years (Boak et al. 2013). Unfortunately, we do not have similarly extensive trend data to track changes in rates of DUIC. Students may be more inclined to participate in DUIC because of the lack of policies and procedures for testing for the presence of cannabinoids in drivers. Currently, it is difficult for police to determine whether or not an individual is operating a vehicle while under the influence of cannabis. While laws enabling Drug Recognition Experts to assess for drug impairment have been in place in Canada since 2008, it remains difficult for police to prove impairment in a timely manner and only a small number are qualified as Drug Recognition Experts (Solomon et al. 2010).

While existing literature has demonstrated that the implementation of graduated driver licensing systems has had a positive impact on MVC rates (e.g., Vanlaar, et al. 2009), there has

 

been little research focusing on the impact that GLS has had on DUIA and DUIC among youth. The current results suggest that type of graduated license may have a very significant effect on both of these behaviors. The odds of DUIA and DUIC were significantly higher among Ontario students with a G2/Full license relative to those with a G1 license. These effects remained significant after controlling for the other variables in the multivariate context, including age, sex, risk taking and substance problems. Students with a G2/Full license are able to drive unsupervised, and this seems a likely explanation for the increased DUIA and DUIC observed in the G2/Full licence group. The supervising driver for G1 drivers is most often a parent (Brookland et al. 2014), and in the absence of parental supervision alcohol and cannabis use is more common. While it is possible that lower rates of DUIA and DUIC for G1 drivers may be partly explained by the lack of opportunity to participate in DUIA and DUIC due to less exposure to driving in general, it seems likely that reduced driving exposure and supervision work together to deter youthful drivers from using substances prior to driving. If this is the case, then one way to limit the prevalence of DUIA and DUIC may be to decrease opportunity by extending the period of young driver supervision. More work to better understand how the mechanisms of the graduated driver licensing system work to reduce DUIA and DUIC behavior is needed.

The results suggest that experiencing a problem with alcohol or drugs increases the chances of DUIA and DUIC among Ontario students. These results are similar to those seen in adult studies (Callaghan, et al. 2013, Mann, et al. 2010a, 2010b), but much less research has examined this issue among adolescent drivers. The type of substance problem seemed specific to the type of hazardous driving behaviour. Those experiencing hazardous drinking were more

 

likely to drive after drinking, while those who reported symptoms of cannabis dependence were more likely to report driving after cannabis use. Interestingly, hazardous drinking also appeared to be associated with DUIC as well, reflecting a relationship of DUIC with drinking also seen in adult studies (e.g., Asbridge, et al. 2014, Walsh and Mann 1999). Both measures in part reflect more frequent and heavier substance use, which could simply mean that these students had more occasions when they could drive after substance use. However, both also capture the experience of substance-related psychosocial harm and inability to control use that may also affect choices and behaviours in other realms such as driving. These results highlight the potential significance of measures of substance problems in the adolescent population, and the kinds of risks that may be associated with these problems.

Risk taking propensities have been associated with increased likelihood of hazardous driving, including drinking and driving, among young drivers (e.g. Jonah 1986). All three variables examined in this study (BSS4, street racing, and joy riding) exerted an effect on drinking and driving behavior, suggesting a very important relationship between risk-taking and DUIA. However, risk-taking measures, while strong correlates of DUIC in univariate analyses, had a more muted effect on DUIC among Ontario students in the multivariate model once other factors were included. Specifically, the effect of the BSS4 appeared weaker for DUIC, and street racing dropped to non-significance. Perhaps youth who would consider DUIA as a very risky behaviour may not feel the same about DUIC, and those drawn to risky behaviours may be more drawn to DUIA. Similarly, students may also perceive DUIA, but not DUIC, as increasing risks of collision involvement (Fischer et al. 2006). Thus, more students in the general student

 

population may be inclined to DUIC because it is seen as less dangerous than DUIA. Prevention efforts might profitably consider these differences in perceptions in the student population.

While these results add to the literature on both DUIA and DUIC behavior, there are important limitations that must be recognized. First, the data used for this research are derived from a cross-sectional study, so causal conclusions cannot be drawn. Longitudinal data would be necessary to demonstrate that licensed drivers increase their DUIA and DUIC behavior as they progress though the graduated licensing system. The results for the current study are also based on self-report data, and associated forms of bias cannot be ruled out. As well, the 65% participation rate for the survey, while considered very good (Paglia-Boak et al, 2009), means that a substantial portion of students did not participate and this may also influence results. Nevertheless, these results are of substantial interest. The findings point to opportunities to extend the benefits of graduated licensing systems by modification of the restrictions placed on drivers, such as extending the period when supervision is required. In view of the importance of understanding DUIA, DUIC and other risk factors for MVCs among young drivers, including causal links and opportunities for prevention, additional research to understand these risk behaviours and how they may be modified is needed.

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**References**

Adlaf EM, Mann RE, Paglia A. Kids, drugs and cars: alcohol, cannabis and driving among Ontario students. *CMAJ.* 2003;168:565-566.

Allen, S., Murphy, K. & Bates, L. What drives compliance? The effect of deterrence and shame emotions on young drivers' compliance with road laws, *Policing and Society*. In press.

Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: Systematic review of observational studies and meta-analysis. *BMJ.* 2012;344:e536.

Asbridge M, Poulin C, Donato A. Motor vehicle collision risk and driving under the influence of cannabis: Evidence from adolescents in Atlantic Canada. *Accid Anal Prev.* 2005;37:1025-1034.

Asbridge M, Rehm J, Mann RE, Cusimano M, Trayling C, Roerecke M, Kumar R, Whipp A, Tallon J, Magee K. Cannabis and traffic crash risk: Findings from a case-crossover study of drivers presenting to emergency departments in two Canadian cities. *Int J Public Health.* 2014;59(2):395-404.

Audet T, Bergeron J, Marcil I. Motivational factors underlying the intention to drink and drive in young male drivers. *J Safety Res.* 2001;32(4):363–376.

Bates, L., Darvell, M. & Watson, B. Young and unaffected by road policing strategies: Using deterrence theory to explain provisional drivers' (non)compliance, *Australian and New Zealand Journal of Criminology*. In press.

 

Begg D, Langley J, Stephenson S. Identifying factors that predict persistent driving after drinking, and driving after using cannabis among young adults. *Accid Anal Prev.* 2003;35:669-675.

Beirness DJ, Davis CG. Driving after drinking in Canada: Findings from the Canadian Addiction Survey. *Can J Public Health.* 2007;98:476-483.

Boak A, Hamilton HA, Adlaf EM, Mann RE. *Drug use among Ontario students, 1977-2013: Detailed OSDUHS findings (CAMH Research Document Series No. 36).* Toronto: Centre for Addiction and Mental Health;2013.

Boase P, Tasca L. *Graduated licensing system evaluation: Interim Evaluation.* Toronto, Ontario: Ministry of Transportation;1998.

Brookland R, Begg D. Adolescents and their parents, attitudes towards graduated licensing and subsequent risky driving and crashes in young adulthood. *J Safety Res.* 2011;42(2):109-115.

Brookland R, Begg D, Langley J, Ameratunga S. Parental influence on adolescent compliance with graduated driver licensing conditions and crashes as a restricted licensed driver: New Zealand Drivers Study. *Accid Anal Prev.* 2014;69:30-39.

Callaghan RC, Gatley JM, Veldhuizen S, Lev-Ran S, Mann RE, Asbridge M. Alcohol- or drug-use disorders and motor vehicle accident mortality: A retrospective cohort study. *Accid Anal Prev.* 2013;53:149-155.

Carpenter C. Did Ontario's zero tolerance & graduated licensing law reduce youth drunk driving? *J Policy Anal Manage.* 2006;25(1):183-195.

Compton, R. P., & Berning, A. (2015). *Drug and Alcohol Crash Risk* (No. DOT HS 812 117).

 

Davison C, McFaull S, Pickett W, Thompson W, Torunian M, Walsh P. Drinking, substance use and the operation

of motor vehicles by young adolescents in Canada. *PLOS One.* 2012;7(8):876-880.

Fischer B, Rodopoulos J, Rehm J, Ivsins A. Toking and driving: Characteristics of Canadian university students who drive after cannabis use - an exploratory pilot study. *Drugs Educ Prev Pol.* 2006;13:179-187.

Haberman PW. Alcohol and alcoholism in traffic and other accidental deaths. *Am J Drug Alcohol Abuse.* 1987;13(4)):475-484.

Hellinga L, McCartt A, Kirley B. Impacts of minimum legal drinking age 21 laws on alcohol-related driving in the United States. *J Safety Res.* 2010;41(1):173-181.

Jonah BA. Accident risk and risk-taking behaviour among young drivers. *Accid Anal Prev.* 1986;18(4):255-271.

Jonah BA, Thiessen R, Au-Yeung E. Sensation seeking, risky driving and behavioral adaptation. *Accid Anal Prev.* 2001;33(5), 679-684.

Li, G., Brady, J. E., & Chen, Q. Drug use and fatal motor vehicle crashes: a case-control study. *Accid Anal Prev Prev. 2013; 60*, 205-210.

Li M-C, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes.

*Epidemiol Rev.* 2012;34(1):65-72.

Long SJ, Freese J. *Regression Models for Categorical Dependent Variables Using Stata.* Third ed. College Park, Texas: Stata Press; 2014.

 

Macdonald S, Mann RE. Distinguishing causes and correlates of drinking and driving. *Contemp Drug Probl.* 1996;23:259-290.

Mann RE, Adlaf E, Zhao J, Stoduto G, Ialomiteanu A, Smart RG, Asbridge M. Cannabis use and self-reported collisions in a representative sample of adult drivers. *J Safety Res.* 2007;38:669-674.

Mann RE, Macdonald S, Stoduto G, Bondy S, Jonah B, Shaikh A. The effects of introducing or lowering legal per se blood alcohol limits for driving: an international review. *Accid Anal Prev.* 2001;33:569-583.

Mann RE, Stoduto G, Anglin L, Pavic B, Fallon F, Lauzon R, Amitay O. Graduated licensing in Ontario: Impact of the 0 BAC provision on adolescents' drinking-driving. In: Mercier-Guyon C, ed. *Alcohol, Drugs and Traffic Safety - T'97. Annecy, France: Centre d'Etudes et de Recherche en Medicin du Traffic*1997:1055-1060.

Mann RE, Stoduto G, Butters J, Ialomiteanu A, Boase P, Asbridge M, Chipman M, Wickens CM. Age group differences in collision risk. *J Safety Res.* 2010a;41(5):445-449.

Mann RE, Stoduto G, Macdonald S, Brands B. Cannabis use and driving: Implications for public health and transport policy. In: Rodner Sznitman S, Olsson B, Room R, eds. *A cannabis reader: Global issues and local experiences. Perspectives on cannabis controversies, treatment and regulation in Europe. Volume 2*. Lisbon, Portugal: European Monitoring Centre for Drugs and Drug Addiction; 2008:173-203.

Mann RE, Stoduto G, Vingilis E, Asbridge M, Wickens CM, Ialomiteanu A, Sharpley J, Smart RG. Alcohol and driving factors in collision risk. *Accid Anal Prev.* 2010b;42(6):1538-1544.

 

Mayhew DR, Simpson HM. *New to the road: Young and novice drivers: Similar problems and solutions?* . Ottawa: Traffic Injury Research Foundation;1990.

O'Malley PM, Johnston LD. Driving after drug or alcohol use by US high school seniors, 2001-2011. *AJPH,* 2013;103(11), 2027-2034.

Paglia-Boak A, Mann RE, Adlaf EM, Rehm J. *Detailed OSDUHS Findings. Drug Use Among Ontario Students 1977-2009 (CAMH Research Document Series No. 27).* Toronto: Centre for Addiction and Mental Health;2009.

Peck RC, Gebers MA, Voas RB, Romano E. The relationship between blood alcohol concentration (BAC), age, and crash risk. *J Safety Res.* 2008;39(3):311-319.

Romano, E., Torres-Saavedra, P., Voas, R. B., & Lacey, J. H. Drugs and alcohol: their relative crash risk. *Journal ofStudies on Alcohol and Drugs*. 2014; *75*(1), 56.

Saunders JB, Aasland OG, Babor TF, De la Fuente JR, Grant M. Development of the Alcohol Use Disorders

Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption BII. *Addiction.* 1993;88:791-804.

Shope J. Influences on youthful driving behavior and their potential for guiding interventions to reduce crashes. *Inj Prev.* 2006;12(1):9-14.

Solomon R, Chamberlain E, Lynch CCL, 56, 51. Canada's new impaired driving legislation: Modest gains and missed opportunities. *Crim Law Quart.* 2010;56:56-81.

Stephenson MT, Hoyle RH, Palmgreen P, Slater MD. Brief measures of sensation seeking for screening and large-scale surveys. *Drug Alcohol Depend.* 2003;72:279-286.

 

Vanlaar W, Mayhew D, Marcoux K, Wets G, Brijs T, Shope J. An evaluation of graduated driver licensing programs in North America using a meta-analytic approach. *Accid Anal Prev.* 2009;41(5).

Viner RM, Coffey C, Mathers C, Bloem P, Costello A, Santelli J, Patton GC. 50-year mortality trends in children and young people: A study of 50 low-income, middle-income, and high-income countries. *Lancet.* 2011;377(9772):1162-1174.

Vingilis E, Seeley J, Wiesenthal DL, Wickens CM, Fischer P, Mann RE. Street racing video games and risk-taking driving: An Internet survey of automobile enthusiasts. *Accid Anal Prev.* 2013; 50, 1-7.

Waller PF. The genesis of GDL. *J Safety Res.* 2003;34(1):17-23.

Walsh G, Mann RE. On the high-road: Driving under the influence of Cannabis in Ontario. *Can J Public Health.* 1999;90:260-263.

Yildirim-Yenier Z, Vingilis E, Wiesenthal DL, Mann RE, Seeley J. Relationships between thrill seeking, speeding attitudes, and driving violations among a sample of motorsports spectators and drivers. *Accid Anal Prev.* 2016; 86: 16-22.

Zuckerman, M. Sensation seeking: behavioral expressions and biosocial bases. In: Smelser NJ, Baltes PB, eds., *International Encyclopedia of the Social and Behavioral Sciences.* New York, Elsevier; 2001: 13905-13908.

 

**Table 1.** Sample Characteristics by Driver Licence Status (*n*=1124, unweighted data).

| | G1 Licence (n=626) | G2/Full Licence (n=498) |
|---|---|---|
| Age (mean, sd) | 16.5 (sd=.72) | 17.3 (sd=.68) |
| % Male | 48.6% | 50.8% |
| Risk Taking (mean, sd) | 7.2 (sd=2.76) | 7.6 (sd=2.60) |
| % Street Racing | 3.2% | 14.9% |
| % Joy Riding | 12.3% | 14.1% |
| % Alcohol Problem | 35.5% | 46.7% |
| % Cannabis Dependency | 2.7% | 3.8% |
| % DUIC | 6.7% | 24.3% |
| % DUIA | 4.8% | 18.9% |

**Table 2**. Weighted Binary Logistic Regression Models Predicting Drinking and Driving for Licensed Ontario Students (*n*=1124, representing 144,300 students) during the Past Year, 2009 OSDUHS

| | Model A: Background Variables | Model B: Risk Taking Behaviors | Model C: Substance Use Problems | Model D: Multivariate Model |
|---|---|---|---|---|
| | *OR* | *OR* | *OR* | *OR* |
| Age | 1.27 | | | 1.33 |
| Male | 1.48 | | | 0.92 |
| G1 License | REF | | | REF |
| G2/Full license | 4.51*** | | | 3.81** |
| Risk Taking | | 1.2*** | | 1.18** |
| Street Racing | | 3.55*** | | 2.06* |
| Joy Riding | | 3.90*** | | 3.47*** |
| Alcohol Problem | | | 5.82*** | 3.49*** |
| Cannabis Dependence | | | 2.87* | 1.43 |

*$p$<0.05; **$p$<0.01; ***$p$<0.001

 

**Table 3** Weighted Binary Logistic Regression Models Predicting Cannabis Use and Driving for Licensed Ontario Students (*n*=1124, representing 144,300 students) during the Past Year, 2009 OSDUHS

| | Model A: Background Variables | Model B: Risk Taking Behaviors | Model C: Substance Use Problems | Model D: Multivariate Model |
|---|---|---|---|---|
| | *OR* | *OR* | *OR* | *OR* |
| Age | 1.32 | | | 1.24 |
| Male | 1.68* | | | 1.31 |
| G1 license | REF | | | REF |
| G2/Full license | 5.03*** | | | 5.40*** |
| Risk Taking | | 1.22*** | | 1.17* |
| Street Racing | | 2.50** | | 1.03 |
| Joy Riding | | 3.19*** | | 2.73** |
| Alcohol Problem | | | 4.22*** | 2.86*** |
| Cannabis Dependence | | | 16.76*** | 13.00*** |

*$p$<0.05; **$p$<0.01; ***$p$<0.001

 