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YOUNG UNLICENSED DRIVERS: THREE STUDIES TO UNDERSTAND THE ASSOCIATION OF LIFESTYLE AND AREA ASSOCIATED RISK

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16. Abstract

Background: A significant proportion of teens killed in motor vehicle crashes die in crashes involving a never-licensed driver (NLD); however, little is currently known about NLDs aside from their crash involvement. Given their contribution to young driver crash-related fatalities, it is important to reduce NLD's crash risk. In order to do so NLD's must be better understood.

Method: Three studies examined the NLDs. The first used Swedish data to examine social disparities among NLDs. The second used data from the US census and the Fatality Analysis Reporting System to evaluate the characteristics of geographic areas in which fatal crashes involving NLDs occurred. The third used data from the Montana Youth Risk Behavior Survey to examine the individual characteristics of NLDs and compare them to teens who were licensed to drive, as well as teenage non-drivers.

Results: The results demonstrated that NLD crashes are associated with socioeconomic disparity. Furthermore, NLDs are at considerable developmental risk, being more involved in normative problem behaviors, alcohol-involved driving, using safety belts less often, having higher levels of suicidality, and reporting more weapon carriage and fighting than teens who are non-drivers and licensed drivers.

Conclusions: It is unclear what underlies the association found in this study and others between socioeconomic disparity and NLDs. However, it is consonant with the greater involvement of never licensed drivers in problem behaviors, particularly those of a more serious nature, such as violence, which have also been shown to be associated with socioeconomic disparity. Future research needs to examine this issue more closely to determine whether the intervention should be targeted at reducing disparities, or whether socioeconomic status could be used to tailor interventions for high-risk populations. This research also supports past research showing that problem driving behavior fits well conceptually and empirically as a problem behavior. Interventions to reduce problem behavior involvement of teenagers might be modifiable to also address never-licensed driving.

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BACKGROUND AND INTRODUCTION

Eleven percent of the nearly 7,500 young drivers killed each year in the United States (US) die in crashes involving a young never-licensed driver (i.e., under age 19 who has never held a driver license) (NLDs). Little is currently known about NLDs aside from their crash involvement (Hanna, Taylor, Sheppard, Laflamme, 2006; Scopatz, Hatch, Hilger DeLucia, Tays, 2003; Williams, Preusser, Ulmer, Weinstein, 1995; Williams, Preusser, 1997). Current understanding of NLDs comes mostly from studies of crash records, with only a small amount of data from self-report studies (Preusser, Leaf, Ferguson, Williams, 2000;Williams, Lund, Preusser, 1985); hence, the available information on the personal characteristics of this group of high-risk drivers is limited.

Considering their contribution to young driver crash-related fatalities, it is important that NLD crash risk be reduced. However, in order to take steps to address NLDs' contribution to crash risk they must be better understood (Shope, 2007). The current available research fails to provide the type or amount of information that is necessary to address the safety issues presented by NLDs. Attributes that are important to understand in order to address NLDs' contribution to crash risk include individual characteristics, driving behavior, area of residence, and how these characteristics compare to those of licensed young drivers (Hasselberg, Vaez, Laflamme, 2005;Laflamme, Diderichsen, 2000). Research indicates that crash rates among young drivers are concentrated by age, sex, and area of residence, with crashes occurring more often among younger drivers, males, and in rural areas (MMWR, 1996; NHTSA, 2005). In addition, other health behaviors and habits are associated with risky driving, including alcohol misuse and drug use (Bingham, Shope, 2004; Bingham, Shope, 2005). In spite of what is known about attributes that are associated with risky driving, extant literature on teenage drivers is nearly devoid of such information on NLDs.

This report presents the research findings from three studies of NLDs that help characterize this group of teen drivers and expand upon the current available information on

NLDs. The first study examined a population-based cohort study linking Swedish national register data for a cohort of 1,616,621 individuals born between 1977 and 1991. The relative crash risk of licensed and unlicensed drivers involved in first-time road traffic crashes were estimated based on household socioeconomic position, social welfare benefits, and level of residential urbanicity. The second study used data from the Fatality Analysis Reporting System (FARS) and the US Census, and Rural-Urban Continuum Codes to characterize and identify differences in the areas in which NLDs are involved in fatal crashes. Study number three used data from the Montana Youth Risk Behavior Survey (YRBS) to examine the psychosocial characteristics and problem behavior involvement of NLDs.

Purpose

Due to the small amount of research on NLDs, the purpose of these studies was primarily exploratory. Variables examined in these studies were those that have been found to be associated with crash risk and driving outcomes in the general population of young drivers. The three studies were:

1- Road traffic crash circumstances and consequences among young unlicensed drivers: A Swedish cohort study on socioeconomic disparities.

2- Area context and young driver fatal crashes in the U.S.

3- Driving Behaviors and Health Practices of Montana Adolescents.

STUDY I

This study is summarized here, but a full report is available in:

Hanna CL, Hasselberg M, Laflamme L, Moller J. (2010). Road traffic crash circumstances and consequences among young unlicensed drivers: A Swedish cohort study on socioeconomic disparities. *BMC Public Health, 10*(14), 2-8.

Teenage drivers have a higher risk of crashes and crash-related injury than adult drivers [1]. This is due to a variety of issues, including their lack of experience, stage of development, and propensity for unsafe driving behaviors such as driving after drinking or using drugs,

disregarding traffic regulations, and driving at high speeds [2]. Crash involvement of teen drivers is also associated with low socioeconomic position [3-10], but the mechanism underlying this association is not understood [5].

Studies of fatal crash records [11-15] and on self-reported driving practices [16,17] conducted in the US, Australia, Italy, New Zealand, and Great Britain indicate that unlicensed driving is one safety issue related to young drivers. Driving unlicensed might also be more likely to result in particular crash types and conditions [11]. For example, a study conducted in Sweden indicated an over-representation of unlicensed young drivers in single-vehicle, substance use-related, and nighttime crashes [18]. This paper examined the risk of crashes among young Swedish licensed and non-licensed drivers based on driver age, socioeconomic position, and area of residence.

Methods

This was a population-based cohort study linking Swedish national register data for a cohort of 1,616,621 individuals born between 1977 and 1991. Crash circumstances for first-time traffic crashes were compared between licensed and unlicensed drivers. The socioeconomic distribution of injury was assessed considering household socioeconomic position, social welfare benefits, and level of urbanicity of the area surrounding the participants' residences. The main outcome measure was relative crash risk.

Results

Crashes involving unlicensed drivers were over-represented among male drivers, suspected impaired drivers, crashes involving severe injuries, crashes occurring in higher speed limit areas, and in fair road conditions. Unlicensed drivers from families in a lower socioeconomic position showed increased relative risks for crashes in the range of 1.75 to 3.25. Those living in rural areas had an increased relative risk for a severe crash of 3.29 (95% CI 2.47-4.39) compared to those living in metropolitan areas.

Conclusions

At the time of the crash, young unlicensed drivers display more risky driving practices than their licensed counterparts. Just as with licensed drivers, low socioeconomic status NLDs are over-represented in the most severe injury crashes. How the mechanisms lying behind those similarities compare between these groups remains to be determined.

STUDY II

Several national studies have indicated that area characteristics like socioeconomic disadvantage and low population density are related to area-specific driving behaviors (e.g., restraint use, speed, and alcohol), and driving situations (e.g., road conditions, vehicle types, and post-crash trauma care) affecting the risk of crash related injury, and that area population density and poverty are related to higher crash risk (Baker, Whitfield, O'Neill, 1987; Frisch, Plessinger, 2007; Huber, Charles, Carozza, Gorman, 2006; van Beeck, Mackenbach, Looman, Kunst, 1991; MMWR, 2009). However, such differences among unlicensed teenage drivers have not been estimated using population-based data. This study utilized population level measures of area characteristics to determine if they were associated with patterns of crash risk among NLDs.

Methods

Data Sources

Counties were the units of analysis in this study (n=3,141), with data included from every U.S. county. Data measuring the characteristics of the counties were taken from public data sources provided by the US Department of Agriculture, the Census Bureau, and the National Highway Traffic Safety Administration.

Measures

Census Division

The US is divided into nine census divisions by state and the District of Columbia. The divisions are based on geographic location, and include the Pacific (Alaska, California, Hawaii,

Oregon, Washington), Mountain (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming), West North Central (Iowa, Kansas, Nebraska, Minnesota, Missouri, North Dakota, South Dakota), West South Central (Arkansas, Louisiana, Oklahoma, Texas), East North Central (Illinois, Indiana, Michigan, Minnesota, Ohio), East South Central (Alabama, Kentucky, Mississippi, Tennessee), New England (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont), and Mid-Atlantic (New Jersey, New York, Pennsylvania) South Atlantic (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia).

Urbanicity

Counties were categorized into three urbanicity levels based on guidelines from the US Department of Agriculture Rural-Urban Continuum Codes. *Urban* counties included all counties in a metropolitan area regardless of population size (n=1,089); *suburban* counties were those adjacent to metropolitan areas and with a population not below 2,500 (n=932); and *rural* counties were those outside metropolitan areas with a population of less than 2,500 (n=1122; (USDA, 2003).

Material Deprivation

Material deprivation was measured using an adapted Townsend Index of Relative Material Deprivation that measures the availability of local goods, services, resources, and amenities. The Townsend Index (Townsend, Phillimore, Beattie, 1996) has been used in mortality and morbidity studies to assess small area conditions (Stjärne, de Leon, Hallqvist, 2004), and was adapted in this study to assess county-level material deprivation. County-level material deprivation scores were calculated using 2000 US Census measures of the percent of population age 16 and older who were unemployed (M=3.45, s=1.7); percent of households with no vehicles (M=22.6, s=7.7); percent of renter occupied housing units (M=2.8, s= 2.0); and percent of households that were overcrowded (i.e., more than 2.01 persons per room) (M=0.31, s=0.71). These four variables were log-transformed to achieve a more symmetric distribution to

improve interpretability of the estimates and confidence intervals. The indicators of material deprivation were each standardized to a distribution with mean=0 and standard deviation =1 and averaged so that higher scores indicated greater material deprivation.

Fatal Crashes Involving NLDs

Data from FARS were used to identify fatal crashes occurring within each county. FARS is a census of all crashes involving at least one motor vehicle traveling on a public roadway that resulted in the death of at least one person (occupant of a vehicle or a non-motorist) within 30 days of the crash. This study included FARS data from January 01, 2000 to December 31, 2006 that involved at least one driver of a four-wheeled motor vehicle who was under the age of 19 and unlicensed at the time of the crash. Drivers with learner's permits, suspended, declined, unknown, or revoked licenses were excluded (<5%). A total of 3,059 fatal crashes met the inclusion criteria. The distribution of NLD fatal crashes across counties was highly skewed, with many counties having two or fewer crashes. For this reason, the outcome for this research was dichotomized such that counties with at least one NLD fatal crash were assigned a value of 1 and those without any fatal NLD crashes in the county during the study period were assigned a value of 0.

Data Analysis

The data were analyzed in three steps. First, logistic regression was used to estimate the unconditional odds of a crash. All main effects and interactions of census division, urbanicity, and material deprivation were tested. This model was used to evaluate the appropriateness of testing the study hypotheses using a model that was conditional on census division. Second, a conditional logistic model was used to test the main effects and interactions of urbanicity and material deprivation conditional on census division. Third, unconditional logistic models were estimated for each census division, separately, to explore variation in the main effects and interactions of urbanicity and material deprivation across the nine census areas. The University of Michigan Institutional Review Board provided ethical review and approval of this study.

Results

Descriptive Analyses

The result of the descriptive analyses for census division and level of urbanicity are shown in Table 1. There were a total of 3,059 NLD crashes occurring in 3,141 counties. The New England census division had the fewest NLD fatal crashes with a total of 55, and the West South Central division had the most with 819 fatal crashes. The Mountain and Middle Atlantic divisions had the largest proportions of counties with fatal NLD crashes with 65.1 and 64.7, respectively. Only 25.7 percent of counties in the West North Central division had any fatal NLD crashes. The divisions with the largest numbers of crashes per county (data not shown in Table

Table 1. Distribution of counties with a YUD fatal crash by division and urbanicity

	Total Counties	Fatal YUD Crashes		Counties with Fatal YUD Crashes	
		N	%	N	%
Division					
New England	67	55	1.8	37	55.2
Middle Atlantic	150	142	4.6	97	64.7
East North Central	437	339	11.0	195	44.6
West North Central	627	226	7.4	161	25.7
South Atlantic	587	607	17.3	310	52.8
East South Central	364	296	9.7	205	56.3
West South Central	470	819	26.8	255	54.3
Mountain	169	460	15.0	110	65.1
Pacific	281	561	18.3	132	47.0
Total	3141	3059		1491	
Urbanicity					
Urban	1089	1109	36.3	533	48.9
Suburban	827	828	27.1	417	50.4
Rural	1225	1122	36.6	638	52.1
Total	3141	3059		1588	

1) were the Mountain (2.72), Pacific (2.00) and West South Central (1.74), and the West North Central division had the fewest crashes per county (0.36).

There were more rural (1,225) than urban (1,089) or suburban (827) counties. Urban and rural counties shared nearly equal proportions of the total crashes, and approximately half of the counties in each area had at least one fatal NLD crash. The ratio of crashes to counties was essentially 1.00 for all three areas.

Unconditional Model

Unconditional logistic regression was used to test main effects and all first and second order interactions of census division, urbanicity and material deprivation. The purpose of this model was to determine whether it was necessary to address the research questions by estimating regression models that were conditional on census division. No significant interactions with census division would indicate that the main effects and interaction of urbanicity and material deprivation were uniform across census divisions, and that division was ignorable. A significant interaction with census division would indicate that the models would need to be tested conditionally to account for variation across division. The results are shown in Table 2.

Table 2. Unconditional logistic regression type 3 effects of census division, urbanicity, and material deprivation

Effect	df	Wald Chi-Square	p
Census Division	8	32.07	<0.001
Urbanicity	2	60.10	<0.001
Material Deprivation	1	18.84	<0.001
Census Division * Urbanicity	16	26.28	0.050
Census Division * Material Deprivation	8	27.00	<0.001
Urbanicity * Material Deprivation	2	0.11	0.947
Census Division * Urbanicity * Material Deprivation	16	33.52	0.006

The main effects of census division, urbanicity, and material deprivation were highly significant. The interaction of census division and urbanicity was nearly significant (0.050), and the interaction of census division and material deprivation, as well as the three-way interaction of the variables, were highly significant, indicating the need to address the purposes of this study using models that conditioned on census division.

Conditional Models

Type 3 logistic regression results of the model conditioned on census division indicated significant main effects and interaction of urbanicity and material deprivation (Table 3). Follow-up comparisons indicated that, compared with urban counties, fatal NLD crashes were significantly less likely in rural counties, but that suburban and urban counties did not differ in their odds of a fatal NLD crash. Greater material deprivation was associated with greater odds of a fatal NLD crash, and the significant interaction of urbanicity and material deprivation resulted from suburban counties having lower odds of a fatal NLD crash compared to urban counties when material deprivation was greater. No differences were found between rural and urban areas for this interaction (see Table 4).

Table 3. Logistic regression type 3 effects of urbanicity, and material deprivation conditional on census division

Effect	df	Wald Chi-Square	P
Urbanicity	2	149.49	<0.001
Material Deprivation	1	82.10	<0.001
Urbanicity * Material Deprivation	2	11.19	0.004

Discussion

Research on area characteristics has consistently indicated that crash risk is lowest in areas with the highest socioeconomic conditions (Hasselberg, Vaez, Laflamme, 2005;

Table 4. Logistic regression effects of urbanicity, and material deprivation conditional on census division

Parameter	df	Estimate	Standard Error	Wald Chi-Square	p	Odds Ratio
Urbanicity						
Rural	1	-0.61	0.06	113.71	<0.001	0.55
Suburban	1	0.03	0.06	0.20	0.653	1.03
Material Deprivation	1	0.18	0.02	82.09	<0.001	1.19
Urbanicity * Material Deprivation						
Rural	1	0.00	0.02	0.01	0.939	1.00
Suburban	1	-0.08	0.03	8.61	0.003	0.92

Laflamme, Diderichsen, 2000). This study is one of the first to examine the association between area characteristics and fatal NLD crashes. Findings suggest that like crashes involving other types of drivers, fatal NLD crashes are most likely to occur in areas with the poorest socioeconomic conditions. Additionally, this study indicates that other area characteristics, such as urbanicity, are also associated with crash likelihood both directly, and as a moderator of socioeconomic conditions.

Fatal NLD crashes were less likely to occur in rural counties relative to urban and suburban areas. This difference in likelihood is a function of population and traffic density, and is not indicative of crash rates in these two areas and is not reflective of the crash risk associated with driving in rural versus urban areas. Because this study examined frequencies and not rates of crash, it cannot be concluded that rural counties are less risky where NLD teen drivers are concerned. As a function of time, fewer crashes occur in rural than in suburban areas, and a larger proportion of crashes in suburban and urban areas are less serious due to lower vehicle velocities and safer roadway geometries, while crashes in rural areas, where undivided two-way motorways and higher vehicle speeds are the norm, result in a higher rate of serious crashes. Therefore, the effect of rural counties seen in this study is likely not a function of actual crash risk, but simply crash likelihood resulting from vehicle and population densities.

The association between material deprivation and the likelihood of a fatal NLD crash at the area level is a likely outcome of several individual-level variables. Areas with greater material deprivation are also more likely to lack other resources, including transportation alternatives. At the individual level, this might translate into fewer financial resources and a lower likelihood of getting licensed due to the costs associated with driver education and licensure. In recent years, state driver education has increasingly been provided by private schools, and less often by public high schools. This has resulted in an increasing cost associated with getting licensed to drive in the U.S., and may provide an incentive for some teens to drive without a license in order to have the mobility that they either need or desire.

Another reason greater material deprivation is associated with a higher likelihood of fatal NLD crashes may result from greater delinquency and problem behavior, and poorer psychosocial adjustment being associated with greater socioeconomic disadvantage. It is possible that a major individual factor creating the association between material deprivation and fatal NLD crash is the greater likelihood that a larger proportion of teens in socioeconomically deprived areas are involved in problem behaviors, generally, including problem driving, specifically, which involves driving without being licensed.

While providing unique information, this study was limited in a number of ways. While a serious concern, fatal NLD crashes are relatively rare events. The infrequency of these events resulted in many counties having no NLD crashes and limited the type of analytic strategies that could be used, and hence the information that could be gleaned from the results regarding actual crash risk. An approach that might be taken in future research would be to base the analyses on the number of people killed in fatal NLD crashes, rather than solely on fatal crash occurrence. While not eliminating the problem of some counties having no fatal NLD crashes, such an approach might provide the basis for better assessing the degree of mortality associated with these crashes, and a better assessment of the importance of reducing driving among NDLs. Finally, the validity of these results is dependent on the accurate assessment of

licensure status in the FARS record. While FARS data are carefully checked in order to accurately portray crashes, some error may have resulted in some teens with revoked or suspended licensed at the time of the crash being identified as never licensed.

Future research should examine more closely the individual level factors related to socioeconomic disadvantage that are also associated with increased driving without a license. Also, future research needs to address issues like those in this paper, but use crash rates rather than occurrence so that factors associated with crash risk can be identified.

STUDY III

Problem Behavior Theory postulates an association between individual psychosocial characteristics and involvement in behaviors that are socially proscribed (Jessor, Jessor, 1977). Research has demonstrated that problem behaviors and psychosocial characteristics are associated with problem driving behavior (e.g., risky driving, drink/driving, drug/driving) and driving outcomes (e.g., citations and crash involvement) (Bingham, Shope, 2004; Bingham, Shope, 2005; Shope, Bingham, 2002; Donovan, 1993). The purpose of this study was to better understand individual characteristics that are associated with driving without having been licensed by contrasting groups of drivers differing in licensure status and age-eligibility for driver licensure.

Methods

Data Sources

YRBS data are collected biennially, and include a national school-based (public and private) survey of a representative sample of 9th-12th grade students. Surveys are administered in the spring and monitor six priority health risk behaviors of adolescents. States in which YRBS data are collected from schools are given the opportunity to specify a small number of additional survey items that address health issues that are particularly important for that state's students. The 2003 (n=2,781), 2005 (n=3,077), and 2007 (n= 4,030) YRBS surveyed Montana high school students. The State of Montana requested that items related to driver licensure status

and driver education be included in the survey. The Montana YRBS data and permission to use those data in research were obtained from the Montana Office of Public Instruction (MOPI). The data were weighted to represent all students in the state and the annual datasets were combined into a single dataset for analysis (n=9,888).

Measures

Items common to all three surveys were used to create 10 multi-item composite measures. The development of these measures was completed in a series of steps. First, the items were organized into conceptual domains based on the content and topic of each item. Second, exploratory factor analysis, beginning with an initial principal components analysis and followed by testing a rotated maximum likelihood solution, were used to test the conceptually-based groups of items as measures of a common domain. The resulting factor structure supported the conceptual grouping of the items. Third, the items loading on the final factors were examined for unidimensionality by estimating a principal components solution for each set. Standardized internal consistency values were then calculated for each measure, and scale scores were calculated.

Outcome Measures

Problem Behavior Onset

The onset of four behaviors that are socially proscribed for teens was measured by four items asking participants to indicate how old they were the first time they drank alcohol (i.e., more than a few sips), tried marijuana, had sexual intercourse, and smoked a whole cigarette. Responses for the onset of alcohol, marijuana, and cigarette use were coded as 1=never, 2=age 8 or younger, 3=9-10 years old, 4=11-12 years old, 5=13-14 years old, 6 = 15-16 years old, and 7=17 years or older. The responses for the onset of sexual intercourse were coded as 1=never, 2=11 years old or younger, 3=12 years old, 4=13 years old, 5=14 years old, 6=15 years old, 7=16 years old, 8=17 years old or older. The value of one was subtracted from all responses and values of zero were recoded to seven for onset of alcohol, marijuana, and

cigarettes, and to 8 for onset of sexual intercourse. The items were then standardized to a mean of zero and standard deviation of one, averaged, and the absolute value of the lowest score was added to all participants' scores so that the lowest value of each measure was zero (α=0.79).

Cigarette Smoking

Three items assessed whether or not the participant had ever smoked daily, past 30-day frequency of smoking, and past 30-day quantity of smoking. The responses for daily smoking were 1=yes and 2=no and were recoded to no=0 and yes=7. Frequency of smoking was measured on a scale of 1=never, 2=1 or 2 days, 3=3-5 days, 4=6-9 days, 5=10-19 days, 6=20-29 days, and 7=all 30 days. Quantity of smoking was scored as 1=none, 2=less than one cigarette per day, 3=one cigarette per day, 4=2-5 cigarettes per day, 5=6-10 cigarettes per day, 6=11-20 cigarettes per day, and 7=more than 20 cigarettes per day. The value of one was subtracted from the items measuring frequency and quantity of smoking cigarettes, and the scores from the three items were averaged to obtain a scale score (α=0.92).

Other Tobacco Use

Two items measured past 30-day frequency of using chewing tobacco or snuff and cigar smoking. The responses to these items were 1=never, 2=1 or 2 days, 3=3-5 days, 4=6-9 days, 5=10-19 days, 6=20-29 days, and 7=all 30 days. The item responses were recoded by subtracting the value of one from each response and then averaged to obtain a scale score (α=0.56).

Alcohol Use

Three items measured lifetime frequency of drinking (i.e., number of lifetime drinking days), frequency of drinking any alcohol in the past 30 days, and the frequency of binge drinking (i.e., five drinks or more in one day) in the previous 30 days. Responses to the lifetime frequency measure were 1=never, 2=1 or 2 days, 3=3-9 days, 4=10-19 days, 5=20-39 days, 6=40-99 days, and 7=100 or more days. The responses to the past 30-day frequency of

drinking were 1=never, 2=1 or 2 days, 3=3-5 days, 4=6-9 days, 5=10-19 days, 6=20-29 days, and 7=all 30 days. The responses to the past 30-day binge drinking item were 1=never, 2=1 day, 3=2 days, 4=3-5 days, 5=6-9days, 6=10-19 days, and 7=20 or more days. These three items were rescaled by subtracting one from each response, and were then averaged to obtain a total scale score (α=0.90).

Marijuana Use

Two items assessed lifetime and past 30-day marijuana use. Lifetime frequency of marijuana use was coded as 1=never, 2=1 or 2 times, 3=3-9 times, 4=10-19 times, 5=20-39 times, 6=40-99 times, and 7=100 times or more. Past 30-day frequency of marijuana use was coded as 1=never, 2=1 or 2 times, 3=3-9 times, 4=10-19 times, 5=20-39 times, and 6=40 times or more. The value of one was subtracted from participants' responses to both items, the items were standardized to mean=0 and standard deviation=1, and averaged. The absolute value of the smallest average score was then added to each score so that the scale score had a low value of zero (α=0.87).

Other Drug Use

Items assessing other drug use measured lifetime frequency of cocaine, heroin, injected drugs, MDMA, methamphetamine, steroids, and inhalants, and past 30-day use of cocaine. Lifetime injection of drugs was coded as 1=never, 2=once, and 3=twice or more often. All other item responses were coded as 1=never, 2=1 or 2 times, 3=3-9 times, 4=10-19 times, 5=20-39 times, and 6=40 times or more. The value of one was subtracted from each item score, the items were standardized to mean=0 and standard deviation=1, and averaged. The absolute value of the smallest average score was then added to each participant's score so that scale scores had a low value of zero (α=0.92).

Safety Belt Use

Two items measured safety belt use while riding in a vehicle as a passenger and while driving. Item responses were 1=never, 2=rarely, 3=sometimes, 4=most of the time, and

5=always. Both items were recoded to have a range from 0 to 4. Then, in order for there to be no missing data due to people not yet driving, all values for individuals reporting that they did not drive were recoded to be equal to the response for safety belt use as a passenger. The two items were then averaged to calculate a scale score (α=0.91).

Alcohol-Involved Driving

Items assessing the past 30-day frequency of riding with a driver who had been drinking, and driving after drinking were measured on a 5-point response scale: 1=never; 2=once; 3=2 or 3 times; 4=4 or 5 times; and 5=6 or more times. One was subtracted from each item score and the responses were averaged to obtain a scale score (α=0.73).

Suicidality

Five items measured the level of suicidality. Specifically, the items measured past 12-month frequency of being so sad that the participant stopped his/her usual activities, considered suicide, planned his or her suicide, attempted suicide, and was injured from a suicide attempt. Responses to the measures of feeling sad, and considering, planning and attempting suicide were 1=yes and 2=no, and were recoded to 0=no and 4=yes. The response scale for the items measuring being injured during a suicide attempt was 1=I did not attempt suicide in the past 12 months, 2= yes, and 3=no and were recoded to 0=no attempt, 2=not injured and 4=injured. The recoded responses were averaged to obtain a total scale score (α=0.83).

Weapon Carriage and Fighting

Three items were used to measure the frequency of past 30-day general weapon carriage and gun carriage, and past 12-month frequency of being in a physical fight. Responses to general weapon and gun carriage were 1=never, 2=1 day, 3=2 or 3 days, 4=4 or 5 days, and 5=6 or more days. Involvement in physical fights was coded as 1=never, 2=once, 3=2 or 3 times, 3=4 or 5 times, 4=5 or 6 times, 5=7 or 8 times, 6=9 or 10 times, 7=11 or 12 times, and 8=more than 12 times. The items were averaged to obtain a scale score (α=0.68).

<u>Independent Measures</u>

Never Licensed Driving Status

Unique to Montana's YRBS were questions relating to driver training and experience. The questions were, "Do you drive?" and "Did you complete driver education (classroom and behind-the-wheel)?" Responses were: "No, I do not drive, I do not have a valid license or permit, and I did not complete driver education;" "No, I do not drive, I do not have a valid license or permit, but yes, I completed driver education;" "Yes, I drive with a valid license or permit, but no, I did not complete driver education;" "Yes, I drive with a valid license or permit, and, I did complete driver education;" and "Yes, I drive regularly on public roads, but I do not have a valid license or permit." The responses to these questions were used to classify participants as non-drivers, licensed drivers and never licensed drivers. These three categories were then combined with participant age and a legal licensure age of 16 to define five categories of drivers: underage non-drivers (UAND), age-eligible non-drivers (AEND), age-eligible licensed drivers (AELD), underage never licensed drivers (UANLD), and age-eligible never licensed drivers (AENLD).

Sex

Participant sex, as reported in the survey was used as a second independent measure.

Data Analysis

Analysis of variance was used to analyze the data with sex and licensure group as independent variables. Models tested the main effects and first order interaction of these variables. Models were estimated separately for each of the 10 outcome measures of problem behavior involvement. Post hoc group differences were tested using single degree of freedom contrasts to isolate the effects of both the main and interaction effects.

Results

The results demonstrated that problem behaviors were associated with sex and licensure status, and in many cases the association between licensure status and problem behavior was moderated by sex. Generally, males reported higher levels of problem behaviors than females with some exceptions. Females reported an earlier onset of problem behaviors, primarily due to

earlier first intercourse (see Table 5), and females reported more frequent cigarette smoking than males (Table 6). Males reported more other tobacco, marijuana, and other drug use compared to females (see Table 7, 8, 9). Females and males did not differ significantly in their self-reported alcohol use (Table 10).

Table 5. Timing of Problem Behavior Onset

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		24.97	<.001
Licensure		160.23	<.001
Sex*Licensure		0.91	0.456
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	2.69	2.66	2.73
Male	2.56	2.52	2.60
UAND	3.04	3.00	3.07
AEND	2.72	2.67	2.77
AELD	2.93	2.91	2.95
UANLD	2.32	2.25	2.40
AENLD	2.12	2.04	2.21

Table 6. Frequency of Cigarette Smoking

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		10.80	0.010
Licensure		89.18	<.001
Sex*Licensure		1.34	0.254
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	1.22	1.14	1.29
Male	1.03	0.95	1.11
UAND	0.50	0.42	0.57
AEND	1.15	1.04	1.25
AELD	0.66	0.62	0.70
UANLD	1.23	1.07	1.39
AENLD	2.08	1.90	2.26

Licensure status was significantly associated with all of the problem behavior measures. Generally, the pattern fit the hypothesis that teens whose licensure was delayed or who were NLD would have the earliest onset and highest levels of problem behavior. Exceptions to this pattern were for other tobacco and alcohol use, with licensed drivers reporting greater use relative to the other licensure groups.

Sex moderated the association between licensure status and other tobacco use, marijuana use, and other drug use. This moderation effect was a result of male teens in the NLD groups having exceptionally high levels of use relative to females in those groups.

Table 7. Frequency of Other Tobacco Use			
Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		234.51	<.001
Licensure		58.94	<.001
Sex X Licensure		12.33	<.001
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.27	0.22	0.31
Male	0.76	0.72	0.80
UAND	0.20	0.16	0.25
AEND	0.35	0.29	0.42
AELD	0.37	0.34	0.39
UANLD	0.65	0.56	0.74
AENLD	0.99	0.89	1.10
Female UAND	0.08	0.03	0.14
Female AEND	0.16	0.07	0.25
Female AELD	0.15	0.11	0.18
Female UANLD	0.45	0.32	0.58
Female AENLD	0.49	0.34	0.64
Male UAND	0.32	0.26	0.39
Male AEND	0.55	0.46	0.63
Male AELD	0.58	0.55	0.62
Male UANLD	0.85	0.72	0.98
Male AENLD	1.50	1.36	1.64

Table 8. Frequency of Alcohol Use			
Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		2.76	0.097
Licensure		121.16	<.001
Sex X Licensure		0.58	0.676
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
UAND	0.91	0.84	0.98
AEND	1.42	1.31	1.52
AELD	1.62	1.59	1.66
UANLD	2.08	1.92	2.23
AENLD	2.50	2.33	2.67

Tables 11 and 12 show the results of models testing the association between sex and licensure status, and alcohol-involved driving, and using a safety belt. Both sex and licensure status were associated with these two outcome measures, with males reporting more alcohol-involved driving and less safety belt use than female teens. The patterns of association between licensure status and these two outcomes were similar to those seen for problem behaviors, with age-eligible non-drivers, and both never licensed driver groups reporting less safety belt use, but only the two NLD groups reporting elevated alcohol-involved driving. The sex by licensure group interaction

Table 9. Frequency of Marijuana Use			
Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		33.49	<.001
Licensure		104.87	<.001
Sex X Licensure		3.40	0.009
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.80	0.75	0.85
Male	0.99	0.94	1.03
UAND	0.48	0.44	0.53
AEND	0.83	0.77	0.89
AELD	0.63	0.61	0.66
UANLD	0.98	0.89	1.07
AENLD	1.54	1.44	1.65
Female UAND	0.42	0.37	0.48
Female AEND	0.74	0.65	0.83
Female AELD	0.59	0.55	0.62
Female UANLD	0.95	0.82	1.08
Female AENLD	1.31	1.15	1.46
Male UAND	0.55	0.48	0.61
Male AEND	0.92	0.83	1.01
Male AELD	0.68	0.65	0.71
Male UANLD	1.02	0.89	1.15
Male AENLD	1.78	1.64	1.92

Table 10. Frequency of Other Drug Use			
Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		35.74	<.001
Licensure		86.89	<.001
Sex X Licensure		6.72	<.001
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.40	0.36	0.44
Male	0.56	0.53	0.60
UAND	0.21	0.17	0.25
AEND	0.40	0.35	0.45
AELD	0.24	0.22	0.26
UANLD	0.63	0.56	0.71
AENLD	0.93	0.84	1.02
Female UAND	0.19	0.14	0.23
Female AEND	0.33	0.26	0.41
Female AELD	0.21	0.18	0.24
Female UANLD	0.60	0.50	0.71
Female AENLD	0.68	0.55	0.80
Male UAND	0.23	0.18	0.29
Male AEND	0.47	0.40	0.54
Male AELD	0.27	0.24	0.30
Male UANLD	0.66	0.56	0.77
Male AENLD	1.19	1.07	1.31

was not significant for safety belt use, but was significant for alcohol-involved driving, with males in the NLD groups showing the greatest elevation in this behavior.

Sex and licensure group were also associated significantly with sucidality and weapon carriage and fighting (Tables 13, 14). Females reported greater suicidality than males, and the two NLD groups had higher levels than the other three licensure groups. Weapon carriage and fighting were highest for males, and for the two NLD groups, and a significant sex by licensure group interaction resulted from males in the two NLD groups reporting much higher rates of these behaviors than females.

Table 11. Frequency of Safety Belt Use

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		91.04	<.001
Licensure		67.97	<.001
Sex X Licensure		1.70	0.147
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	2.80	2.74	2.85
Male	2.42	2.36	2.47
UAND	2.98	2.92	3.03
AEND	2.73	2.65	2.80
AELD	2.91	2.88	2.94
UANLD	2.31	2.20	2.42
AENLD	2.11	1.98	2.24

Table 12. Frequency of Alcohol-Involved Driving

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		25.14	<.001
Licensure		75.39	<.001
Sex X Licensure		2.55	0.037
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.58	0.54	0.63
Male	0.74	0.70	0.79
UAND	0.30	0.26	0.35
AEND	0.45	0.39	0.52
AELD	0.55	0.53	0.58
UANLD	0.91	0.82	1.00
AENLD	1.09	0.99	1.19
Female UAND	0.28	0.23	0.34
Female AEND	0.37	0.28	0.46
Female AELD	0.52	0.49	0.55
Female UANLD	0.79	0.67	0.92
Female AENLD	0.94	0.80	1.09
Male UAND	0.32	0.26	0.39
Male AEND	0.54	0.45	0.63
Male AELD	0.59	0.56	0.62
Male UANLD	1.03	0.90	1.16
Male AENLD	1.23	1.09	1.38

Discussion

Problem behavior theory (PBT) has been previously tested as a conceptual model for motor vehicle-related risk behavior (Donovan, 2002; Shope, Bingham, 2002). Prior research has applied PBT to examine psychosocial predictors of traffic offense and crash involvement,

showing that parental involvement, attitudes toward deviant behavior, and cigarette, alcohol, and other drug use are related to the driving outcomes of young adults (Bingham, Shope, 2004a, 2004b; Bingham, Shope, Zakrajsek, Raghunathan, 2008; Bingham, Shope, Zhu, 2008).

Table 13. Frequency of Weapon Carriage and Fighting

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		385.70	<.001
Licensure		53.91	<.001
Sex X Licensure		7.10	<.001
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.38	0.34	0.41
Male	0.90	0.86	0.93
UAND	0.44	0.40	0.48
AEND	0.48	0.42	0.53
AELD	0.47	0.45	0.49
UANLD	0.88	0.80	0.95
AENLD	0.92	0.84	1.01
Female UAND	0.26	0.21	0.30
Female AEND	0.27	0.20	0.34
Female AELD	0.25	0.22	0.28
Female UANLD	0.60	0.49	0.70
Female AENLD	0.50	0.38	0.63
Male UAND	0.62	0.57	0.68
Male AEND	0.68	0.61	0.75
Male AELD	0.69	0.66	0.71
Male UANLD	1.16	1.05	1.26
Male AENLD	1.34	1.23	1.46

Table14. Suicidality

Type 3 Tests of Fixed Effects			
Effect		F Value	Pr > F
Sex		83.15	<.001
Licensure		52.44	<.001
Sex X Licensure		2.32	0.055
Single Degree of Freedom Contrasts			
		95% CI	
Effect	Estimate	Lower	Upper
Female	0.93	0.88	0.98
Male	0.61	0.57	0.66
UAND	0.57	0.53	0.62
AEND	0.81	0.74	0.87
AELD	0.50	0.47	0.52
UANLD	0.96	0.86	1.06
AENLD	1.02	0.91	1.13

This study supports and extends those previous findings, demonstrating an association between licensure status and driving without a license and involvement in problem behaviors, driving risk behaviors that increase the chance of crash involvement and injury, illegal behavior related to weapons, and indicators of mental health.

PBT posits that problem behavior involvement has a syndromal character. Teens are not specialists when it comes to

involvement in problem behaviors. Rather, they are generalists, with involvement in one problem behavior being associated with an increased likelihood of involvement in others. Where driving without being licensed is concerned, not only is PBT supported, but these results show that there are also more serious manifestations of behavioral under-control that relate to driving without a license. Teens who drive without ever being licensed are not only at risk of greater involvement in normative problem behaviors, but also at increased risk for involvement in more serious illegal behaviors, and diminished mental health. Driving without ever being licensed is potentially an indicator of significantly increased risks to healthy psychosocial development.

CONCLUSIONS

This research supports findings of previous studies indicating that socioeconomic disparity is associated with never-licensed driving. In recent years in the U.S., there has been a trend away from driver education provided in public high schools where the immediate costs associated with becoming licensed were restricted to a small licensing fee. In place of driver education through public high schools, private driving schools have grown in number, and with driver education through the public sector have come higher costs associated with completing driver education. In the past, other costs associated with driving, in particular the cost of gasoline, were also much less. These costs to teens being licensed in the U.S. currently remain low relative to other high-income nations in which licensing fees, and the cost of gasoline are greater. Given the recent trends associated with getting licensed and operating a motor vehicle in the U.S. and the still higher costs in other western countries, it is not a surprise to find an association of socioeconomic disparity with never-licensed driving.

This research also demonstrated an association between licensure status, never-licensed driving in particular, and normative and non-normative problem behaviors, and violence. Prior research has shown an association between driving outcomes and psychosocial variables, including problem behavior involvement, hostility, and aggressivity (Bingham, Shope, 2004;

Bingham, Shope, 2005). This research extends knowledge in this area, showing an association of never-licensed driving with violence aimed at others and at oneself. These associations provide markers of risk that can be used to tailor interventions, and suggest that intervention approaches that have been used to reduce other problem behaviors might also be effective in reducing never-licensed driving.

Future research should examine this issue in a longitudinal sample so that the temporal ordering of involvement in the various behaviors and their associations with each other can be better understood.

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