Summer 8-11-2020

Pilot Survey of Driving Behaviors Associated with Adverse Weather amongst Collegiate Students

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ABSTRACT

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By

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July 7th, 2020

Motor vehicle crashes have demonstrated to be one of the leading causes of death and unintentional injury within the United States (Center for Disease Control and Prevention (CDC), 2020). Of the 5,891,000 motor vehicle crashes that occur each year, approximately 21% of these crashes are weather-related (Federal Highway Administration (FHWA), 2020). The population most impacted by motor vehicle crashes within the United States is teens, who are three times more likely to experience crashes than adults (CDC, 2020). To better understand driving behaviors used by early adults, the current study examined defensive driving behaviors implemented by collegiate students to prevent motor vehicle collisions. The purpose of the study was to investigate the driving behaviors of college students during adverse weather conditions. Undergraduate students were recruited, and participants anonymously recorded their responses to questions assessing their driving behavior. The results suggested that students avoid driving in the car in adverse weather (e.g., fog, rain, or ice), but they do not avoid driving during night conditions. Implications of the results are that adverse weather conditions are likely to be avoided by GSUSPH students and all motor vehicle drivers, thus encouraging the public health community to continue designing and implementing developed road strategies to promote driver safety.

Pilot survey of driving behaviors associated with adverse weather amongst collegiate students

By

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B.S. Exercise Science, GEORGIA STATE UNIVERSITY

A Thesis Submitted to the Graduate Faculty

of Georgia State University in Partial Fulfillment

of the

Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA

30303

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Acknowledgments

First and foremost, I would like to thank my thesis committee for the countless hours put into the development of this investigation and for hours put into making myself a better student and public health analyst. Without your insightful comments, feedback, and encouragement, I would not have reached this point in which I am today, Dr. Emily Graybill and Prof. John Steward.

I would also like to extend my sincerest gratitude to my family for their untethering faith and belief in me and everything that I set out to achieve.

Author's Statement Page

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-Myles Bostic

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INTRODUCTION

1.1 Background

Motor vehicle crashes are among the leading causes of death and unintentional injury within the United States (Center for Disease Control and Prevention (CDC), 2020). Of the 5,891,000 motor vehicle crashes that occur each year, approximately 21% of these crashes are weather-related (Federal Highway Administration (FHWA), 2020). Weather-related crashes are defined as those crashes that occur in the presence of adverse weather conditions, that specifically hinder visibility and driver safety. Adverse weather conditions blocking visibility described within the literature include rain, sleet, snow, and fog (Collins English Dictionary, 2020). Road weather conditions that are also seen to impact motor vehicle safety on the road are icy roads, wet pavement, and high wind speed (FHWA, 2020). This study aims to measure road safety interventions used by college students to prevent weather-related crashes.

Recent investigations have been conducted to better understand and predict weather conditions to improve driver safety (Andrey et al., 2013). Road strategies are developed as a result of these investigations for the primary purpose of reducing unintentional injury as a result of adverse weather conditions (Chen et al., 2009). Unintentional injury is understood as injuries that occur within a short period that are unplanned and can be harmful in the outcome (Norton et al., 2006). The population impacted the most by motor vehicle crashes within the United States are teens, who are three times more likely to experience crashes than an adult (CDC, 2020). Several factors may contribute to motor vehicle collisions. The purpose of this literature review is to provide an overview of the research on weather impact, motor vehicle crash threats, measuring driver anxiety, and driver adaptation.

Research within the current body of literature examining motor vehicle crash threats helps us understand and predict the impact of adverse weather conditions on the number of collisions and severity of reported injury (Black et al., 2015). Data were available through traffic and highway safety administrations, along with meteorological data were used to draw conclusions on the impact that adverse weather has on motor vehicle collisions (Black et al., 2015; Chagnon et al., 2006; Cheng et al., 2017; Naik et al., 2016; Zhao et al.,2019). Chagnon and his team of researchers analyzed snowfall data from 507 weather stations to conclude that snowfall periods are increased in centimeters of snow in the South Dakota and Great Lake areas compared to areas near the gulf coast during years 1900 - 2016 (Chagnon et al.,). Investigators sought to assess the threat in which weather can potentially have on motor vehicle drivers by conducting surveys asking questions about driver anxiety and avoidance behaviors (Andrey et al., 2013). Mills and colleagues assessed collision data of Waterloo from 2002 – 2016 covering all winter months and learned that sixty-six percent more collisions happened during winter storm conditions as compared to summer storm conditions. Andrey and his fellow researchers (Andrey et al. 2013) conducted a primary investigation to analyze drivers' adaptations. They concluded that drivers become "acclimatized" to weather conditions and still drive above posted speed limits in winter weather. Both studies contribute to measuring collision risk as a result of driver behavior.

To contribute to the growing body of literature on driving adaptations in response to inclement weather, the primary goal of this study is to bridge the knowledge gap of road safety interventions utilized by college students to prevent weather-related injury. Motor vehicle drivers' behaviors will be surveyed using the Driving and Riding Avoidance Scale (DRAS) to learn more about road safety interventions. Open-ended responses will be collected through participant responses to questions about what weather conditions present the most risk, followed by their adaptations to such terms (Stewart et al., 2004). Based on this approach, we will be able to assess the following: college students' opinions on driving during adverse weather conditions; the likelihood that collegiate drivers implement avoidance behaviors to prevent unintentional injury; and what weather conditions present the most risk for motor vehicle collisions.

1.2 Research Questions

In the current study, we will be seeking to answer the following questions: (1) What are college students' opinions of driving during adverse weather conditions? (2) What is the likelihood that collegiate drivers implement defensive driving techniques to prevent motor vehicle collisions?

REVIEW OF THE LITERATURE

Per the CDC, one of the leading causes of injury and death amongst early adult drivers are motor vehicle crashes. Further efforts have gone into understanding why early adults' drivers are involved in nearly 12% of all fatal crashes within the United States (NHTSA, 2009; NHTSA 2008). Early adult motor vehicle crashes have been attributed to driver inexperience and risk taking seeing that crashes are associated with risk taking behaviors such as speeding and risk taking for adverse road conditions (Rhodes et al., 2005). Current research has directed its efforts to understand the decision making and rationale process of early adults as they engage in risk behaviors such as alcohol consumption and cigarette smoking. Investigations have not yet been extensively used in traffic safety for early adults but is sanctioned for investigation due to the driving behaviors in response to ever changing road situations (Mayhew et al., 2007). The investigation team of the current study sought to explore the gray area in the current body of literature on early adult drivers in adverse weather conditions.

Many investigators have studied the practicality of correlating crash data with weather data to predict the chance of motor vehicle danger (e.g., Black et al., 2015; Chagnon et al., 2006; Cheng et al., 2017; Zhao et al., 2019). Naik and colleagues (2016) explored the feasibility of combining the severity of single-vehicle crash data and weather data. These investigators sought to bring a much more in-depth analysis of the public health issue of truck-involved crashes not only on a national level but also state levels. Lack of crash and weather characteristics supported the rationale of investigating the feasibility of aggregating weather station data with roadway and crash data (Naik et al., 2016). The Nebraska Department of Roads' Office of Highway Safety (NDDOR-OHS, 2011) provided crash data according to the officers' investigation report. Detailed 15-min Nebraska weather data came from the National Climatic Data Center (NCDC) from monitoring stations observing visibility, precipitation, air temperature, sky condition, wind speed, and wind direction. A geographic information system software was used to integrate the data on crash data and weather conditions. Models within the study were utilized to help capture weather-related factors to address the issue of weather impact. Results demonstrated that weather station data could be used as an indicator for particular truck crashes (Naik et al., 2016). Wind levels were reported as being statistically significant in truck crashes; rain and warmer conditions were also associated with more severe car crashes (Naik et al., 2016). The investigators developed a method that researchers can use to understand the severity of the impact of weather on crash and roadway data.

Weather Impact

To further expand the research on weather impact, specific to motorcycles, Naik, and colleagues (2016) sought after the need to explore crash trends not only amongst four-wheel vehicles but also motorcycles. Researchers Cheng and colleagues wanted a better understanding of the severity of motorcycle injury as they are related to injury using data reports from weather stations along with roadway and highway crash statistics (2017). The purpose of their study was to use multiple models to highlight existing weaknesses in data, but also to yield more reliable findings for research on weather impact data on motor vehicles. (Cheng et al., 2017). The rationale for study within this scope is due to the lack of data examining weather conditions that increase the severity of motorcycle crashes. Crash data were obtained from the Office of Traffic and Safety in San Francisco, California, because it was ranked as a city that is unsafe for motorcyclists (Office of Traffic Safety, 2014). The Transportation Injury Mapping System compiled four different types of variable outcomes for motorcyclists. Weather data were collected through Weather Underground, which is a source that contains weather information updated every hour measuring several weather characteristics such as temperature, humidity, dew point, and pressure.

Results yielded an increase in air temperature was seen to reduce the possibility of fatal motorcycle crashes. In addition, it was also noted that an increase in air temperature did increase the likelihood of other severity outcomes. The results also demonstrated the ability to utilize a system specific to motorcyclists as a predictor for potential crash events. It shows that it is possible to develop a model with minimal outcome deviations based up weather and roadway characteristics for crash estimations. The implications of the research also yield information that serves as beneficial to National Highway and Traffic Safety agencies as they educate drivers on the risk of a motor vehicle collision in adverse weather.

Researchers Black and colleagues (2015) examined the correlation between weather precipitation and travel risk to contribute to the growing body of literature on weather's impact on motor vehicle operation. Winter precipitation (e.g., snow, sleet, freezing rain) is associated with an increase in traffic crashes (Black et al., 2015). This investigation aimed to provide more insight into the risks of collision, injury, and fatality with winter weather conditions in the United States (Black et al., 2015). Two primary data sets were utilized to collect crash and weather data: Automated Surface Observing System (ASOS), hourly weather reports, and the National Highway Traffic Safety Administration's providing crash reports for the 32 states that participated. A matched-pair design was used to analyze the effect winter weather had within the sample 13 cities. For the investigation, 308,619 crashes, 460 fatalities, and 95,334 injuries were attributed to winter precipitation. The relative risk of collisions during winter precipitation varied among the 13 cities sampled. Each city saw at least a 15% increase in crash risk for each city during the time of winter precipitation (Black et al., 2015). The research's importance is to help us understand how to measure the relative risk of a crash in winter precipitation nationwide (Black et al., 2015). The matched pairing system of the national highway and meteorological data from the 13 states demonstrated that with all 50 states cooperating in the ASOS program, a national data set on risk could be developed (Black et al., 2015).

Zhao and researchers investigated the effects of monthly weather conditions on crashes experienced on freeways (2019). They examined the correlations between these two factors and their impact on the total crash, fatal and injury crash, and even property-damage-only (PDO) (Zhao et al., 2019). The Connecticut Department of Transport provided crash data, and weather station data were acquired by the National Centers for Environmental Information (NCEI) for the years of 2011-2015 (Jolliffe, 2002). Random parameters negative binomial models with first-order were utilized to analyze the data. The principal component analysis was used to reduce the dimensionality of the dataset. The results suggested that lower temperatures, heavy fog days, decreased precipitation, smaller wind spread, higher monthly traffic volumes, and narrow road shoulders were correlated with high monthly crash rates (Zhao et al., 2019). This research highlighted the effects of monthly weather conditions on freeway crashes. The results could guide highway engineers to develop strategies for driving safety interventions (Zhao et al., 2019).

Chagnon and researchers examined the temporal and spatial characteristics of 30-day heavy snowfall in areas east of the Rocky Mountains (Chagnon et al., 2006). The reasoning behind the investigation stemmed from the knowledge gap of daily snowfall impact on driving, which was created by the surplus of climatology data on rainfall (Chagnon et al., 2006). The rationale for conducting the investigation is to understand how snowfall varies across the Eastern United States to understand the frequency of extreme snow. The selection of weather stations required careful choice. Inclusion criteria for weather stations included not missing more than 10% of snowfall data during 1900-2016, those with daily 6-hour observations, and those that measured temporal frequencies of snow stations.

Data from seven hundred and twenty-four stations were acquired from a Midwestern Regional Climate Center (MRCC) tool. The highest amount of snowfall as observed north of the Gulf of Mexico up to the Canadian Border. Temporal analyses illustrated 30-day heavy snowfall periods beginning in the winter of 1959/60, with the highest occurrence in the third quarter (1959-1987) (Chagnon et al., 2006). This research provided a foundation for future research exploring extreme 30-day heavy snowfall amounts.

To follow up on their recent investigation, Chagnon partnered with his researchers to conduct a second investigation with a broader analysis of snowstorms across the United States (2006). Snowstorms across the United States have created many problems, including property damage and loss of life (Chagnon et al., 2006). The rationale for conducting the research was to fill the void in a lack of quality historical snowstorm data and regional differences in snowfall magnitude (Chagnon et al., 2006). At 1550 weather stations in the United States, daily snowfall data were assessed through two phases of evaluation to ensure quality information.

Quality data were provided for 208 weather stations that possessed sizable portions of snowstorm data dating back to 1901. The analysis illustrated that most areas of the United States had had years without snowstorms. The annual minimum of one or more storms happened in high elevation areas in the West and Northeast (Chagnon et al., 2006). Temporal distributions of snowstorms exhibited fluctuation during 1901-2000 with downward trends in the lower South, Midwest, and West Coast areas. Upward trends were noted in the midwest, east, and northeast for 1901-2000 (Chagnon et al., 2006). The impact this investigation has on public health is that it allows us to develop better forecasting based upon historical data. It aids investigators in their interpretations of climatology stemming from yearly trends.

To understand mobility-related decisions based upon winter storms' situational characteristics, Mills and his team of colleagues examined the impact of winter storms and the related risk information had on driving decisions and behaviors (2020). The study explored relative risks based upon temporal, location, and storm characteristics to provide insight on both short- and long-term shifts given the sensitivity of behavior change. The rationale for the investigation was to provide a historical analysis of relative collision risk to provide context for survey-based evaluations and mobility-related decisions (Mills et al., 2020). The study area for the investigation took place in The Regional Municipality of Waterloo (RMW), a region located near the Great Lakes that experiences many precipitation events (snow included) at varying intensities throughout the year. Collision data were taken of the RMW, including over 41,600 collisions, covering all winter months (November-April) from 2002 to 2016 and their crashes on

RMW managed roads. Weather data were utilized by multiple sources where precipitation data would be processed hourly and daily, along with weather and road service information. A matched-pair, retrospective cohort method was used to estimate injury collision risk. Winter storm periods were matched to dry weather periods to isolate the influence. Qualities evaluated were the onset of a storm, the spread, duration, and intensity. There were 196 control pairs used that included 4650 event collisions and 1904 control collisions. The relative risk for injury collisions during all winter storms is 1.66 (Mills et al., 2020). This implies that 66 percent more collisions happened during winter storm conditions as compared to summer storm conditions. The depth of this research shows that the institutions responsible for ensuring road safety provide information that is insufficient and does not compensate for the effects of winter storms. It also indicates that behaviors appear to be influenced by the form of precipitation and storm intensity.

Liu and investigators set out to bridge the gap of data regarding extreme weather events' intensity, projected growth in frequency, duration, and ability to affect the risk of motor vehicle collision (Liu et al., 2017). The primary goal of the investigation was to measure the association between the frequency of extreme heat and precipitation events and the risk of a motor vehicle collision in Maryland between 2000 and 2010 (Liu et al., 2017). Their efforts in their investigation are supported by the rationale of bringing more data into the scarcity of research providing context on how the frequency of extreme weather events can impact risks. The demographic of the study focused on all motor vehicle drivers within the state of Maryland. Data were collected by the Maryland State Police on the entire state through their automated collision reporting system (MAARS) and had all motor vehicle collisions from January 1, 1997, to December 31, 2013. Extreme heat and precipitation data were analyzed using daily meteorological data to give location and calendar day inputs. A time-stratified case-crossover analysis was done to assess the association between the occurrence of extreme heat and precipitation and events and the risk of vehicle collisions.

Twenty-eight-day intervals (each interval has 28 days) were selected as the control periods to measure association. Over 1.3 million motor vehicle collisions were analyzed between January 1, 2000, and December 14, 2012. The majority of motor vehicle collisions (95%) occurred on roads with no significant defects or obstructions (Liu et al., 2017). There was a twenty-three percent increase in the odds of a motor vehicle collision associated with a one-day rise in extreme events (Liu et al., 2017). This study, in large to effectively develop targeted interventions that could be utilized as a prevention source not only in Maryland but also in the United States. Motor vehicle injuries have been one of the leading causes of mortality for years, and the investigation provides a scope of focus.

Chen and his fellow researchers examined the impact of windy environments, particularly bridges, on motor vehicle crashes (Chen et al., 2004). There was a need for scientific data supporting bridge management in hazardous windy conditions (Chen et al., 2004). Regarding operations of the bridge, there was not a guideline for motor vehicles to follow (Chen et al., 2004). The rationale behind conducting the investigation was to provide a systematic analysis of vehicle performance on bridges in windy environments. The researchers began their study by doing a full interaction analysis between the bridge and the vehicle. From there, predictions were made regarding bridge vibration, vehicle response in the directions, rolling and rotation under wind action, and road roughness.

Results from the investigation demonstrated that the proposed collision analysis model could be used to predict the collision driving speeds for any windy condition (Chen et al., 2004). Lowering driving speeds was seen to reduce the collision risk if the wind speed was perceived to be high (Chen et al., 2004). Results also suggested that driving on a bridge during extremely windy conditions should be prohibited to minimize crash risk (Chen et al., 2004). The investigation's public health implications are their ability to provide guidelines for driving on bridges in windy conditions. Hence, reducing the burden in which wind can have on motor vehicles. The investigation prompted the investigation team to conduct a broader examination of the correlation between single-vehicle crashes and adverse weather conditions within the United States (Chen et al., 2009). Weather (e.g., strong wind, snow, and icy rain) is known to impact the number of crashes occurring within the U.S. The investigations rationale was single-vehicle non-collisions had not been investigated sufficiently. Also, the safety of normal operations was studied. An overview of environmental and topographic conditions around the U.S. was able to be conducted as a result. An injury assessment framework was developed to assess the injury-related response and injury risks (Chen et al., 2009). The potential public health impact the analysis provides is a better-developed traffic design that will optimize the number of driving routes and strategies in adverse weather conditions.

Zhang and his colleagues set out to explore the impact of traffic characteristics and weather variable data on crash frequency (Zhang et al., 2020). The investigation aimed to measure the rate of crash types within the urban highway setting (Zhang et al., 2020). The literature preceding this article examines in depth predictor models focusing on crash frequency and crash severity; this created a grey area on information on the crash type (Zhang et al., 2020). Three datasets were used to prepare for analysis: 1. Historical crash data from January 1, 2018, to October 31, 2018, from the Wuhan Municipal Public Security Bureau 2. Roadway speed limit 3. Traffic data detected by Loop Detectors (L.D.s)

For the analysis, a scenario-based data aggregation approach of significance was utilized to identify traffic conditions before the occurrence of crashes. Statistical counting models and Poisson regression model were used for the crash frequency to analyze the impact of potential factors. To assess the fit of the models, a Bayesian Information Criterion, along with an Akaike Information Criterion, was used to evaluate the goodness-of-fit to determine the statistical fit.

The best fitted variable combination for crash frequency included all traffic and weather variables, including its interaction with the speed limit (Zhang et al., 2020). The binomial model displayed an excellent prediction of performance for rear-end collision and side-impact collisions (Zhang et al., 2020). The variables included in the two models were average speed, traffic volume, weather, and speed limit. The results showed the factors of traffic and weather showed similar trends regarding collision (Zhang et al., 2020). High average speed and traffic volume increased the probability of rear-end and side-impact collisions (Zhang et al., 2020). This investigation could aid in future developments of traffic countermeasures to improve the safety of driving on the urban expressway.

In summary, the results of the research conducted by the investigators listed contributed to the current study by offering different methods of analysis to draw estimations of weathers impact on motor vehicle drivers. Their methods in turn provided insight on how to effectively generate an analysis for the measurement of the impact weather has on collegiate student driving behaviors. Their results also provided foresight into predictions that could be made regarding collegiate drivers' avoidance behaviors.

Given the present literature focusing on the impact adverse weather conditions have on motor vehicle driver's mobility, research has moved toward the direction of understanding the attributed behaviors as a result of collisions during unfavorable weather conditions. It is essential to understand drivers' behaviors during adverse weather to predict the followed responses of motor vehicle operators. It is especially crucial to the current study to provide insight into how collegiate drivers greet adverse weather.

Measuring Driver Anxiety

While understanding weather impact is beneficial to determining driver behaviors, being able to measure driver anxiety is also a prominent theme of investigation within public health. Driver anxiety has been seen to stem from prior experiences with motor vehicle collisions, and because of an avoidant behavior has shown the potential to be developed (Clapp et al., 2011). The Driving and Riding Avoidance Scale is a tool to measure self-reported avoidance amongst motor vehicle drivers (Stewart et al.,2004). Research into the DRAS tool's validity has shown promise in displaying internal consistency over two months; however, questions remain due to the surveys' inability to specifically ask for participants to report avoidance due to driver anxiety.

Driving and Riding Avoidance Scale

Stewart and his researchers set out to assess the reliability and validity of their Driving and Riding Avoidance Scale (DRAS) amongst a sample of university undergraduates (Stewart et al., 2004). DRAS is designed to assess avoidance behaviors in individuals who have and have not experienced motor vehicle injury (Stewart et al., 2004). The rationale supporting the investigation is that if the study yields similar findings, the survey tool is valid and reliable. In study one, 386 crash undergraduate survivors were attending a large public university. In study two, sixty-seven undergraduate students who experience at least one crash were surveyed over a four-week interval in exchange for extra credit. In study three, one hundred and eighteen undergraduate crash survivors were interviewed.

The first study revealed that the scale was internally consistent and also that crash survivors that received medical treatment displayed more significant avoidance that those who were uninjured or didn't need medical attention (Stewart et al., 2004). Study two revealed test-retest reliability over a four-week interval (Stewart et al., 2004). The investigation's impact was its ability to implement and evaluate driving and riding avoidance in a non-clinical setting (Stewart et al., 2004). The consistency of the DRAS tool displayed amongst each study demonstrates that it is a useful measure for driving behaviors.

Following up on the designer's evaluation of the DRAS tool, Taylor and his team investigators of this study set out to analyze the psychometric properties for the Driving Riding & Avoidance Scale (DRAS) utilizing revised instructions (Taylor et al., 2018). Developed and experimented in three U.S. studies implemented by Stewart & St. Peter (2004), the DRAS system was seen to be a relatively easy tool to evaluate the psychometric properties of their system. Recommendations followed that with modified instructions, the DRAS survey could be beneficial for other investigators (Stewart et al., 2004). The experiment's rationale was to evaluate the use of the DRAS system with modified instruction (Taylor et al., 2018). A random sample of 1,500 adults was recruited to participate in the study from a New Zealand electoral roll that comprised 98% of the population. Participants were invited to take part in a survey and based upon given their response, and their survey data became available to researchers. The age ranged between 18 years and 87 years for the participant group. To compare the psychometric properties of the modified DRAS survey, several other psychometric tests were utilized, such as the Driving Situations Questionnaire (DSQ), Driving Cognitions Questionnaire (DCQ), Driver Behavior Questionnaire (DBQ), and Driver Social Desirability Scale (DSDS). Data were analyzed using SPSS.

The DRAS scores within the study were much lower than past research utilizing student samples as compared to the general population. Internal consistency and psychometric properties were very similar to those reported by Stewart & St. Peter (Taylor et al., 2018). The modified DRAS demonstrated convergent validity amongst the tested driving measures (Taylor et al., 2018). Implications from this investigation indicate that the DRAS tool can measure psychometric factors amongst the general population. This is important due to its ability to fill in the knowledge gap of anxiety amongst drivers and those behaviors that come with it.

Modified Interviewing

Clapp and researchers set out to measure associations associated with fear and travel avoidance (Clapp et al., 2011). For this study, collision severity, collision-related distress, and stress history were analyzed due to the small amount of literature available (Clapp et al., 2011). The rationale for the investigation to bring additional knowledge to what is known about the driving behavior of anxious individuals (Clapp et al., 2011). Three hundred and fifty-six undergraduate students across two universities were recruited to take part in the study. To qualify for the study, students had to be in at least one traffic collision. Information regarding collision involvement was collected using a modified interview developed by Blanchard and Hickling (2004). Stressful events were assessed using a screening device modified from the Life Events Checklist (LEC; Blake et al., 1990). Anxious driving behavior was surveyed using the Driving Behavior Survey.

Evidence of the effects indicates an association between collision distress and anxious behavior only in those reporting severe life stress (Clapp et al., 2011). The data also shows that stress history serves as a vulnerability factor for anxious driving behavior (Clapp et al., 2011). In the broader scope of public health, this provides further context into the risks of anxious driving behaviors and how they may develop.

In brief, the literature present contributes to the understanding weather impact has on motor vehicle drivers by providing insight into the anxiety attributed as a result of adverse weather conditions. The current study benefits from the research by understanding the reliability and the validity of the DRAS tool. The researchers' evaluations of the tool have provided considerations of the potential limitations in which the survey could potentially have in understanding driver behaviors.

Driver Adaptation

As a result of prior experience with adverse weather conditions and motor vehicle collisions, research has understood that driver anxiety can be developed. Driver Anxiety and their perceptions of adverse weather have formed beliefs within drivers influencing their decisions on the road (Andrey et al. 2013). It is essential to understand said driver adaptations to comprehend how drivers respond to certain weather conditions. This relates to the current study as we seek out potential avoidance behaviors amongst collegiate students.

Andrey and researchers examined driver's adaptation to inclement weather in Canada (2013). Researchers explored this public health topic using two temporal scales to do the following: 1.) Survey if drivers have become acclimatized to weather conditions 2.) Survey drivers' beliefs on posted speed limits (Andrey et al., 2013). The scope has been focused upon winter-weather conditions within Canada; that way, they can utilize it to generate a risk analysis of driving in these conditions (Andrey et al., 2013). Collision data were collected for 23 cities over ten years. A matched-pair design was utilized comparing both casualty-collision frequency and weather events (matched control periods).

Winter weather (ice, freezing rain, snow) is associated with elevated risks of collision (Andrey et al., 2013). It was also noted that drivers still drive well above posted speed limits in the event of inclement weather (Andrey et al., 2013). The bigger picture of the investigation is that it provides insight into the consequences of unsafe driving behaviors. Research conducted includes the knowledge of the growing body of literature measuring driving behavior by exploring collision risk and adaptations.

To contribute to research investigating motor vehicle drivers' adaptations to adverse weather conditions, Barjenbruch and his team of researchers assess drivers' awareness and response to two significant winter storms impacting the Metropolitan Area of Utah (Barjenbruch et al., 2016). The purpose of the investigation was to learn how motor vehicle drivers obtained information about storms before traveling and to understand whether they changed their travel plans and how to accommodate the wind (Barjenbruch et al., 2016). The Utah Department of Transportation is interested in understanding traffic patterns on freeways in Salt Lake County. This is due to their belief that driving challenges (precipitation rate, snow-covered roads, wet conditions, time of day, etc.) (Utah Department of Transportation, 2020). In collaboration with the investigators' selected storm events and the information on anticipated surface transportation, Utah Weather Partners was disseminated via the National Weather Station and Utah Department of Transportation service stream. Telephone and professional surveys were conducted via cell phone numbers to assess weather information drivers obtained prior too, the sources information was obtained from, and how exactly they utilized the data based upon their perceptions of severity.

Calls were made the day following the storm to rate on a scale from 0 to 2 on the vagueness of the report (Barjenbruch et al., 2016). Driver behavior was assessed using changes in speed and travel time via the Performance Measurement System (PeMS). Based upon the investigators' analyses, storm one was reported to be forecasted accurately, which contrasts the second report was under forecasted according to the participants (Barjenbruch, 2016). Survey responses for both storms indicated 34% of respondents stated that they did not adjust their driving behaviors to accommodate the storm while the vast majority modified their behavior, given the storm's impact (Barjenbruch et al., 2016). In particular, changes noted were in a shift in travel schedule, changed routes, deciding not to drive at all, or utilizing mass transits. The majority of participants (88%) reported that they were satisfied with the information gathered from the weather reports (Barjenbruch et al., 2016). Conclusions made from this study reflect how motor vehicle drivers comprehend and utilize weather information to adjust their driving routines. They also benefit the growing body of research on driver adaptation by providing insight into how weather information and forecast influence driver behaviors. The research listed above benefits the current study by providing insight as to how motor vehicle drivers adapt to adverse weather conditions that present a crash risk.

Defensive driving techniques taught as a from of driver adaptation on the road has been a theme under review to evaluate its effectiveness on improving motor vehicle driving. Millard and his team of investigators conducted a study measuring the effectiveness of an emergency and defensive driving course by measuring their visual and perceptual skills (Millard et al., 2013). The rationale of the investigation was evaluating the course’s ability to provide and improve the ability to drive a motor vehicle (Millard et al., 2013) Pre and post-tests scores were evaluated amongst participants collected from the TRS 233 Emergency and Defensive Driving Techniques course at Eastern Kentucky University. Test scores of 117 students were obtained from the Traffic Safety Institute Office evaluating the effectiveness of the driving course. The results of the study demonstrated a significant difference in the student's ability to search, identify, predict, decide and execute defensive driving skills over the course of the TRS 233 course (Millard et al., 2013). The contribution the investigation has to the public health community is that defensive driving courses have the ability to improve the short-term driving skills amongst student drivers.

The review demonstrated several individuals and environmental factors that impact motor vehicle operations on the road. Individual factors that were present throughout the literature that influence driver behavior were driver anxiety (Clapp et al., 2011) perceived risk (Mills et al., 2020) and driver awareness (Barjenbruch et al., 2016). Driver anxiety was seen to be influenced by experience with prior motor vehicle collisions (Clapp et al., 2011). Adaptations were then seen to be developed as a result of the collisions as opposed to forecasting potential adverse conditions (Clapp et al., 2001). The majority of motor vehicle drivers adapt to their routines based upon accurate forecasted information (Barienbruch et al., 2016)

Environmental factors were present throughout the literature that is known to impact motor vehicle behavior were adverse weather conditions (Black et al., 2015; Cheng et al., 2017; Zhao et al., 2019; Mills et al., 2020). The findings implied that interventions such as reducing speed limits, installing roundabouts, improved signage, and road blockages would mediate the risk of motor vehicle crashes during adverse weather. Information will benefit the current study as we seek out to accurately measure preventative behaviors implemented by collegiate students in adverse weather conditions to avoid collisions.

METHODS AND PROCEDURES

3.1 Context of the Study

The purpose of the study was to examine the feasibility of a pilot survey administered online to college students assessing driving behaviors during adverse weather conditions. The goal was to understand better the driving behaviors implemented by collegiate students to prevent motor vehicle collisions. Within the current investigation, we sought to answer the following questions: (1) What are college students' opinions of driving during adverse weather conditions? (2) What is the likelihood that collegiate drivers implement defensive driving techniques to prevent motor vehicle collisions? Based on prior research, it is to our belief that collegiate students implement avoidance behaviors to prevent motor vehicle collisions.

3.2 Study Procedure

Students were recruited via Georgia State's SONA system. The SONA system is a login portal for participants to direct them to an external website (i.e., Qualitrics) where they can anonymously complete the surveys for research. Participants completed a 28-response modified DRAS survey comprised of demographic and driving history (age, gender, institution name, licensure, and years of driving). On a scale ranking driving behavior from "avoid rarely or none of the time" to "avoid most of the time," students provided their avoidance behaviors to certain adverse weather conditions. In addition, two short response questions were added to supplement the assessment of collegiate driving behaviors which were: (1) What weather conditions make you the most nervous as a driver? (2) What do you do to be safe when driving in those weather conditions? Elements of the DRAS tool were included within the survey to better understand the avoidant behaviors of the college motor vehicle drivers.

Driving and Riding Avoidance Scale (DRAS)

As previously stated, DRAS (Stewart et al. 2004) is a tool that was developed to assess avoidance behaviors for several driving scenarios. A modified version of the DRAS survey was utilized to ensure the instrument's validity and to ensure that avoidance responses were given (Taylor et al., 2018). Concurrent with Stewart's study utilizing the DRAS tool, respondents were requested to rank their likeliness of scenario behaviors listed in accordance to the following: "Avoid rarely or none of the time", "Not as likely to avoid", "Likely to avoid", and "Avoid most of the time" (Stewart et al., 2004). A 4-point Likert scale was utilized, which ranges include 0(=avoid rarely or none of the time), 1(=not as likely to avoid), 2(=likely to prevent), 3(=avoid most of the time). Participants were requested to select a response for each driving scenario that describes how they would behave. Scores could range between 0 to 48 with higher scores demonstrating a higher avoidance of unfavorable road scenarios. Subscales were also present measuring avoidance of weather (items 10,11,13), avoidance of traffic (items 4-9, and 12), and riding avoidance (items 1-3 and 14-16).

Modified Survey Questions

Based upon recommendations amidst the conclusion of Taylor's research, open ended questions were developed by the current investigation team to ensure which weather scenario presented the most risk and what driving behavior followed. Respondents answered the two additional short response questions at the end of the survey categorizing their beliefs as to which adverse weather conditions present the most risk to them. Responses were recorded and will be ranked in accordance to which weather condition presents the most risk. Statements made about which behavior exuded by the participants will be noted and presented in a descriptive format.

3.3 Sample

For the study, undergraduate collegiate students from Georgia State University's School of Public Health (GSUSPH) were invited to take part in our survey assessing driving behaviors. To obtain a human subject as a part of the investigation, human subjects approval was obtained from the university Institutional Review Board (IRB). With regard to recruitment, the driving behavior survey was displayed on the Bachelor of Science of Public Health (BSPH) website to engage students in effort to increase survey respondents. In addition to, the behavior survey was made readily available through the SONA system for one summer course which had an enrollment of 50 students. To supplement recruitment efforts the survey was distributed to BSPH students enrolled in the summer course available. Inclusion criteria for the students within the School of Public Health were as follows: Undergraduate Student, Licensed, Motor Vehicle Driver, 18 years of age or older. Exclusion criteria within the recruitment of participants were as follows: refusal to provide consent, not currently a licensed driver.

3.4 Statistical Analysis

The purpose of the investigation was to evaluate a pilot survey protocol and questionnaire assessing college students' opinions of driving during adverse weather conditions, the likelihood that collegiate drivers implement defensive driving techniques to prevent motor vehicle collisions, and what adverse weather conditions present the most risk for unintentional injury. Given prior evaluations of the DRAS survey, the current study reported descriptive statistics based upon sample size utilized from GSUSPH. Short responses recorded underwent a thematic analysis to organize reoccurring themes of weather conditions that present the most hazard to GSUSPH students.

RESULTS

The results demonstrated 22 responses with participants varying in age from 19 to 24 years of age (Table 4.1). Of the responses recorded, two participants did not fit within the inclusion criteria due to licensure and institution; therefore, their responses were discarded from the final analysis of the data. A majority of the responses (76%) came from female collegiate students, while the remainder were from male students (24%) as represented in (Table 4.2).

Table 4.1 Years of age distribution

Years of Age	**Freq.**	**Perc**
18 - 20	11	50%
21 - 24	11	50%
25 and above	0	0%

Table 4.2 Gender Demographics

Total: 22			
Gender	**Freq.**	**Perc.**	**Difference**
Male	6	27.2%	-10
Female	16	72.7%	+10

The distribution in driving years ranged from less than or equal to one year to 6 years of driving for the current study and represented in Table 4.3. The average driving age amongst the sample was 4 years. Given that information we were able to progress into measuring the likeliness of avoidance based upon the entire sample's response. This information can be found within Table 4.4.

Table 4.3 Years of driving distribution

Years of Driving	**Freq.**	**Perc.**
≤ 1 yr.	4	18.1%

2 – 4 yrs.	11	50%
5 - 7 yrs.	7	31.8%
≥ 8 yrs	0	0%

Table 4.4 Percent avoidance amongst the sample

Item	**Avoidance responses and percentages**			
	Avoidance rarely or none of the time	**Not as likely to avoid**	**Likely to avoid**	**Avoid most of the time**
I put off a brief trip or errand that required driving the car	7 (31%)	8 (36%)	6 (27%)	1 (4%)
I chose to walk or ride a bicycle someplace to avoid driving in the car	9 (40%)	5 (22%)	1 (4%)	7 (31%)
I avoided driving a car if I could	11 (50%)	7 (31%)	3 (13%)	1 (4%)
I avoided driving on	9 (40%)	10 (45%)	2 (9%)	1 (4%)

residential streets				
I avoided driving on busy city streets	3 (13%)	10 (45%)	8 (36%)	1 (4%)
I avoided driving on the highway	8 (36%)	11 (50%)	1 (4%)	2 (9%)
I avoided driving through busy intersections	5 (22%)	7 (31%)	8 (36%)	2 (9%)
I travelled a longer distance to avoid driving through heavy traffic or busy streets	4 (18%)	4 (18%)	9 (40%)	5 (22%)
I rescheduled making a drive in the car to avoid traffic	5 (22%)	5 (22%)	6 (27%)	6 (27%)

I avoided driving the car because the weather was bad (e.g. fog, rain, or ice)	2 (9%)	2 (9%)	12 (54%)	8 (36%)
I avoided driving the car after dark	4 (18%)	10 (45%)	6 (27%)	2 (9%)
I avoided riding in a car if I knew the traffic was heavy	1 (4%)	8 (36%)	8 (36%)	5 (22%)
I rescheduled making a drive in the car to avoid bad weather (e.g., fog, rain, or ice)	1 (4%)	3 (13%)	12 (54%)	6 (27%)
I put off a brief trip or errand that required riding in a car	8 (36%)	11 (50%)	2 (9%)	1 (4%)

I chose to ride a bus someplace to avoid driving in the car	14 (63%)	3 (13%)	2 (9%)	3 (13%)
I avoided activities that required using a car	10 (45%)	11 (50%)	0	1 (4%)

Overall, the results show the likeliness of them avoiding driving on residential streets, highways, or choosing an alternative route of transportation was not likely. In conditions of heavy traffic, the sample reported avoiding busy roads. In the case of busy highways and intersections, respondents were seen to avoid driving in these locations or taking a longer route. The likeliness of putting off a trip to avoid driving amongst the sample displayed a low likeliness. The sample reported that they would avoid driving in the car due to adverse weather (e.g., fog, rain, or ice) but would drive during night conditions. It was observed the participants would reschedule trips to avoid being in adverse weather.

In addition to descriptive analysis, a thematic analysis was conducted to evaluate participant responses to the following weather condition assessing driver behavior: "What weather conditions make you the most nervous as a driver?" and "What do you do to be safe when driving in those weather conditions?". For the question probing responses for what weather conditions make the participants the most nervous, majority of the sample (19 responses; 86%) noted that rainy conditions make them the most nervous. The remaining percentage of the sample (3 responses, 14%) noted that snowy conditions make them the most nervous. Concerning behaviors following the adverse weather condition, most of the sample indicated that they "drive slower" to ensure their safety to prevent a collision.

DISCUSSION

5.2 Discussion of Research Questions

The current study collected information about GSUSPH collegiate driver behavior through surveys that focused on only the assessment of driver behavior and not driver risk. The goal of the investigation was to examine the feasibility of a pilot survey administered online to college students while assessing their driving behaviors during adverse weather conditions. To ensure that the study stayed on track of evaluating collegiate student driving behaviors, we were guided by the following research questions: (1) What are college students' opinions of driving during adverse weather conditions? (2) What is the likelihood that collegiate drivers implement defensive driving techniques to prevent motor vehicle collisions? Concerning the DRAS tool's responses, participants reported a relatively high level of avoidance of driving during adverse weather conditions. Respondents were seen within the majority to be "likely to avoid" adverse weather conditions such as rain, snow, fog, ice, etc. However, in the nighttime, most collegiate students were seen as "not as likely" to avoid driving. This demonstrates that students did not avoid driving during dark conditions.

Findings within the modified survey revealed the greatest amount of concern about rainy conditions presented the most hazard for collegiate students' collisions. This conclusion was made through the thematic analysis of student responses to the following question "what weather conditions make you the most nervous as a driver". Each of the 22 respondents that provided consent answered the following question with 19 of those responses stating rainy conditions and the other 3 stating snowy conditions. Per conclusions made within prior research (Clapp et. al 2011), driving scenarios that appear to present the most risk of collision to motor vehicle drivers increase anxiety and avoidant behaviors. Anxiety within the context of the study is demonstrated as nervous and avoidant behavior. This led to the conclusion that rainy conditions are seen to present the most risk for collegiate students. Per standing research, rain conditions are associated with more severe crashes, thus supporting the position of avoidance GSUSPH students have (Naik et al., 2016). When prompted to respond to behaviors exuded to prevent a collision, the majority of participants noted that driving slowly is how they would avoid injury. The remainder of the sample suggested that not driving would be the best way to avoid a collision. This implies that defensive driving techniques implemented amongst collegiate students consist of, but not limited to, driving slow or not driving at all.

5.3 Study Strengths and Limitations

The current investigation followed a strict inclusion criterion that governed responses allowed for analysis. There was limited to the number of participants responses due to reach of the recruitment in addition to the rigor of the inclusion criteria impacting the depth of the study. Similar to researcher Stewart's findings, the rigorous screening process did not allow for the current study to screen for prior experience with the nature of motor vehicle collisions, which stands for further evaluation in assessing avoidance behaviors in future investigations (Stewart et al. 2004). The responses collected provide insight into the minds of college students. However, generalizability is limited due to the specified nature of the assessment.

The response rate amongst the general body of BSPH students was also undetermined because of the investigations team limited knowledge of the reach of the BSPH website and the enrollment of course sampled. Per the recruitment method, the behavioral survey was made available for access through the following methods: posting on the BSPH website for access, posting through the SONA system for one summer course providing extra credit which had an enrollment of 50 students, and through distribution to BSPH students enrolled in one summer course available. The clarity as to how many students the survey reached is a limitation due to the investigation team not being able to assess the its recruitment strategies reach.

For the current study, we were assessing reported driving behaviors and perceptions amongst collegiate students of adverse weather conditions. A limitation amongst the current study's surveying is that it only assesses driving behaviors as opposed to the DRAS survey assessing not only driving avoidance behaviors but also riding and general avoidance. Within the survey, the term "riding" which is language that probes respondents to answer not only as a driver but also as a passenger which limits the assumption of the investigation only assessing driving behaviors. The research was based on inquiry of college students' opinions of driving during adverse weather conditions and also the likelihood that collegiate drivers implement tactics or strategies to prevent motor vehicle collisions.

Limitations of the open-ended method is the generalizability and validity of the questions seeing as though they were recently developed by the investigation team and have not stood evaluation. There was also the possibility of misinterpretation of language example being the word "nervous" and "safe" due to each individual having their own personal definition of the idea. It is the belief of the investigation team that respondents answered the open-ended question "What weather condition makes them the most nervous as a driver?" as to which weather condition presents the most risk to them. With regard to the question "What do you do to be safe when driving in those weather conditions" it is the belief of the author that respondents presumed safe implied avoiding motor vehicle collision. While it is desirable to use survey instruments developed in published sources it is also important to consider the need to develop modified questions that specifically answer the guiding research questions.

In terms of the study's hypothesis, the results of the investigation are concurrent with early predictions that were made. The research also demonstrated similar avoidance behaviors in light of adverse weather conditions to the previous study utilizing the DRAS tool (Stewart et al. 2004). Due to our non-clinical sample, as seen in prior investigations, it is unsure if distress attributed to severe injuries as a result of a collision was taken into account (Stewart et al. 2004). Similar psychometric properties utilized within Stewart's DRAS tool were used along with the recommendations of modified surveying that were made by Taylor to ensure the assessment of avoidance behaviors (Stewart et al. 2004; Taylor et al. 2018). The current study sought to better understand collegiate student driving behaviors during adverse weather conditions. It was able to conclude which weather conditions present the most hazard and the likeness of avoidance followed by the driving behavior implemented in said weather conditions.

5.4 Implications of Findings

The pilot survey of driving behaviors associated with adverse weather amongst collegiate students demonstrated the ability to survey driving behaviors. The modified DRAS survey utilized within the investigation does not provide an analysis to reach a definitive conclusion of collegiate student behaviors in adverse weather conditions. Avoidance behaviors within the assessment does not provide insight into the demise of motor vehicle crash rates. However, driving behaviors were able to be observed amongst the sample in the avoidance of adverse weather conditions.

There are gaps in knowledge of understanding the regional difference between northern and southern weather conditions. Georgia State University has shown to be a school with a community of students whose origin is nationwide. There is not a lot of published research in the area exploring regional weather impact differences however there is acknowledgement of the difference in weather conditions that people may encounter. The results however demonstrated that students within the sample are likely to avoid adverse weather conditions. Amongst all understood adverse weather conditions, rainy weather is expected to present the most risk to collegiate drivers and thus mandate some form of defensive driving technique to avoid a collision which goes to support conclusions made in prior investigations (Naik et al., 2016). Types of defensive driving demonstrated in the current study, along with Chen's research, motor vehicle drivers reduce speed to avoid collisions in adverse weather conditions (Chen et al., 2004). Based on the subscales, additional assumptions made following the data analysis were that students are not as likely to avoid driving in traffic or ride in a car. However, students are seen as possible to avoid driving in adverse weather conditions.

CONCLUSION

For future investigations into the matter of investigation of college student driving behaviors during adverse weather conditions, recommendations suggested for future assessments are as follows: larger sample size, expanded inclusion criteria, and modified surveying. Having a larger sample size will not only improve the strength of the data, but it will also enhance the generalizability of the study for future investigators seeking to implement similar strategies within their own communities. Expanding the inclusion criteria will allow for more responses provided by participants to be recorded for analysis to enhance the depth of the information supplied (Stewart et al., 2004). To ensure the safety of early adult drivers, there ought to be more of an emphasis on driving training amongst early adults in adverse weather conditions.

Currently, defensive driving is a tool utilized by drivers in effort to educate them about road conditions and has shown short-term improve in driver's ability to search, identify, predict, decide and execute defensive driving skills. However, its long-term effectiveness is still undetermined and suggests conducting careful research into its effectiveness of ensuring behavior change on the road.

The importance of the data collected within the investigation goes to demonstrate avoidance and driving behaviors exuded by early adults. This investigation demonstrates the need for further analysis into the driving behaviors of early adults as we, as the public health community, seek to influence the amount of injuries and fatalities amongst this group of drivers. Avoidance behaviors are demonstrated within early adult drivers during adverse weather conditions however cognition leading to those behaviors is still a grey area within research that justifies further investigation. With the conclusion of the investigation, it is the hope of the author that the current pilot study examining driving behavior amongst early adults is further pursued thus reducing the burden motor vehicle collisions has on mortality of early adult drivers.

REFERENCES

Barjenbruch, K., Werner, C. M., Graham, R., Oppermann, C., Blackwelder, G., Williams, J., Merrill, G., Jensen, S., Connoly, J. (2016) Drivers' Awareness of and Response to Two Significant Winter Storms Impacting a Metropolitan Area in the Intermountain West: Implications for Improving Traffic Flow in Inclement Weather. Weather, Climate & Society, 8(4), 475-491. https://doi-org.proxygsu-gsu1.galileo.usg.edu/10.1175/WCAS-D-16-0017.1

Black, A. W., & Mote, T. L. (2015). Effects of winter precipitation on automobile collisions, injuries, and fatalities in the United States. Journal of Transport Geography, 48, 165–175. https://doi.org/10.1016/j.jtrangeo.2015.09.007

Centers for Disease Control and Prevention (2020) Motor Vehicle Injury. Source: https://www.cdc.gov/publichealthgateway/didyouknow/topic/vehicle.html

Changon, S.A. Changnong, D. (2006). A spatial and temporal analysis of damaging snowstorms in the United States. Nat. Hazards, 37, pp. 373-389

Changon, S.A., Changon, D., Karl, T.R.. Temporal and spatial characteristics of snowstorms in the contiguous United States. J. Appl. Meteorol. Climatol., 45 (2006)

Chen, S. R., & Cai, C. S. (2004). Accident assessment of vehicles on long-span bridges in windy environments. Journal of Wind Engineering & Industrial Aerodynamics, 92(12), 991–1024. https://doi-org.proxygsu-gsu1.galileo.usg.edu/10.1016/j.jweia.2004.06.002

Chen, S. R., Cai, C. S., & Wolshon, B. (2009). From Normal Operation to Evacuation: Single-Vehicle Safety under Adverse Weather, Topographic, and Operational Conditions.

Natural Hazards Review, 10(2), 68–76. https://doi-org.proxygsu-gsu1.galileo.usg.edu/10.1061/(ASCE)1527-6988(2009)10:2(68)

Cheng, W., Gill, GS., Sakrani, T., Dasu, M., Zhou, J. (2017) Predicting motorcycle crash injury severity using weather data and alternative Bayesian multivariate crash frequency models. Source: https://www.ncbi.nlm.nih.gov/pubmed/28888158

Clapp, J. D., Olsen, S. A., Danoff-Burg, S., Hagewood, J. H., Hickling, E. J., Hwang, V. S., & Beck, J. G. (2011). Factors contributing to anxious driving behavior: The role of stress history and accident severity. Journal of Anxiety Disorders, 25(4), 592–598. https://doi-org.proxygsu-gsu1.galileo.usg.edu/10.1016/j.janxdis.2

Inclement weather in Canada. Journal of Transport Geography, 28, 192–203. https://doi.org/10.1016/j.jtrangeo.2012.08.014

Liu, A, Soneja, S., Jiang, C., Huang, C., Kerns, T., Beck, K., Mitchell, C., Sapkota, A. (2017) Frequency of extreme weather events and increased risk of motor vehicle collision in Maryland. Source: http://eds.a.ebscohost.com/eds/detail/detail?vid=12&sid=dc9f587b-78a7-490d-a480-4098b9b75098%40sdc-v-sessmgr03&bdata=JkF1dGhUeXBlPWlwLHNoaWImc2l0ZT1lZHMtbGl2ZSZzY29wZT1zaXRl#AN=S0048969716326791&db=edselp

Mayhew, D., Simpson, H., 2002. The safety value of driver education and training. Injury Prevention: Journal of the International Society for Child and Adolescent Injury Prevention 8 (Suppl. 2), ii3–ii7

Millard, C. (2013) The effectiveness of an Emergency and Defensive Driving Techniques Course Component: Analyzing Student Response to Searching, Identifying, Predicting, Deciding and Executing Skills. Source: https://encompass.eku.edu/cgi/viewcontent.cgi?article=1113&context=etd

Mills, B., Andrey, J., Doberstein, B., Doherty, S., Yessis, J. (2019) Changing patterns of motor vehicle collision risk during winter storms: A new look at a pervasive problem. Source: https://www.ncbi.nlm.nih.gov/pubmed/30897524

Naik, B., Tung, LW, Zhao, S., Khattak, AJ. (2016) Weather impacts on single-vehicle truck crash injury severity. Source: https://www.ncbi.nlm.nih.gov/pubmed/27620935

NHTSA, 2008. Traffic Safety Facts, 2007. U.S. Department of Transportation, National Center for Statistical Analysis, Washington, D.C

NHTSA, (2009). Traffic Safety Facts, 2008. U.S. Department of Transportation, National Center for Statistical Analysis, Washington, D.C

Rhodes, N., Brown, D., Edison, A., (2005). Approaches to understanding young driver risk taking. Journal of Safety Research 36, 497–499

Stewart, A. E., & St. Peter, C. C. (2004). Driving and riding avoidance following motor vehicle crashes in a non-clinical sample: Psychometric properties of a new measure. Behavior Research and Therapy, 42, 859–879. https://doi.org/10.1016/ S0005-7967(03)00203-1

Taylor, J. E., Sullman, M. J. M., & Stephens, A. N. (2018). Measuring anxiety-related avoidance with the Driving and Riding Avoidance Scale (DRAS). European Journal of Psychological Assessment. https://doi.org/10.1027/1015-5759/a000502 (Supplemental)

U.S. Department of Transportation Federal Highway Administration (2020) How do weather event impact roads? Sources:https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm#:~:text=Weather%20Impacts%20on%20Safety,1%2C235%2C000%20%2D%20are%20weather%2Drelated.

Zhang, H., Li, S., Wu, C., Zhang, Q., & Wang, Y. (2020). Predicting Crash Frequency for Urban Expressway considering Collision Types Using Real-Time Traffic Data. Journal of Advanced Transportation, 1.

Zhao, S., Wang, K., Liu, C., & Jackson, E. (2019). Investigating the effects of monthly weather variations on Connecticut freeway crashes from 2011 to 2015. Journal of Safety Research, 71, 153–162. https://doi-org.proxygsu-gsu1.galileo.usg.edu/10.1016/j.jsr.2019.09.011

APPENDICES

Georgia State University
Informed Consent

Title: *Pilot survey of driving behaviors associated with adverse weather amongst collegiate studentss.*
Student Principal Investigator: *Myles Bostic, MPH Candidate*
Principal Investigator: *Emily Graybill, Ph.D, NCSP*

Procedures

You are being asked to take part in a research study. To take part in this study, you must be at least 18 years of age. If you decide to take part, your role in the study will last 20 minutes over the course of 1 survey. You will be asked to do the following:

- Provide personal information such as age, gender, and your driving licensing history.
- Provide information classifying likeliness of a driving behavior
- Provide a response on their opinion of driving risks

Participants will be directed from SONA to an external website (i.e., Qualtrics) where they will complete a questionnaire on a computer and from a location of their choosing.

Compensation

This study will require no more than 20 minutes. If you decide to take part through the SONA system, you are eligible to receive 0.5 research credits for your participation. If you take part in the study outside of the SONA system, you will not be compensated.

Voluntary Participation and Withdrawal

You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. You may refuse to take part in the study or stop at any time. This will not cause you to lose any benefits to which you are otherwise entitled.

Contact Information

Contact Myles Bostic at (706) 664-1551 or by email at mbostic4@student.gsu.edu

- If you have questions about the study or your part in it
- If you have questions, concerns, or complaints about the study

The IRB at Georgia State University reviews all research that involves human participants. You can contact the IRB if you would like to speak to someone who is not involved directly with the study. You can contact the IRB for questions, concerns, problems, information, input, or questions about your rights as a research participant. Contact the IRB at 404-413-3500 or irb@gsu.edu.

Consent

If you are willing to volunteer for this research, please confirm your consent to participate via email to student investigator Myles Bostic (mbostic4@student.gsu.edu) and he will send you the Qualtrics survey link.

RECRUITMENT EMAIL

Greetings,

My name is Myles Bostic and I am a research assistant working with Dr. Emily Graybill at Georgia State University. We are conducting a research study to measure road safety interventions used by college students to prevent weather-related accidents. I am emailing to ask if you would like to take about 20 minutes to complete a survey for this research project. Participation is completely voluntary, and your answers will be anonymous.

If you are interested, please click on the link for the survey and additional information:

If you have any questions, please do not hesitate to contact me at mbostic4@student.gsu.edu.

Thank you for your time.

Myles Bostic
Masters Candidate
Georgia State University

Survey Questions

3 Parts: Fill in the blank, LIKERT Scale, Short Response

- Today's Date
- Age
- Gender
- Institution Name
- Are you a licensed driver?
- How long have you been driving?

DRAS (Driving and Riding Avoidance Scale) (Stewart & St. Peter, 2004)

A scale from 0 (avoid rarely or none of the time) to 3 (avoid most overall of the time). The total score constitutes the sum of all 20 item ratings (range 0–60), with higher scores representing greater avoidance. There are subscale scores for general avoidance (items1–3, 12, 18–20), avoidance of traffic and busy roads (items 5–10,15), avoidance of weather or darkness (items 11–14, 17), and riding avoidance (items 4, 13–16).

1. I put off a brief trip or errand that required driving the car
2. I chose to walk or ride a bicycle someplace to avoid driving in the car
3. I avoided driving a car if I could
4. I avoided riding in a car if I could
5. I avoided driving on residential streets
6. I avoided driving on busy city streets
7. I avoided driving on the motorway
8. I avoided driving through busy intersections
9. I travelled a longer distance to avoid driving through heavy traffic or busy streets
10. I rescheduled making a drive in the car to avoid traffic
11. I avoided driving the car because the weather was bad (e.g., fog, rain, or ice)
12. I avoided driving the car after dark
13. I avoided riding in a car because the weather was bad (e.g., fog, rain, or ice)
14. I avoided riding in a car after dark
15. I avoided riding in a car if I knew the traffic was heavy
16. I avoided riding in a car on the motorway
17. I rescheduled making a drive in the car to avoid bad weather (e.g., fog, rain, or ice)
18. I put off a brief trip or errand that required riding in a car
19. I chose to ride a bus someplace to avoid driving in the car
20. I avoided activities that required using a car

What weather conditions make you the most nervous as a driver?

What do you do to do be safe when driving in those weather conditions?