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THE RELATIONSHIPS AMONG MENTAL HEALTH, MEDICINAL DRUGS, DRINKING AND DRIVING AND ROAD RAGE AND MOTOR VEHICLE COLLISIONS ON A REPRESENTATIVE SAMPLE OF ONTARIO ADULTS

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ABSTRACT

Studies have demonstrated the relationships between motor vehicle collisions and anxiety and/or mood disorders, antidepressant and anxiolytic medication use, drinking and driving, and road rage. It is unclear if symptoms of anxiety and/or mood disorders are directly associated with motor vehicle collisions or if other factors mediate the effect. This thesis examines the effects of psychiatric distress, medication use, drinking and driving, and road rage on motor vehicle collisions. Cross-sectional data from the Centre for Addiction and Mental Health Monitor were used in a hierarchical logistic regression analysis. Demographic predictors, psychiatric distress, and mediating variables were entered in blocks into five models. Findings indicated the relationship between psychiatric distress and motor vehicle collisions was not mediated by antidepressant and/or anxiolytics; however, it was mediated by drinking driving and road rage. The cross-sectional data make the causal nature of these relationships unclear and further research is needed.

Keywords: Motor Vehicle Collisions, Anxiety Disorders, Mood Disorders, Drinking and Driving, Road Rage, Antidepressants, Anxiolytics, Human Factors, Medicinal Drugs, and Mental Illness

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LIST OF ABBREVIATIONS

APA	American Psychiatric Association
BAC	Blood Alcohol Concentration
BZDs	Benzodiazepines
CAMH	Centre for Addiction and Mental Health
CDD	Centre for Disease Control and Prevention
CIDI	Composite International Diagnostic Interview
CCMTA	Canadian Council of Motor Transport Administrators
CNS	Central Nervous System
DSM	Diagnostic and Statistical Manual of Mental Disorders
DUI	Driving under the influence of alcohol
GAD	Generalized Anxiety Disorder
GHQ-12	General Health Questionnaire-12
MAOIs	Monoamine Inhibitors
MI	Mental Illness
MIs	Mental Illnesses
MVCs	Motor Vehicle Collisions
OCD	Obsessive Compulsive Disorder
PTSD	Postraumatic Stress Disorder
SCID	Structured Clinical Interview for the DSM
SDLP	Standard Deviation of Lateral Position
SNRIs	Selective Norepinephrine Reuptake Inhibitors
SSRIs	Selective Serotonin Reuptake Inhibitors
TCAs	Tricyclic Antidepressants

Chapter 1- Study Objectives

1.1 Introduction

The public health consequences and economic impact of MVCs are very high, given that studies suggest most MVCs are avoidable (Vingilis & Wilk, 2008; WHO, 2004a). The road safety issue has become prominent enough to have World Health Day 2004 targeted towards road safety (Health Canada & Transport Canada, 2004). In Canada, the most recent data are from the year 2005, with a reported 660,183 MVCs (Transport Canada, 2008). Within Canada, Ontario had the highest frequency of MVCs with approximately 230,000 crashes in 2005 (Transport Canada, 2008). The economic burden created by MVCs occurs through direct and indirect costs to society (Vodden, Smith, Eaton & Mayhew, 2007). Direct costs are immediate expenses that result from MVCs, such as property damage, emergency response, and insurance administration (Vodden et al., 2007). Indirect costs are human consequences, for instance disability payments, pain, and suffering (Vodden et al., 2007). Across the nation, MVCs cost Canada between $25 billion to $63 billion Canadian dollars per year (Health and Transport Canada, 2004; Vodden et al., 2007). In Ontario, MVCs have been estimated to have a price tag as high as $17.9 billion Canadian dollars per year; the data have indicated the MVC problem has the most substantial economic impact within Ontario when compared to other provinces (Vodden et al., 2007). Given the current impact MVCs have on our society and the potential for a greater negative impact in the future, it is necessary to determine the causes and correlates of MVCs in an attempt to modify current trends and prevent MVCs.

Researchers have repeatedly indicated that the causes of MVCs are multifactorial (Elvik & Vaa, 2004; Vaa, 2003; Petridou & Moustaki, 2000). Previous studies have focused on investigating the relationships between MVCs and human risk factors such as anxiety and/or mood disorders, psychotropic medication for anxiety or depression, drinking and driving, and road rage. That is, most studies have examined the direct effects of human factors on MVCs. However, "third variable effects" are possible (McKinnon, Krull & Lockwood, 2000). Given that anxiety and mood disorders are correlated with psychotropic medication use, it is not clear whether it is the disorder per

se that is associated with MVCs or the medication use that is associated with MVCs. Similarly, anxiety and mood disorders are correlated with drinking and driving and with road rage. It is not known whether the disorders are directly associated with MVCs or whether drinking and driving or road rage mediates the effect.

1.2. Purpose and Objectives

The purpose of this study is to examine the direct and indirect effects of the human factors psychiatric distress (a proxy for anxiety and/or mood disorders), antidepressant and/or anxiolytic medication use, drinking and driving, and road rage on MVCs. Specifically, the objectives of this research project are the following:

- To estimate the direction and strength of association between psychiatric distress and MVCs.
- To estimate the relationship between individual predictors and MVCs, after controlling for a group of predictor variables selected based on the literature.
- To determine if antidepressant and/or anxiolytic medication use mediates an association between psychiatric distress and MVCs.
- To determine if drinking and driving mediates an association between psychiatric distress and MVCs.
- To determine if road rage mediates an association between psychiatric distress and MVCs.

Chapter 2- Symptoms of Anxiety and/or Mood Disorders, Anxiolytic and Antidepressant Psychotropic Medications, Drinking and Driving, and Road Rage in Relation to Motor Vehicle Collisions: Literature Review

2.1 A Historical Perspective on Motor Vehicle Collisions (MVCs): The Scope of the Problem from Past to Present

Canadians rely heavily on motor vehicles for transportation; we are among the most mobile people in the world (Canadian Council of Motor Transport Administrators (CCMTA), 2006a). Over 19.4 million vehicles use the nation's roads and nearly 22 million drivers are operating vehicles on greater than 1,420,000 kilometres of road in Canada (Transport Canada, 2008). Regular utilization of motor vehicle transportation can have negative consequences for road users as they may become involved in motor vehicle collisions (MVCs) (CCMTA, 2006a). The number of drivers and vehicles in Canada has continued to rise in recent years, however, overall the number of MVCs that result in property damage, personal injury, or fatality have exhibited a decline over the past 20 years (Ramage-Morin, 2008; Transport Canada, 2006; Transport Canada, 2001; Vodden et al., 2007).

In 1988, there were an estimated 797,700 MVCs in Canada (Transport Canada, 2001). Annually, the frequency of MVCs continued to increase, peaking in 1990 with 805,000 MVCs (Transport Canada, 2001). Through the 1990s, there was a steady decline in MVC involvement due to numerous improvements in road safety, such as: technological advances to vehicles, legislation and enforcement of speed limits, and declines in drinking and driving (Ramage-Morin, 2008). From 2000 to 2005, the frequency of MVCs has demonstrated annual variations; however overall from the 2000 to 2005, there was a 6 % increase in the frequency of MVCs (Transport Canada, 2008). The most recent data are from the year 2005, with a reported 660,183 MVCs (Transport Canada, 2008). Within Canada, Ontario had the highest frequency of MVCs with approximately 230,000 crashes in 2005 (Transport Canada, 2008). Ontario is Canada's most populous province, the home to approximately 7.1 million of Canada's 19.4 million vehicles (Transport Canada, 2008). Understanding the nature of the MVC problem in Ontario would be a crucial step towards reducing the number of MVCs in Canada.

The most severe health impacts of MVCs are injuries and deaths that result from crashes. Internationally, an estimated 1.2 million people are killed each year and up to 50 million are injured (WHO, 2004a). From 2002 to 2006 there were an average of 147,998 MVCs that resulted in at least one injury and 2,534 MVCs that resulted in at least one death in Canada (Transport Canada, 2007). In Ontario, during 2005 there were 766 fatalities and 71,850 injuries as a result of MVCs (Transport Canada, 2008). If current trends continue within Canada and around the world, the World Health Organization (WHO) has predicted road traffic injuries will be the third leading cause of burden of disease by 2020 (WHO, 2004a).

The economic burden created by MVCs occurs through direct and indirect costs to society (Vodden et al., 2007). Direct costs are immediate expenses that result from MVCs, such as property damage, emergency response, and insurance administration (Vodden et al., 2007). Indirect costs are human consequences, for instance disability payments, pain, and suffering (Vodden et al., 2007). Global estimates have indicated the annual estimated cost of MVCs to be $US 518 billion per year (WHO, 2004a). Across the nation, MVCs cost Canada between $25 billion to $ 63 billion Canadian dollars per year (Health and Transport Canada, 2004; Vodden et al., 2007). In Ontario, MVCs have been estimated to have a price tag as high as $17.9 billion Canadian dollars per year (Vodden et al., 2007). Reducing the economic and health burden created by MVCs in Ontario, where MVCs have the largest negative economic and health consequences in the country, could be a crucial step to improving the situation across Canada.

The public health consequences and economic impact of MVCs are very alarming, given that studies suggest most MVCs are avoidable (Vingilis & Wilk, 2008; WHO, 2004a). The World Report on Traffic Injury Prevention stated injuries related to MVCs are preventable (WHO, 2004a). The road safety issue has become prominent enough to have World Health Day 2004 targeted towards road safety (Health Canada & Transport Canada, 2004). The motto for that year was "Road safety is no Accident" (Health & Transport Canada, 2004; WHO, 2003). From a Canadian perspective, the nation has taken a strong initiative towards improving the safety of the roads, the aim being to make Canada's road the safest in the world. In spite of this initiative, studies still indicate that MVCs frequency has continued to rise in recent years (Transport Canada,

2008). MVCs remain an important issue in Canada as they persist as one of the leading contributors of years of life lost among Canadians (CCMTAa, 2006).

Given the current impact MVCs have on our society and the potential for a greater negative impact in the future, it is necessary to determine the causes and correlates of MVCs in an attempt to modify current trends and prevent MVCs.

2.2 Overview

The causes and correlates of MVCs are multifactorial (Vaa, 2003) and can be divided into two broad categories: environmental factors and person factors. Environmental factors are factors related to the vehicle or the roadway. For example, MVCs have been associated with poor weather conditions and darkness (Dewar & Olson, 2002). Person factors include socio-demographic, behavioural, psychological, and medical factors. For example, young drivers and male drivers of all ages, especially young male drivers, have been found to have a higher risk of MVCs (Transport Canada, 2007; Lemieux, Fernandes, & Rao, 2008; Dewar & Olson, 2002). In addition, older drivers (over 65 years of age) are often found to be at a higher risk of MVCs (Petridou, & Moustaki, 2000; Transport Canada, 2007; Lemieux et al., 2008; Dewar & Olson, 2002; Elvik & Vaa, 2004).

High-risk driving behaviours such as drinking and driving often predict MVCs (Fergusson, Swain- Campbell, & Horwood, 2003; Vassallo et al., 2008). Alcohol use is a frequently studied behavioural factor that has been reported as a cause and correlate of MVCs (Compton et al., 2002; Ogden & Moskowitz, 2004; Vaa, 2003; Vassallo et al., 2008). Research has indicated that as blood alcohol concentration (BAC) increases, MVC risk rises exponentially (Compton et al., 2002). Even at low levels of consumption, studies have indicated that alcohol impairs driving ability (Ogden & Moskowitz, 2004).

Other behavioural factors that may be related to MVCs, as well, include anxiolytic and/or antidepressant medication use, road rage, and speeding (Ray, Fought, & Decker, 1992; Neutel, 1995; Neutel, 1998; Hours et al., 2008; Leufkens, Vermeeren, Smink, Ruitenbek, & Ramaekers, 2007; Verster, Volkerts, & Verbaten, 2002; King & Parker, 2008; Mann et al., 2007; Wells-Parker et al., 2002). For example, Hours et al.

(2008) reported that consuming antidepressants in the week prior to an MVC was associated with an increased risk of being responsible for the crash. Few investigations have been conducted to examine the relationship between road rage and MVCs. However, research has indicated road rage is associated with a greater risk of MVCs (Mann et al., 2007).

Psychological and medical factors, which include mental illnesses (MIs) have also demonstrated an association to MVCs (Blaszczynski et al.,1998; Hopewell, 2002; Tsuang, Boor, & Fleming, 1985; Vaa, 2003). Generally, individuals with symptoms of anxiety and/ or mood disorders have impairments in cognitive and psychomotor functioning (Hopewell, 2002). This impairment may negatively affect the driving ability in individuals with anxiety and/or mood disorders. As a result, it is possible that individuals with symptoms of anxiety and/or mood disorders are at a greater risk of collisions.

Studies have indicated anxiolytic and/or antidepressant medication use may produce impairment that negatively affects driving ability (Brunnauer, Laux, Geiger, Soyka, & Moller, 2006; Sagberg, 2006). It is also well established that drinking and driving impairs the driving ability (Compton et al., 2002). It can also be suggested as well that road rage affects the driving ability of both victims and perpetrators (Mann et al., 2007; Wells-Parker et al., 2002). Moreover, it is important to recognize that these risk factors may cluster together. As Jessor (1993) posits, risk factors tend to co-vary and tend to be linked to "longer term life outcomes", such as MVCs.

This review will summarize the studies examining the relationships of the following risk factors to MVCs: symptoms of anxiety or mood disorders, psychotropic medication use, drinking and driving, and road rage.

2.3 Methods of Acquiring and Synthesizing the Literature

2.3. 1 Literature Review Methodology

Relevant articles for this literature review were retrieved from Google Scholar, PsycInfo, and PUBMED. This review began with the retrieval of articles examining the relationship between MVCs and each one of the following explanatory variables: mental

illness (MI), depression, anxiety, road rage, road rage victimization, or road rage perpetration, drinking and driving, alcohol, psychotropic medications, antidepressants, anxiolytics, and psychiatric distress. Articles examining the relationships between any of the previously stated covariates were also included. Articles focusing on the multiple relationships among predictors and MVCs were identified and reviewed, such as "depression and antidepressants and MVCs".

Database searches were conducted using the following terms: antidepressants, anxiolytics, psychotropic drugs, psychotropic medications, road rage, road rage victimization, drinking and driving, motor vehicle collisions, car accidents, traffic collisions, driving ability, depression, anxiety, road traffic crash, road traffic accident, and road safety, benzodiazepines (BZDs), MAOI (Monoamine Oxidase Inhibitors), SSRIs (Selective Serotonin Reuptake Inhibitors), TCAs (Tricyclic Antidepressants), Buspirone, self medication, angry driving, substance abuse, impaired driving, and driving under the influence. Often two or three search terms were merged into phrases such as "depression, impaired driving and motor vehicle collisions".

Relevant articles were identified by reviewing abstracts and the full-text articles to determine the relevance to the review. Additional sources were identified by examining the references of the selected articles. Publications generated from the Centre for Addiction and Mental Health (CAMH) Monitor survey data supplemented the selected articles included in this review. Publications from the CAMH Monitor data that looked at the relationships between the previously stated predictors and MVCs were reviewed. This review was limited to English language sources only.

For the purposes of this review, the articles were examined for: location; study type; study design; sample characteristics; risk factors evaluated; measures; outcome evaluated (e.g. MVCs, driving test, traffic violations, and standard deviation in lateral position (SDLP)), control for covariates and confounders; mediators; and the presence of complex conceptual relationships among predictor variables.

2.3.2. Road Safety Methodological Approaches

Epidemiological or observational and experimental approaches are two complementary methods that have been used in road safety research to study symptoms of MI, psychotropic medication use, and risk taking behaviour, such as drinking and driving and road rage (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002). The combination of experimental and epidemiological research provides the highest quality information if one wants to understand the causal connection between a behavioural factor and MVCs (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002). Experimental studies determine the nature of the impairment produced by human factors on a performance task. The performance tasks typically are driving tasks using driving simulators, closed driving circuits, regular roads or psychomotor tasks. The ideal experiments are double blind with subjects randomly assigned to the active treatment or control group (Matthews, 2006; Vingilis & Macdonald, 2002). Researchers then record performance differences between the two groups (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002).

The primary limitations to the experimental approach, particularly in laboratory and simulator experiments, are external validity issues (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002). Often, the human factors present and the driving environment in an experiment are not representative of the real world (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002).

Observational or epidemiological designs are used to estimate the strength and direction of association between potentially causal risk factors and outcomes of interest. Descriptive studies examine the incidence and prevalence of both exposures and outcomes across groups defined by personal characteristics, geographic area and over time. Analytic studies then compare the probabilities of an outcome between two or more exposure groups, using first crude (unadjusted) and then adjusted estimates to control for potential confounding variables. For example, the cohort design is an observational design in which MVC rates are compared between a group of individuals who have a behavioural risk factor for MVCs and a group of individuals who do not have the behavioural risk factor (Koepsell & Weiss, 2003). For instance, an investigation may be conducted in which the collision rate for individuals who have a MI is compared to the

collision rate for participants who do not have a MI (Eelkema, Brosseau, Koshnick, & McGee, 1970). Observational studies can act as a guide for paths of experimental research; if a specific behavioural factor is present significantly more often in individuals who are involved in collisions, it provides added justification for making the behavioural factor the subject of experimental research (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002).

Survey research is another epidemiological approach. Generally, surveys rely on a participant's self-reported presence or absence of a behavioural factor and their self-reported MVC involvement. Surveys can be used to determine if an association is present between a behavioural factor and MVCs (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002). Surveys, when properly conducted, may be a preferred source of data for three reasons. First, probability sampling allows one to be confident that the sample is not biased and to estimate how precise the data are likely to be (Flower Jr., 2002). Secondly, standardized measurement that is consistent across all respondents ensures comparable information is gathered from everyone who participated, which allows meaningful statistics to be generated (Flower Jr., 2002). Third, a special purpose survey may be the only case in which information for numerous variables is present for the purposes of a given analysis (Flower Jr., 2002). This case allows for the possibility of examining the relationships among many variables at the same time. For example, one may have to look to a survey for information if one wants to study the relationship among psychiatric distress, antidepressant and/or anxiolytic psychotropic medications, drinking and driving, road rage and MVCs because it is not available from any other source (Flower Jr., 2002).

Survey research is, however, not without limitations. Self- report surveys are subject to limitations that are related to how participants interpret and respond to the questions asked. It is well established that question wording, format, and context can have a strong influence on responses (Schwarz, 1999). In addition, a well-known drawback to survey research is social desirability bias (Krosnick, 1999). Respondents tend to overreport attractive characteristics and behaviours and to underreport characteristics and behaviours that are looked upon negatively (Krosnick, 1999).

Another drawback to survey research is respondents mis-recalling information (Flower Jr., 2002). Minor events are more often forgotten than significant events and recollection of recent events tends to be better than events that occurred in the distant past (Flower Jr., 2002). In particular, self-report surveys have been criticized because individuals tend to have difficulty recalling events that have occurred more than two months prior to responding to a questionnaire (Jenkins, Earl-Richardson, Slingerland, & May, 2002; Mock, Acheampong, Adjei, & Koepsell, 1999). Some researchers have also suggested salient events are less likely to be forgotten (Groves, 1989; Sudman & Bradburn, 1973). Various scholars have suggested injurious MVCs are salient events and, as a result, they are remembered well up to 12 months following a crash (Roberts, Vingilis, Wilk, & Seeley, 2008; Vingilis & Wilk, 2008; Begg, Langley, & Williams, 1999). Furthermore, Begg, Langley and Williams (1999) noted high levels of agreement between self-reported collision involvement and injuries when compared to police and hospital data in a sample of young adults.

Analytic epidemiological studies use a different approach from the previously described descriptive methods. They attempt to establish which behavioural factors are over represented in drivers involved in MVCs (Vingilis & MacDonald, 2002). One type of analytic epidemiological study design is the case-control design. In this design efforts are made to control for potential confounders. For example, drivers involved in MVCs are compared with drivers that have not experienced a MVC, matched for age, sex, and location of crash (Vingilis & Macdonald, 2000). However, in case-control research it is difficult to determine how long individuals have been exposed to a behavioural risk factor before their collisions; for example, how long participants have been using psychotropic medication prior to being involved in MVCs. Culpability analysis is another related approach. This approach typically involves determining the proportion of drivers deemed responsible for a collision that had a behavioural factor present prior to their collision (e.g. blood alcohol concentration (BAC) of > 0). However, case-control, culpability analysis, and cross-sectional methods share the limitation of their inability to determine causation. They can only suggest an association between a behavioural factor and MVCs (Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002).

2.3.3 Data Sources for Road Safety Research

Data for road safety studies come from three major sources: laboratory; clinical or hospital, police; and social survey data (Roberts et al., 2007; Vingilis & Wilk, 2008). The majority of studies on MVCs are based on clinical samples (including emergency room and hospital data) and police data (Vingilis & Wilk, 2008). The laboratory approach is associated with tighter control over nuisance factors and yields objective measures of driving performance from driving simulators. The limitation is the artificiality of the experimental paradigm. Clinical and police data are acquired from administrative databases, which limits the type of risk factors that can be examined to trauma or collision related variables and some demographic factors (Vingilis & Wilk, 2008). Data from administrative sources can be available for large samples but may be biased, for example, in terms of severity of injury in the case of hospitalization data. They also have incomplete or missing information on important confounders. Studies using social survey data offer a unique opportunity as data can be collected for multiple risk factors for MVCs (Flower Jr., 2002; Vingilis & Wilk, 2008). Self-report data from large population based surveys can be generalizable to large populations and have a good representation of confounders but can be limited by cross-sectional design, social desirability of responses, and non-response bias. However, since MVCs are rare events, surveys examining risk factors for MVCs require large sample sizes. The few population survey studies that have been conducted have focused on specific populations, such as participants age 65 and above or teens and young adults (Leveille, 1994; Vassallo et al., 2008; Vingilis & Wilk, 2008). Some survey studies have examined large samples, representative of the population in the geographic vicinity from which participants were recruited (Mann et al., 2007; Vingilis & Wilk, 2008).

Road safety data sources are subject to validity problems as well. Administrative datasets, which include clinical and/or police data, have been criticized for having biased samples, as they over-represent individuals who sustain a serious injury or die as a result of an MVC (Vingilis, & Wilk, 2008). Self-report surveys are often criticized on the presumption that self-report data are subject to poor recall for events, especially if two months or more have passed since the event (Vingilis, & Wilk, 2008). However, the literature has indicated participants remember salient events such as MVCs well (Vingilis

& Wilk, 2008). Yet, over time individuals may have difficulty recalling the details of events as memory often is distorted or attenuated (Vingilis & Wilk, 2008). For example, participants may have difficulty recalling the purpose of medication use but recall they are consuming medications.

In any study of MVCs, it is important to understand the role of demographic predictors. These factors may be associated with MVC risk. They have the potential to confound associations between a behavioural risk factor and MVCs; therefore, a brief discussion of their role in MVCs is necessary.

2.3.4 Demographic Predictors of Motor Vehicle Collisions

Motor vehicle collisions have been attributed to a variety of demographic predictors including age, gender, income, education, marital status, and driving distance. Information concerning demographic predictors is important to consider when conducting human factors research. Demographic predictors may serve as variables that must be controlled for in an effort to determine the true relationship between a human factor variable and MVCs. If not controlled for, a demographic predictor may act as a confounding variable, which can lead to overestimating or underestimating an association. For example, a study of the association between anxiety disorder and MVCs should control for respondents' gender, if respondents' gender emerges as a significant independent predictor of collision involvement. Studies have indicated women are more likely than men to have anxiety disorders (Somers, Goldner, Waraich & Hsu, 2006; Health Canada, 2002); however, men are more often involved in MVC (Transport Canada, 2008). Therefore, if an association is present or absent between anxiety disorders and MVCs, it could be due the confounding effects of gender on the relationship between anxiety disorders and MVCs.

2.3.4.1 Age

Numerous studies have found a relationship between age and negative driving outcomes such as MVCs, motor vehicle injuries, and motor vehicle fatalities (Elvik & Vaa, 2004; Fergusson et al., 2003; Mann et al., 2007; U.S. Department of Transportation, 2008; Noyes, 1985). In particular, higher rates of negative driving outcomes have been found among younger age groups (less than 30 years old) or older age groups (65 and

above) (Elvik & Vaa, 2004; Mann et al. 2007; Noyes, 1985; U.S. Department of Transportation, 2008). Age can also be considered a human risk factor for MVCs, along with the other demographic predictors. While it can be used to target prevention programming, it is not modifiable. In this study, the focus will be on human factors for MVCs that are malleable and behavioural risk factors for MVCs.

2.3.4.2 Gender

Studies have demonstrated a relationship between gender and negative driving outcomes, including MVCs; however, the relationship often varies by the age of participants. Most studies have indicated that males are more likely to be involved in MVCs and are overrepresented in MVC fatalities (Dewar & Olson, 2002; Lemieux et al., 2008; Mann, et al.; Noyes, 1985). The U.S. Department of Transportation (2008) noted that across all age groups, men were more often killed or injured in MVCs. Investigations examining age and gender associations with negative driving outcomes have consistently indicated young males (less 30 years of age) have an elevated risk of negative driving outcomes, including MVCs. In addition, among the elderly (65 years of age and above), the opposite trend emerges as women appear to have an elevated risk of negative driving outcomes, including MVCs (Dewar & Olson, 2002; Elvik & Vaa, 2004). It should also be noted that gender is a human risk factor for MVCs, however, it is not malleable. The focus of the upcoming review of human factors for MVCs will be on malleable behavioural human risk factors.

2.3.4.3 Marital Status

Researchers have indicated that marital status is a risk factor for MVCs (Leveille et al., 1994; Mann et al., 2007; Mann et al., in press; Metzner, 2004; Noyes, 1985). Studies with a measure of marital status included as a predictor have found being single/never married to be related to an elevated risk of MVCs (Mann et al., 2007; Noyes, 1985). In addition, being divorced has also been associated with MVCs (Petridou & Moustaki, 2000).

2.3.4.4 Education

Few studies have examined the relationship between education and negative driving outcomes, such as MVCs. Currently, the literature indicates that in some cases having less than a high school education is a risk factor for MVCs (Metzner, 2004;

Noyes, 1985; Redelmeier & Tibishirani, 1997), while some other studies have indicated having less than high school education was related to a lower risk of MVCs (Mann et al., 2007; Mann et al., in press).

2.3.4.5 Income

A measure of a drivers' income was rarely included in the literature concerning negative driving outcomes, such as MVCs. Wadsworth, Moss, Simpson, and Smith (2005) found no evidence to indicate that income would be a predictor of MVCs. Furthermore, Mann et al. (2007) noted household income did not significantly predict an elevated odds of MVCs.

2.3.4.6 Driving Distance or Exposure

An understanding of the primary exposure, driving distance, is crucial when assessing the relationship between a human factor and MVCs (Vaa, 2003). It is relatively frequent that driving distance or exposure, has not been controlled for when assessing the risk of MVCs in the presence of a behavioural factor (Vaa, 2003). The research has indicated that young and elderly drivers are less exposed drivers than other age groups (Chipman, MacGregor, Smiley, & Lee-Gosselin, 1992). Experts have also found that individuals with MI may drive much less frequently or over shorter distances than other drivers (Cushman, Good, & States, 1990). Studies that do not include a measure of driving distance introduce bias into their findings and possibly bias risk estimates of MVCs, given the presence of a behavioural risk factor. Therefore, it is crucial to control for driving distance when there is a measure of this variable.

2.4. Other Human Factors Involved in Motor Vehicle Collisions: Developing a Conceptual Model

2.4.1 Human Factors as Predictors of Motor Vehicle Collisions

Human factors defines a scientific discipline that examines the interactions between people and devices (Olson & Dewar, 2002). In this case, the device of interest is the motor vehicle (Olson & Dewar, 2002). In an effort to prevent MVCs, examining human factors that are present at the time of MVC may be a valuable approach. Experts in road safety have repeatedly stated that human factors are a major contributor to MVCs (Cremona, 1986; Olson & Dewar, 2002; Elvik & Vaa, 2004; Petridou & Moustaki, 2000). Estimates have indicated that driver related behaviours are a probable contributor in 90-

95% of MVCs (Cremona, 1986; Petridou & Moustaki, 2000; Treat et al., 1979). Treat et al. (1979) conducted a unique investigation, with rigorous methodology, into the role of human factors in crashes. The researchers collected data from MVCs on multiple levels. The levels of data collection included police reports, data from on-the-scene investigation by technicians, and MVCs that were subject to a review by a multidisciplinary team of experts. Data were collected from a large sample of drivers in an American county (n= 118,111). The investigators found in 64 to 71% of crashes human factors were identified as a definite cause; in 90 to 93% of crashes, human factors were indicated as a probable cause. Furthermore, a sub-category in the analysis of human conditions, or states, defined as physical, psychological, experiential features, have a detrimental effect on the ability of a driver to process information and control a vehicle (Treat et al., 1979). The investigators noted alcohol and other drug impairments were the two most frequently observed human conditions, or states, in drivers involved in MVCs; emotional upset was ranked sixth in their collision analysis (Treat et al., 1979).

Human factors in MVCs are interrelated. It is useful to model the relationship of these factors to allow a clearer conceptualization of their contribution to MVCs. Age and gender are demographic factors that can also be considered human factors. However, age and gender are not modifiable human factors, and as noted previously this review will focus on modifiable behavioural human factors. Petridou and Moustaki (2000) devised four categories of human factors in the causation of MVCs. The first group of factors were those that reduced driving capability on a long-term basis, for example aging, disease and disability. Included in the category of disease are MIs. The second category of factors was those that reduce driving capability on a short-term basis, such as acute psychological stress, short-term drug effects, and acute alcohol intoxication. Two additional categories were factors that promote risk-taking behaviour. Factors that promote risk-taking behaviour with a long-term impact were characteristics such as alcoholism and habitual speeding. Factors that promote risk-taking behaviour with a short-term impact were behaviours that included moderate alcohol intake, psychotropic drug use and compulsive acts (Petridou & Moustaki, 2000). For the purposes of this study, the Petridou and Moustaki framework has been extended. A fifth category, added to the framework of human risk factors for MVCs are factors that reduce driving

capability immediately. Road rage would be included in this category and could also be considered a factor that promotes risk taking in the short-term.

2.5. Factors That Reduce Driving Capability on a Long- Term Basis: Psychiatric Distress (a Proxy for Symptoms of Anxiety and Mood Disorders) and MVCs

2.5.1 Definition and Prevalence of Factors to Reduce Driving Capability on a Long-Term Basis: MI; Anxiety and Depression

MIs are defined by alterations in thinking, mood and/or behaviour associated with substantial amounts of distress and impaired functioning (Health Canada, 2002). Health Canada (2002) estimated the one-year prevalence of MI in Canada to be approximately 20%. The two most common types of MIs were anxiety disorders and mood disorders, including major depression (Health Canada, 2002).

Anxiety disorders represent a category of many similar disorders including Obsessive Compulsive Disorder (OCD), Posttraumatic Stress Disorder (PTSD), and Generalized Anxiety Disorder (GAD) (American Psychiatric Association (APA), 2000). Anxiety disorders are characterized by feelings of fear and distress that disrupt normal daily functioning (Health Canada, 2002). Individuals suffering from anxiety disorders experience excessive anxiety, fear, or worry. This causes them to either avoid situations that might lead to anxiety or develop compulsive rituals to reduce their anxiety. Other symptoms of anxiety disorders include restlessness, being easily fatigued, difficulty concentrating, irritability, muscle tension, and disturbed sleep (APA, 2000).

Recently, a comprehensive estimate of the one- year and lifetime prevalence of anxiety disorders worldwide was generated in a systematic meta-analysis (Somers et al., 2006). The authors estimated that worldwide the one-year prevalence of anxiety disorders was 10.6 % and that the lifetime prevalence was 16.6% (Somers et al., 2006). The one-year prevalence of anxiety disorders is 12% in Canada (Health Canada, 2002). Anxiety disorders are more prevalent in women than men (Somers et al, 2006; Health Canada, 2002). Anxiety disorders (or symptoms of these disorders) are an important factor to consider in the context of MVCs. A population of anxious drivers who are impaired by their illness may have an increased risk of MVC (De Gier, 1993).

Mood disorders represent a diverse group of disorders, the primary feature of mood disorders are disturbances in mood (APA, 2000). Unipolar depression, also known as major depression, represents the most common type of mood disorder (Health Canada, 2002). Unipolar depression, which involves depression only, is characterized by a period of depressed mood or loss of interest or pleasure in nearly all activities (APA, 2000; Health Canada, 2002). Individuals often suffer from other symptoms including: changes in sleep and psychomotor activity; decreased energy; difficulty thinking, concentrating, or making decisions; or recurrent thoughts of death or suicidal ideation, plans, or attempts (APA, 2000). Unipolar depression may result in clinically significant distress or impairment in social or other important areas of functioning (APA, 2000). Psychomotor changes are manifested in nearly 69% of unipolar depressed samples (Nelson & Charney, 1980). Impairment in cognitive, and/or psychomotor functioning has often been cited as a possible reason for the potential for an increased MVC risk that may occur in depressed populations (Cremona, 1986).

The point prevalence of depression has been estimated to be 5 to 10% (WHO, 2001). Lifetime prevalence of depression is 10 to 20 % in women and slightly lower in men (WHO, 2001). In Canada, the one-year prevalence of major depression was between 8% and 8.2%, from the Joint Canadian and United States Survey of Health and Health Canada reports (Health Canada, 2002; Vasilliadis, Lesage, Adair, Wang, & Kessler, 2007).

2.5.2 Driving Impairment Associated with MI and Psychotropic Medications to Treat MIs: Anxiety and Mood Disorders

Anxiety and mood disorders (or symptoms of these disorders) may be a crucial risk factor for MVCs because of the impairment both disorders produce. At a Federal Highway Administration conference on psychiatric disorders and commercial drivers conducted by the U.S. Department of Transportation, a comprehensive model was generated of the possible areas of impairment that are directly or indirectly associated with mental disorders or the associated use of psychopharmacologic agents (Dewar & Olson, 2002; Metzner et al.,1993). Researchers found that specific areas of impairment were associated with MVCs, and other negative driving outcomes, through MI either

directly or indirectly due to psychopharmological agents such as psychotropic medications. These areas include: information processing; visuospatial functioning; impulse control and risk taking; judgment, particularly the ability to predict and anticipate; and problem solving and mental flexibility (Dewar & Olson, 2002; Metzner et al., 1993). Given the numerous possible areas of impairment associated with mental illness, one would expect mental illnesses to reliably be associated with MVCs. However, studies present a mixed perspective on the issue.

2.5.3 MI and Symptoms of Mood and/or Anxiety Disorders: Risk Factors for MVCs

The relationship between MI and negative driving outcomes, including MVCs, has been a topic of research for over 40 years. Studies examining the relationship between MI and MVCs provide mixed findings; there is a noticeable tendency across studies to associate the presence of MIs (or symptoms of MIs), including anxiety and mood disorders (or symptoms of these conditions), with an elevated risk of MVCs. Many scholars have demonstrated MI is a risk factor for MVCs (Brenner & Selzer, 1969; Crancer & Quiring, 1969; Eelkema et al., 1970; Katsrup, Dupont, Bille, & Lund, 1977; Katsrup, Dupont, Bille, & Lund, 1978; Selzer, Rogers, & Kern, 1968; Waller, 1965; Vingilis & Wilk, 2007; Sagberg, 2006). Other studies, however, have not found this relationship between MI and MVCs (Armstrong & Whitlock, 1980; Cremona, 1986). The inconsistent results across the literature make it necessary to review these studies in detail, critiquing their methodology to uncover a greater understanding of the nature of the relationship between MI, including anxiety and/ mood disorders, and MVCs (Metzner et al., 1993).

2.5.4 Methodological Problems with Studies Examining the Association between Mental Illness and MVCs including Anxiety Disorders and MVCs, and Mood Disorders and MVCs

The problems with studies investigating the relationship between mental illness and MVCs arise mostly because of limitations relating to conceptual (construct validity), methodological (internal validity and external validity) and statistical (statistical conclusion validity) challenges (Selzer et al., 1968; Rorsman, Hagnell, & Lanke, 1982; Armstrong & Whitlock, 1980; Bulmash et al., 2006; Janelle, Singer, & Williams, 1999). Construct validity is present when a measure of a human risk factor, such as anxiety

and/or mood disorders, relates to at least one other measure of the same factor but it is not related to other human risk factors (Grembowski, 2001). At least eight different measures of anxiety and/or mood disorders (or symptoms of these conditions) were applied in the studies reviewed. With such a wide variety of measures of MI being utilized, it is not surprising that findings for the association between MI and MVCs vary. Also, researchers often do not ask participants with MI if they are taking psychotropic medications to treat their MI in MVC studies. The exclusion of a measure of psychotropic medication use is very problematic. Psychotropic medication use may impair similar cognitive and psychomotor skills related to driving as MI impairs (Hopewell, 2002). In some studies, the interpretation of results becomes difficult because it is not possible to separate the amount of variance attributed to MI or psychotropic medication use (Hopewell, 2002; Vaa, 2003).

Internal validity refers to the quality of the study in terms of its design, conduct and the accuracy with which the study reflects the true effect of specific risk factors on the outcome (Last, 2001). There are at least seven threats to internal validity: selection bias, history, maturation, regression to the mean, instrumentation, attrition, and testing. For example, selection bias may occur if individuals from certain ethnic backgrounds less often report the presence of anxiety and or mood disorders because they are less likely to access mental health services due to cultural beliefs and as a result receive a diagnosis. External validity reflects the generalizability of study findings to an intended target population (Kopesell & Weiss, 2003). External validity challenges may occur when there are problems generalizing the study population to a referent population; when one cannot determine the role of participants in a crash; and when there are difficulties generalizing experimental studies to the real world, especially experiments using driving simulators.

Statistical conclusion validity reflects how reasonable or accurate the conclusions drawn about the data are given the statistical tests conducted (Grembowski, 2001; Trochim, 2006). Statistical conclusion validity may be threatened by studies with small samples sizes, and as a result low power, which may be insufficient to detect an effect (Grembowski, 2001; Trochim, 2006). Statistical conclusion validity may also be challenged by operationally defining MI using methods that have low reliability.

2.6. Description of Studies

The following section will summarize the epidemiological and experimental literature examining the relationship between MI, including anxiety and mood disorders (or symptoms of these conditions) and MVCs. Overall, 20 studies were reviewed summarizing 19 investigations. In addition, nine review articles were reviewed. The studies were conducted in the United States, Canada, England, Holland, and the Nordic nations.

2.7 Results of Studies on Associations between MI (Anxiety and Mood Disorders) and MVCs

Various descriptive investigations have compared mentally ill drivers who were involved in a crash to the general population, noting which demographic factors have a higher frequency among the mentally ill (Katsrup et al., 1977; Schukit & Grunderson, 1977; Katsrup et al., 1978). Other descriptive studies of MVCs have compared the crash rate of mentally ill drivers to non-mentally ill drivers (Waller, 1965; Crancer & Quiring, 1969; Eelkema et al., 1970). In one of the earliest descriptive studies, Waller (1965) compared the driving records of a sample of individuals with chronic medical conditions (n= 1801) to a control group (n= 926) for crash and traffic violation rates. Generally, traffic violations are any instances when a driver breaks a law pertaining to driving practices, parking or the condition of the motor vehicle. The researchers also compared the two groups for demographic factors such as age, sex, occupation, marital status, and number of miles driven annually. Within the chronic medical conditions group, there was a subset of mentally ill participants (n= 231). Waller (1965) found individuals with mental illness were more often male, unemployed, and single or divorced compared to controls. Mentally ill drivers averaged twice as many MVCs per mile driven, compared to healthy controls. The most crucial finding was that the collision and violation rates of drivers with chronic medical conditions (including mental illness) were significantly higher than the comparison sample (Waller, 1965). An important drawback of this study is the fact that no measures of psychotropic medication use were provided and, as a result, psychotropic medications use was not controlled or examined as a mediator.

Kastrup, Dupont, Bille, and Lund, (1977) and Kastrup, Dupont, Bille, and Lund, (1978) examined the characteristics of MVCs involving persons registered as psychiatric inpatients in Denmark. This research defined the mentally ill as psychiatric inpatients who had been admitted to the hospital for any length of time between April 1970 to June 1974, and who were involved in MVCs that led to at least one person injured between July 1972 and June, 1974 (Kastrup, et al., 1977; Kastrup et al., 1978). The two studies used the same dataset. However, in the former study, all mentally ill patients, regardless of their role in an MVC, were included, while in the later study only mentally ill patients who were drivers were included in the study (Kastrup et al., 1977; Kastrup et al., 1978). Both studies included measures of age, sex, and blood alcohol levels. The authors found that women, individuals age 25-54, and those who were drinking and driving were overrepresented among MVCs that resulted in injury when the drivers were mentally ill inpatients (Katsrup et al., 1978). In addition, they noted mentally ill drivers were more often injured in an MVC (Katsrup et al., 1978). The findings of this investigation are not definitive, given the absence of a measure of driving exposure, and no information on psychotropic medication use to treat MI is provided in this study.

A small number of descriptive studies have examined collision rates among mentally ill inpatients, and compared them with drivers in the general population or matched controls to determine the relationship between MI and MVCs (Crancer & Quiring, 1969; Eelkema et al., 1970). Eelkema, Brosseau, Koshnick and McGee (1970) evaluated psychiatric patients before and after hospitalization for MVCs and violation rates. A group of mentally ill patients (n= 238), which included 15 psychoneurotics were compared to a control group (n= 290) matched by age, sex, and county of residence. Psychoneurotic disorders are characterized by anxiety or depression (Crancer & Quiring, 1969). The collision rate before hospitalization was higher for all mentally ill drivers when compared to the collision rate after hospitalization for all mentally ill drivers (Eelkema et al., 1970). In addition, the researchers calculated collision ratios, comparing the collision rate of the MI group to the collision rate of the control group, before and after the period of hospitalization. For example, if the collision ratio is greater than one, it indicates the collision rate of mentally ill drivers was higher than the control group (Eelkema et al., 1970). Before hospitalization the collision ratio (mentally ill: control)

was greater than one but after hospitalization the ratio drops below one. This suggests the control group had a higher rate of collisions than those with mental illness after hospitalization.

These findings must be interpreted with caution, as no information on the type of treatment, if any, received by the mentally ill participants was included (Eelkema et al., 1970). This is a crucial omission as treatment with psychotropic medications or psychotherapy may lessen the severity of MI and MVC risk.

Rorsman, Hagnell and Lanke (1982) conducted a retrospective cohort study on a Swedish population under observation for a 25-year period. The authors described the relationship between MI and violent death, including fatal MVCs (Rorsman et al., 1982). Among the 25 victims of violent deaths, 14 deaths were caused by an MVC (seven were drivers). Among men in the cohort, the "accidental" death rate was nearly three times higher among individuals with psychiatric disorders when compared to controls. Drawbacks of this study include the fact that the researchers did not report how they operationally defined MI, and there was a small sample of fatal MVCs in the study.

Another group of descriptive studies focus almost exclusively on the relationship between anxiety and/or mood disorders and MVCs (Fairclough, Tattersall, & Houston, 2006; Bulmash et al., 2006). A novel approach used to relate anxiety and driving outcomes is to record anxiety levels and driving performance during a driving test to receive a driver' s licence (Fairclough et al., 2006). Fairclough et al. (2006) used this technique to measure State Anxiety in 13 driving test candidates during an official driving test. Only six out of 13 drivers passed the official driving test. Results indicated that drivers who failed the driving test had significantly higher levels of state anxiety in the formal test session than during a normal driving lesson, mock test or compared to individuals who passed the test (Fairclough et al., 2006).

Overall, descriptive epidemiological studies have indicated participants with MI, in particular anxiety and/or mood disorders, more often have negative driving outcomes, including MVCs. The greater frequency of MVCs among the mentally ill when compared to controls persist even after adjusting for driving distance. No clear gender trends

emerge from descriptive studies for MI and MVCs (Waller, 1965; Kastrup et al., 1977). Also, among descriptive studies no prevalence or frequency estimates of psychotropic medication use were included.

Numerous, but not all, analytic studies have demonstrated a relationship between MI and MVCs. Culpability analyses have consistently found an association between anxiety and/or mood disorder and MVCs. Only participants who were responsible for causing MVCs are included in culpability analyses (Vingilis & Macdonald, 2002; Hours et al., 2008). Selzer et al. (1968) conducted a case control study comparing drivers culpable for a fatal MVC (n= 96) to controls matched by age, sex, and county of residence (n= 96) over a three year period for measures which included serious psychopathology. Researchers interviewed the employers and significant others of the driver who caused a fatality as well as those in the control group. This study found drivers who caused fatal crashes had significantly higher rates of depression than controls, with nearly three times as many culpable drivers being depressed compared to controls (Selzer et al., 1968). However, this study is weakened by using a measurement of MI that used interviews with the deceased driver's employer and/or significant others to indicate the presence of MI. A more valid measure of MI would be to determine the presence of symptoms or a diagnosis of MI by consulting the drivers' physicians and medical records.

Sagberg (2006) conducted a valuable case-control study using drivers (n= 4448) who were culpable for a MVC based on an administrative dataset to determine the relative risk of crash involvement. The author collected additional self- report data from questionnaires, obtaining information on about 54 medical conditions or symptoms. Questionnaires were mailed out to a random sample of drivers identified from insurance company records as having a crash in the past six months, both cases and controls were identified based on culpability for a MVC. Included on the questionnaire were measures of anxiety, depression, and antidepressant and anxiolytic medication use. Adjusted odds ratios, controlled for age and driving distance, indicated anxiety (OR = 3.15), feeling depressed (2.43), and taking antidepressants (1.70) were all significant risk factors for MVCs (Sagberg, 2006). The study was limited by a low response rate (30%). One of the

strengths of this study was the format in which the questions were asked of participants. Researchers asked participants to respond if they were "feeling blue, depressed" or "anxiety" (p. 31), instead of using clinical definitions, which some participants may find confusing or unclear. The logic for this is that people can provide more valid answers about medical conditions without having medical knowledge or training, if questions are asked using everyday language (Sagberg, 2006).

Some case control studies have not found an association between MI and MVCs (Armstrong & Whitlock, 1980; Cushman et al., 1990). Armstrong and Whitlock (1980) examined the relationship between MI and MVCs, comparing a hospitalized mentally ill sample (n= 100), which included 62 participants with anxiety and mood disorders, to individuals hospitalized for physical illness (n = 100) matched for age, sex, and social background. Participants were asked a series of questions about driving behaviour, including driving experience and collision records. No significant differences were found in the number of individuals involved in a collision during a period of six months to three years, before admission to hospital between the physically ill and mentally ill groups (Armstrong & Whitlock, 1980). A serious limitation of this investigation is the lack of a control group without physical illness or MI to compare the number of individuals involved in MVCs to. Though it is unlikely individuals would be at hospital for reasons other than physical or mental illness, a control group without physical or mental illness could be generated from individuals who appear at hospital to visit family or friends. Recently, a systematic meta-analysis of previous literature found that both physical illness and MI are associated with an increased risk of MVC (Vaa, 2003). It is possible that both physically ill populations and mentally ill populations are at a greater risk of MVC compared to the general population. However, there is no significant difference in MVC risk between these two groups (Vaa, 2003).

Mann et al. (in press) investigated the impact of psychological distress on MVC involvement using cross-sectional data over a three year period (2002-2004) from the CAMH (Centre for Addiction and Mental Health) Monitor survey, a population-based survey of Ontario adults (N= 4935). The investigators included two measures of psychological distress; one of these was the depression-anxiety subscale of the GHQ-12.

Results indicated that the odds of MVCs increased significantly as scores on the depression-anxiety subscale increased. Every one-unit increase in the depression-anxiety scale score was associated with 5% increase in the odds of being involved in an MVC (scores range from 0-18).

Vingilis and Wilk (2007) examined the relationship between MI and MVC injuries in a prospective cohort study using stronger methodology. The researchers analyzed data from a large longitudinal social survey dataset (N= 14,529) to examine health related predictors including distress of subsequent MVC injuries. To identify the presence of distress, participants were asked a subset of questions from the Composite International Diagnostic Interview (CIDI) (Robins et al., 1988). The CIDI subset included items which asked the frequency with which participants felt symptoms of nervousness, restlessness, sadness, hopelessness, worthless, and/or everything in life was an effort in the previous month (Vingilis, & Wilk, 2007). Distress was measured at least two years prior to MVC injury. Results indicated participants with psychological distress were overrepresented among individuals with MVC injuries (Vingilis & Wilk, 2007). Vingilis and Wilk (2007) have a stronger methodology than the earlier studies of MI and MVCs, as the researchers included measures of medication use and alcohol use. Some strengths of this investigation were the large sample size, and the longitudinal nature of the data source, which allowed the researchers to determine the temporal relationship between the psychological distress and motor vehicle injury. The study was limited by the measure of motor vehicle injury as researchers could not determine a respondent's role in the MVC when an injury occurred. A more methodologically sound approach would be to include measures to determine if the respondents were driving the motor vehicle at the time of the collision.

Only two experimental studies concerning the relationship of symptoms of anxiety and/or mood disorders and negative outcomes on driving were found. Janelle, Singer and Williams (1999) looked at the influence of arousal and cognitive anxiety on attentional capabilities in a sample of young females using a simulated racecar-driving task. The goal was to examine how anxiety and arousal influence driving ability (Janelle et al., 1999). The researchers proposed that increases in anxiety and/ or

arousal might result in a narrowing of the attentional field, while at the same time increasing susceptibility to distraction (Janelle et al., 1999). Participants were randomly assigned to one of six groups, three anxiety groups and three controls groups. All participants completed three racecar driving sessions. However for the anxiety groups, each respondents drove in three sessions operationally defined as the familiarization session (low anxiety), the practice session (moderate-anxiety) and the competition session (high-anxiety). An analysis of the anxiety groups demonstrated higher levels of anxiety during the competition sessions. During the driving tasks, higher levels of anxiety were associated with slower reaction times and poor performance on the racecar driving task in terms of slower speeds (Janelle et al., 1999). The generalizability of these findings is limited because the sample included only young females and may not reflect real world situations.

Bulmash et al. (2006), using a quasi-experimental design, examined the association between depression and driving ability by comparing 18 unmedicated depressed outpatients with 29 controls for numerous measures of driving ability, including number of crashes, and road position, speed deviation, and reaction time using a driving simulator. A crash was defined as an instance where the car was steered out of the predefined lane boundaries and a driver made contact with something else on the road (Bulmash et al., 2006). There was a correlation between crashes, road position and reaction time during the four simulated driving trials (Bulmash et al., 2006). The depressed sample exhibited slower steering reaction times and an increased number of crashes across trials (Bulmash et al., 2006). A unique strength of this investigation was the exclusion of depressed drivers taking antidepressants. This might allow less tentative conclusions to be drawn about the association between mood disorders and MVCs.

2.8 Review Studies Examining the Relationship between Mental Illnesses; Anxiety and Mood Disorders and MVCs

In addition to the individual studies that have been considered, review studies examining the relationship between MI and MVCs will be discussed. Review studies have come to a wide variety of conclusions about the relationship between mental illness and MVCs. Some reviews have argued it is unclear if there is a relationship, others have argued the variables are associated, while still other reviews has indicated there is no

evidence of a relationship (Noyes, 1985; Tsuang et al., 1985; Cremona, 1986; Metzner et al., 1993; Iancu, Spivak, Pinhas, Wiener & Weizman, 1996; McDonald & Davey, 1996; Kuch, Cox, & Evans, 1996; Blaszczynski et al., 1998; Dewar & Olson, 2002; Vaa, 2003; Menard, & Korner- Bitensky, 2008; Silverstone, 1988). The conclusions of a review may largely depend upon whether the studies described in these review articles included MI inpatient samples or MI outpatient samples or both and if the review is narrative or systematic. The majority of individuals with anxiety and/or mood disorders are outpatients (Verster et al., 2005; Health Canada, 2002; Rorsman et al., 1982). Reviews examining studies conducted using psychiatric inpatient populations may have limited generalizability, as psychiatric inpatients tend to have more severe MI and are not typical of most individuals with anxiety and/or mood disorders. The type of review conducted may affect the conclusions drawn from the review. Traditional or narrative review articles may be more prone to bias than systematic reviews (Akobeng, 2005). Authors of narrative reviews sometimes use subjective and informal methodology for acquiring and interpreting studies (Akobeng, 2005). Also, they might select studies, which reinforce their own clinical experiences or preconceived notions about the subject area (Akobeng, 2005). A systematic review, however, adopts explicit methodology to find, critique, and synthesize the literature (Akobeng, 2005). Because of these differences in reviews and samples, varying conclusions about the association between MI and MVCs may be drawn by different types of reviews based simply on differing methodology (Noyes, 1985; Tsuang et al., 1985; Cremona, 1986; Iancu et al., 1996).

One narrative review summarized evidence concerning the association between MI and MVCs, including the effects of alcohol, illicit drugs and psychotropic medications (Cremona, 1986). This investigator noted that few studies examined the association between MI and MVCs but that the limited studies on this topic found no evidence of an increased incidence of MI among individuals involved in an MVC (Cremona, 1986). However, within this review, the author acknowledges negative results were likely due to the lack of evidence available. It was postulated that depressed drivers may be more likely to be involved in collisions due to factors such as poor concentration, slowed response time, and suicidal ideation leading to an association between depression (or symptoms of this condition) and MVCs (Cremona, 1986; Silverstone, 1988). In

addition, drivers with anxiety disorders may display heightened alertness levels and increased worry, which might be detrimental to their driving ability as it leads to decreased working memory capacity, more distraction, reduced attentional ability, and difficulty making decisions (Cremona, 1986; Charlton et al., 2004). As a result, anxiety disorders (or symptoms of these conditions) could be correlated to MVCs (Cremona, 1986).

More recently, researchers have conducted a narrative review of the literature for a large variety of MIs and their associations with MVCs (Iancu et al., 1996). This narrative review included studies with non- mentally ill samples and indicated that no clear conclusions can be drawn about psychoneurotic disorders and MVCs (Iancu et al., 1996). However, this paper reviewed only two studies, both of which used similar study designs to determine the collision rates for psychoneurotic respondents before and after hospitalization.

Blaszcynski et al. (1998) reviewed the literature concerning the relationship between MVCs and MI following MVCs. They noted a high prevalence of anxiety or mood disorder following a MVC, with estimates ranging from 21 to 67% for depression, and 4 to 87% for anxiety disorders (Blaszcynski et al., 1998). In addition, the authors noted that studies have indicated the presence of a psychiatric disorder emerged as a risk factor for MVCs in their review of the literature.

The previously cited reviews have provided narrative reviews of the literature, in which studies included in the review may not have been chosen systematically. A stronger method to determine the relationship between MI including anxiety and/or mood disorders (or symptoms of these conditions) and MVCs is a systematic meta-analysis of the literature (Vaa, 2003). In this systematic review, Vaa (2003) examined 62 reports, from mostly case-control studies giving a total of 298 results from studies conducted in 14 nations. Results pooled for a meta-analysis can include measures such as relative risk (risk ratio) or odds ratios (Akobeng, 2005). The aim of this review article was to determine how numerous health related risk factors affected the risk of being involved in a MVC, including MI, and in particular, depression or depressive disorders. Of the 298 results, 33 provided quantitative findings related to mental disorders, yielding a relative

risk of MVC involvement of 1.72. Specifically, depression or depressive symptoms generated a relative risk of collision involvement of 1.67. However, a weakness of this meta-analysis was the use of a collection of heterogeneous operational definitions to determine the association between MI and MVCs. For example, studies that included a measure of the use of one, two, or three psychotropic medications indicated the presence of MI. A more rigorous approach would be to use validated measures of symptoms or diagnoses and include medication use as a separate variable to examine the individual effects of illness and medication use. Vaa (2003) noted numerous additional confounding factors were controlled for in the studies used for the meta-analysis. However, often the driving exposure or distance had not been controlled for when calculating relative risk in the studies reviewed, arguably the most important confounding factor (Vaa, 2003).

A recent systematic review conducted by Menard and Korner- Bitensky (2008) examined literature concerning the association of individuals with MI, taking psychotropic medications and MVCs. The researchers examined 14 studies using a wide variety of study designs, including descriptive epidemiological research, case-control studies, and culpability analyses, and noted MI was associated with an elevated risk of MVC in 8 out of 14 studies. All but one study that reported an association between MI and MVCs used mentally ill inpatients. However, it is well known that most people living with anxiety and mood disorders tend to be outpatients (Verster et al., 2005; Health Canada, 2002; Rorsman et al., 1982). A major weakness of this review was that studies were compared on their findings with little mention of study design, operational definition, and strengths and weaknesses of the methodology used in the individual studies reviewed.

2.9 Summary

Overall, the majority of studies examining the relationship between anxiety and/or mood disorders (or symptoms of these conditions) and MVCs demonstrate an association. Among all studies that did not find an association, the results must be interpreted cautiously as problems with selection of control group, or small sample sizes make the validity and reliability of these findings questionable. Generally, the flaws in the literature are related mostly to sampling and data collection, and operational definitions (Walsh, Gier, Christopherson, & Verstraete, 2004). Descriptive studies found that drivers

involved in MVCs with symptoms of MI usually were more often women, between 25 and 54 (Waller, 1965; Blanchard et al., 1994; Katsrup et al., 1977). Studies using culpability analyses, cross sectional and longitudinal studies from administrative or social surveys, consistently indicated there was an association between anxiety and/or mood disorders and MVCs (Selzer et al., 1968; Sagberg, 2006; Vingilis & Wilk, 2007; Mann et al. (in press)).

2.10 Factors That Reduce Driving Capability in the Short-Term and Promote Risk Taking in the Short-Term: Anxiolytic and Antidepressants Psychotropic Medications

2.10.1 Methodological Deficiencies in the Literature

Studies investigating the relationship between anxiolytics (anti-anxiety medications) or antidepressants and MVCs share many of the same challenges as the literature on the relationship between anxiety and/or mood disorders (or symptoms of these conditions) and MVCs. There are similar challenges in terms of conceptual, methodological, and statistical considerations. Therefore, only the methodological deficiencies that are unique to anxiolytic or antidepressant and MVCs literature will be discussed in this section.

Construct validity challenges to medication use are due to the wide variety of methods that have been used to define medication use, including invasive methods such as collecting blood, urine, sweat, and saliva samples (Walsh et al., 2004). There can be problems with collection, handling, transportation and toxicological analyses for invasive methods of determining medication use (Walsh et al., 2004). Numerous studies have examined prescription records of medication use among drivers injured in MVCs. Merely receiving a prescription for a psychotropic drug does not ensure that the person is taking the medication (Ray et al., 1992; Leveille et al., 1994; Neutel, 1995). Other non-invasive methods for determining medication use include self- reported use and pill counting. However, self-report survey measures provide a simple, non-invasive, and standardized method of determining psychotropic drug use and they have demonstrated good

concordance with prescription records and physician reports (Beck et al., 2005a; Kwon, et al., 2003; Cotterchio, Kreiger, Darlington, & Steingart, 1999).

Confounding by indication can distort the relationship between anxiolytic and/or antidepressant use and MVCs (Last, 2001). It would occur, for example if participants prescribed these medications also have other risk factors for MVCs. If findings indicate an elevated risk among participants taking psychotropic medications, it is not possible to separate the amount of variance accounted for by the medication use versus the condition.

2.10.2 Definition and Prevalence of Anxiolytic and Antidepressant Psychotropic Medication Use

Several, but not all, studies have demonstrated that drivers taking psychotropic medications are at a greater risk of MVCs (Alvarez & del Rio, 2002). Psychotropic medications affect the central nervous system (CNS); they are substances that have the ability to change an individual's consciousness, mood, or thinking processes (WHO, 2004b). Psychotropic medications also have been shown to interfere to varying degrees with driving skills (Vingilis & Macdonald, 2002). Within the category of medications designated as psychotropic, antidepressants and anxiolytics may be classified as depressants (Vingilis & Macdonald, 2002).

Antidepressant and anxiolytic medications are categorized by the biological effect of the drug. In addition, medications can also be described as early generation medications and newer generation medications. Generally, newer generation medications are equally as effective or more effective in controlling symptoms than previous antidepressants and anxiolytics (Rickels, 1978; Williams et al., 2000; Argyropoulos, Sandford, & Nutt, 2000). In many cases, newer medications produced fewer side effects than older medications (Rickels, 1978; Williams et al., 2000; Argyropoulos et al., 2000). The three most common types of medications used to treat depression are Monoamine Oxidase Inhibitors (MAOIs), Tricyclic Antidepressants (TCAs), and Selective Serotonin Reuptake Inhibitors (SSRIs) (Wickens, 2005). There are three important classifications of anxiolytic medications: barbiturates, benzodiazepines (BZDs), and Buspirone (Rickels, 1978; Argyropoulos et al., 2000). The earliest generation of antidepressants were the

MAOIs, followed by TCAs (Wickens, 2005; Williams et al., 2000). The earliest generation of anxiolytics were the barbiturates (Rickels, 1978). The next generation of anxiolytics were BZDs. Numerous studies have indicated barbiturates, BZDs, MAOIs, and TCAs impair performance on cognitive and psychomotor tasks (Department of Transport, 2003; Leveille et al., 1994). Additionally, numerous studies have found a relationship between BZD use and MVCs (Ray, et al., 1992; Neutel, 1995; Neutel, 1998). Some studies have found a relationship between TCAs and driving ability, including MVCs (Leveille et al., 1994; Verster et al., 2005), while others have found no evidence of a relationship (Barbone et al., 1998).

The newest generation and the current standard antidepressant medication treatment used are the SSRIs (Wickens, 2005). Studies examining the relationship between SSRIs and MVCs or driving ability have mixed findings (Barbone et al., 1998; Verster et al., 2005; Brunnauer et al., 2006). It is difficult to determine the relationship between SSRIs and MVCs because most of the available studies have been conducted using patients with anxiety and/or mood disorders, which may introduce confounding into estimates of the relationship. A newer and increasingly popular treatment for anxiety disorders is Buspirone (Argyropoulos et al., 2000). Studies examining the relationship between Buspirone and MVCs have not demonstrated an association (Verster et al., 2005; van Laar, Volkerts, & van Willgenburg, 1992).

Also, it is important to note that some types of antidepressants are prescribed to treat anxiety disorders and that some type of anxiolytics may be prescribed to treat mood disorders (Argyropoulos et al., 2000). Generally, antidepressants and anxiolytics produce similar, unwanted side effects that negatively affect driving ability, including the inability to concentrate, psychomotor slowing, and sleep disturbances (Brunnauer et al., 2006; Wickens, 2005; Argyropoulos et al., 2000).

In Canada, a large population-based survey estimated slightly over 7% of Canadians had used any psychotropic medications in the past year and slightly fewer than 6% of Canadians had used antidepressants in the past year (Beck et al., 2005a; Beck et al., 2005b). In addition, the researchers noted that psychotropic medication use was more prevalent among women and increased with age (Beck et al., 2005a). Among drivers

involved in a collision, it has been estimated that between 6-21% were taking a psychotropic medication at the time of the crash (De Gier, 1993; Kibrick & Smart, 1972). Furthermore, an estimated 10% of individuals killed or injured in crashes were taking some sort of psychotropic medication that may have been a contributory factor (De Gier, 1993).

2.11 Description of Studies

The following section will summarize the epidemiological and experimental literature examining the relationship between antidepressants and/or anxiolytics and MVCs. Overall, 14 studies were reviewed and an additional 17 review articles were reviewed. The studies were conducted in the United States, Canada, England, Holland, Spain, Norway, France, and Australia.

2.12 Antidepressants and Anxiolytics and MVCs

Descriptive studies relating antidepressant and/or anxiolytic medication use to MVCs are rare. Only one review article that summarized the descriptive literature met the criteria to be included in this review. Kibrick and Smart (1972) reviewed studies measuring the incidence of psychotropic medication use among the general population, people involved in fatal MVCs, and people involved in non-fatal MVCs. The study indicated the incidence of psychotropic drug use prior to a crash among drivers was between 11 and 15% (Kibrick & Smart, 1972).

Analytic studies associating antidepressant and/or anxiolytic use with MVCs have adopted various designs, samples and medication measurement techniques. Wadsworth et al. (2005) conducted a cross-sectional study examining the association between psychotropic medication use and "accidents," including MVCs, using data from a large cross-sectional population based survey (n= 7979). A logistic regression analysis was conducted in which the researchers controlled for numerous demographic, health, and lifestyle factors. No significant relationship was observed between anxiolytic or antidepressant use and MVCs (Wadsworth et al., 2005). However, the findings of this study are limited by a very low response rate (27%), which could introduce bias into the study if respondents differed from non-respondents. In addition, the rate of MVCs in this sample was very low (2%) (Wadsworth et al., 2005). Thus, the sample size of medication users involved MVCs might have had too little statistical power to detect a significant

relationship (Wadsworth et al., 2005). A strength of this investigation was the measurement and adjustment for both anxiety and depression (Wadsworth et al., 2005).

Among anxiolytic and antidepressant use and MVC studies, the relationship between the anxiolytic BZD and MVCs is frequently examined (Ray et al., 1992; Neutel, 1995; Leveille et al., 1994; Movig et al., 2004; Hemmelgran, Suissa, Huang, Boivin, & Pinard, 1997; McGwin, Sims, Pulley, & Roseman, 2000). One popular design has been to conduct a cohort study sampling an adult population of BZD users and non-users identified using prescription records (Ray et al., 1992; Neutel, 1995; Neutel, 1998; Hemmelgran et al., 1997). Studies using subpopulations of the elderly or young adults with a similar design as described above are common (Neutel, 1998; Ray et al., 1992; Hemmelgran et al., 1997). Neutel (1995) conducted a cohort study using data from a provincial health plan (from 1979 to 1986) to determine BZD exposure among adults. Participants were divided into groups to assess the risk of hospital admission for injurious MVCs into hypnotic BZD users (n = 78,070), anxiolytic BZD users (n= 147 726), and controls (n = 97,826). Within two weeks of receiving a prescription, the odds of an injurious MVC were 6.5 and 5.6 for BZD hypnotic and anxiolytic users versus controls (Neutel, 1995). Within four weeks of receiving a prescription, the odds of an injurious MVC were 3.9 and 2.5 for BZD hypnotic and anxiolytic users. However, a key limitation in this study was that the researchers did not include a measure of anxiety or mood disorders or symptoms of these disorders, which could confound the observed association (Neutel, 1995). It is unclear whether it is the BZD use or the illness for which the medication was prescribed that was associated with the increased risk of injurious MVC (Neutel, 1995). A strength of this investigation was the large, representative sample of adults used.

Another group of BZD and MVC studies categorize BZD users depending upon the half-life of the drug used (Hemmelgran et al., 1997; Dubois, Bedard, & Weaver, 2008). Elimination, or half-life, is a measure of how long it takes for half of the dose of the medication consumed to leave the body (Dubois et al., 2008). Hemmelgran, Suissa, Huang, Boivin and Pinard, (1997) examined the association between BZD and MVCs in an elderly population, applying classification of BZD users by half-life. The scholars

conducted a nested case-control study using a sample of elderly drivers from Quebec. They defined cases as drivers involved in an injurious MVC. BZD exposure was divided into two groups: drugs with long-elimination (> 24 hours) and short elimination (< 24 hrs). The first week of long-elimination BZD use was significantly associated with MVCs, yielding a rate ratio of 1.45. In addition, when long-elimination BZDs were used for up to one year, there was a significant association with MVCs with a rate ratio of 1.26. This study was weakened by not controlling for drinking and driving or driving exposure.

Prospective case-control studies relating anxiolytics or antidepressants use to MVCs have been conducted using clinical samples as well. Movig et al. (2004) conducted a prospective case-control study where they studied patients who presented at a hospital for injuries from an MVC (n= 110) and compared them to controls selected by roadside surveys (n= 816). They found BZD users were over five times more likely to be involved in a MVC after adjustment for age, gender, and other drug use (Movig et al., 2004). This study was strengthened by the adjustment for the use of other drugs, including alcohol, in the analysis. A common limitation of the antidepressant and/or anxiolytic and MVC literature, which was also present in this study, is the failure to control or adjust for the affect anxiety and/or mood disorders or reasons for taking the medications, making it impossible to determine how much of the variance is accounted for by medication use compared to the MI being treated.

Not all of the case-control studies examining the relationship between BZDs or antidepressants and MVCs have demonstrated an association. Leveille et al. (1994) conducted a case-control study using a sample of elderly persons who sought treatment for MVC injuries. BZD users (n = 234) were matched with non-user controls by age, gender, and county of residence (n = 447). The author found that BZD users did not have a significantly elevated odds of being in a MVC after adjusting for multiple factors, including education, marital status, and annual miles driven. However, the use of TCAs was associated with MVCs (OR= 2.5) (Leveille et al., 1994). This study is weakened by the absence of information on MI, including anxiety and/or mood disorders (or symptoms of these conditions). Another limitation to this study is the small number of BZD users

involved in MVCs (n = 22) and that approximately half were taking trizolam, a BZD primarily prescribed to treat insomnia that may have very short- half life (Leveille et al., 1994; Dubois et al., 2008). The findings concerning BZDs with a short-half and MVCs are mixed (Hemmelgran et al., 1997; Dubois et al., 2008).

Studies conducting culpability analyses, or using proxy measures of culpability such as unsafe driving actions, have also been utilized to examine the effects of antidepressants and anxiolytic use on MVC involvement (Hours et al., 2008; Drummer et al., 2004; Dubois et al., 2008; McGwin et al., 2000). The four studies that have been conducted have found an association between anxiolytics and MVCs. In three of the four studies, measures of antidepressant use were recorded (Hours et al., 2008; Drummer et al., 2004; McGwin et al., 2000). Two of the studies which recorded antidepressant use found an association between antidepressants and responsibility for MVCs (Hours et al., 2008; Drummer et al., 2004). Hours et al. (2008) conducted a case- control study of culpable injured drivers from the Étude de Suivi d'une Population d'Accidentés de la Route dans le Rhône (ESPARR) cohort, a French cohort of crash victims from the Rhone region. Cases were culpable injured drivers (n= 388) and controls were non-culpable drivers (n = 304) (Hours et al., 2008). The researchers found that consuming antidepressants within one week of a collision was associated with almost a four times greater odds of being responsible for an MVC, adjusted for age, type of journey, and alcohol consumption (Hours et al., 2008). However, there was no relationship between anxiolytic use and MVCs. This investigation is weakened by the restriction of participants to those having been responsible for a collision and being hospitalized for an injury. Not all individuals involved in MVCs appear in hospital; as a result, data from a hospital sample may be biased (Vingilis & Macdonald, 2002). More importantly, the researchers may not have detected an association between anxiolytics and MVCs because the sample of cases and controls (n = 22) left them too little power to detect an effect.

Case-crossover studies offer an important advantage, over other designs, as cases can act as their own controls (Kopesell & Weiss, 2003). Barbone et al. (1998) examined the relationship between anxiolytic and antidepressant medication use using data from population based records of residents from an English county who visited a general

practitioner during a three year period (n= 410,305). The researchers included anyone who took a psychoactive substance over the three year period prior to a crash. For each participant, the odds of having a crash while exposed to one of the medications was calculated, compared to the period when the participant was not taking the medications (Barbone et al., 1998). The odds of MVCs were significantly higher while using BZD and other anxiolytics (1.62 and 2.18). However, researchers found no impact of using TCAs or SSRIs. This study was limited by the lack of measurement and control for other covariates, including driving distance and MI.

Several experimental studies have determined the effects of medication use on driving ability in samples of healthy volunteers (Leufkens et al., 2007; Ramaekers, 2003a; Verster et al., 2005). Most of the experimental studies in the literature were conducted by a group of Dutch researchers who use the on-the-road driving test (O`Hanlon, 1984), a test usually conducted on a closed driving circuit with the primary outcome being SDLP (Leufkens et al., 2007; Verster, Volkerts, & Verbaten, 2002). Standard Deviation of Lateral Position is a measure of vehicle control looking at the degree of side to side motion of the vehicle while in a traffic lane (Leufkens et al., 2007; Verster et al., 2005). Leufkens et al. (2007) compared the effects of two varieties of a commonly prescribed BZD used to treat anxiety and panic disorders on driving abilities of healthy volunteers (n = 18). This was a double blind placebo controlled three way crossover design with six treatment orders that used the on-the-road driving test (O`Hanlon, 1984). Both BZD formulations significantly increased SDLP, compared to the placebo treatment. Strengths of this study include, the fact that participants act as their own control and comparison group and the exclusion of participants with chronic medical conditions such as MI (Leufkens et al., 2007).

There is a wide of range of literature concerning anxiolytic and antidepressant use and MVCs. The subject area is so voluminous that a review of this literature would not be complete without comparing the findings of review studies.

2.13 Review Studies Examining the Relationship between Antidepressants and/or Anxiolytic and MVCs

A large number of review studies have been conducted on the relationship between antidepressants and/or anxiolytic and MVCs (Thomas, 1998; Ramaekers, 2003; Department of Transport UK, 2003; Vingilis & Macdonald, 2000; Vingilis & Macdonald, 2002; Kibrick & Smart, 1972; De Gier, 2006; Ray, 1992; Hindmarch, 1986; Walsh et al., 2004; Kelly, Drake, & Ross, 2004; Rapoport & Bannina, 2007; Linnola & Seppala, 1985; Ray, 1992; Verster et al., 2005). These reviews can be divided based on whether they are systematic or narrative reviews, similar designs or type of testing settings, and the categories of anxiolytics or antidepressants under investigation. Traditional or narrative review articles may have poorer methods than systematic reviews (Akobeng, 2005). Authors of narrative reviews sometimes use subjective and informal methodology while acquiring and interpreting studies (Akobeng, 2005). Also, they might select studies, which reinforce clinical experiences or preconceived notions about the subject area (Akobeng, 2005). A systematic review, however, adopts more explicit methodology to find, critique, and synthesize the literature (Akobeng, 2005). Reviews can further be divided depending upon if they examine studies that adopt similar designs or type of testing settings, e.g., reviews of driving simulator studies only or experiments using the on-the-road driving test (Rapoport & Bannina, 2007; Verster et al., 2005). Other reviews focus only on examining specific categories of anxiolytics or antidepressants, such as only examining individual studies on the relationship between BZDs and MVCs (Thomas, 1998).

Two review studies from on-the-road driving experiments were conducted to determine the impact of anxiolytics and antidepressants on driving ability. Verster, Veldhuijzen and Volkerts (2005) examined 14 placebo-controlled double blind studies, 12 studies with samples of healthy volunteers and 2 studies using anxious outpatients. All drivers were tested using the standard on-the-road driving test (O'Hanlon, 1984). The on-the-road driving test involved driving on a highway circuit maintaining a speed of 95 km/h and maintaining SDLP in the slower or right traffic lane (Ramaekers, 2003a). SDLP was the main outcome in these studies (Verster et al., 2005). Treatments considered to be anxiolytics included BZDs, TCAs, SSRIs, Buspirone, and barbiturates. The reviewers wanted to compare deviations in SDLP to a standard criterion in order to predict MVC risk. It was not possible to validate deviations in SDLP induced by anxiolytic medication

use to actual MVCs (Ramaekers, 2003a). However, the reviewers were able to validate the test compared to an alternate criterion highly associated with MVC risk, BAC (Ramaekers, 2003a). The reviewers used a BAC calibration curve generated based on social drinkers who performed the standard on-the-road driving test at various BACs (including .05, .08, and .10) (Verster et al., 2005). This study found a strong relationship between BAC and SDLP (r = .98) (Verster et al., 2005). Measures of SDLP found with anxiolytic drugs were compared to the alcohol calibration curve (Verster et al., 2005). In several of the studies, BZD use caused detriments of SDLP that were comparable to a BAC of between .05 and .10 (Verster et al., 2005). Furthermore, the use of barbiturates led to deficits in SDLP that were comparable to a BAC of more than 0.10 (Verster et al., 2005). However, no association was found between Buspirone and SDLP (Verster et al., 2005). In addition, the reviewers noted that TCAs impaired driving ability; deviations of SDLP after acute administration of TCA resembled those observed at a BAC of .08 (Raemakers, 2003; Verster et al., 2005). A strength of the studies reviewed was that participants were excluded if they abused alcohol or drugs. In addition, for studies using healthy volunteers, individuals with any chronic medical condition, including MI, were excluded. A limitation of the antidepressant and anxiolytic experimental driving studies reviewed was that when healthy volunteers were used they tended to be from a very narrow age range of between 21 to 40 years (Ramaekers, 2003a). This limits the generalizability of findings to other age groups.

Five review studies assessed the effects of medicinal drugs on driving with some focus on BZDs and TCAs. These narrative review studies examined experimental and epidemiological evidence for an association between BZDs and TCAs and MVCs using epidemiological and experimental studies from survey, administrative, and police data sources (Walsh et al., 2004; Kelly et al., 2004; De Gier, 2006; Vingilis & Macdonald, 2002; Vingilis & Macdonald, 2000). For example, De Gier (2006) reported that studies consistently found an association between BZD use and MVCs. However, the investigator concluded that no association was found between TCAs and MVCs in the epidemiological literature. He posited that the lack of association may be due to tolerance effects for drivers on prolonged treatment (De Gier, 2006). A strength of this study was the extensive descriptions of prevalence estimates and the association between

antidepressant and anxiolytic use across studies. A weakness of these investigations is that only a small number of epidemiological and experimental studies on the relationship between antidepressant or anxiolytics and MVCs are available for review.

Overall, review studies provide support for the relationship between anxiolytic and antidepressant medication use and MVCs. Reviews of experimental research were strengthened by the extensive standardized methods across studies.

2.14 Summary of Literature on the Relationships between MVCs and Antidepressant and Anxiolytic drugs

Generally, studies examining the relationship between antidepressant and anxiolytics and MVCs have found an association. Older generations of antidepressants and/or anxiolytics, especially BZDs and in particular those BZDs with longer-elimination periods, have been associated with increased MVC risk. A smaller number of studies have found an association between TCAs and MVCs. The evidence for an association between newer generations of anxiolytics and antidepressants such as SSRIs and Buspirone and MVCs are mixed. A major limitation of the anxiolytic and antidepressant and MVC literature is that rarely are symptoms of anxiety and/or mood disorders measured and adjusted for in these studies. If a relationship between antidepressants or anxiolytics and MVCs is observed, it is not possible to tell what amount of variance is accounted for by medication use, compared to the condition for which the medication was prescribed.

2.15 Factors That Reduce Driving Capability in the Short-Term: Drinking and Driving

2.15.1 Definitions and Prevalence Estimates of Drinking and Driving

Drinking and driving can simply be defined as operating a motor vehicle when one has a BAC of greater than zero (Ogden & Moskowitz, 2004). However, when measures of BAC are not available, drinking and driving has frequently been defined as having two or more drinks within an hour of driving (Ialomiteanu & Adlaf, 2007; Chou et al., 2006; Beirness & Davis, 2007). Currently, the one-year prevalence of drinking and driving has been reported to be between 11 and 12 % from estimates generated using

population based surveys in United States and Canada (Chou et al., 2006; Beirness & Davis, 2007).

2.15.2 Drinking and Driving and MVCs

It is well established that drinking and driving increases the risk of MVCs (Compton et al., 2002; Hingson & Winter, 2003; Perrine, Peck, & Fell, 1989; Ogden & Moskowitz, 2004). Cremona (1986) estimated that alcohol is a factor in 25% of all collisions and 50% of all fatal collision on the road. Crashes that involve alcohol are a concern, as they are more likely to result in injuries and deaths (Hingson & Winter, 2003). Data gathered by the Traffic Injury Research Foundation for 2004 found that nearly 35% of all fatally injured drivers were drinking and that alcohol was a contributing factor in about 17% of drivers who were involved in MVCs that resulted in serious injuries to the drivers that year in Canada (CCMTA, 2006b). Quantitative studies investigating the relationship between drinking and driving and MVCs increased during the 1950s and 1960s with the advent of portable breath testing devices that allowed investigators to determine BAC at the scene of a crash (Moskowitz, 2002). These studies have demonstrated a clear dose response relationship between BAC and MVCs (Cremona, 1986).

Case-control studies conducted from the advent of the portable breath testing devices to the present have reached similar conclusions. Drivers are sampled immediately after a crash and compared to control drivers often matched by age, sex, and location of collision for BAC (Compton et al., 2002). These studies have demonstrated an association between drinking and driving and MVCs (McCarroll & Haddon, 1962; Borkenstein, Crowther, Shumate, Zeil & Zylinan, 1964; Compton et al., 2002). Borkenstein, Crowther, Shumate, Zeil and Zylinan (1964) conducted a large case control study relating drinking and driving to MVCs. The authors compared alcohol levels in 6000 drivers involved in MVCs and 7600 non-involved drivers over one year in Grand Rapids, Michigan to estimate the probability of collisions at BAC levels ranging from .00 to over .25 (Borkenstein et al., 1964). They demonstrated that BAC was exponentially related to the probability of being involved in MVCs (Borkenstein et al., 1964). In particular, a BAC at or above 0.04 was significantly associated with an elevated

probability of being involved in a crash (Borkenstein et al., 1964). For example, the relative risk of being involved in a MVC at a BAC .08 (the level at which a driver is legally considered to be impaired) was 1.88. At a BAC of .15 to .25, researchers reported that the risk of MVC was nearly 21 times greater than the risk for drivers who had not consumed alcohol. However, the Grand Rapids study has often been criticized for not adjusting for differences in cases and controls on confounding factors such as age, gender, and driving distance; these factors were unequally distributed between the BAC groups (Moskowitz, 2002).

In the past few years, case-control studies determining the relationship between drinking and driving and MVCs have applied a more rigorous methodology. Compton et al. (2002) assessed the odds of a crash for alcohol impaired drivers at various BACs when compared with alcohol free controls (N= 14 985). After adjusting for numerous factors including age, gender, marital status, and drinking frequency, the scholars found that the relative risk of MVC began to increase at a BAC of as little as .02 (Compton et al., 2002). At a BAC of .08, the risk of MVC increased to nearly three times that of someone who had not consumed any alcohol (Compton et al., 2002). As BAC increased, collision risk rose exponentially, peaking with a relative risk of nearly 154 times greater for driving at a BAC of $\geq$ 0.25 (Compton et al., 2002).

Laboratory studies present similar findings to the epidemiological literature, that alcohol is a causal risk factor for MVCs. Moskowitz, Burns, Fiorentino, Smiley, and Zador (2000) used an experimental design to examine the effects of alcohol during a driving task, where MVCs and measures of attention were included as outcomes. Participants (n = 168) were tested in a 2 x 4 x 3 factorial design (gender, age groups, and drinking practices). This study includes equal numbers of men and women and divided drivers into four age categories: youthful drivers (19-20 years old), young adult drivers (21-24 years old), adult drivers (25-50), and older drivers (51-69). Also, light, moderate and heavy drinkers were included (Moskowitz et al., 2000). Participants were tested in two sessions, one with a placebo treatment (non-alcoholic beverages) and the other with alcohol treatment. For the alcohol treatment, participants were treated with decreasing BACs, ranging from .10 to .00 at increments of .02. Testing trials were one week apart

for the driving simulator task. Moderate and heavy drinkers began the testing battery at .10, while light drinkers began the battery at .08 (Moskowitz et al., 2000). Across all drinking behaviour types, alcohol impaired all driving related skills at levels as low as .02 (Moskowitz et al., 2000). In particular, there were a significantly higher number of collisions (as measured on the simulator task) at a BAC level of .06 and above (Moskowitz et al., 2000).

2.16. Summary of the Relationship between Drinking and Driving and MVCs

Drinking and driving has frequently been demonstrated as an independent risk factor for MVCs. However, the causation of MVCs is multifactorial (Vaa, 2003), and though drinking and driving has consistently demonstrated elevated risk of MVCs, estimates vary depending on what covariates, if any, are controlled for. Drinking and driving is not the lone human risk factor for MVCs and it is therefore necessary to look at how drinking and driving relates with other risk factors to cause MVCs on a population level.

2.17 Factors That Reduce Driving Capability Immediately and Promote Risk Taking In the Short-Term: Road Rage

2.17.1 Definition and Prevalence of Road Rage

Road rage has been defined as any attempt to intimidate, threaten, or cause harm to another driver, pedestrian or passenger (Mann et al., 2007). Road rage is clearly an act of interpersonal aggression where there are victims and perpetrators (Mann et al., 2007). Road rage is often used interchangeably in the literature with the term aggressive driving. However, aggressive driving signifies an overlapping and more general construct than road rage. Aggressive driving describes a wide variety of driving behaviours such as cutting in and out of traffic and excessive horn honking (James & Nahl, 2000; Mann et al., 2007). Prevalence estimates of road rage vary considerably likely due to the lack of a standard definition of road rage in the literature. A survey of drivers (n= 526) in the United Kingdom estimated approximately 90% of motorists have experienced a road rage incident in the past 12 months (Joint, 1995). Prevalence estimates of road rage victimization or perpetration in Ontario indicate that over a three-year period, the average one-year prevalence of road rage victimization was nearly 45% and the average one-year prevalence of road rage perpetration was approximately 33% during the same time period

(Smart, Mann, Zhao & Stoduto, 2005). Individuals who are perpetrators and/or victims of road rage are more often male and young (Smart & Mann, 2002).

2.17.2 Road Rage and MVCs

Few studies have investigated the relationship between road rage and MVCs. Research that has been conducted has consistently illustrated that road rage is a risk factor for MVCs (King & Parker, 2008; Mann et al., 2007; Wells-Parker et al., 2002). The analytic studies that are available have used cross-sectional, self-report survey data generated from samples of adult drivers (King & Parker, 2008; Mann et al., 2007; Wells-Parker et al., 2002). King and Parker (2008) surveyed 171 adult drivers to determine if aggressiveness was related to crash involvement and traffic violations. The researchers noted aggressive drivers committed more traffic violations than non-aggressive drivers (King, & Parker, 2008). More importantly, they found collision-involved drivers were significantly more angry and hostile than non-collision-involved drivers (King, & Parker, 2008). The major limitation of this study comes from the technique used to select the sample. The authors did not control for any other predictors that could bias the findings, such as drinking and driving.

Wells-Parker et al. (2002) examined the relationship between road rage and MVCs by analyzing data from a large telephone survey of Americans (n= 1,382). Participants were asked 17 questions about road rage perpetration behaviour developed by James and Nahl (2000). A factor analysis generated two road rage factors: verbal frustration and threatening/ angry driving (Wells-Parker et al., 2002). The authors included two measures of crash involvement: any crash in the past 12 months and any serious MVC in the past 12 months (Wells-Parker et al., 2002). After controlling for age and gender, high scores for the threatening/ angry driving scale were associated with both measures of crash involvement, however verbal frustration was not significantly associated with either collision measure (Wells-Parker et al., 2002). Wells-Parker et al. (2002) were the first to demonstrate an association between road rage and MVCs. A limitation of this study is the restriction of the definition of road rage to include questions about perpetration only. It is possible that road rage victimization may be associated with MVCs (Mann et al., 2007). In addition, although there is an overlap between road rage perpetration and victimization, not all road rage perpetrators are victims and vice-versa

(Ashbridge, Smart, & Mann, 2003). By narrowing the focus to only road rage perpetrators the researchers may have excluded a group of individuals who were involved in road rage incidents.

Mann and collaegues (2007) determined the relationship between road rage victimization and/or perpetration and MVCs in a large representative sample of Ontario adults (n = 4897). After adjusting for demographic predictors such as age and gender, the researchers found the odds of a collision were increased nearly 90% among individuals who reported road rage victimization only. The odds of a collision for individuals who reported road rage perpetration was nearly 85% higher (Mann et al., 2007). However, those who reported both victimization and perpetration reported an increase of nearly 160% in the odds of having an MVC (Mann et al., 2007).

2.17.3 Possible Reasons for Road Rage Being a Risk Factor for MVCs

Researchers have offered at least three explanations for the elevated risk of MVCs among road rage victims and perpetrators. One proposition is that road rage victims and perpetrators are the same individuals, who for an unknown reason are more likely to experience both types of road rage and be involved in MVCs (Mann et al., 2007). Another proposition is that the increased collision risk in the two groups has different origins. Perpetrators have an elevated risk because they drive faster and are more aggressive. Victims, on the other hand, have other behaviours, like driving slowly in fast moving traffic and they have difficulty making decisions on the road that may increase collision risk as other drivers may react aggressively by speeding past these drivers, tailgating, or cutting them off on the road (Mann et al., 2007). The final proposition is that a road rage incident is an interactive process in which the distinction between perpetrators and victims is blurred; both parties are angered and the situation escalates and this results in an increased risk of MVCs (Mann et al., 2007).

2.18 Summary of the Literature Concerning Road Rage and MVCs

The few studies available have suggested an association between road rage and MVCs. However, more research is needed to determine the association between road rage and MVCs using a wide variety of experimental and epidemiological study designs to confirm that there is a relationship between road rage and MVCs.

2.19 Confounders, Mediators, Covariates, and Other Complex Relationships in the Literature

A methodological deficiency present in a large number of studies reviewed was a failure to control for potential confounders or covariates when determining the association between a human factor of interest, such as symptoms of anxiety and mood disorders, antidepressants and anxiolytic medications, drinking and driving, or road rage perpetration and victimization, and MVCs. Confounders are variables that are associated in a non-causal manner with the human factor of interest, and are also independent causes of MVCs but are not intermediate steps on the causal pathway. For example, if age causes an increased crash risk (by slowing reaction time or decreasing visual acuity), and older drivers are also more likely to be prescribed a psychotropic drug, the observed relationship between the drug and MVCs could be partly due to the effect of age. Confounders may be partially or entirely responsible for the association between the human factor of interest and MVCs, resulting in the generation of biased risk estimates from studies that do not control for confounders (Szklo & Nieto, 2007). These risk estimates would not accurately estimate the effects of a human factor of interest on MVCs and other negative driving outcomes. Many variables have been reported to confound risk measures between a human factor of interest and MVCs including age, sex, and driving distance.

Arguably, the most important confounders, which were frequently not controlled for in these studies, were measures of driving exposure, number of years with a licence, or driving experience. Driving experience includes measures of driving distance or hours spent driving. There is an abundance of evidence indicating that greater driving distance is associated with higher collision rates (Vaa, 2003). Epidemiological studies of MI, in particular those that examined the effects of anxiety and/or mood disorders (or symptoms of these conditions), frequently did not control for driving exposure (Eelkema et al., 1970; Sagberg, 2006). This potential confounder should be assessed in future studies.

Anxiolytic and antidepressant medication use may be considered a mediating or intervening variable as these medications may precede MVCs. A mediating or intervening variable is a variable which occurs on the causal pathway between the exposure and the outcome. It causes variability in outcome and varies with the exposure.

As with classic confounders, mediating variables are associated with both the exposure and the outcome (Last, 2001). For this reason, they are statistically indistinguishable from confounders and must be identified with knowledge of causal relations among variables of interest. For example, symptoms of anxiety and/ or mood disorders are believed to predate anxiolytic and antidepressants use by many years (Waller, 1965). Thus, medication use could be considered an intervening variable that must be controlled when examining the independent relationship between MVCs and symptoms of anxiety and mood disorders. However, in numerous studies it was not controlled for (Bulmash et al., 2006; Selzer et al., 1968; Armstrong & Whitlock, 1980).

2.20. Relationships among Explanatory Variables

Human factors such as anxiety and mood disorders (or symptoms of these conditions), antidepressant and/or anxiolytic medication use, drinking and driving, and road rage victimization and/or perpetration might be associated with one another. In this section, the literature investigating the associations among explanatory variables will be reviewed.

2.20.1 Anxiety and/ or Mood Disorders or Symptoms and Antidepressants and/ or Anxiolytic Psychotropic Medication Use

Few studies were identified that examined the association between anxiety and/or mood disorders or symptoms and antidepressant and/or anxiolytic use. Ohayon, Caulet, Priest and Guilleminault (1998) investigated the prevalence of antidepressant or anxiolytic medication use among individuals with anxiety and depressive symptoms in a population-based survey of a representative sample of non-institutionalized English residents (n= 4972). Among participants with anxiety symptoms, approximately 44% were taking antidepressants and nearly 53% of participants with anxiety symptoms or depressive symptoms were using anxiolytics.

In Canada, Beck et al. (2005a) examined the relationship between anxiety and/or depressive disorders (or symptoms of these conditions) and antidepressant and/or anxiolytic medication use in a large, nationally representative, cross-sectional survey (n = 36,984). The researchers stated the prevalence of antidepressants and anxiolytics or

sedative hypnotic use in the past 12 months among individuals with mood disorders to be approximately 39% (Beck et al., 2005a). Among individuals with a lifetime anxiety disorder the prevalence was found to be nearly 22% (Beck et al., 2005a).

2.20.2 Anxiety and/ or Mood Disorders or Symptoms and Drinking and Driving

Some studies have presented evidence that anxiety and/or mood disorders, or their symptoms, are associated with drinking and driving (Lapham et al., 2001; Shaffer et al., 2007; Stoduto et al., 2008). These investigations were conducted using driving under the influence of alcohol (DUI) offenders who entered a treatment program (Lapham et al., 2001; Shaffer et al., 2007). Participants were interviewed using a structured diagnostic interview, such as CIDI, which diagnoses a series of anxiety and/or mood disorders or symptoms of these disorders. Lapham et al. (2001) reported that the one-year prevalence of depressive disorders or anxiety disorders among DUI offenders was nearly 20% among women, and about 7% among men (Lapham et al., 2001). The one-year prevalence of Generalized Anxiety Disorder (GAD) and Post-Traumatic Stress Disorder PTSD among female DUI offenders was 22% and among male offenders it was 8.5% (Lapham et al., 2001). The generalizability of these study results is limited as the sample was restricted by race and ethnicity, including only individuals of Caucasian or Hispanic decent (Lapham et al., 2001). Previous studies have indicated that Hispanics are overrepresented among both first and repeat DUI offenders (Baca, Lapham, Skipper, & Hunt, 2004).

A related line of research examines the associations between anxiety and/or mood disorders and alcohol use disorders or problems. Rush et al. (2008) used a large representative sample of Canadians (n= 36 984) to estimate the prevalence of MI, in particular anxiety and mood disorders, and comorbid substance use disorders, including alcohol use disorders. The scholars noted that the prevalence of alcohol use disorders among respondents with anxiety and/or mood disorders was about two times that of individuals without MI (16.1% compared to 8.9%) (Rush et al., 2008).

2.20.3 Anxiety and/ or Mood Disorders or Symptoms and Road Rage

Few studies have investigated the association between MI or symptoms of MI and road rage victimization or perpetration. Investigations designed to examine this

relationship typically use cross-sectional survey data (Smart, Ashbridge, Mann, & Adlaf, 2003; Fong, Frost, & Stansfeld, 2001). Smart et al. (2003) investigated the relationship between psychiatric distress and road rage victimization or perpetration using data for a one year period from a representative sample of Ontario adults (n = 2,610). The researchers divided the sample into five clusters of road rage offenders: verbal threat offenders (cluster 1), verbal victims (cluster 2), hardcore road rage offenders (cluster 3), verbal victim-offenders (cluster 4), and no road rage involvement (cluster 5). Only in cluster 3 was the proportion of participants with psychiatric distress (27.5%) significantly higher than the average for the total sample, while the proportion of participants in cluster 5 (no road rage involvement) with psychiatric distress (10.9%) was significantly lower than average for the total sample.

2.20.4 Road Rage and Drinking and Driving

The studies that have investigated the relationship between road rage and drinking and driving have consistently found an association between the two variables. Studies examining this relationship have analyzed data from cross-sectional, self report surveys of the general population, or drivers receiving treatment for alcohol problems related to drinking and driving (Yu, Evans,& Perfetti, 2004; Beck, Wang, & Mitchell, 2005). Yu et al. (2004) conducted a cross-sectional study with a sample of clients at alcoholism and substance abuse treatment facilities for drinking and driving (n =431) over an eight month period. The authors found a relationship between road rage and drinking and driving; the variables were moderately correlated ($r = .29$, $p < .01$) (Yu et al., 2004). However, the generalizability of the findings is limited as only repeat DUI offenders were included in the sample (Yu et al., 2004).

Beck et al. (2005) demonstrated an association between drinking and driving and aggressive driving using data from a population based, self-report survey of Maryland drivers. The researchers found that aggressive drivers, when compared to non-aggressive drivers had nearly 15 times greater the odds of driving after having too much to drink, after adjusting for demographic factors, frequency of driving and alcohol beliefs. However, these findings are limited due to validity problems because of the operational definitions of aggressive driving and drinking and driving. When selecting drivers for the non-aggressive groups the authors excluded any driver who acknowledged drinking and

driving. Therefore, the odds ratio reported is likely biased towards over estimating the odds of drinking and driving for aggressive drivers.

2.21 Summary of Studies Examining the Relationships between Predictors

Studies have demonstrated a higher prevalence of antidepressant and anxiolytic medications use among individuals with symptoms of anxiety or mood disorders (Beck et al., 2005a). Anxiety and mood disorders are overrepresented among drinking drivers, especially female drinking drivers (Lapham et al., 2001). Also, psychiatric distress was over-represented among serious road ragers (Smart et al., 2003). An association between drinking and driving and road rage has also been established (Yu et al., 2004)

2.22 Anxiety and/or Mood Disorders, Antidepressants and Anxiolytics and MVCs

Some researchers have argued that depressed drivers taking antidepressant psychotropic medications may experience more negative driving outcomes while driving, including MVCs, than the unmedicated depressed driver (Brunnauer et al., 2006; Wingen, Ramaekers & Schmitt, 2006). Individuals with mood disorders and who use antidepressants may have impaired driving abilities because of impairments in their cognitive and psychomotor functioning (Brunnauer et al., 2006; Lane & O'Hanlon, 1999). In addition, antidepressants may have sedating effects for participants with mood disorders, further impairing driving ability (Brunnauer et al., 2006). A review of the literature yielded only four studies that examined the effect of antidepressant psychotropic medication use on driving outcomes, including MVCs, in depressed patients (Hobi et al, 1982; Schmitt, Wingel, Riedel, & Ramaekers, 2004; Brunnauer et al., 2006; Wingen, Ramaekers, & Schmitt, 2006). These studies use an experimental design, testing samples of medicated depressed inpatients tested with an on-the road driving test and road tracking task (Hobi et al, 1982; Schmitt et al., 2004; Brunnauer et al., 2006; Wingen et al., 2006).

Hobi et al. (1982) conducted a non-randomized comparative study in which they compared the driving performance of 20 depressive patients on antidepressants for three to four months of treatment to 32 healthy unmedicated controls. Participants were tested on two testing days. Day one was two to four weeks into the treatment period and day two was two to three months later. Participants were tested on a variety a performance tasks including a road tracking task which measured 'time within the lane', 'time outside

the lane', and 'frequency outside the lane' (Hobi et al., 1982). Patients performed more poorly than controls on all measures in a road-tracking task (Hobi et al., 1982). However, a weakness of this study, like many experimental studies examining the relationship between antidepressant use and MVCs for depressed populations, is that it cannot be determined what proportion of the observed deficits in performance are due to the medication and not the mental illness itself.

Brunnauer et al. (2006) examined a population of 100 depressed inpatients taking a wide range of antidepressant medications, using a non-randomized naturalistic study design. Antidepressant medication drug choice was determined by each patient's treating psychiatrist. The scholars assessed psychomotor functioning in areas the German guidelines for road and traffic safety had deemed to be crucial for assessing driving ability, such as visual perception, selective attention, vigilance, and reactivity and stress tolerance. Results indicated that 76% of the patients taking any antidepressants did not meet the German standard to drive (Brunnauer et al., 2006). In addition, results varied across the type of antidepressant used (Brunnauer et al., 2006). Notably, 90% of TCA users and 72% of SSRIs users failed to meet the criteria to drive, as they displayed mild or severe impairments in driving abilities (Brunnauer et al., 2006). However, the generalizability of these findings is limited by the use of depressed inpatients only. The majority of individuals with mood disorders are outpatients (Health Canada, 2002; Verster et al., 2005). More importantly, it is still not possible in this research to determine what degree of the variability in driving performance is due to mood disorders versus antidepressant medication use.

Wingen, Ramaekers and Schmitt (2006) performed an insightful quasi-experimental study in which they assessed driving performance and cognitions of depressed outpatients receiving long-term antidepressant treatment. The investigators sampled 24 subjects who used one of two types of antidepressants, SSRIs or Selective Norepinephrine Reuptake Inhibitors (SNRIs), and compared them to 24 controls matched for age, and sex. A strength of this investigation was the exclusion of participants who had chronic medical conditions, a history of illnesses and/or were using illicit drugs (Wingen, Ramaekers, & Schmitt, 2006). Previous studies have indicated these variables

are potential confounders (Vaa, 2003). Investigators tested the subjects' driving ability using a road tracking test and a car following test on a closed driving circuit (Wingen et al., 2006). Results indicated depressed outpatients being treated with antidepressants had a significant impairment in driving ability when tested on a closed driving circuit (Wingen et al., 2006). In particular, the medicated patients had higher SDLP and a statistically significant impairment on all driving performance measures (Wingen et al., 2006).

Few studies have been undertaken to determine the relationship between anxiety disorders, anxiolytic medication use and negative driving outcomes such as MVCs. Studies that have been conducted share some common characteristics. Generally, the studies that have been conducted adopt a double blind crossover design, testing the driving ability of samples of anxious inpatients or outpatients in normal traffic (Moore, 1977; van Laar et al., 1992; O'Hanlon et al., 1995).

Moore (1977) used a crossover design to assess the driving ability of 14 clinically anxious inpatients who were taking the anxiolytic medication Medazam. Participants were all male, military personnel between the ages of 20 to 40 who received anxiolytics for three weeks, and placebos for three weeks. Drivers performed a braking test, a real driving test, and a simulated driving test. Results indicated no differences in major or minor errors in braking or simulated driving tests; however, in real driving tests conducted in normal traffic, participants made more minor "technical" errors (Moore, 1977). Since all participants were male, military personnel from a narrow age group, findings cannot be generalized to the general population (Vingilis & Wilk, 2007).

Two investigations examined the effect of multiple types of anxiolytic psychotropic medications on the driving ability of anxious individuals during driving tests. Drivers were tested on car following where they were asked to maintain a constant speed and SDLP was measured. One investigation involved an integration of three experiments determining the effects of BZDs and BZD-like anxiolytics on driving (O'Hanlon et al., 1995). The other investigation compared the effects that Buspirone and BZDs had on driving ability in a double blind experiment (van Laar et al., 1992). O'Hanlon et al. (1995) directly examined the driving performance of medicated and

unmedicated anxious patients when on benzodiazepines. The authors were investigating whether the unmedicated anxious patients are in fact poorer drivers than healthy volunteers and whether the difference in these groups remained when the anxious patients were treated with anxiolytic medications. One of the three experiments involved patients diagnosed with GAD or Adjustment Disorder with anxious mood (n = 56) (O'Hanlon et al., 1995). In this experiment, anxious patients were randomly assigned to conditions where they received one of three types of benzodiazepines during a three-week period. All subjects completed two driving test. Ten subjects across the three benzodiazepine groups failed to complete their first driving tests. Eight patients drove with a SDLP that was greater than the limit during their first driving test. During the second series of driving tests, three patients exceed the SDLP limit and two patients failed to complete the test. Overall, results indicated that anxious patients' baseline driving tests, in terms of SDLP, were completely normal.

Van Laar, Volkerts and van Willgenburg (1992) conducted a study which supports the argument that drivers with anxiety disorders or symptoms taking anxiolytic psychotropic medications are impaired and at a greater risk of MVCs. Researchers randomly assigned two group of patients with mild to moderate GAD to receive one of the two most commonly prescribed anxiolytics; diazepam, a type of benzodiazepine (n=12), or Buspirone (n=12). The drivers were actively treated with the drug for four weeks, with a placebo treatment for one week pre and post treatment. The drivers were tested weekly using the standard on the road driving test (O'Hanlon, 1984). The key outcome measures were SDLP and speed deviation. Results indicated that subjects in the diazepam group were unable to complete the test during the first and second weeks because of serious sedative reactions. Diazepam significantly impaired driving ability, which was evident by significant deficits in SDLP for three of the four treatment weeks, when compared to placebo baseline performance. In addition, participants in the diazepam group had a decreased ability to control speed during the first treatment week. The Buspirone group did not show any deficits in SDLP or speed deviation, over the treatment period (van Laar et al., 1992).

2.23 Alcohol, Antidepressants and Anxiolytics and MVCs

Alcohol and anxiolytic medications, such as BZD, act as central nervous system (CNS) depressants. The combined effects of these CNS depressants are additive (Seppala, Mattila, Palva & Aranko, 1986). Studies have suggested that alcohol and BZDs may cause deficits in cognitive and psychomotor performance in areas such as vigilance that are important for driving (Kurzthaler et al., 2003; Ogden & Moskowitz, 2004). In a descriptive study by Kurzthaler et al. (2003), the authors measured the prevalence of alcohol use and BZD use among Austrian adults involved in injurious MVCs who presented at a trauma hospital (n = 269). Alcohol and BZD use was examined in blood samples taken less than two hours after a crash. The findings indicated that approximately 1.9% of the sample was using both BZDs and alcohol (Kurzthaler et al., 2003).

Vingilis, Larkin, Stoduto, Parkinson-Heyes, and McLellan (1996) conducted a case control study in which they interviewed MVC victims injured in a crash who presented at the trauma unit at a hospital (n= 149). The researchers compared individuals who had a BAC of greater than zero to individuals who were not drinking at time of admission (Vingilis et al., 1996). Approximately 21% of admitted drivers were alcohol positive. Among drivers who tested positive for alcohol, 32% were taking prescription medications. A significantly higher proportion of the admitted drivers who tested positive for alcohol were medication users, compared to drivers who were not drinking (Vingilis et al., 1996); however, these findings may be limited because drivers who appeared in the hospital for injuries related to MVCs may not be representative of all drivers involved in MVCs (Vingilis & Wilk, 2007).

Movig et al. (2004) conducted a prospective observational case-control study over a 15 month period, sampling individuals who required hospitalization following a MVC (n= 110) and controls who completed roadside surveys within one week of a case appearing at hospital (n = 816). Researchers found the odds of injurious MVCs associated with drug and alcohol combinations (including BZDs and alcohol) were elevated more than 112 times, after adjusting for various factors such as age, and gender (Movig et al., 2004).

2.24 Summary of Literature on Multiple Factors and MVCs

Multivariate studies have indicated repeated use of anxiolytic or antidepressant medications among anxious or depressed populations is associated with negative driving outcomes in experimental studies. Combined alcohol and anxiolytics, specifically BZD use, has been associated with MVCs.

2.25 Conceptual Synthesis

Petridou and Moustaki (2000) provided a framework that can serve as a basis for examining factors that contribute to MVCs. Studies have indicated that symptoms of anxiety or mood disorders, psychotropic medications used to treat anxiety or depression, drinking and driving, and road rage may act independently and in combination as predictors of MVCs (Crancer & Quiring, 1969; Mann et al., 2007; Ogden & Moskowitz, 2004; Vingilis et al., 1988; Vingilis & Wilk, 2008; Wingen et al., 2006); however, the focus of this research has predominantly been on examining the relationship between a human factor variable and MVCs. In addition, a small number of studies have focused on relationships between human or behavioural factor variables and MVCs. Considering the complex and multifactoral causation of MVCs, there is a need for a conceptual model to guide multivariable analyses to determine the collective and individual role of human factors variables in the risk for MVCs. Psychiatric distress (a proxy measure for anxiety and/or mood disorders) may act as a long-term behavioural factor that reduces driving capability. If psychiatric distress and anxiolytic and/or antidepressant medications, drinking and driving, or road rage is present these behavioural factors might be associated with an elevated risk of MVC. Symptoms of an anxiety and/or mood disorder may act as a long-term factor to reduce driving capability and they may independently increase risk of MVCs. However, the elevated risk of MVC may be mediated by: taking anxiolytic or antidepressant psychotropic medications, drinking and driving and road rage (victimization and perpetration) (See Figures 2.1-2.4).

Figure 2.1: Model of the Hypothesized Relationship among Symptoms of Anxiety or Mood Disorders, Antidepressant or Anxiolytic Psychotropic Medications and MVCs

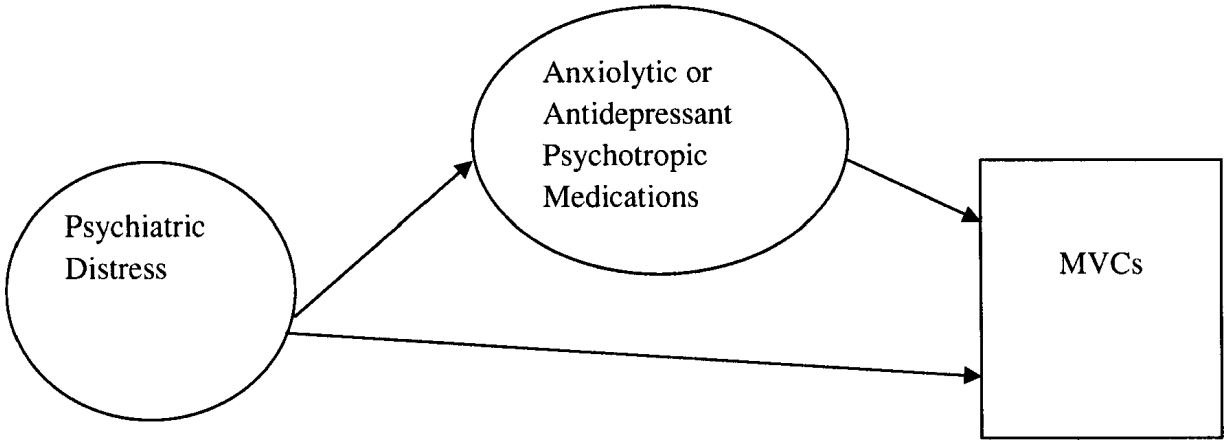


Figure 2.2: Model of the Hypothesized Relationship among Symptoms of Anxiety or Mood Disorders, Drinking and Driving, and MVCs

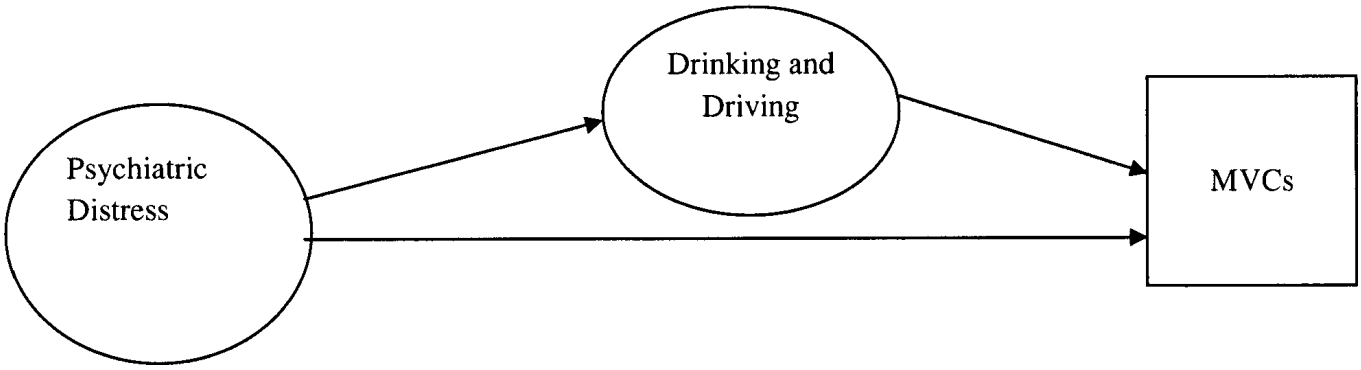


Figure 2.3: Model of the Hypothesized Relationship among Symptoms of Anxiety or Mood Disorders, Road Rage and MVCs

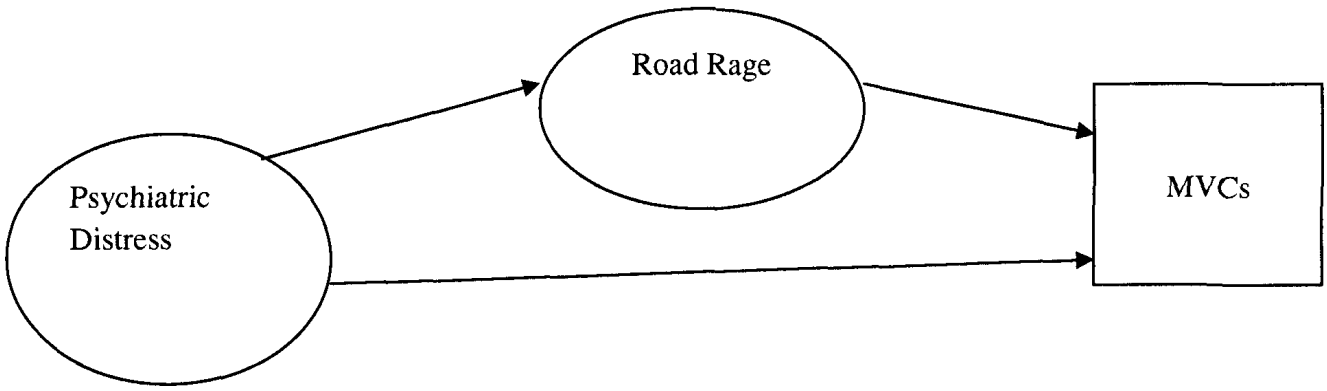
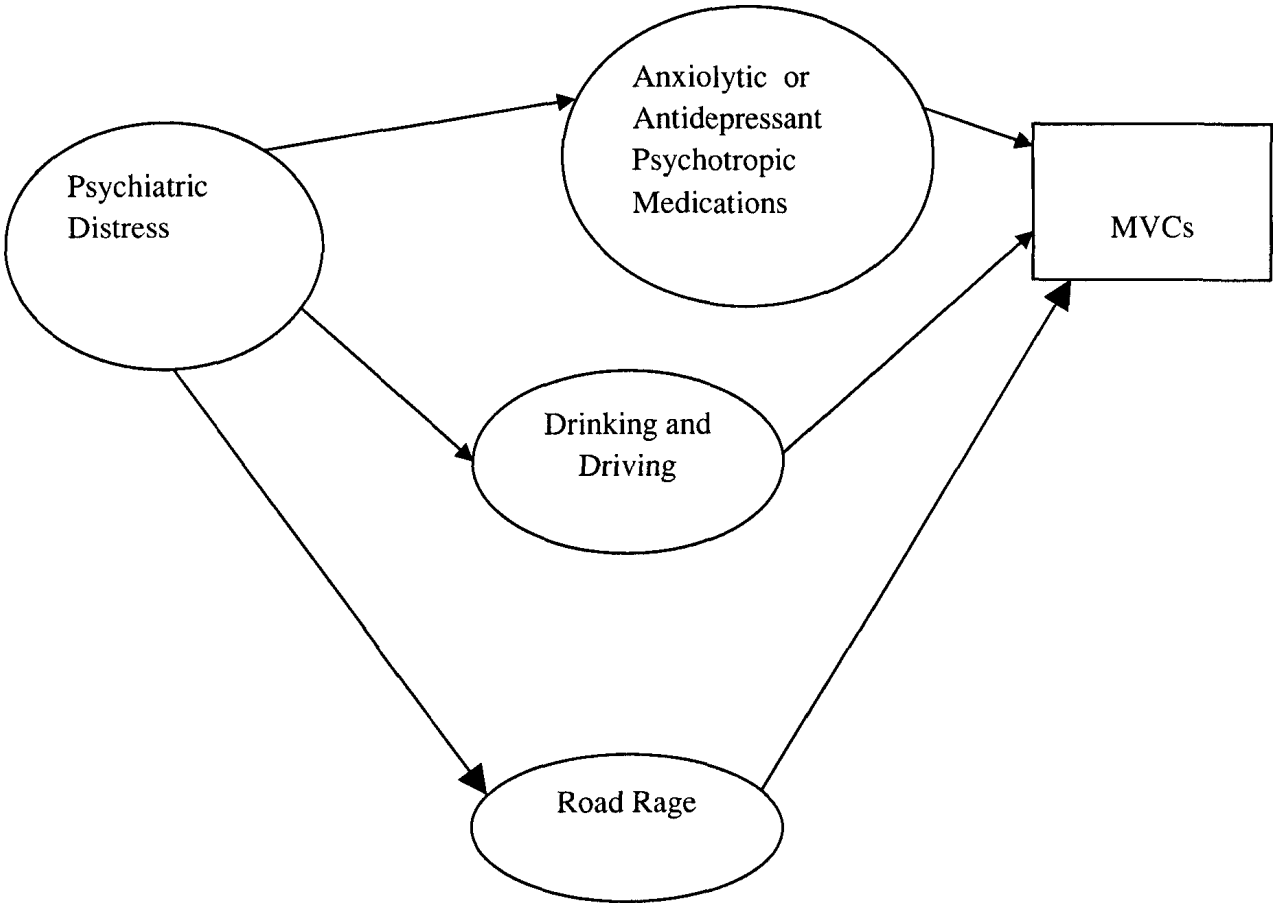


Figure 2.4: Model of the Hypothesized Relationships among Symptoms of Anxiety or Mood Disorders, Antidepressant and Anxiolytic Psychotropic Medications, Drinking and Driving, Road Rage and MVCs



2.26 Rationale

Researchers have repeatedly indicated that the causes of MVCs are multifactorial (Elvik & Vaa, 2004; Vaa, 2003; Petridou & Moustaki, 2000). Previous studies have focused on investigating the relationships between MVCs and human risk factors such as anxiety and/or mood disorders, psychotropic medication for anxiety or depression, drinking and driving, and road rage. That is, most studies have examined the direct effects of human factors on MVCs. However, "third variable effects" are possible (MacKinnon, Krull & Lockwood, 2000). Given that anxiety and mood disorders are correlated with psychotropic medication use, the relative independent effects of the condition and the treatment on MVC risk are unclear. Similarly, anxiety and mood disorders are correlated with drinking and driving and with road rage. It is not known whether the disorders are directly associated with MVCs or whether the drinking driving or road rage mediates the effect.

In the examination of a mediational hypothesis, the relationship between a predictor variable and an outcome variable is decomposed into two putative causal paths, as shown in Figures 2.1 through 2.4 (MacKinnon et al., 2000). One of the paths directly links the predictor variable to the outcome variable, for example anxiety and/or mood disorders to MVCs (the direct effect) and the other links the intermediate variable (also known as mediator) to the outcome variable, for example psychotropic medication use to MVCs (the indirect effect) (McKinnon et al., 2000). An indirect or mediated effect suggests that the predictor variable causes the intermediate variable (the mediator), which, in turn causes the outcome variable (MacKinnon et al., 2000).

A substantial proportion of individuals with symptoms of anxiety and mood disorders have been found to consume anxiolytic and antidepressant psychotropic medications (Ohayon et al., 1998; Beck et al., 2005a). De Gier (1993) estimated that psychotropic medications were a contributing factor to approximately 10% of MVCs that resulted in injuries or fatalities. It has been demonstrated that psychotropic medications impair the driving ability of individuals with diagnosed anxiety and/or depressive disorders; however, to date no study has assessed the multivariate relationship of anxiety and/or mood disorders, and anxiolytics and antidepressants on MVC risk.

Alcohol is a legally consumed substance that has been associated with negative driving outcomes including MVCs (Ogden & Moskowitz, 2004). The presence of symptoms of anxiety and/ or mood disorders has been found in drinking and driving populations (Lapham et al., 2001). It is possible that individuals who have a pre-existing anxiety disorder or mood disorder are overrepresented in drinking and driving populations because they consume alcohol to cope with their symptoms (Lapham et al., 2001; Lapham, Baca, McMillan, & Lapidus, 2006; Khantzian, 1985); therefore, it is possible that drinking and driving partially mediates the association between anxiety and/or mood disorders and MVCs. Finally, aggressive driving or road rage and MI, including symptoms of anxiety and/or mood disorders, have been linked (King & Parker, 2008). Road rage has been associated with an increased risk of MVCs (Mann et al., 2007; Wells-Parker et al., 2002). It is possible that road rage mediates the risk of MVCs. The cognitive and psychomotor deficits associated with symptoms of anxiety and/or mood disorders may cause driving errors which leads to road rage victimization. It is also possible that persons suffering with anxiety or mood disorders are more sensitive to the behaviour of other drivers and perceive themselves to be victimized. During, or soon after victimization, driving may be more difficult for individuals with symptoms of anxiety and/or mood disorders as they are distracted by worrying about being victimized. When this happens, drivers are at greater risk of being involved in a crash. Road rage perpetration may mediate the risk of MVCs, as individuals with symptoms of anxiety and/or mood disorders may express frustration and anger more often on the road.

It is possible that each of the three factors mediate the risk of MVCs for individuals with symptoms of anxiety and/ or mood disorders through distinct pathways. Anxiolytic and antidepressant medication use may create cognitive deficits in the long-term. The acute effects of alcohol before driving impair the cognitive and psychomotor response of the drivers (Ogden & Moskowitz, 2004). Perpetrating road rage and reacting to being a victim of road rage may distract drivers to the point where this partially mediates collision involvement. The purpose of this study is to examine the direct and indirect effects of the human factors of symptoms of an anxiety and/or mood disorder, antidepressant and/or anxiolytic medication use, drinking and driving, and road rage on MVC risk. Specifically, the following questions will be examined.

1) What is the strength and direction of association between MVCs and the individual predictors variables of age, sex, marital status, or education, psychiatric distress, antidepressant and/or anxiolytic medication use, drinking and driving, and road rage related to MVCs?

2) Does an independent association exist between MVCs and symptoms of anxiety and/or mood disorders? If so:

3) Does anxiolytic and antidepressant psychotropic medication use mediate the association between symptoms of anxiety and/or mood disorders and MVCs?

4) Does drinking and driving mediate the association between symptoms of anxiety and/or mood disorders and MVCs?

5) Does road rage (victimization and/or perpetration) mediate the association between symptoms of anxiety and/or mood disorders and MVCs?

Chapter 3: Methods

3.1. Study Design

This study is a secondary data analysis conducted with cross-sectional data from the Centre for Addiction and Mental Health (CAMH) Monitor Survey, a large population based survey of Ontario adults (individuals aged 18 and over) (Ialomiteanu & Adlaf, 2008; Ialomiteanu & Adlaf, 2007; Ialomiteanu & Adlaf, 2005; Ialomiteanu & Adlaf, 2004; Ialomiteanu & Adlaf, 2003).

3.2. CAMH Monitor

3.2.1. Survey Design

The CAMH Monitor is an ongoing monitoring survey of Ontario adults. For the purpose of this survey, the province is divided into six geographical regions: Toronto, Central West, Central East, West, East, and North. Since its inception in 1996, the CAMH Monitor has been administered by the Institute for Social Research (ISR) at York University. It was designed as the primary method of monitoring addictions and mental health issues in Ontario, including alcohol use, drug consumption, substance use problems, public opinion regarding drug issues and policies, mental health status, and gambling (Ialomiteanu & Adlaf, 2007). For the years 2002, 2003, 2004, and 2006, which are of interest for the current study, the response rate varied between 58 -61%. The CAMH Monitor Survey has a high response rate when compared to response rates of other high quality health risk surveys, such as the 2004 edition of the Behavioural Risk Factors Surveillance System, the largest survey of health risks conducted by the Centre for Disease Control and Prevention (CDC) (Ialomiteanu & Adlaf, 2007; CDC, 2005).

The CAMH Monitor is an aggregation of independent monthly surveys. As a repeated survey it provides more up to date information than one-time surveys (Ialomiteanu & Adlaf, 2007). Furthermore, since the survey is the sum of repeated samples, it yields better statistical estimation than one-time surveys (Ialomiteanu, & Adlaf, 2007).

3.2.2 Sample Design

Two-stage probability sampling was used to select respondents for the survey. Each month respondents were selected from a sample of all active area codes and household phone numbers in Ontario. The phone numbers were provided by American Telephone and Telegraph (ATT) Long Lines Tape. In stage one, a random sample of telephone numbers were selected within each region of Ontario; within each region any household telephone number has an equal probability of being selected. In the stage two, within each household, a respondent 18 years of age or older is selected to complete the survey according to the most recent birthday of the household members (Ialomiteanu, & Adlaf, 2007). The most recent birthday technique produces an unbiased sample and it is a relatively non-intrusive technique (O'Rourke & Blair, 1983). Furthermore, individuals who were unable to complete the interview in English or French were excluded (Ialomiteanu, & Adlaf, 2007). Unanswered numbers were called back a minimum of 12 times and households that initially refused to participate were re-contacted to ensure maximum participation (Ialomiteanu, & Adlaf, 2007). To increase precision for all areas of the province, the sample is equally collected from the six regions of the province. The CAMH Monitor sample is representative of Ontarians age 18 and older (n= 9,118, 084 from 2001 Ontario Census) (Ialomiteanu & Adlaf, 2007).

Two-stage probability sampling differs in subtle ways from simple random sampling. The selection of respondents from household by last birthday creates a design effect, but this effect is so small that makes little or no difference in estimates (Bondy, 1994; Northrup, 1993). Because of this, the design effect was excluded from the current study.

3.2.3 Sample Weighting

Since equal numbers of participants were selected from each of the six regions in the province, weights are required to restore population representation. To restore population representativeness, weighting is measured by the variable 'final annualized relative weight' (FWGHT). FWGHT represents weighting by the number of interviewed respondents. Sampling weights are a function of the number of household members, the region, and the survey wave, or month, of sampling. As a result, when referring to the study population the weighted sample sizes will be reported (Ialomiteanu & Adlaf, 2007).

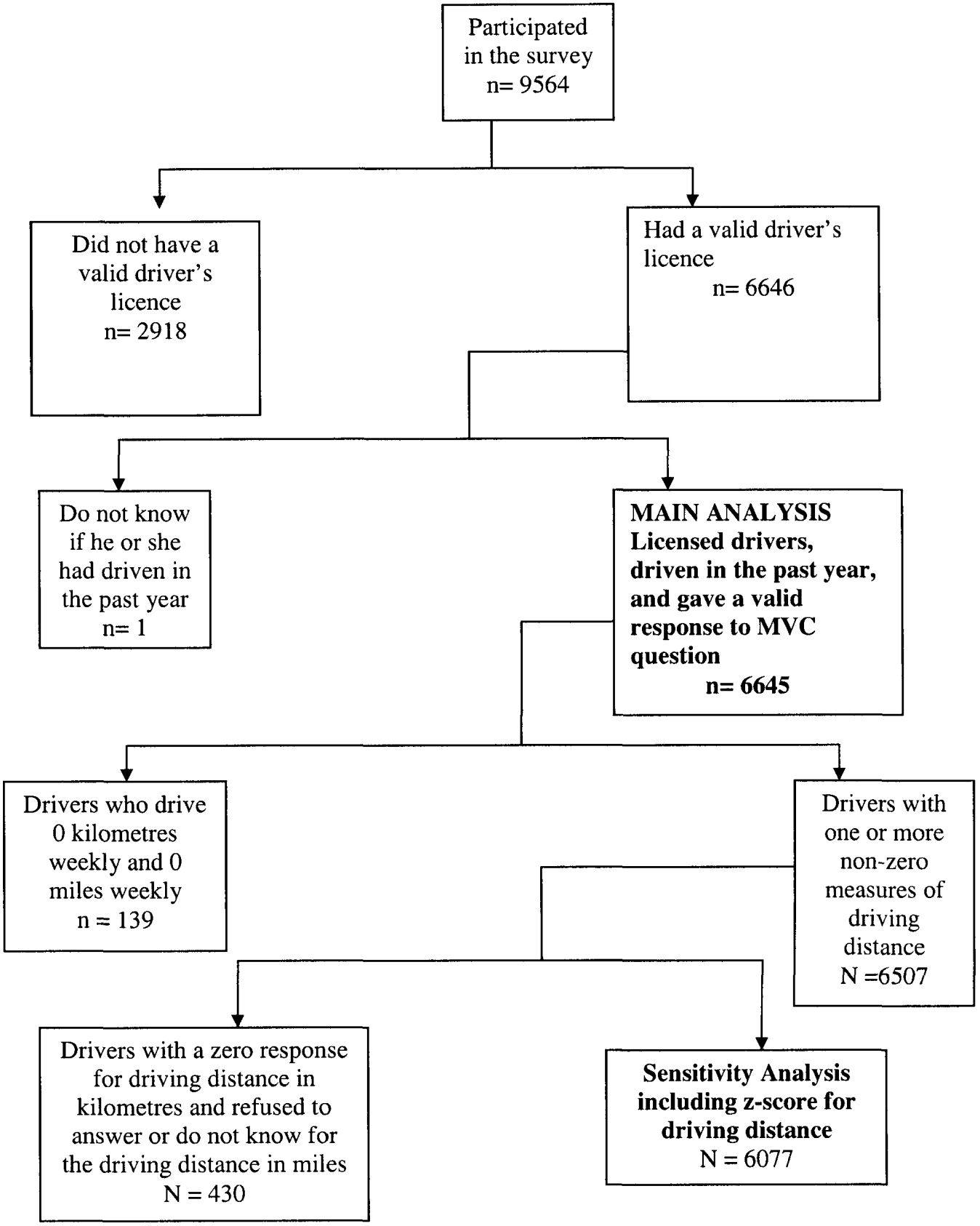
3.3 Study Population

The current study includes respondents from the 2002, 2003, 2004, and 2006 waves of the CAMH Monitor (n = 6,645). These four years were selected, as they were the only time frames during which all study variables were included. From this sample, 2,918 participants were excluded because they responded don't know, refused or their responses were missing for the outcome variable (MVCs) and did not have a valid driver's licence. The sample includes only the drivers who had a valid driver's licence

3.3.1 Inclusion criteria and Exclusion criteria

To be included in the study sample participants must have currently had a valid driver's licence and have driven a motor vehicle in the past 12 months. After applying those two inclusion criteria the participants who remained were those who provided a valid response to the MVC item along with having a valid driver's licence and having driven in the past year. For the sensitivity analysis that included a measure of driving distance, an additional criterion was added to those stated above. Participants must have reported a single measure of driving distance in kilometres and/or miles. Participants were excluded if both their recorded responses were 0 (0 in kilometres and 0 in miles). If recorded responses were available in both kilometres and miles, participants were excluded if they had either of these combinations, 0 for driving distance in kilometres and do not know or refused to answer in miles or 0 for driving distance in miles and refused to answer or do not know in kilometres.

Figure 3.1: Study Sample Selection



3.4 Sample Size Calculations and Power

The necessary sample size was determined using the SAS Proc Power procedure based on the Pearson Chi-squared test for two proportions in SAS, version 9.1. Health Canada (2002) estimated the one-year prevalence of MI to be about 20%; this measure was used as the reference proportion. A recent meta-analysis estimated the relative risk of MVCs for individuals with MI to be 1.72 (Vaa, 2003). In addition, the sample was weighted as previous literature has indicated that the ratio of individuals with MI to individuals without MI was 1:4 (Health Canada, 2002). With a power of 80%, $(1- \beta) = 0.80$, and with $\alpha = .05$, the minimum sample required to detect a relative risk or odds ratio of at least 1.72 is 480 respondents. Relative risk and odds ratio estimates are approximately equal when considering rare events, defined by a prevalence of 10% or less, such as MVCs (Kopesell & Weiss, 2003).

3.5 Data Collection

Data were collected from January 10 to December 22, 2002; January 10 to December 30, 2003; January 3 to December 30, 2004; and January 3 to December 30, 2006 (Ialomiteanu, & Adlaf, 2008). All interviewers were conducted by trained staff from the Institute for Social Research (ISR). The interviewers used telephone, video monitor, and computer keyboard to ask and record participant's responses (Bondy, 1994). The computer program associated with the questionnaire controlled the presentation of questions during the interview on the video monitor (Bondy, 1994). The Computer Assisted Telephone Interviewing (CATI) system followed a programmed skip pattern, and customized the wording of some questions to make the interview flow smoothly, ensuring consistency between interviewers.

CATI technology allowed for the blind supervision of interviewers, while also creating computer data files (Bondy, 1994). CATI systems are preferred over pen and paper questionnaires because they produce fewer errors and less missing data (Catlin & Ingram, 1988). With the CATI system the interviewer is notified of out of range values immediately, and cannot proceed until the error is corrected. Also, the interviewers were able to add typed comments to the data file during the interview. A computer record was kept of deviations so that irregularities in responses could be traced (Bondy, 1994).

3. 6 Survey Instrument and Scales

The CAMH Monitor was written for use with a CATI interviewing system, corresponding to a telephone interview averaging 25 minutes in length (Ialomiteanu, & Adlaf, 2008; Ialomiteanu, & Adlaf, 2003). The survey includes sections on driving, alcohol use, drug use, and mental health indicators (Ialomiteanu, & Adlaf, 2008). There are over 300 items, but no respondents answered all items. Furthermore, there were logical skips patterns. For example, if a participant was asked if they consumed any alcoholic beverages in the past year and responded no, they would skip any questions about alcohol consumption in the past seven days.

There are two types of items on the CAMH Monitor. Full panel items are items that are included during all months. Panel items appear only during six months of a given year. Therefore, approximately half the sample responds to the panel items. For this study, only full panel items were used. All missing values, do not know, and refused to answer responses were excluded from this analysis. Only the sections, which directly pertain to the thesis project will be explained in further detail in the following sections. For more information on these items see Table 3.1, and to see these items as they appeared on the survey, see Appendix A.

3.7 Measures

3.7.1 Psychiatric Distress: The General Health Questionnaire- 12 (GHQ-12)

During a telephone interview, participants were asked to respond to the 12 items on the GHQ-12. As the creator of the GHQ-12, Goldberg (1972) described it, the GHQ-12 is most successful when used as a screening tool for "affective neuroses", which represents individuals with minor depression and anxiety states (Goldberg, 1972). The GHQ-12 has occasionally been used as a screening instrument for the detection of minor psychiatric disturbances in community and non-psychiatric settings (Hardy, Sharpio, Rick, & Haynes, 1999; Prevalin, 2000). The 12-items that make up the GHQ-12 ask participants over the past few weeks about their ability to concentrate, play a useful role in life, make decisions, enjoy daily activities, face problems, feel happy, lose sleep over worry, feeling under constant strain, overcoming difficulties, feel unhappy/depressed, lost confidence, and feelings of worthlessness (See Appendix A). For each item on the GHQ there are four response options. Items were scored using the binary scoring system in which the four possible response options to any individual item are coded 0,0,1, and 1

(Goldberg et al., 1997). The binary scoring method for the GHQ-12 has demonstrated the highest sensitivity (83%) of any GHQ scoring method (Goldberg et al., 1997). The specificity of this method is approximately 75%, yielding a receiver operator curve (ROC) area under the curve of 0.88 (Goldberg et al., 1997). When using the binary scoring method across studies it has been recommended to use a scoring threshold of 1/2, where scores of less than 2 are defined as non-cases and scores of 2 or greater are defined as cases of psychiatric distress (Goldberg et al., 1997). For this study, scores on the twelve items were summed. Individuals with a score of 2 or greater were defined as having psychiatric distress.

3.7.2 Psychotropic Medication Use

Two items were used to generate the psychotropic medication use variable. One item was a binary measure of respondents' use of prescription medication to treat depression in the past year. Participants that endorsed the use of psychotropic medication received a score of 1 and those who did not use medication were coded as a 0. Another item was a binary measure of respondents' use of prescription medications to treat anxiety in the past year (See Appendix A) and was coded in a similar manner. Individuals who endorsed using anxiolytic medications received a score of 1 and those who did not use medications were coded as a 0. The scores were then summed. Summed scores were then recoded so that any individuals with a score of 1 or greater were identified as antidepressant and/or anxiolytic medication users.

3.7.3 Drinking and Driving

Drinking drivers were identified using a single item from the survey. A count variable for drinking and driving asked respondents the number of times in the past year they had driven within an hour of consuming two or more alcoholic drinks (see Appendix A). This count variable was recoded into a binary measure of drinking and driving. Scores of one or more incident of drinking and driving identified an individual as a drinking driver.

3.7.4 Road Rage

Participants responded to four items inquiring about road rage victimization and four items asking about road rage perpetration, adopted from a classification system for road rage behaviours developed by Smart and Mann (2002). The researchers defined six

road rage behaviours for which drivers could be a victim or be a perpetrator. These behaviours included: general expressions of anger and frustration at traffic situations or drivers, but not directed at them, such as waving hands, shouting, honking (Smart & Mann, 2002). In addition, gestures clearly aimed at other road users were added as another category of road rage behaviours (Smart & Mann, 2002). Furthermore, the authors defined physical intimidation to include actions such as tailgating; verbal threats to injure other road users; physical injury of other road users or vehicles; and causing the death of other drivers or passengers. From this taxonomy, eight road rage items were developed (See Appendix A). Questions were originally coded to record the number of times participants had been a victim of the following events while driving: shouts, curses or rude gestures; threats to hurt yourself or others with you or damage your vehicle; intentional or attempted damage of the vehicle you were in; intentionally hurt or threatened to hurt you or others with you in a vehicle (Ialmotineau & Adlaf, 2003). Four items asked participants if they had been perpetrators of the previously stated events. There is no standard measure of road rage victimization or perpetration; as a result, no validity information for these scales was available. The count responses were re-categorized into a binary measure of road rage. Each of the eight scores was dichotomized, as having one or more road rage incident and no road rage incidents. All eight road rage item scores were summed and further recoded so that at least one road rage experience of any kind defined an individual as being exposed to road rage.

3.7.5 Motor Vehicle Collisions (MVCs)

The outcome variable of interest in this study is MVCs. During the data collection participants were asked to provide the number of MVCs they have been involved in that resulted in damage to the driver, another person or a vehicle. During the data cleaning process, MVCs were recoded into a binary variable, with a coding of 1 for individuals involved in an MVC and 0 for those not involved in an MVC.

3.7.6 Demographic Covariates

Age, gender, marital status, education, and driving distance were considered in relation to the study questions. Age was divided into five categories: 18-29, 30-39, 40-49, 50-64, and 65+. Male or female gender was recorded. Marital status was originally coded as six categories, but was recoded into three categories: married/ living with a partner;

widowed, divorced, or separated; and never married because this was a common method of categorizing marital status in the literature (Mann et al., in press). Previous studies suggest marital status be divided into the three categories used for this thesis project (Noyes, 1985; Redelmeier & Tibshirani, 1997). Education was recoded from 14 categories into two categories: never completed high school and completed high school. The variable, driving distance, was derived as an aggregation of z-scores for drivers who reported their weekly driving distance in kilometres, weekly driving distance in miles, or driving distance for both miles and kilometres. For a detailed explanation of the derivation of the driving distance variable, see Appendix C.

3.8 Secondary Data Source

For this thesis project a secondary data source was used. Secondary data are data that have not been collected for the purpose of this study (Sorensen, Sabroe, & Olsen, 1996). Secondary data sources have numerous advantages as they reduce costs, save time, are usually more representative of the population, often have large samples, and have a reduced chance of bias due to effect of the diagnostic process or attention caused by the research question (Sorensen et al., 1996). Major disadvantages of secondary data are related to the fact that the researchers do not control their selection and quality, and the methods of their collection may be impossible to validate. The road rage victimization and perpetration items are a case in which, because data were not collected for the purpose of this thesis, they cannot be validated and consequently the data available were not validated.

3.9 Data analysis

Data analyses were conducted using Statistical Package for Social Science (SPSS) 16 and Statistical Analysis Software (SAS) 9.1. In this analysis, the study variables were selected from the variables collected during the interviews for the CAMH Monitor.

3.10 Statistical Analyses

3.10.1 Bivariate (or Univariable) Analyses (Frequencies and Odds Ratios)

As a preliminary step, bivariate analyses were conducted to determine if any associations were present between the variables of interest and MVCs. Frequencies for each independent variable were calculated. Bivariate odds ratios were calculated for each independent predictor individually looking at the effect it had on MVCs.

3.10.2 Multivariate Analysis

To examine the research questions outlined in the literature review, three sets of multivariate logistic regression analyses were conducted. The first multivariate logistic regression analysis included the covariates age, gender, marital status, education, psychiatric distress, antidepressant and anxiolytic psychotropic medication use, drinking and driving, and road rage entered into a logistic regression model in a single step.

In a second set of analysis a hierarchical multivariate logistic regression analysis model was conducted to examine the possible mediating, or indirect effect, of antidepressant and anxiolytic medication on the relationship between psychiatric distress and MVCs. A hierarchical regression involves entering variables systematically into a model according to theoretical or pragmatic considerations (e.g. one variable is considered more important or easier to quantify than another) (Norman & Streiner, 2003). This technique is favoured over the use of a stepwise or statistical regression technique as, generally, the decision to include or exclude variables is based solely on statistical criterion (Norman & Streiner, 2003). A review of the literature noted a series of variables that are predictors of MVC involvement. These variables will be grouped conceptually into blocks and entered into a series of models (Tabachnick, & Fidell, 2007). For this analysis, variables were entered in blocks based on the conceptual framework (see Figures 2.1 to 2.4). Demographic predictors were entered as the first conceptual group, or "block," of variables (Tabachnick, & Fidell, 2007).This block was followed by entering psychiatric distress, and antidepressant and anxiolytic medication use in separate blocks. Variables were entered in these blocks based on the assumption that psychiatric distress may precede antidepressant and anxiolytic medication use.

In the third set of multivariate hierarchical logistic regression analyses, the mediating effect of drinking and driving or road rage were assessed. To determine the possible mediating, or indirect, effects of drinking and driving on the relationship between psychiatric distress and MVCs, covariates were entered in blocks to create a model, which included covariates entered in the following order: demographic predictors, psychiatric distress and drinking and driving. Drinking and driving was conceptualized as a short-term factor that reduces driving capability and as a result is a risk factor for MVCs in the short-term. Though cross-sectional data were used for this analysis, it was

argued based on the Petridou and Moustaki (2000) framework for the causes and correlates of MVCs, that psychiatric distress may precede problem drinking behaviours such as drinking and driving.

In the fourth analysis model a multivariate hierarchical logistic regression analysis was conducted to determine if road rage mediated the relationship between psychiatric distress and MVCs. Variables were entered in blocks in the following order: demographic predictors, psychiatric distress and road rage. As an extension to the Petridou and Moustaki conceptual framework for the causes and correlates of MVCs, road rage was added as an immediate factor for collision involvement. Despite the cross-sectional dataset used for this analysis, it has been proposed that psychiatric distress precedes road rage and road rage may mediate the association between psychiatric distress and MVCs.

3.10.3 Mediation

To assess the potential of antidepressant and/or anxiolytic medication use, drinking and driving and road rage as potential mediating variables on the relationship between psychiatric distress and MVCs, Baron and Kenny (1986) criteria for mediation were applied.

To examine if antidepressant and/or anxiolytic medication use mediates an association between psychiatric distress and MVCs (see Chapter 2, Figure 2.1) the following three steps are necessary. A relationship between psychiatric distress and MVCs must be demonstrated, antidepressant and/or anxiolytic medication use must be related to psychiatric distress, and antidepressant and/or anxiolytic medication use must be related to MVCs. Mediation is present if the relationship between psychiatric distress and MVCs is reduced when antidepressant and/or anxiolytic medication use is entered into a model (Baron & Kenny, 1986).

To examine if drinking and driving mediates an association between psychiatric distress and MVCs (see Chapter 2, Figure 2.2) the following three steps are necessary. A relationship between psychiatric distress and MVCs, a relationship between drinking and driving and psychiatric distress, and a relationship between drinking and driving and MVCs have to be demonstrated. Mediation is present if the relationship between

psychiatric distress and MVCs is reduced when drinking and driving is entered into the model (Baron & Kenny, 1986).

To examine if road rage mediates an association between psychiatric distress and MVCs (see Chapter 2, Figure 2.2) the following three steps are necessary. A relationship between psychiatric distress and MVCs, a relationship between road rage and psychiatric distress, and a relationship between road rage and MVCs have to be demonstrated. Mediation is present if the relationship between psychiatric distress and MVCs is reduced when road rage is entered into the model (Baron & Kenny, 1986).

3.11 Sensitivity Analyses: The Exclusion of Weighting

Survey weighting is a controversial issue for complex surveys such as the CAMH Monitor (Gelman, 2007). Researchers have often noted the challenges that emerge when applying survey weighting to regression models (Gelman, 2007). When one wants to estimate a population mean it is standard to apply weighting. However, it is not clear what to do in more elaborate analyses such as logistic regression models (Gelman, 2007).

Apart from the difficulty that comes with deciding how to apply weighting to more complex analyses, in some cases, applying post adjustment weighting may lead to dramatic differences in the frequency distributions and estimates of risk when compared to un-weighted samples (Massey & Botman, 1988). Yet, researchers have argued that post adjustment weighting in surveys may remove or reduce multiple sources of bias in the study findings related to non-response and undercoverage (Massey & Botman, 1988; Casaday & Lepkowski, 1999).

As a result, an unweighted analysis of the previously described multivariate logistic regression models was conducted because of the controversy surrounding the application of weighting to elaborate analyses such as logistic regression for complex survey data (see Appendix C). To see how the relationships between individual variables of interest and MVCs were affected by the exclusion of weighting, an analysis without weighting was conducted.

3.12 Sensitivity Analyses: The Inclusion of Driving Distance

Many scholars have indicated estimates of MVC risk may be confounded without the inclusion of a measure or driving distance or mileage (Vaa, 2003; Cushman et al., 1990). The CAMH Monitor survey includes an item on driving distance, or exposure, where respondents are provided the option of giving an estimate of driving distance in kilometres or miles. However, a portion of the survey respondents had recorded responses in both miles and kilometres. As a result, a sensitivity analysis of the previously described multivariate logistic regression models was run including a z-score measure of driving distance.

Table 3.1. Study Variables

Variable	How and What is Measured
Outcome Variable	
	A binary measure of MVC involvement in the past 12 months
Motor vehicle collision involvement in the past 12 months	1 = at least one motor vehicle collision in the past 12 months 0 = no motor vehicle collisions in the past 12 months
	Independent Variables
Demographic Variables	
Age	**Categorical** Age was categorized into one of five groups based on participants' responses about year of birth 18-29 years old 30-39 years old 40-49 years old 50-64 years old (reference category) 65 and above
Gender	**Binary** 1 = Male 0 = Female (reference category)
Marital status	**Categorical variable** 1 = married or living with a partner (reference category) 2 = widowed, divorced, or separated 3 = never married
Education	**Binary** 1 = graduated from high school 0 = never graduated from high school

Table 3.1 (Continued)

Exposure Variable	
Psychiatric distress	Generated using the binary scoring method for the GHQ-12 (Goldberg et al., 1997) **Binary** 1= presence of psychiatric distress (GHQ total score of ≥ 2) 0= absence of psychiatric distress (GHQ total score of < 2)
Mediating Variable	
Antidepressant and anxiolytic medication use	**Binary** 1= yes 0= no
Drinking and Driving	**Binary** Drinking drivers were individuals who consumed 2 or more drinks with an hour of driving 1= yes 0= no
Road Rage	**Binary** Road ragers are individuals who were involved in a road rage incident as a perpetrator and/or victim in the past 12 months 1= yes 0= no

Chapter 4: Results

4.1 Description of the Study Population Analyzed

A weighted sample of 6645 Ontario drivers met the eligibility criteria for this study. Over the four years selected for this sample the response rate ranged from 58-61%. As displayed in Table 4.1, the frequency of MVCs in this sample was just under 8%. Also, Table 4.1 provides the descriptive statistics for the demographic predictors in the sample. The mean age of participants was approximately 44 years old. When age was divided into five categories, the largest age group was those between 40-49 years of age. The elderly (age 65 and above) made up the smallest age group. The division of age into five categories allowed for groups of similar sizes. Slightly more than half of the sample was male. More than two thirds of the sample were married or living with a partner. In addition, nearly 89% of participants had reported high school completion.

The frequency of psychiatric distress was substantial with a prevalence of 19% (see Table 4.1). The prevalence of antidepressant and/or anxiolytic medication use was just under 9% (see Table 4.1). Just over 9 % of participants admitted to drinking and driving in the past year (see Table 4.1). More than 20% of the sample reported a road rage incident as a victim and/or perpetrator in the past year (see Table 4.1.).

Table 4.1 Characteristics of Sample Participants for All Variables of Interest

Variable	**Frequency (Percent)**
Any Motor Vehicle Collision Involvement (in the past 12 months)	
Yes	511 (7.7)
No	6134 (92.3)
Age Range (18-94)	
Mean	44.85
Standard Deviation	16.21
Median	43.00
Age (groups)	
18-29	1316 (20.2)
30-39	1379 (21.1)
40-49	1503 (23.0)
50-64	1369 (21.0)
65+	955 (14.6)
Gender	
Female	3203 (48.2)
Male	3442 (51.8)

Table 4.1 (Continued)

Marital Status	
Married/ Living with a partner	4510 (68.3)
Widowed/Separated/ Divorced	722 (10.9)
Never Married	1369 (20.7)
Education (Completed High School)	
Yes	5828 (88.6)
No	753 (11.4)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	1264 (19.0)
No	5380 (81.0)
Psychotropic Medication Use (Prescribed to treat Anxiety/panic attacks or Depression or both types of symptoms)	
Yes	524 (8.8)
No	5458(91.2)
Drinking and Driving (in the past 12 months)	
Yes	536 (9.4)
No	5150(90.6)
Any Road Rage Incidents (in the past 12 months)	
Yes	1351 (20.5)
No	5241 (79.5)

4.2 Internal Consistency Reliability of the GHQ-12: Cronbach's Alpha

To examine the internal consistency reliability of the GHQ-12, a Cronbach's Alpha test statistic was calculated. The Coefficient alpha for the GHQ-12 was high (α = .85). For the 12 items of the GHQ the inter-item correlations are displayed on Table 4.2. The average inter-item correlation was .33.

Table 4.2 Descriptive Statistics for the Inter-Item Correlations of the GHQ-12 items

	Mean	Minimum	Maximum	Range	Variance	N of Items
Inter-Item Correlations	.332	.184	.560	.377	.006	12

4.3 Description of the Study Population According to MVC Involvement

As previously stated, slightly under 8% of eligible respondents reported involvement in at least one MVC. When participants were divided by their reported involvement in MVCs, important differences were observed between drivers involved in MVCs and non-MVC involved drivers. Drivers reporting involvement in MVCs were on average five years younger than those not reporting involvement in collisions (see Table 4.2). Furthermore, when age was categorized into five groups, the drivers age 18-29 and

30-39 formed a greater proportion of MVC involved drivers. In contrast, drivers age 40 and above were more frequent among the non-MVCs involved drivers. In terms of gender, a greater proportion of male drivers reported MVCs. A greater proportion of collision involved drivers were never married, while a higher proportion of non-collision involved drivers were married. Not completing high school was more frequently reported among non-MVC involved drivers.

For the exposure variable, psychiatric distress was more frequent among MVC reporting drivers with over 30% of collision involved drivers experiencing psychiatric distress. The proportion of MVC reporting drivers using antidepressant and/or anxiolytic medication was slightly greater for the MVC involved drivers. Drinking and driving was reported more frequently among collision involved drivers. Finally, a much greater proportion of collision involved drivers reported road rage.

Table 4.3 Weighted Frequencies and Percentages for Demographic and Risk Factors for Respondents Reported Motor Vehicle Collisions (MVCs) and not Reported MVCs

Variable	***Reported being in a Motor Vehicle Collision in the past 12 months (N=511) (%)***	***Not Involved in a Motor Vehicle Collision in the past 12 months (N= 6134) (%)***
Age (Range 18-91)		Age Range (18-94)
Mean	40.03	45.25
Standard Deviation	16.52	16.12
Median	37.00	44.00
Age (groups)		
18-29	164 (32.5)	1152 (19.1)
30-39	120 (23.8)	1259 (20.9)
40-49	86 (17.1)	1417 (23.5)
50-64	80 (15.9)	1289 (21.4)
65+	54 (10.7)	901 (15.0)
Gender		
Female	229 (44.8)	2974 (48.5)
Male	282 (55.2)	3160 (51.5)
Marital Status		
Married/ Living with a partner	291 (57.4)	4219 (69.2)
Widowed/Separated/ Divorced	50 (9.9)	672 (11.0)
Never Married	166 (32.7)	1203 (19.7)

Table 4.3 (Continued)

Education (Completed High School)		
Yes	469 (93.1)	5359 (88.2)
No	35 (6.9)	718 (11.8)
Psychiatric Distress (GHQ Score ≥ 2)		
Yes	156 (30.5)	1108 (18.1)
No	356 (69.5)	5024 (81.9)
Psychotropic Medication Use (Prescribed to treat Anxiety/panic attacks or Depression or both types of symptoms)		
Yes	48 (10.3)	476 (8.6)
No	416 (89.7)	5042(91.4)
Drinking and Driving		
Yes	67 (14.4)	469 (9.0)
No	397 (85.6)	4753 (91.0)
Any Road Rage Incidents		
Yes	156 (30.8)	1195 (19.6)
No	350 (69.2)	4891 (80.4)

4.3.1 Summary of Univariate Analysis

The average age of participants in the sample was 44 years of age. The largest age group were individuals from 40 to 49 years of age. Males composed the largest proportion of the sample at approximately 52%. Being married or living with a partner characterized more than 2/3 of sample and nearly 89% of the sample had completed high school. Nearly 1/5 participants reported psychiatric distress and the reported prevalence of antidepressant and/or anxiolytic medication use was under 9%, the reported frequency of drinking and driving was just above 9% and 20% of participants reported road rage.

Among MVC involved drivers, some demographic predictors stand out. Drivers ages 18 to 29 composed the largest proportion of collision involved drivers. Males composed the largest proportion of drivers involved in MVCs and being never married was reported more frequently among those that reported MVCs. Psychiatric distress and any road rage incidents occur much more frequently among collision involved drivers. To a lesser extent, antidepressant and/or anxiolytic medications and drinking and driving were more frequent among collision involved drivers as well.

4.4 Examining the Associations among Study Variables

Appendix B presents a correlation matrix for the variables of interest. The exposure of interest, psychiatric distress, was significantly related to 6 out of 8 variables.

Notably, psychiatric distress was correlated with MVCs, antidepressant and/or anxiolytic medications use, road rage, and drinking and driving. The strongest of these correlations was between psychiatric distress and antidepressant and/or anxiolytic medication use (r= .18, $p \leq .001$). There was a small but significant correlation between psychiatric distress and MVCs (r = .08. $p \leq .001$). MVCs were significantly correlated with 6 out of 8 variables as well. Apart from the aforementioned relationship with psychiatric distress, MVCs were correlated with drinking and driving (r= .07, $p \leq .001$) and road rage (r= .05, $p \leq .001$). However, antidepressant and/or anxiolytic medication use was not related to MVCs. There was no evidence of an association between gender and MVCs (see Appendix B).

4.5. Bivariate (Univariable) Analyses

This section will summarize the relationship between MVCs and the individual variables of interest with bivariate (univariable) unadjusted odds ratios, including: demographic predictors, psychiatric distress, antidepressant and anxiolytic medications, drinking and driving, and road rage incidents.

4.5.1. Demographic Predictors

The relationship between age and MVCs in this sample provided some of the strongest associations. Drivers in the second oldest age group, between 50 to 64 years, acted as the reference category for all subsequent analyses. This age category was selected as the reference group as drivers in this age group had the lowest frequency of injuries and fatalities in Canada (Transport Canada, 2008). Those in the youngest age group (18-29) were 130% more likely to report MVCs, when compared to the reference group (OR = 2.30, p = .000). Those in the second youngest age group (30-39) were 54% more likely to be involved in MVCs (OR= 1.54. p = 004).

Surprisingly, gender was not significantly associated with MVCs. Using the participants who were married or living with a partner as the reference category, being never married was associated with twice the odds of reporting MVCs (see Table 4.4). With having completed high school as the reference category, not completing high school was associated with a 45% decrease in the odds of MVCs (see Table 4.4).

4.5.2 Factors of Interest: Psychiatric Distress, Antidepressant and Anxiolytic Medication Use, Drinking and Driving, and Road Rage

Psychiatric distress had one of the strongest associations with MVCs, as drivers with psychiatric distress were twice as likely to report MVCs (OR =1.99, $p \leq .000$) when compared to non-distressed drivers. Surprisingly, antidepressant and/or anxiolytic medication use was not associated with MVC involvement. Drinking and driving was associated with a 69% elevated odds of reporting MVCs (OR= 1.69, $p \leq .000$). Reporting involvement in road rage was associated with an 82% increased odds of being involved in MVCs ($p \leq .000$).

Table 4.4- Bivariate Analyses for Respondents Involved in a Motor Vehicle Collision in the past 12 months (Unadjusted Odds Ratios and 95% confidence intervals)

Variable	Unadjusted Odds Ratio & (95% CI)
Age groups	
18-29	2.30***
	(1.74, 3.04)
30-39	1.54**
	(1.15, 2.07)
40-49	0.99
	(0.72, 1.35)
50-64 (ref)	--
65+	0.98
	(0.69, 1.39)
Gender	
Female (ref)	--
Male	1.16
	(0.97, 1.39)
Marital Status	
Married/ Living with a partner(ref)	--
Widowed/Separated/ Divorced	1.07

Table 4.4 (Continued)

	(1.62, 2.43)
Education (Completed High School)	
Yes (ref)	--
No	0.55***
	(0.39, 0.78)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	1.99***
	(1.63, 2.42)
No (ref)	--

Table 4. 4 (Continued)

Psychotropic Medication Use (Prescribed to treat Anxiety/panic attacks or Depression or both types of symptoms)	
Yes	1.23 (0.91, 1.68)
No(ref)	--
Drinking and Driving (in the past 12 months)	
Yes	1.71*** (1.30, 2.25)
No (ref)	--
Any Road Rage Incidents (in the past 12 months)	
Yes	1.82*** (1.49, 2.22)
No(ref)	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

4.5.3 Summary of Bivariate Analyses

Numerous study variables were independently associated with MVCs. When compared to respondents in the 50-64 age group, age was associated with MVCs for drivers under the age of 40. Furthermore being never married was associated with elevated odds of MVCs, while not completing high school was associated with a lesser risk of MVCs. Psychiatric distress had one of the strongest associations to MVCs, as the presence of psychiatric distress was associated with nearly twice the odds of MVCs. Antidepressant and/or anxiolytic medication use was not associated with MVCs. However, both drinking and driving and road rage involvement were related to an increased risk of MVCs.

4.6. Logistic Regression Analyses

To determine if any of the predictor variables of interest were associated with MVCs, a binary logistic regression analysis was conducted. The predictor variables (age, gender, marital status, education, psychiatric distress, antidepressant and/or anxiolytic medication use, drinking and driving, and road rage) were entered in a single step. Results of this model can be seen in Table 4.5. Adjusting for all other predictors of interest, only the age category of 18-29 was associated with MVCs while using the 50 to 64 years of group as a reference category. Being between the ages of 18 to 29 was associated with a 50% elevated odds of MVCs. Male gender was not related to MVCs. Being unmarried was associated with a 43% increased risk of MVCs when married or

living with partner provided the reference category. Interestingly, not completing high school was associated with a 40% lower risk of MVC involvement.

Psychiatric distress was related to a 72% increase in the odds of MVCs. However, consuming antidepressant and/or anxiolytic medications was not significantly related to an increased risk of MVCs. Drinking and driving was related to a 35% increase in the risk of MVCs, however it was not a significant predictor of MVCs but did approach significance (p= .059). Involvement in road rage incidents, either as a victim and/or perpetrator, was associated with a 68% increase in MVC involvement.

Table 4.5 Logistic Regression Model All Predictors Entered in One Step

Variable	OR (95% CI)	B (SE)
Age groups		
18-29	1.50*	0.407
	(1.03, 2.20)	(0.194)
30-39	1.22	0.201
	(0.64, 1.27)	(0.171)
40-49	0.90	-0.105
	(0.88, 1.71)	(0.176)
50-64 (ref)	--	--
	1.02	0.023
65+	(0.68, 1.55)	(0.211)
Gender		
Female (ref)	--	--
Male	1.07	0.064
	(0.86, 1.32)	(0.110)
Marital Status		
Widowed/Separated/ Divorced	0.94	-0.067
	(0.63, 1.38)	(0.198)
Never Married	1.43*	0.357
	(1.06, 1.93)	(0.152)
Married/ Living with a partner (ref)	--	--
Education		
(Completed High School)		
Yes (ref)	--	--
No	0.60*	-0.509
	(0.39, 0.94)	(0.226)
Psychiatric Distress (GHQ Score ≥ 2)		0.541
Yes	1.72***	(0.120)
	(1.36, 2.17)	--
No (ref)	--	

Table 4.5 (Continued)

Antidepressant or Anxiolytic Psychotropic Medication Use	1.19	0.174
Yes	(0.84, 1.69)	(0.178)
No (ref)	--	--
Drinking and Driving (in the past 12 months)	1.35	0.302
Yes	(0.99, 1.85)	(0.160)
No (ref)	--	--.
Any Road Rage Incidents (in the past 12 months)		
Yes	1.68***	0.517
	(1.34, 2.10)	(0.114)
No (ref)	--	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

4.6.1 Summary of Logistic Regression Modelling

The logistic regression analysis for a model with all variables entered in a single step yielded some findings that were similar to previous studies. The youngest age group (18-29) was independently associated with a greater risk of MVCs. Interestingly, gender was not associated with MVCs. In addition, reporting being never married was associated with an increased risk of MVCs, while reporting not completing high school was associated with a lower risk of MVCs. The primary exposure of interest, psychiatric distress, was associated with MVCs; however, antidepressant and/or anxiolytic medication use was not related to MVCs. Furthermore, contrary to numerous other studies, after adjusting for other factors of interest drinking and driving was not associated with an increased risk of MVCs. Finally, reported road rage whether as a victim or a perpetrator was associated with an elevated risk of MVCs.

4.7. Un-weighted Sample Sensitivity Analysis

Researchers have argued that post adjustment weighting in surveys may remove or reduce multiple sources of bias in the study findings related to non-response and undercoverage (Massey & Botman, 1988; Casaday & Lepkowski, 1999). However, in some cases, weighting leads to dramatic differences in the frequencies of the exposure and outcome in a sample (Massey & Botman, 1988). In addition, the association between the exposure and the outcome may differ when compared to the un-weighted sample (Massey & Botman, 1988).

As a result, to examine if the findings of this thesis were consistent when weighting is removed, a sensitivity analysis was done in which the sample used in the main analysis was analyzed without weighting. The distribution of the factors of interest without weighting was very similar to the weighted sample; however, some minor differences emerged. When the weighting is removed the frequency of MVCs in the sample drops from nearly 8% in the weighted sample to approximately 7% in the un-weighted sample. Another trend that emerged was that after weighting was removed, over half of the sample was female, but when weighting was included, more than half of the sample was male. Apart from the previously stated differences in the distribution of the un-weighted sample, for all other factors of interest the un-weighted sample is almost identical to that of the weighted sample (See Appendix D, Table D.1). The un-weighted sample and the weighted sample were extremely similar when divided by into MVC involved drivers and non-MVC involved drivers (see Appendix D, Table D.2).

Bivariate analysis without weighting resulted in similar findings of the weighted analysis. For the age categories, the point estimates were slightly larger. In contrast, for the exposure and mediating variables (psychiatric distress, antidepressant and/or anxiolytic medication use, drinking and driving, and road rage) the point estimates were very similar but slightly smaller (see Appendix D, Table D.3).

The un-weighted logistic regression model, where all variables were entered in one step, produced similar findings to the weighted logistic regression model in the main analysis. However, in the un-weighted sample, generally, point estimates for the odds ratios in most cases were smaller (see Appendix D).

4.8. Driving Distance Sensitivity Analysis

To determine if including a self-report measure of driving distance or exposure affected the results of this analysis a self-report measure of driving distance or exposure was included in a subsequent analysis, where all the above predictors of interest were entered in a single step into a binary logistic regression model. Due to measurement and recording errors with the driving distance variable, driving distance was measured using a z-score (see Appendix C for a detailed description of the issue). As noted previously in the methods section, experts have argued driving distance may be an important

confounder when examining the association between human factors and MVCs (Vaa, 2003).

To assess the effect of driving distance, the same analysis as described for the main analysis was conducted again, but this time a z-score measure of driving distance was included. The weighted sample for the driving distance analysis included 6077 participants and had a similar distribution to the sample used for the main analysis (see Appendix E, Table E.1). Furthermore, the distribution of the driving distance sample was nearly identical to the sample used in the main analysis when participants were divided into drivers involved in MVCs and non-MVC involved drivers (see Appendix E, Table E.2)

The bivariate analysis for the driving distance sample yielded some subtle differences from the main analysis, which excluded a measure of driving distance. As a single predictor, the unadjusted estimates for the relationship between self-reported driving distance and MVCs indicated self-reported driving distance was not significantly related to MVCs (see Appendix E, Table E.4). However, for the sample of participants who had a measure of driving distance, there were other subtle differences in the bivariate analyses between the weighted sample that excluded measures of driving distance. For example, the four age categories displayed a slight increase in each of their odds ratios. Other demographic predictors presented almost identical unadjusted odds ratio estimates to the sample used in the main analysis. Another notable change was that the association between antidepressant and/or anxiolytic medication use and MVCs increased and moved closer to being statistically significant ($p = .081$) (see Appendix E, Table E.5).

A logistic regression model for the driving distance sample, where all the predictor variables were entered in one step generated similar results to the main analyses. The finding that stood out from this analysis was after adjusting for all other variables of interest, in a model designed to examine the possible mediating effect of antidepressant and anxiolytic medications use (Model 3), driving distance had a significant relationship with MVCs ($OR = 1.14$, $p = .004$) (see Appendix E, Table E.7). For every one unit increase in driving distance z-score, the odds of MVCs increased 14

%. Otherwise all findings were very similar to those reported for the main analysis (see Appendix E).

Chapter 5: Results From the Hierarchical Logistic Regression Models

5.1 Hierarchical Logistic Regression Models

To examine the potential mediating effects of self-reported antidepressant and/or anxiolytic medication use, road rage, and drinking and driving on the relationship between psychiatric distress and MVCs, a series of hierarchical multivariate logistic regression models were run. In hierarchical logistic regression, variables are entered in steps following theoretical or pragmatic grounds for factors of interest that may predict MVCs (Norman & Streiner, 2003). To assess the potential mediating effects of each potential mediator individually, variables of interest were entered in the following sequence into the hierarchical logistic regression models: demographic predictors, psychiatric distress, and a potential mediating variable (antidepressant and/or anxiolytic medication use, drinking and driving, or road rage).

Model 1 consisted of demographic predictors; this was the first step in all subsequent models. Demographic predictors may be related to MVCs and they provide a series of pre-existing baseline factors that are not malleable. At the next step, psychiatric distress, was added (Model 2) as these symptoms have been considered long-term factors that affect driving capability and, as a result, may predict MVCs (Petridou & Moustaki, 2000). In addition, it has been theorized that a substantial proportion of individuals with anxiety and/or mood disorders (or symptoms of these conditions) consume antidepressant and/or anxiolytic medications to treat their disorders (Beck et al., 2005a). Some researchers have theorized symptoms of MI may directly or indirectly via psychotropic medication use be related to MVCs (Hopewell, 2002). Therefore, one of the mediation models (Model 3) examined the potential mediating affect of antidepressant and/or anxiolytic medication use on the association between psychiatric distress and MVCs.

Furthermore, two other potential mediating variables have been identified and their possible impact as mediating variables will be examined as an exploratory analysis. It has been proposed that alcohol use may follow the development of psychiatric distress, as individuals attempt to self-medicate (Khantzian, 1985). In addition, it is well-established that drinking and driving is a cause and/or correlate of MVCs (Compton et al, 2002). Therefore, it is possible that drinking and driving mediates the relationship between psychiatric distress and MVCs. To determine if drinking and driving does mediate the

relationship between psychiatric distress and MVCs, a multivariate hierarchical logistic regression model was run in which drinking and driving was added as an additional step following demographic predictors and psychiatric distress (Model 4). Another possibility examined was that road rage, whether it be victimization and/or perpetration, may mediate the association between psychiatric distress and MVCs. Road rage may lead individuals to be distracted by negative emotions after victimization, or anger and frustration expressed during perpetration. In addition, studies have demonstrated an association between road rage and MVCs (Mann et al., 2007). To examine this possibility, an additional hierarchical logistic regression model was developed which included road rage as a predictor variable entered after the demographic predictors and psychiatric distress (Model 5).

Table 5.1 displays the results of two hierarchical logistic regression models: the demographic predictors model (Model 1), which includes the predictor variables age, sex, marital status, and education are entered in a single step and another model (Model 2) where psychiatric distress is added on as a subsequent step after the demographic predictors.

From Model 1, there were some key findings. In Model 1, the addition of demographic predictor significantly improved the fit the model (Model $\chi^2 = 70.82$, $p \leq .001$). For the age variable, using the 50-64 years of age group as a reference category, the youngest age category (18-29) was associated with 79% greater odds of being involved in MVCs. Furthermore, being between 30 to 39 years of age was associated with being 43% more likely to be involved in MVCs. Gender was not associated with elevated odds of MVCs. When using married or living with a partner as the reference category for the categorical variable marital status, being never married was associated with a 37% increase in the odds of MVCs. Finally, for the dichotomous variable education, not completing high school was associated with a decreased risk of MVCs (OR = 0.63, p = .013) (see Table 5.1).

For Model 2, the variable psychiatric distress was added on an additional level following demographic predictors. Both the complete model with demographic predictors and the addition of psychiatric distress in a separate block was significant (Model $\chi^2 = 104.65$, $p \leq .001$, Block $\chi^2 = 33.82$, $p \leq .001$). Adding psychiatric distress to the model

produced nearly identical results for the associations between each individual demographic predictor and MVCs, as displayed in Model 1(see Table 5.1). After adjusting for demographic predictors, the presence of psychiatric distress was associated with 85% increase in the odds of MVCs.

Table 5.1 Hierarchical logistic regression models examining the effect of demographic predictors and psychiatric distress on MVCs

Variables	Model 1[a]		Model 2[b]	
	OR (95% CI)	B (SE)	OR (95% CI)	B (SE)
Age				
18-29	1.85***	0.615	1.76***	0.565
	(1.29, 2.65)	(0.182)	(1.23, 2.52)	(0.182)
30-39	1.39*	0.330	1.32	0.274
	(1.02, 1.90)	(0.160)	(0.96, 1.80)	(0.161)
40-49	1.00	0.005	0.95	-0.052
	(0.73, 1.39)	(0.165)	(0.69, 1.32)	(0.166)
50-64(ref)	--	--	--	--
65+	0.92	-0.079	0.95	-0.047
	(0.63, 1.35)	(0.195)	(0.65, 1.40)	(0.195)
Gender				
Female(ref)	--	--	--	--
Male	1.16	0.148	1.20	0.186
	(0.95, 1.41)	(0.100)	(0.98, 1.43)	(0.100)
Marital Status				
Married/ living with a partner (ref)	--	--	--	--
Widowed/Divorced/ Separated	1.19	0.176	1.09	0.085
	(0.85, 1.68)	(0.100)	(0.77, 1.54)	(0.175)
Never Married	1.39*	0.326	1.34*	0.290
	(1.05, 1.79)	(0.145)	(1.01, 1.77)	(0.145)
Completed High School				
Yes (ref)	--	--	--	--
No	0.64*	-0.445	0.62**	-0.471
	(0.43, 0.95)	(0.198)	(0.42, 0.92)	(0.199)
Psychiatric Distress				
Yes			1.94***	0.661
			(1.56, 2.40)	(0.110)
No(ref)			--	--
Model Chi-square	70.83***		104.65***	
Block Chi-square			33.82***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$
[a]Model 1: Demographic predictors
[b]Model 2: Demographic Predictors and Psychiatric Distress

Table 5.2 displays the results of Models 3 through 5. In Model 3, antidepressant and/or anxiolytic medication use was added as a subsequent block following the demographic predictors and psychiatric distress. Antidepressant and/or anxiolytic

medication use was added to determine if the use of these medications mediated the relationship between psychiatric distress and MVCs. The addition of the antidepressant and/or anxiolytic depressant use as a subsequent block of variables was not significant (Block $\chi^2 = .40$, $p = .53$). In hierarchical regression, if a variable mediates the association between the exposure and the outcome variable, when the mediating variable is added to a model, one would expect to see the odds ratio of psychiatric distress to decrease (Baron & Kenny, 1986; MacKinnon et al., 2000). Since antidepressant and/or anxiolytic medication use was not significantly related to MVCs in the current study, the potential mediating variable did not meet one of the fundamental criteria to assess mediation; the mediator should be associated with the outcome (Baron & Kenny, 1986; MacKinnon et al., 2000). Therefore, there was no evidence of an association between antidepressant and/or anxiolytic medication use after adjusting for other demographic predictors, and psychiatric distress (see Table 5.2). However, after entering antidepressant and/or anxiolytic medication use in a subsequent level of the hierarchical logistic regression model, the odds of MVCs associated with psychiatric distress displayed a slight decrease. In this model, the associations between any demographic predictor and MVCs are similar to those reported in Model 1 (see Table 5.1).

In Model 4, drinking and driving was added in an additional block following the demographic predictors and psychiatric distress to examine its potential mediating effect. The drinking and driving variable entered as a block was significant (Block $\chi^2 = 5.844$, $p = .016$). The estimates of the associations between demographic predictors and MVCs were very similar to those in Model 1 (see Table 5.2.). As an individual predictor and after adjusting for other variables in the model, drinking and driving was associated with MVCs (See Table 5.2). After entering drinking and driving in a subsequent level of a hierarchical logistic regression model, the association between psychiatric distress and MVCs decreased ($OR = 1.77$, $p \leq .001$) - a decrease in the association from a model that excluded any potential mediating variables and included only demographic predictors and psychiatric distress (Model 2), which would suggest drinking and driving partially mediates an association between psychiatric distress and MVCs. To assess mediated or indirect effect, the Baron and Kenny (1986) mediation criteria were used to determine if drinking and driving mediates the association between psychiatric distress and MVCs.

The indirect or mediated pathway is displayed in Table 5.4 and Figure 5.2. Psychiatric distress was significantly associated with drinking and driving. Further, after adjusting for demographic predictors and drinking and driving in a hierarchical regression model (Model 4), psychiatric distress was associated with MVCs. Also, drinking and driving was related to MVCs in that same model. The effect of psychiatric distress was partially mediated by drinking and driving (see Table 5.1 and Table 5.2). The percentage of the total effect mediated was approximately 22.2%.

Model 5 was designed to examine the possible mediating effect of road rage on the relationship between psychiatric distress and MVCs. The road rage variable entered as a block was significant (Block χ^2 =13.56, $p \leq .001$). Variables were entered into blocks in the following order: demographic predictors, psychiatric distress, and road rage. The relationships between any individual demographic predictor and MVCs were similar to those reported in Model 1, a model that included only demographic predictors. Road rage, after adjusting for demographic predictors and psychiatric distress, was associated with increased odds of MVCs (OR = 1.65, $p \leq .001$) (see Table 5.2.).

After entering road rage in a subsequent level of a hierarchical logistic regression model, the association between psychiatric distress and MVCs decreased (OR = 1.77, $p \leq .001$), a decrease in the association between psychiatric distress when compared to a model that included only demographic predictors and psychiatric distress (Model 2) that suggests road rage partially mediates the association between psychiatric distress and MVCs (Baron & Kenny, 1986; MacKinnon et al., 2000; MacKinnon & Dwyer, 1993). To assess the mediated or indirect effect of road rage on the association between psychiatric distress and MVCs, Baron and Kenny's mediation criteria to determine mediation were applied. The indirect or mediated pathway and direct pathways are displayed in Table 5.5 and Figure 5.3. Psychiatric distress was significantly associated with road rage. Further, after adjusting for demographic predictors and road rage in a hierarchical regression model (Model 4), psychiatric distress was still associated with MVCs. Also, road rage was related to MVCs in a model adjusting for demographic predictors and psychiatric distress. The association between psychiatric distress and MVCs was partially mediated

by road rage (see Table 5.1 and Table 5.2). The percentage of the total effect mediated was approximately 27.7%.

Table 5.2. Hierarchical logistic regression models examining the effect of antidepressant and/or anxiolytic medications, drinking and driving, and road rage on the association between psychiatric distress and MVCs

	Model 3[c]		Model 4[d]		Model 5[e]	
Variables	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)
Age						
18-29	1.78**	0.577	1.52*	0.421	1.65**	0.504
	(1.24, 2.55)	(0.183)	(1.06, 2.18)	(0.184)	(1.17, 2.33)	(0.176)
30-39	1.32	0.281	1.29	0.258	1.31	0.273
	(0.97, 1.82)	(0.161)	(0.94, 1.77)	(0.161)	(0.97, 1.77)	(0.154)
40-49	0.95	-0.047	0.86	-0.153	0.86	-0.146
	(0.69, 1.32)	(0.166)	(0.62, 1.20)	(0.170)	(0.63, 1.19)	(0.163)
50-64 (ref)	--	--	--	--	--	--
65+	0.96	-0.039	0.99	-0.002	1.04	0.037
	(0.66, 1.41)	(0.196)	(0.67, 1.49)	(0.203)	(0.72, 1.50)	(0.189)
Gender						
Male	1.21	0.194	1.06	0.060	1.16	0.152
	(0.99, 1.48)	(0.101)	(0.87, 1.30)	(0.103)	(0.96, 1.41)	(0.097)
Female(ref)	--	--	--	--	--	--
Marital Status						
Married/Living with partner (ref)	--	--	--	--	--	--
Widowed/Divorced/	1.08	0.080	1.01	0.005	1.13	0.122
Separated	(0.77, 1.53)	(0.176)	(0.70, 1.45)	(0.187)	(0.81, 1.57)	(0.169)
Never Married	1.33*	0.286	1.40*	0.338	1.31*	0.273*
	(1.00, 1.77)	(0.145)	(1.06, 1.86)	(0.143)	(1.00, 1.72)	(0.139)
Completed High School						
Yes(ref)	--	--	--	--	--	--
No	0.62*	-0.472	0.59*	-0.534	0.60*	-0.514
	(0.42, 0.92)	(0.199)	(0.39, 0.89)	(0.215)	(0.41, 0.87)	(0.194)
Psychiatric Distress						
Yes	1.91***	0.647	1.77***	0.367	1.77***	0.571
	(1.53, 2.38)	(0.112)	(1.42, 2.20)	(0.148)	(1.43, 2.18)	(0.107)
No(ref)	--	--	--	--	--	--
Antidepressant and/or Anxiolytic med use						
Yes	1.11	0.108				
	(0.80, 1.55)	(0.170)				
No (ref)	--	--				
Drinking& Driving						
Yes			1.44*	0.367*		
			(1.08, 1.92)	(0.148)		
No (ref)			--	--		
Road Rage						
Yes					1.65***	0.499
					(1.34, 2.02)	(0.105)
No(ref)					--	--
Model-chi square	105.05***		101.46***		13.56***	
Block- chi square	.40		5.84*		91.45***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$,

[c]Model 3: Adding Antidepressant and Anxiolytic Medications to model 2 (see Model 2)

[d]Model 4: Adding Drinking and Driving to model 2 (see Model 2)

[e]Model 5: Adding Road Rage to model 2 (see Model 2)

Table 5.3 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Antidepressant and/or Anxiolytic Medication Use

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
Psychiatric Distress – Antidepressant and/or Anxiolytic Medication Use	3.47*** (2.86, 4.23)	1.245*** (0.100)
Antidepressant and/or Anxiolytic Medication use- MVCs (controlling for psychiatric distress)	1.11 (0.80, 1.55)	0.108 (0.170)
Psychiatric Distress- MVCs (controlling for Antidepressant and/or Anxiolytic med use)	1.91*** (1.53, 2.38)	0.647*** (0.112)

Figure 5.1. Psychiatric Distress and Antidepressant and/or Anxiolytic Medication Use Path Analysis Model Adjusting for other Variables of Interest

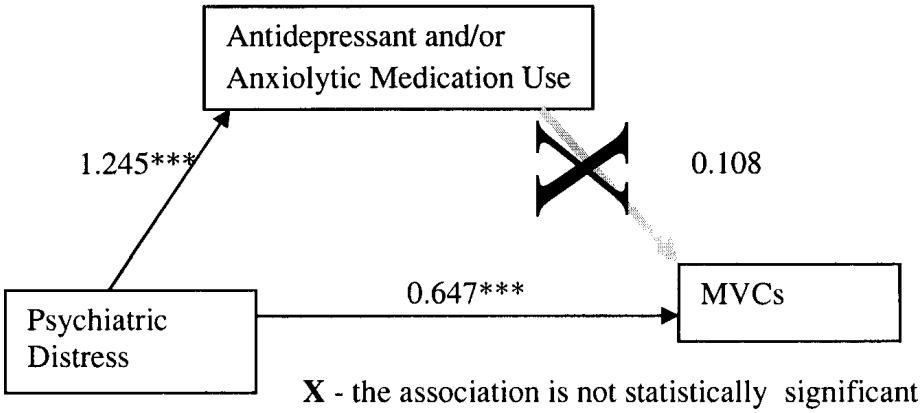


Table 5.4 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Drinking and Driving

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Drinking and Driving	1.56*** (1.25, 1.94)	0.445*** (0.111)
b = Drinking and Driving- MVCs (controlling for psychiatric distress)	1.44* (1.08, 1.92)	0.367* (0.148)
c' = Psychiatric Distress- MVCs (controlling for drinking and driving)	1.77*** (1.42, 2.20)	0.571*** (0.112)

Indirect Effect (a x b) = 0.163
Direct Effect (c') = 0.571
Total Effect (a x b + c') = .734
Proportion of indirect effect = Indirect effect/ Total Effect = 22.2%

Figure 5.2. Psychiatric Distress and Drinking and Driving Path Analysis Model Adjusting for Demographic Predictors, Psychiatric Distress and Drinking and Driving

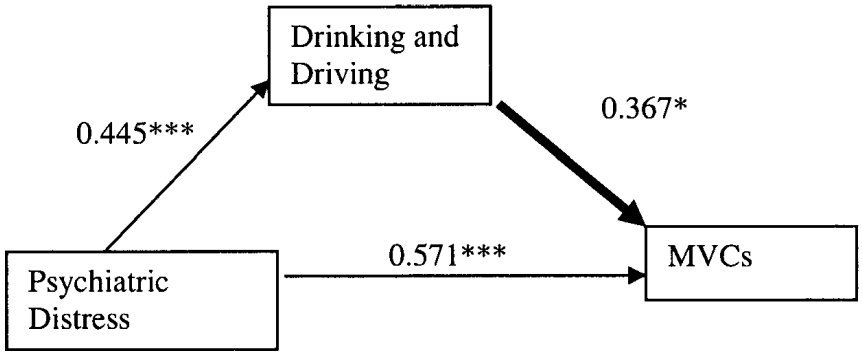
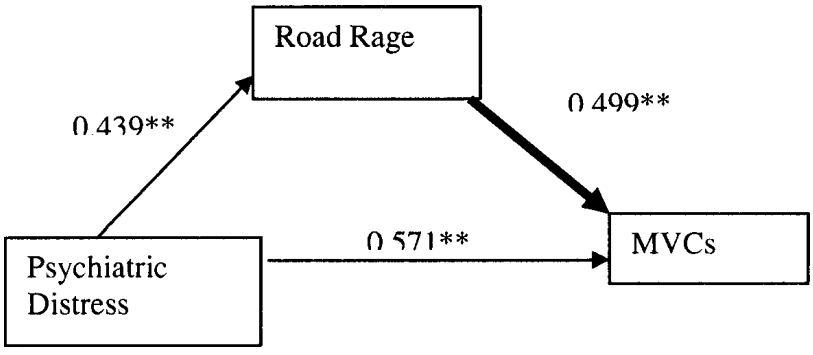


Table 5.5 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Road Rage

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Road Rage	1.55*** (1.34, 1.79)	0.439*** (0.075)
b = Road Rage- MVCs	1.65*** (1.34, 2.02)	0.499*** (0.105)
c' = Psychiatric Distress-MVCs	1.77*** (1.43, 2.18)	0.571*** (0.107)

Indirect Effect (a x b) = 0.219
Direct Effect (c') = 0.571
Total Effect (a x b + c') = .790
Proportion of indirect effect = Indirect effect/ Total Effect = 27.7%

Figure 5.3 Psychiatric Distress and Road Rage and MVCs Path Analysis Model Adjusting for Demographic Predictors, Psychiatric Distress and Road Rage



5.2 Sensitivity Analysis without Weighting

To examine if the findings of the main analysis prevail after removing the weighting, a sensitivity analysis was conducted that excluded weighting. Generally, across all five models, the findings were similar to those displayed in the main analysis (see Appendix D, Tables D.5 and D.6). There was evidence to suggest road rage partially mediated the association between psychiatric distress and MVCs, according to Baron and Kenny's mediation criteria. Interestingly, when weighting is excluded both drinking and driving and antidepressant and/or anxiolytic medication use were not significant predictors of MVCs. However, in the main analysis drinking and driving was a significant predictor of MVCs (see Appendix D, Table D.6. and Table 5.2). In spite of drinking and driving and antidepressant and/or anxiolytic medication use not meeting the Baron and Kenny criteria to formally assess mediation there are some notable observations from this analysis. A decrease in the observed association between psychiatric distress and MVCs occurred after adding antidepressant and/or anxiolytic medication use to a model that included demographic predictors and psychiatric distress entered in previous steps. In a separate model, after the inclusion of drinking and driving following demographic predictors and psychiatric distress there was a decrease in the estimated association between psychiatric distress and MVCs.

5.3 Sensitivity Analysis with Driving Distance Variable

To determine if including only the participants who provided a measure of driving distance affected this analysis, a sensitivity analysis was conducted where only participants who included a valid measure of driving distance were included. For Model 1, the model that included only demographic predictors, findings were nearly identical to those from the main analysis (see Appendix E, Table E.6). In Model 1, driving distance, after controlling for other demographic predictors, was significantly related to MVCs. For every one-unit increase in driving distance z-score, there is an 11% increase in the risk of MVCs (see Appendix E, Table E.6). Model 2 displayed similar trends to the main analysis where psychiatric distress was associated with MVCs and driving distance remained a significant predictor of MVCs (see Appendix E, Table E.6).

Model 3, the model in which antidepressant and anxiolytic medication use was added along with demographic predictors and psychiatric distress, displayed similar findings to the main analysis. Driving distance was significantly associated with MVCs after adjusting for all other factors of interest (see Appendix E, Table E.7). More importantly, this model provided no evidence to suggest antidepressant and/or anxiolytic medication was related to MVCs, and similar to the main analysis there was no evidence to suggest antidepressant and/or anxiolytic medication use mediated the association between psychiatric distress and MVCs. After entering antidepressant and/or anxiolytic medication use in a subsequent level of the hierarchical logistic regression model, the odds of MVCs associated with psychiatric distress displayed a small decrease (see Appendix E, Table E.7).

Model 4, which included drinking and driving as the third step variable following demographic predictors and psychiatric distress, displayed nearly identical findings to the corresponding model in the main analysis. Drinking and driving was significantly associated with MVCs after controlling factors that were entered in the previous blocks. In addition, there was evidence to suggest, drinking and driving partially mediated the relationship with psychiatric distress as the odds of MVCs recorded a decrease in the association (Baron & Kenny, 1986; MacKinnon, Krull & Lockwood, 2000). Model 5, the road rage mediation model in the driving distance sample displayed very similar trends to the model in the main analysis: road rage partially mediated the association between psychiatric distress and MVCs (see Appendix E, Table E.7).

Chapter 6: Discussion

6.1 Summarizing the Results in the Context of the Research Objectives

MVCs continue to have a large public health and economic impact in Canada (Transport Canada, 2008; Vodden et al., 2007). However, despite this substantial economic and public health impact of MVCs, little is known about the influence of potentially important health risk factors, such as MI on MVCs. The current thesis was designed to further knowledge in this area. The objectives of this thesis were to examine the relationship between psychiatric distress and MVCs and to determine if antidepressant and/or anxiolytic medication use, drinking and driving or road rage mediated this relationship. The relationship between psychiatric distress and MVCs was robust and was evident throughout the main analysis. In the main analysis, there was inconclusive evidence to suggest antidepressant and/or anxiolytic medication use mediated the relationship between psychiatric distress and MVCs because of the small number of medication users involved in MVCs (n =48). Use of these medications was not significantly related to MVCs as an individual predictor across any of the models in the main analysis. However, when antidepressant and/or anxiolytic medication use was included in a hierarchical logistic regression analysis there was a slight decrease in the relationship between psychiatric distress and MVCs, and although the evidence of mediation was not strong a mediating effect could not be ruled out. However, the results clearly suggested that drinking and drinking and road rage each mediated an association between psychiatric distress and MVCs.

6.2 Psychiatric Distress and MVCs

Psychiatric distress was more frequent among MVC involved drivers, which was consistent with previous work (Vingilis & Wilk 2007; Mann et al., in press; Sagberg, 2006; Bulmash et al., 2006). Psychiatric distress was found to be associated with MVCs, across all models included in the main analysis.

Researchers have offered multiple explanations for the association between psychiatric distress (a proxy measure for anxiety and/or mood disorders) and MVCs, while demonstrating the relationship (Sagberg, 2006; Bulmash et al., 2006). Bulmash et

al. (2006) argued MVCs might be consistent with some symptoms of a mood disorder such as difficulty making decisions, and impaired concentration. Mann et al. (in press) suggest the relationship between psychiatric distress and MVCs is caused by elevated stress, as psychiatric distress and depression are related to psychomotor deficits and are associated with an increased likelihood of injury (Haslam, Atkinson, Brown, & Haslam, 2005; Azorin, Benhaim, Hasbroucq, & Possamai, 1995). Anxiety disorders may lead to an elevated risk of MVCs through a similar pathway to mood disorders. Drivers with anxiety disorders may display a heightened sense of alertness and increased worry, which may lead to decreased working memory capacity, reduced attentional abilities, and difficulty making decisions (Cremona, 1986; Charlton et al., 2004).

However, it is important to note that given the cross-sectional nature of the data we cannot infer causation and directionality of these relationships. These results could be interpreted through an alternate causal pathway: involvement in MVCs may contribute to the development of psychiatric distress (Vingilis et al., 1996; Blanchard et al., 1994; Blaszczynski, 1998; Kupchik et al., 2007). The design of this thesis does not allow the separation of these two causal pathways. Both may be important and more research is needed to clarify which pathway may explain the findings of this study (Mann et al., in press).

6.3. Comparison of the Mediation Models to the Literature and Interpretation

6.3.1 Psychiatric Distress, Antidepressant and/or Anxiolytic Medication Use, and MVCs

Model 3, of the hierarchical logistic regression models outlined in Chapter 5, was designed to examine the potential mediating effect of antidepressant and/or anxiolytic medication use on the association between psychiatric distress and MVCs. This model allows one to determine the amount of variance in the relationship between psychiatric distress and MVCs that may be accounted for by indirect pathways through which antidepressant and/or anxiolytic medication use may act as a mediating variable (MacKinnon et al., 2000; Baron & Kenny, 1986; Norman & Streiner, 2003). After the inclusion of antidepressant and/or anxiolytic medication use in a subsequent step

following demographic predictors and psychiatric distress, the association between psychiatric distress and MVCs decreased.

A decrease in the magnitude of the association between psychiatric distress and MVCs such as this would suggest that antidepressant and/or anxiolytic medication use mediated the relationship between psychiatric distress and MVCs, if antidepressant and/or anxiolytic medication use was associated with MVCs (Baron & Kenny, 1986; MacKinnon & Dwyer, 1993; MacKinnon et al., 2000). However, though, there was a slight decrease in the strength of the association between psychiatric distress and MVCs, there was no evidence to suggest antidepressant and/or anxiolytic medication use mediated this effect.

The findings of this thesis are similar to a substantial number of studies available in the literature (Barbone et al., 1998; Moskowitz et al., 1986; van Laar et al., 1992; Verster et al., 2005; Ramaekers, 2003a), although some other studies have found a relationship between psychiatric distress and MVCs and antidepressant and/or anxiolytic medication use and MVCs (Sagberg, 2006; Hours et al., 2008; Leveille et al., 1994; Vaa, 2003). The results might suggest that the newer generations of antidepressant and/or anxiolytic medication, such as SSRIs and Buspirone, do not produce impairment, which instead may be related to anxiety and/or mood disorder (or symptoms of these disorders), and thus do not effect the risk of MVCs for individuals with anxiety and/or mood disorders (or symptoms of these conditions) (Richelson, 2001; Moskowitz, 1986; Lane & O'Hanlon, 1999). These newer antidepressant and/or anxiolytic medications seem not to affect the association between psychiatric distress (a proxy measure for symptoms of anxiety/or mood disorders) and MVCs.

However, given that the derived variable for antidepressant and/or anxiolytic medication use was based on two broad questions inquiring about medication use to treat depression and medication use to treat anxiety or panic attacks in the past year alone (see Appendix A), it is not possible to draw definitive conclusions about the effects of antidepressant and/or anxiolytic medication use because there is no information on the type of medications consumed, doses, duration of medication use, and the side effects respondents experienced (Ramaekers, 2003b). This thesis provides some evidence for the

suggestion that newer medications may have no effect on the association between psychiatric distress and MVCs, however, at this stage, this conclusion must be considered tentative.

Furthermore, the lack of a mediating effect by antidepressant and/or anxiolytic medication use could be attributed to drivers with psychiatric distress becoming tolerant to the effects of the medications by the time they are responding to the survey. Some studies have indicated that for certain types of antidepressant and/or anxiolytic medications, such as TCAs, complete tolerance to the partial impairment related to consuming these medication develops within two weeks (Ramaekers, 2003b; Verster et al., 2005).

6.3.2 Psychiatric Distress, Drinking and Driving, and MVCs

Model 4, of the hierarchical logistic regression models outlined in Chapter 5, was designed to examine the potential mediating effect of drinking and driving. After the inclusion of drinking, the association between psychiatric distress and MVCs decreased, and it was estimated that the indirect pathway accounted for more than 22% of the total effect observed between psychiatric distress and MVCs (see Table 5.1 and see Table 5.2.).

A decrease in the magnitude of the association between psychiatric distress and MVCs would suggest that drinking and driving mediates the relationship between psychiatric distress and MVCs (MacKinnon et al., 2000; Baron & Kenny, 1986). Since psychiatric distress was associated with drinking and driving, drinking and driving was associated with MVCs and psychiatric distress was associated with the relationships among these variables, these observations fulfill all the criteria for mediation outlined by Baron and Kenny. Also, these findings are in agreement with previous studies. Generally, a variable might be classified as a mediator if it accounts to some extent for the association between the predictor and the outcome variable (Baron & Kenny, 1986). Several studies looking at samples of convicted impaired drivers suggested that a sizeable subgroup experience depressed mood and negative outcomes, including MVCs, may be

more common among these individuals (Stoduto et al., 2008; Lapham et al., 2001; Shaffer et al., 2007; Mann et al., 2007; Wells-Parker, Dill, Williams, & Stoduto, 2006).

There are several possible explanations for drinking and driving mediating the association between psychiatric distress and MVCs. Depressed mood may be related to physiological and cognitive processes that are in turn related to heavy drinking (Ramsey, Kahler, Read, Stuart, & Brown, 2004; Stoduto et al., 2008). It has been well established that alcohol impairs driving ability and is associated with an increased risk of MVCs (Compton et al., 2002; Perrine et al., 1989; Borkenstein et al., 1964). Although mental illness (and symptoms of these conditions) impairs driving ability and may increase MVC risk (Hopewell, 2002), consuming alcohol may further exacerbate this relationship in a subgroup of drivers with psychiatric distress, to increase their likelihood of being involved in MVCs.

Stoduto et al. (2008) have proposed that depressed mood might act as a marker for being more likely to drive after drinking. It is possible that depressed respondents who drink and drive are at a greater risk of MVCs than non-depressed individuals are. Yet another possibility is that individuals with psychiatric distress, a proxy measure of symptoms of anxiety and/or depression, drink to relieve their symptoms as a method of self-medicating (Khantzian, 1985; Bolton, Cox, Clara, & Sareen, 2006; Weiss, Griffin, Mirin, 1992; Harris & Edlund, 2005), and it is possible that their risk of MVCs is greater than that seen among those without anxiety and/or depression who drive after drinking (Stoduto et al., 2008).

6.3.3 Psychiatric Distress, Road Rage, and MVCs

Model 5 was designed to determine if road rage acted as a mediating variable (see Chapter 5, Table 5.2.); road rage was entered in a subsequent step following demographic predictors and psychiatric distress. After the inclusion of road rage, the association between psychiatric distress and MVCs decreased. There was a 4% decrease in the odds ratio estimate of the association between psychiatric distress and MVCs (see Table 5.1 and see Table 5.2.). A decrease in the magnitude of the association between psychiatric

distress and MVCs would suggest that road rage mediates the relationship between psychiatric distress and MVCs (MacKinnon et al., 2000; Baron & Kenny, 1986).

This is the first study that has examined the potential mediating effect of road rage on the relationship between psychiatric distress and MVCs. Previous studies have focused on either examining the relationship between mental illness and road rage (Fong et al., 2001; Smart et al., 2003) or the relationship between road rage and MVCs (King & Parker, 2008; Mann et al., 2007; Wells-Parker et al., 2002).

There are at least two interpretations for the results of this study. Psychiatric distress may make drivers more sensitive to the actions of others on the road; they may perceive that they are victims of road rage more often. During or soon after a road rage incident, victims with psychiatric distress may become preoccupied with worrying about the incident, causing them to have more trouble making decisions on the road, and more difficulty concentrating. Road rage victimization, therefore, may be the pathway through which psychiatric distress relates to MVCs for some drivers. Road rage perpetration may mediate the association between psychiatric distress and MVCs as an extension of the long-standing relationship between mental illness and violence (Asnis, Kaplan, Hundorfean, & Saeed, 1997). Individuals with psychiatric distress may be more likely to perform acts of interpersonal aggression or react violently because they have trouble regulating their negative emotions and act aggressively to deal with these emotions (Davidson, Putman, & Larson, 2000; Gross & Munoz, 1995). Individuals with psychiatric distress may express their anger by performing road rage behaviours. This may involve performing dangerous driving behaviours such as tailgating or speeding in an attempt to perform a road rage behaviour. The impairment related to psychiatric distress, along with the dangerous driving that is related to perpetrating road rage, may allow road rage to mediate the association between psychiatric distress and MVCs (Petridou & Moustaki, 2000; Mann et al., 2007;Vassallo et al., 2008).

6.4. Limitations

One of the limitation of this study is that it is primarily generalizable to Ontario adults (age 18 and above) living in households with telephone landlines and cannot be

generalized to individuals who inhabit prisons, hospitals, do not have landlines and military dwellings (Ialomiteanu & Adlaf, 2007).

It is also important to note the GHQ-12 is not a validated proxy measure of anxiety and/or mood disorders. Therefore, at this stage it is uncertain to what degree an individual classified as having psychiatric distress might truly have an anxiety and/ or mood disorder.

The most important limitation of this study is the cross-sectional data source. Since all the variables of interest were measured at the same time, one is unable to establish the temporal sequence necessary to infer causation. It is equally likely that psychiatric distress develops following a MVC and is a sequlae of a MVC (Vingilis et al., 1996). On the CAMH Monitor, the MVC item inquires about involvement in the past year. However, psychiatric distress is determined by GHQ-12 scores referring to feelings in the past few weeks. Therefore, it is possible that a sizable number of individuals with psychiatric distress may have developed their distress following a MVC.

In addition, because self-report data were used in this study, the data may be affected by many sources of bias. Respondents may have a good memory for salient events but may not remember the actions that led to an event. Over time the sequence of activities that led to an event may be distorted or attenuated. Also, social desirability bias may occur (Krosnick, 1999). As participants may have altered accounts of events to present the situation in an attractive manner. Also, question wording and format can have a strong influence on responses given by participants (Schwarz, 1999).

Variables derived from a single survey item or a pair of survey items such as antidepressant and/or anxiolytic medication use and MVCs come with unique limitations. Variables derived from a single item or a pair of items may capture only a small amount of information concerning the behaviour of interest. Another important limitation to this study is the issues with the measurement of driving exposure. Three response patterns for the driving exposure measures were recorded, driving exposure was measured in kilometres, miles, and both (see Appendix C). No drivers were supposed to be asked driving exposure, in kilometres and miles, but for a subgroup of individuals who were

asked driving distance in both miles and kilometres, substantial variability was observed between their responses. Therefore, the validity of the driving distance or exposure measure may be in question (See Appendix C).

The small number of antidepressant and/or anxiolytic medication users who reported collision involvement (n= 48) in this study means that the analysis may have had insufficient statistical power to detect an association between antidepressant and/or anxiolytic medication use and MVCs or to provide a valid and reliable measure of the potential mediating effect of antidepressant and/or anxiolytic medication use on the relationship between psychiatric distress and MVCs.

Another important limitation was the fact no statistical method was used to assess mediating effects. Though, Baron and Kenny (1986) criteria were applied no statistical test of mediation were conducted.

6.5 Directions for Future Research

The collection of longitudinal data is critical to disentangling the causal nature of the association between psychiatric distress and MVCs, and to assess the potential mediating role of antidepressant and/or anxiolytic medication use, drinking and driving, and road rage. Future studies should aim to use a longitudinal design in which baseline information on mental health status is collected and drivers are followed forward in time. Mental illness should be diagnosed using validated measures of mood and/or anxiety disorders, which reflected well accepted diagnostic criteria such as the most recent edition of the DSM. Data should be collected on the mental health treatment participants received and if they are consuming antidepressant and/or anxiolytic medications, or any other type of psychotropic medications prescribed to treat mental illness. Future studies should also measure the categories of antidepressant and/or anxiolytic medications consumed, the dose and duration of medication use, and the side effects experienced while consuming these medications (Ramaekers, 2003b). It is also important to know if participants are using any other non-prescription medications, as they may be crucial indicators of possible collision risk (Ramaekers, 2003b).

Another important consideration in future studies would be to include measures of and adjust for other types of chronic medical conditions such as diabetes or heart disease (Vaa, 2003; Sagberg, 2006), which may confound the relationship between mental illness and MVCs. Researchers may also want to include measures related to driver fatigue and vision, which also may be potential confounding variables and risk factors for MVCs (Vaa, 2003).

6.6 Summary and Conclusions

In sum, the key findings of this study are the following. Psychiatric distress displayed a robust relationship with MVCs. There was no evidence to suggest antidepressant and/or anxiolytic medication use mediated the relationship between psychiatric distress and MVCs. The results also suggest that drinking and drinking mediated an association between psychiatric distress and MVCs. The results suggest that road rage mediated the association between psychiatric distress and MVCs. However, it is important to note that given the cross-sectional nature of the data, the causal nature of these relationships is unclear. Nevertheless, this thesis serves as an important step in determining the mediators of the relationship between psychiatric distress and MVCs. Even though much progress has been made in addressing the MVC problem, MVCs still cost Canadian society up to $63 billion dollars annually and in 2005 there were over 660, 000 MVCs that resulted in over 145,000 injuries and more than 2500 deaths (Transport Canada, 2008; Vodden et al., 2007). Given this enormous public health impact, more efforts need to be directed towards understanding and reducing MVCs in Canada.

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Appendix A Relevant Question from the CAMH Monitor Survey

[# ===== DRIVING ==========]

>sd7b< [define <d><8>] [define <r><9>] [#ASK ALL]
[r] The next questions are related to driving.
[n]
[r] Do you currently have a valid driver's licence?
[n]
1 yes
5 no
d don't know r refused
@
[@] <1,d,r> [goto drive]
<5> [goto adr] [#changed from goto INT_RR per LM]

>drive<
[r] During the past 12 months, have you driven a car, van, truck, motor cycle or[n]
[r] any other type of motor vehicle? [n]
1 yes
5 no
d don't know r refused
@
[@] <1>
<5,d,r> [goto adr] [#changed from goto INT_RR per LM]

>dr1< [define <d><9998>][define <r><9999>]
[open dr1]
[r] Now I would like to ask you how much you drive in a typical WEEK. Please [n]
[r] think of all the driving you do. Remember to count any driving you have [n]
[r] done in a car, motorcycle, truck or van. Count driving you did in vehicles [n]
[r] you own, borrowed, rented or use for work.
[n]
[r] On average, about how many kilometres or miles do you drive in a typical week?[n]
[bold][yellow]
Interviewer: Use 0 for none, and r for refused. If R is having trouble, can't
answer, says that it is too difficult a question etc. use "d" for don't know.
[n][white]
Enter number of miles here @miles
Enter number of kilometres here @kilo
[@miles][optional] <r> [goto dr5]

<0>
<d> [goto dr1b]
<1-9996> [goto dr5]
[@kilo] [optional] <0>
<1-9996> [goto dr5]
>check_err< [define <d><8>][define <r><9>]
[bold][yellow]
INTERVIEWER: You have indicated that the respondent drives
ZERO miles or
kilometres a week. Is this correct?
[n][white]
1 yes, correct
5 no, mistake
@
[@] <5> [goto dr1]
<1>
[store <0> in dr1@miles]
[store <0> in dr1@kilo]
[goto dr5]

>dr1b< [define <d><8>][define <r><9>]
[r] Well, to start would it be easier for you to think about how
much you drive [n]
43
[r] in kilometers or miles? [n]
1 Kilometres
5 Miles
d don't know/can't answer/too difficult etc.
r refused
@
[@] <1> [goto dr1c]
<5> [goto dr1d]
<d,r> [goto dr5]

>dr5< [define <d><98>][define <r><99>]
[r] DURING THE PAST 12 MONTHS, how often, if at all, were
you involved in an [n]
[r] accident or collision involving any kind of damage or injury to
you or [n]
[r] another person or vehicle while you were driving?
[n]
0 never
1-9 Enter number of times
10 ten times or more
d Don't Know r Refused
@

[@]<0,1-10,d,r>

[# ====== DEMOGRAPHICS =======]
>age< [define <d><9998>][define <r><9999>][define
<a><9997>]
[r] Finally, these last questions are for classification purposes only.
[n]
[r] First, in what year were you born? [n]
1890-1988 Enter year
a after 1988
d don't know r refused
@
[@] <1890-1988>
<a,d,r>

>gend< [return][open cb][allow 1][loc 45/1]
[setkey <esc> to <skcb>]
[setkey <f7> to <j>]
[define <d><8>][define <r><9>]
[bold][yellow] INTERVIEWER: Enter respondent's gender please
[n][white]
1 Male
5 Female
d Don't know
@
[@] <1,5,d>
[store gend in RGENDER

>sd5< [define <d><8>] [define <r><9>]
[r] At present are you married, living with a partner, widowed,
divorced, [n]
[r] separated, or have you never been married?
[n]
1 married
2 living with a partner
3 widowed
4 divorced
5 separated
6 never married
d don't know r refused
@
[@] <1-6,d,r>

>sd2< [define <d><98>][define <r><99>]
[r] What is the highest level of education you have completed?

[n]
1 No schooling
2 Some elementary school
3 Completed elementary school
4 Some high school/junior high
5 Completed high school
6 Some community college
7 Some technical school (College Classique, CEGEP)
8 Completed community college
9 Completed technical school (College Classique, CEGEP)
10 Some University
56
11 Completed Bachelor's Degree (Arts, Science,Engineering, etc.)
12 Post graduate Training: MA, MSc, MLS, MSW, etc.
13 Post graduate Training: PhD, "doctorate"
14 Professional Degree (Law, Medicine, Dentistry)
d Don't Know r Refused
@
[@] <1-14,d,r>

[# ==== GHQ-12 ==]
[# ==GENERAL HEALTH QUESTIONNAIRE ======]

>int4< [#ASK ALL]
[r] In the next few questions we would like to know if you have experienced any [n]
[r] medical complaints, and how your health has been in general, over the past [n]
[r] few weeks. [n]
Press "Enter" to continue @
[@][nodata]

>gq1< [define <d><8>][define <r><9>]
53
[r] Over the past few weeks, have you been able to concentrate on whatever [n]
[r] you're doing? [n]
[r] Would you say better than usual, same as usual, less than usual, or [n]
[r] much less than usual? [n]
1 better than usual
3 same as usual
5 less than usual
7 much less than usual
d don't know r refused

@
[@] <1,3,5,7,d,r>

>gq2<
[r] Over the past few weeks, have you felt that you are playing a useful part [n]
[r] in things? [n]
[r] Would you say more so than usual, same as usual, less so than usual, or [n]
[r] much less than usual? [n]
1 more so than usual
3 same as usual
5 less so than usual
7 much less than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq3<
[r] Over the past few weeks, have you felt capable of making decisions about [n]
[r] things? [n]
[bold][cyan]
Would you say more so than usual, same as usual, less so than usual, or much
less than usual?
[n][white]
1 more so than usual
3 same as usual
5 less so than usual
7 much less than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq4<
[r] Over the past few weeks, have you been able to enjoy your normal day-to-day [n]
[r] activities? [n]
[bold][cyan]
Would you say more so than usual, same as usual, less so than usual, or much
less than usual?
[n][white]
1 more so than usual

3 same as usual
5 less so than usual
7 much less than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq5<
[r] Over the past few weeks, have you been able to face up to your problems? [n]
[bold][cyan]
Would you say more so than usual, same as usual, less so than usual, or much
less than usual?
[n][white]
1 more so than usual
3 same as usual
5 less so than usual
7 much less than usual
0 r volunteers "i have no problems"
d don't know r refused
@
[@] <1,3,5,7,0,d,r>

>gq6<
[r] Over the past few weeks, all things considered, have you been feeling [n]
[r] reasonably happy? [n]
[bold][cyan]
Would you say more so than usual, same as usual, less so than usual, or much
less than usual?
[n][white]
1 more so than usual
3 same as usual
5 less so than usual
7 much less than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq7<
[r] Over the past few weeks, have you lost much sleep because of worry? [n]
[r] Would you say not at all, no more than usual, rather more than usual, or [n]

54
[r] much more than usual? [n]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq8<
[r] Over the past few weeks, have you felt constantly under strain?
[n]
[r] Would you say not at all, no more than usual, rather more than
usual, or [n]
[r] much more than usual? [n]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq9<
[bold][cyan] Over the past few weeks... [n][white]
[r] ...have you felt you could not overcome your difficulties?
[n]
[bold][cyan]
Would you say not at all, no more than usual, rather more than
usual, or
much more than usual?
[n][white]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq10<
[r] Over the past few weeks, have you been feeling unhappy and
depressed? [n]
[bold][cyan]
Would you say not at all, no more than usual, rather more than

usual, or
much more than usual?
[n][white]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq11<
[bold][cyan] Over the past few weeks, have you...[n][white]
[r] ...been losing confidence in yourself? [n]
[bold][cyan]
Would you say not at all, no more than usual, rather more than
usual, or
much more than usual?
[n][white]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

>gq12<
[r] Over the past few weeks, have you been thinking of yourself as
a worthless [n]
[r] person? [n]
[bold][cyan]
Would you say not at all, no more than usual, rather more than
usual, or
much more than usual?
[n][white]
1 not at all
3 no more than usual
5 rather more than usual
7 much more than usual
d don't know r refused
@
[@] <1,3,5,7,d,r>

[# ==== PSYCHOTHERAPEUTICS ==========]
>ps11< [#ask all] [define <d><8>] [define <r><9>]

[r] In the past 12 months, have you taken any prescription
medication to reduce [n]
[r] anxiety or panic attacks? [n]
1 yes
5 no
d don't know r refused
@
[@] <1,d>
<5,r> [goto ps16]

>ps16< [# ask all] [define <d><8>] [define <r><9>]
[r] In the past 12 months, have you taken any prescription
medication to treat [n]
[r] depression? [n]
1 yes
5 no
d don't know r refused
@
[@] <1,d>
<5,r> [goto end_psy]

[# ===== DRINKING & DRIVING
==========]
>dd1< [define <d><8>][define <r><9>]
[if chek eq <1> goto adr] [#not a current drinker] [#changed
from goto INT_RR per LM]
[r] During the past 12 months, have you driven a motor vehicle
after having two [n]
[r] or more drinks in the previous hour? [n]
1 yes
5 no
7 don't drive
d don't know r refused
@
[@] <1>
<5,7,d,r> [goto adr] [# goto INT_RR]

[# ========= ROAD RAGE ========]
>INT_RR< [# ASK ALL]
[r] Now some questions about things that might happen when you
are driving [n]

[r] or are a passenger in a car, van, truck or motorcycle.
[n]
Press "Enter" to continue @
[@][nodata]

>rr1< [define <d><98>][define <r><99>][define <n><97>]
[r] During the past 12 months, how many times has someone in another vehicle [n]
[r] shouted, cursed, or made rude gestures at you or others with you? [n]
0 never
1-95 enter number of times
96 or more times
n I have not driven/I have not been a passenger in the last 12 months
d Don't Know r Refused
@
[@] <0,1-96,d,r>
<n> [goto END_RR]

>rr2<
[r] During the past 12 months, how many times has someone in another vehicle [n]
[r] THREATENED to hurt you or others with you, or THREATENED to damage the [n]
[r] vehicle you were in? [n]
0 never
1-95 enter number of times
96 or more times
n I have not driven/I have not been a passenger in the last 12 months
d Don't Know r Refused
@
[@] <0,1-96,d,r>
<n>[goto END_RR]

>rr3<
[r] (During the past 12 months,) how many times has someone in another vehicle [n]
[r] INTENTIONALLY DAMAGED or ATTEMPTED to damage the vehicle you were in? [n]
0 never
1-95 enter number of times
96 or more times
n I have not driven/I have not been a passenger in the last 12 months

d don't know r refused
@
[@] <0,1-96,d,r>
<n>[goto END_RR]

>rr4<
[bold][cyan]
During the past 12 months,
[white]
[r] how many times has someone in another vehicle
[n]
[r] INTENTIONALLY HURT or THREATENED to hurt you or others with you? [n]
0 never
1-95 enter number of times
96 or more times
n I have not driven/I have not been a passenger in the last 12 months
d don't know r refused

>rr5<
[bold][cyan]
During the past 12 months,
[white]
[r] how many times have YOU shouted, cursed, or
[n]
[r] made rude gestures at a driver or passenger in another vehicle? [n]
0 never
1-95 enter number of times
96 or more times
n I have not driven/I have not been a passenger in the last 12 months
d don't know r refused
@
[@] <0,1-96,d,r>
<n>[goto END_RR]

>rr6<
[r] Still thinking about the past 12 months, how many times have you threatened [n]
[r] to hurt a driver or passenger in another vehicle, or threatened to damage [n]
[r] their vehicle? [n]
0 never
1-95 enter number of times

96 or more times
d Don't Know r Refused
@
[@] <0,1-96,d,r>

>rr7<
[bold][cyan]
During the past 12 months,
[white]
[r] how many times have you intentionally damaged
[n]
[r] or attempted to damage another driver's vehicle?
[n]
0 never
1-95 enter number of times
96 or more times
d don't know r refused
@

>rr8<
[bold][cyan]
During the past 12 months,
[white]
[r] how many times have you intentionally hurt or
[n]
[r] attempted to hurt a driver or passenger in another vehicle?
[n]
0 never
1-95 enter number of times
96 or more times
d don't know r refused
@
[@] <0,1-96,d,r>
>END_RR<

Appendix B Correlation Matrix

Table B.1. Correlation Matrix For All the Variables of Interest in the Main Analysis

Variable	Age	Gender	Marital status	Education	Psychiatric Distress	Antidepressant and/or Anxiolytic Medication Use	Drinking and Driving	Road Rage	MVCs
Age		-0.02	-0.41***	-0.27***	-0.10***	0.01	-0.10***	-0.08***	-0.09***
Gender			-0.40	-0.05***	-0.07***	-0.13***	0.18***	0.02	0.02
Marital Status				0.06	0.09	0.01	0.07	0.02	0.08***
Education					0.00	0.00	0.00	0.03	0.04***
Psychiatric Distress						0.18***	0.05***	0.08***	0.08***
Antidepressant and/or Anxiolytic Medication Use							0.00	0.00	0.01
Drinking and Driving								0.02	0.05***
Road Rage									0.07***
MVCs									

Note: MVCs = Motor Vehicle Collisions, *p ≤ .05, **p ≤ .01, *** p ≤ .001.

Appendix C: A Detailed Explanation of Problems Related to the Measure of Driving Distance or Exposure

Appendix C.1. Problems Concerning Driving Items On the Centre for Addiction and Mental Health (CAMH) Monitor

In the process of identifying necessary demographic predictors to control for in a logistic regression analysis, driving distance emerged as an important variable to be included among the demographic predictors that will be controlled for in the series of proposed models (see methods section).

There is one item on the CAMH Monitor that addresses driving distance. This question (dr1) asked, "On average, about how many kilometres or miles do you drive in a typical week?" Only respondents who had a valid driver's licence and who had driven in the past 12 months at the time of the survey were asked this question. In this dataset, there was a weighted sample of 6645 participants who met both criteria and answered the question.

For this question, participants had the option of responding in either miles or kilometres. However, there is evidence to suggest that some participants' responses were recorded in both miles and kilometres; there were 5761 valid responses to this question in kilometres and 1485 in miles. The sum of these responses yields a total of 7246, which is greater than the number of participants in the dataset (N=6645).

Within the 7246 responses to the open ended typical weekly driving distance question, 5160 were only in kilometres, 884 were only in miles, and 601 were in both kilometres and miles. Just over 9% of participants responded to this question in both miles and kilometres. Within this group of people who answered in both miles and kilometres, there are substantial differences in the proportion of zero responders among the same participants depending on whether the answers in miles or kilometres are examined. More than 25% of participants who answered in both miles and kilometres have recorded responses of zero kilometres driven. Among the same subgroup of participants, over 96% had recorded responses of zero miles driven. This discrepancy raises questions about the validity of the measure. If the subgroup who answered in both miles and kilometres were merely individuals who mistakenly answered in both units of

measurement their answers should be comparable, and the difference in their responses should be attributed to a conversion from miles to kilometres or vice versa. However, this seemed not to be the case, because of the discrepancy in reported driving distances of zero, which varied dramatically depending upon the units of distance reported. It is possible that many of the individuals in the kilometres and miles subgroup responded only kilometres or miles, however, in the coding process, instead of being given the code for system missing (period) for the distance unit they did not reply in, they received a zero.

This discrepancy with the driving distance variable derived from the dr1 question on the CAMH Monitor has called into question the construct validity of the measure. Its inclusion in the analysis may introduce systematic bias unless these issues can be resolved. To further understand these discrepancies within the data, participants who answered in both miles and kilometres (N= 601) were compared with participants who answered in miles only (n = 884) or in kilometres only (N = 5160). If a response was only available in miles it was converted to kilometres using the standard conversion factor (1 miles = 1.61 km). If both answers in miles and kilometres were available, only answers in kilometres were used for comparison. To avoid the potential confounding effects of age, the dataset was stratified by age. Age was divided into five categories: 18-29, 30-39, 40-49, 50-64, 65 and above. The dataset was separately stratified by gender to avoid potential confounding effects. On the suspicion that a human error in coding may have occurred at a specific time frame, frequencies were compared for miles-kilometres and kilometres or miles groups by year of interview. Note the results of this exploratory analysis (see Appendix C.2).

Given the varying distributions of kilometres only, miles only, and kilometres and miles subgroup, z-scores for driving distance were used to provide a measure of driving exposure. All driving distance measures were converted to z-scores. The formula used to calculate a z-score was:

$Z = X-\mu/\sigma$

μ= mean in kilometres or miles

σ= standard deviation in kilometres or miles

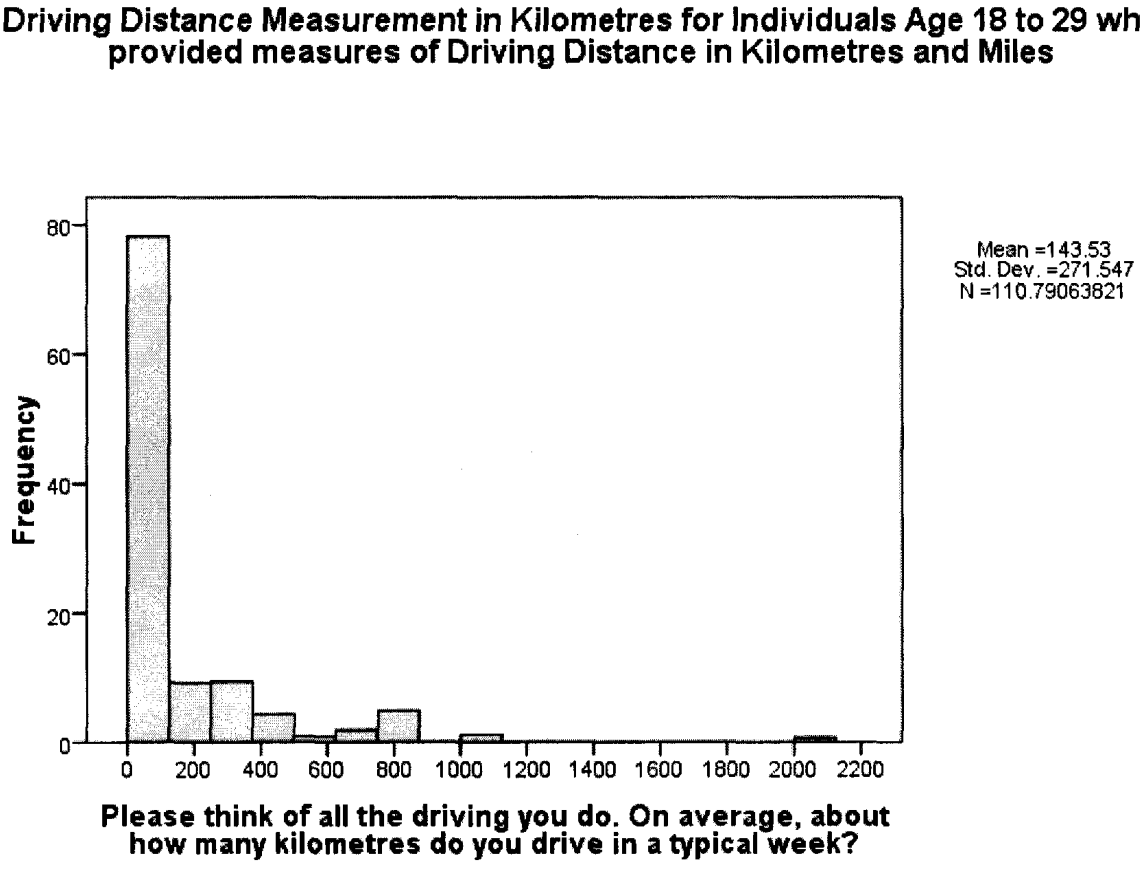
For individuals with driving estimates in miles and kilometres, half the z-score in each driving distance unit was calculated and summed to provide a comparable z-score to those for kilometres only, and miles only. The use of the z-score allows all estimates of driving distance to be applied to the same distribution, where the relative position of each drivers distance can be used to estimate driving distance.

Appendix C.2. Exploratory Analysis of the Kilometres only, Miles Only and Kilometres and Miles Subgroups

Table C.2.1 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in km Stratified by Year of Interview

Year Of Interview					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2002	12	2.0	2.0	2.0
	2003	115	19.1	19.1	21.1
	2004	187	31.2	31.2	52.2
	2006	287	47.8	47.8	100.0
	Total	601	100.0	100.0	

Figure C.2.1. Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Respondents Age 18 to 29



rhhwtall= region-household weight, cumulative

postadj wgt= post-adjustment weight

Figure C.2.2. Driving Distance Subgroup with Recorded Responses Miles and Kilometres Estimates in Kilometres for Respondents Age 30 to 39

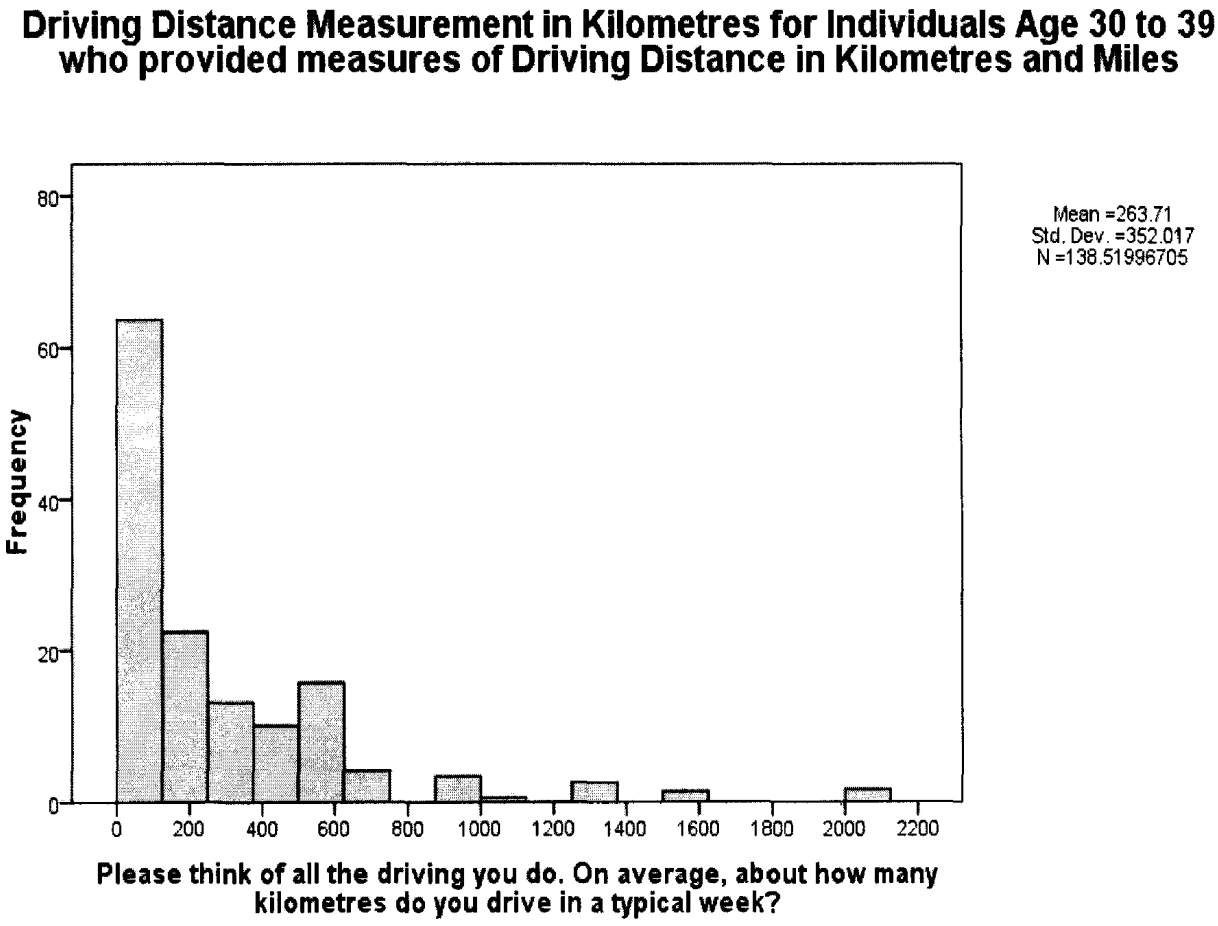
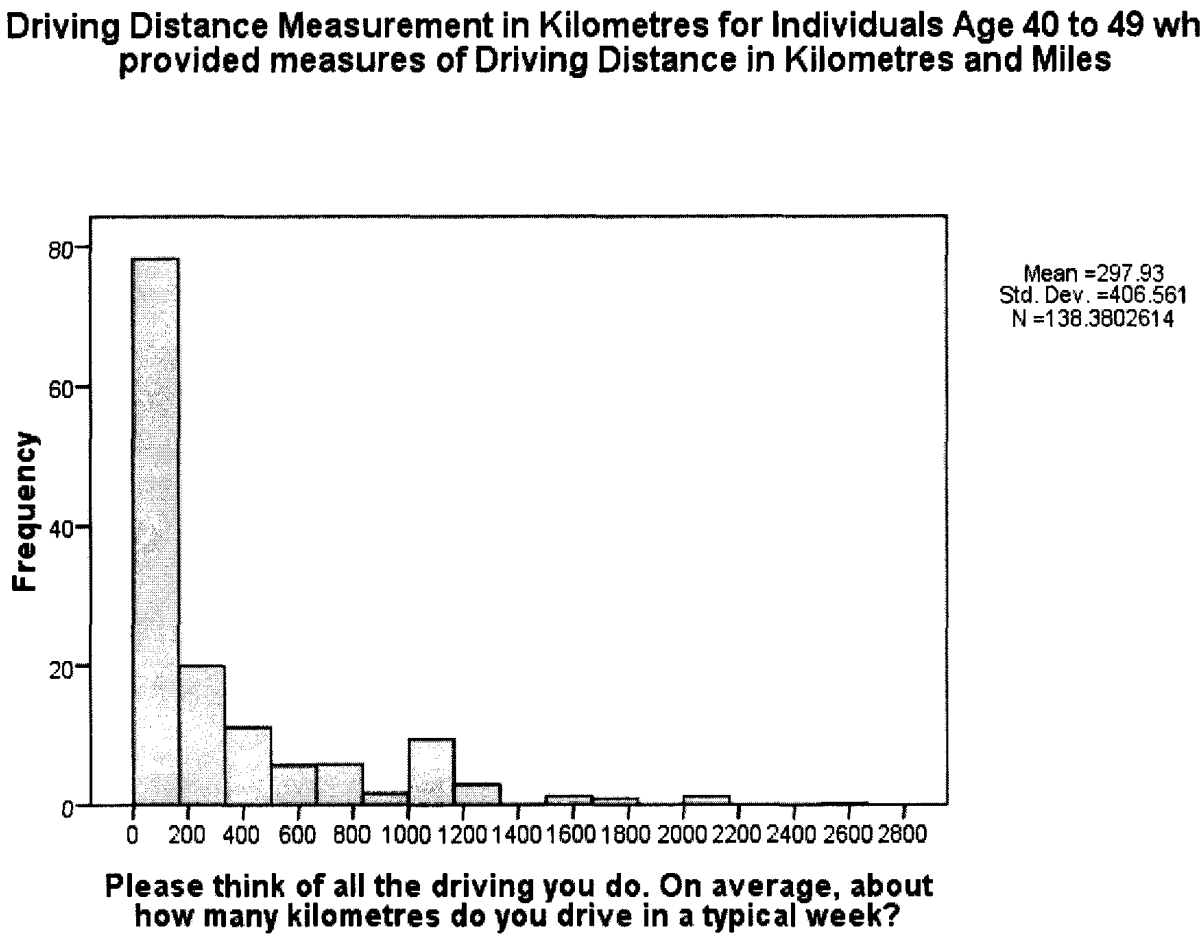
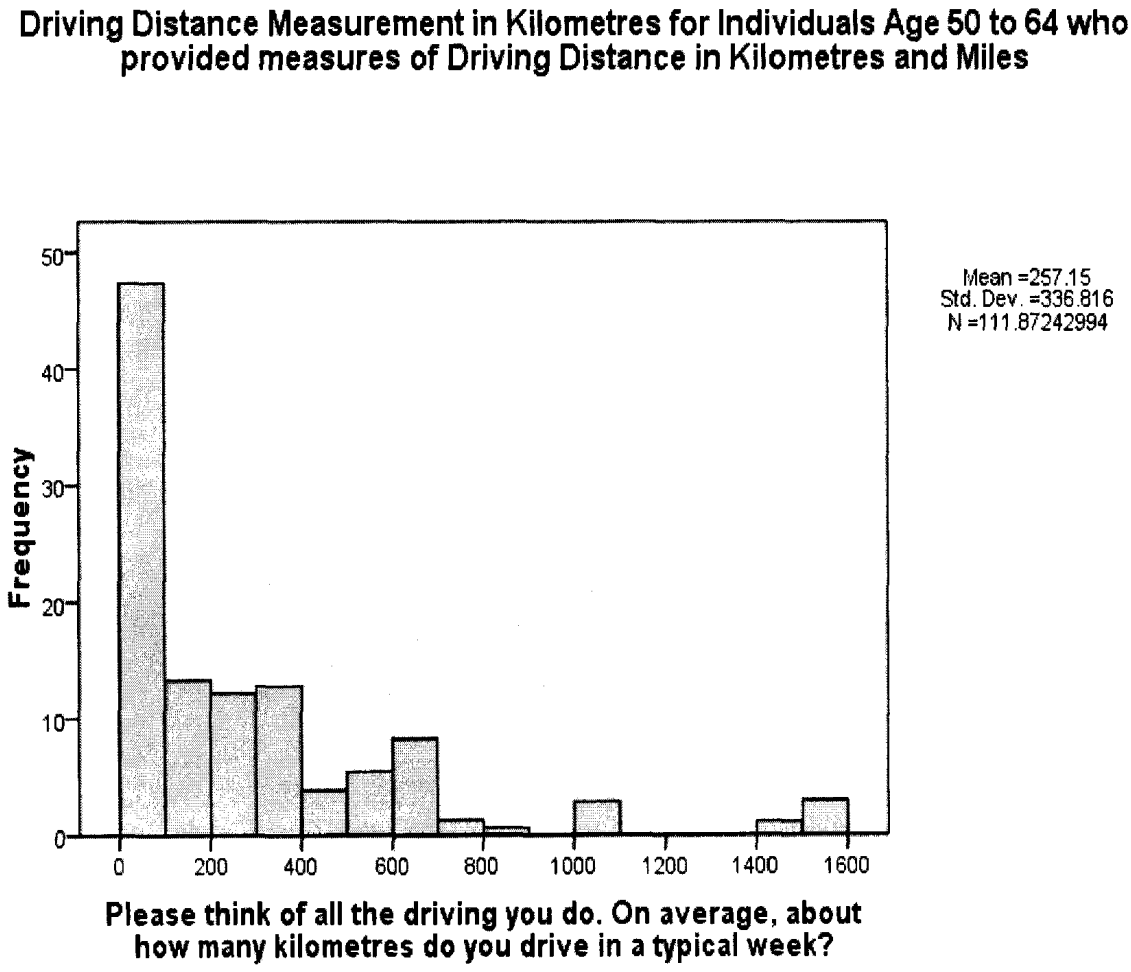


Figure C.2.3. Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Respondents Age 40 to 49



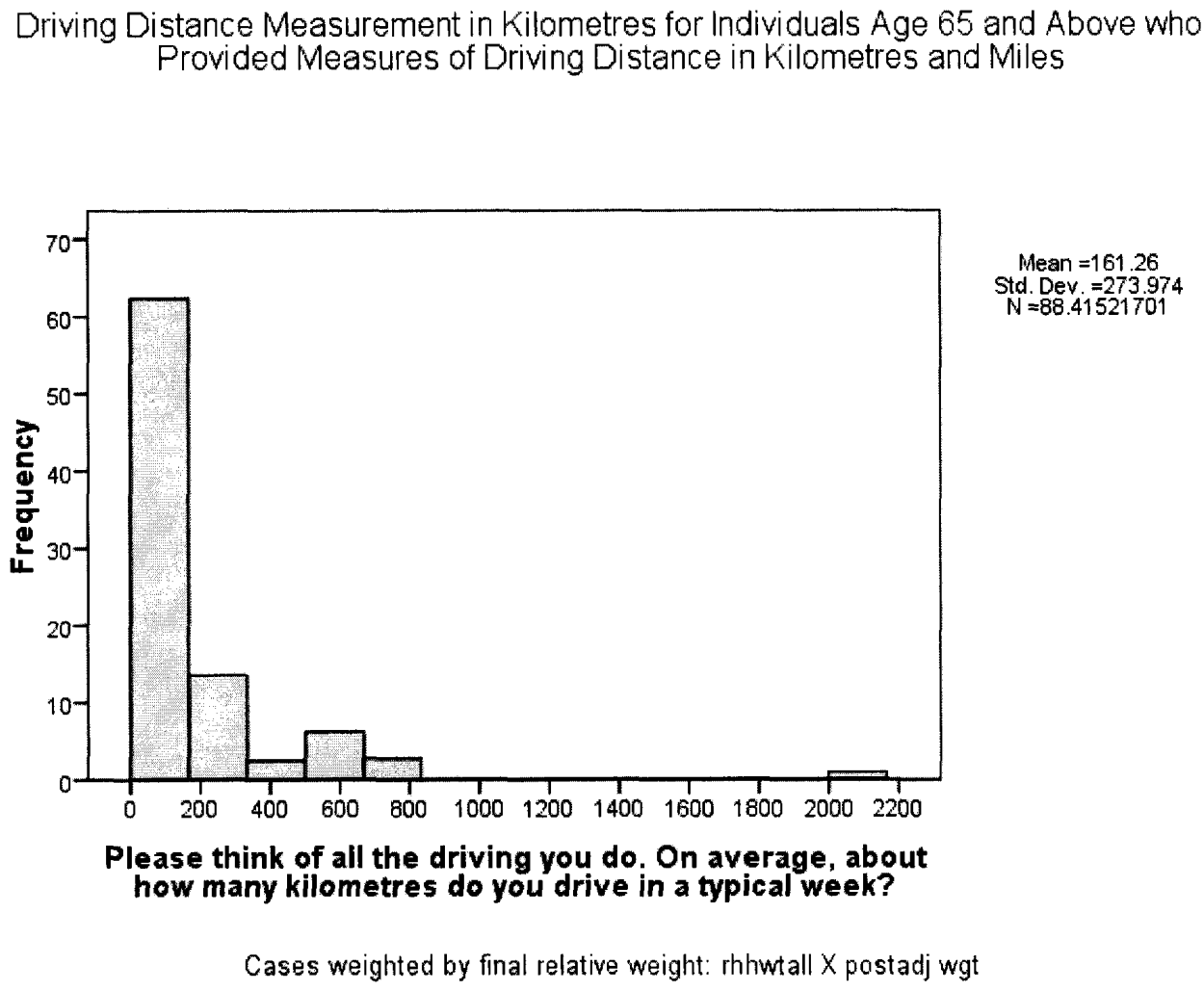
Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.4 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Respondents Age 50 to 64



Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.5 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Respondents Age 65 and Above



Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Miles (Converted to Kilometres) Stratified by Age

For Drivers 18 to 29 years of age in the subgroup of drivers with driving distance estimates recorded in miles and kilometres, all the estimates of driving distance in miles were recorded as 0 miles (n = 110).

Figure C.2.6 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Converted to Kilometres from Miles for Respondents Age 30-39

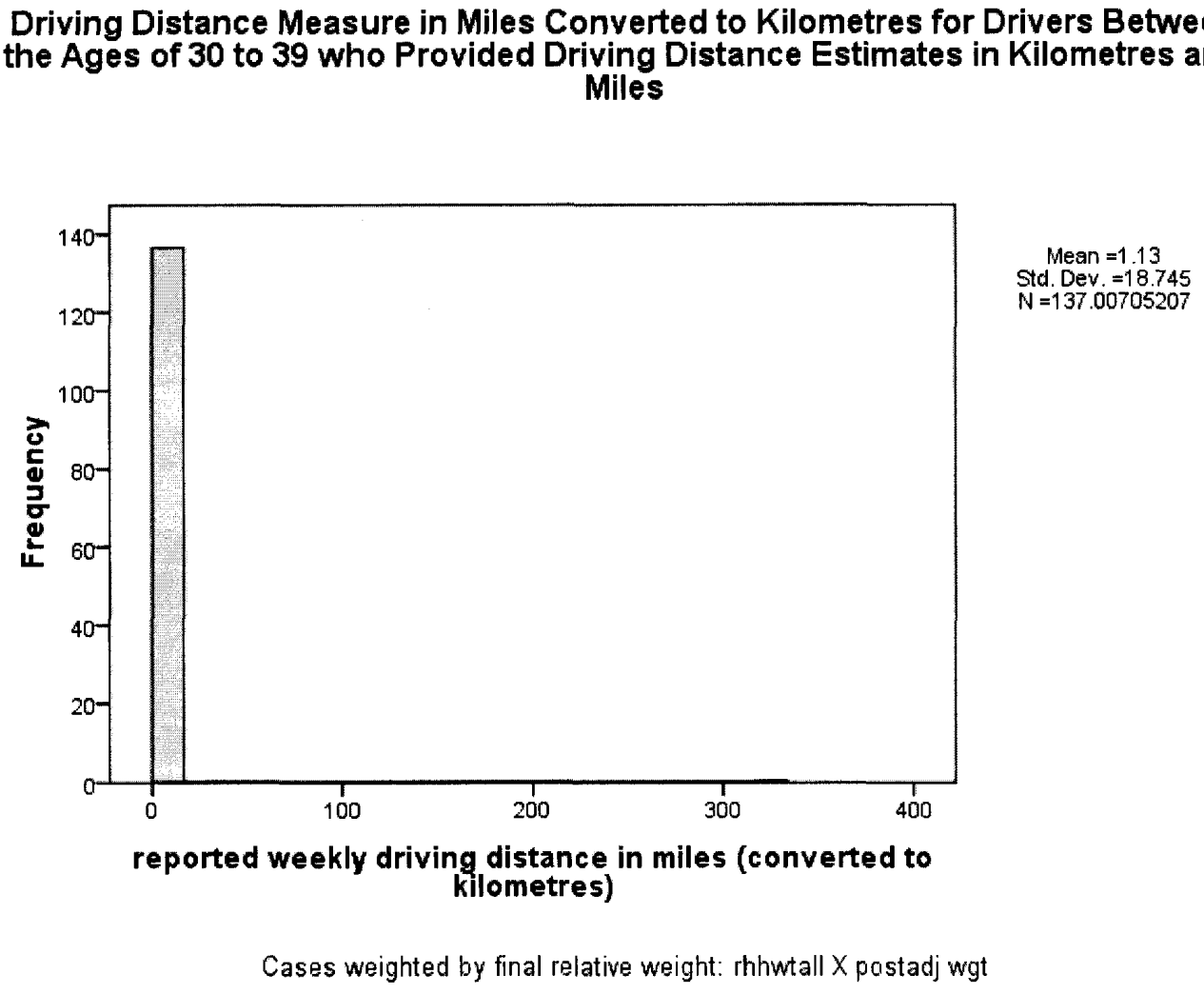


Figure C.2.7 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Converted to Kilometres from Miles for Respondents Age 40-49

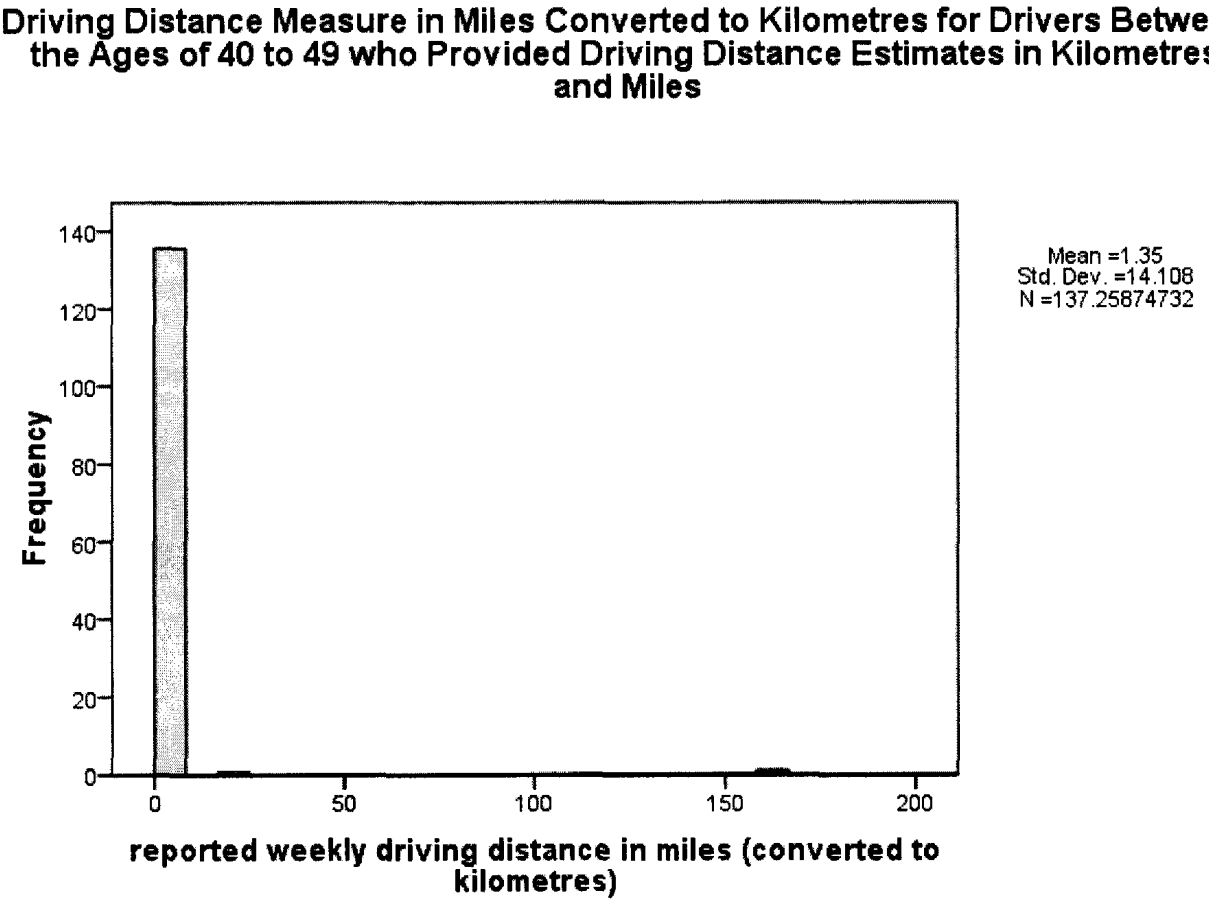


Figure C.2.8 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Converted to Kilometres from Miles for Respondents Age 50-64

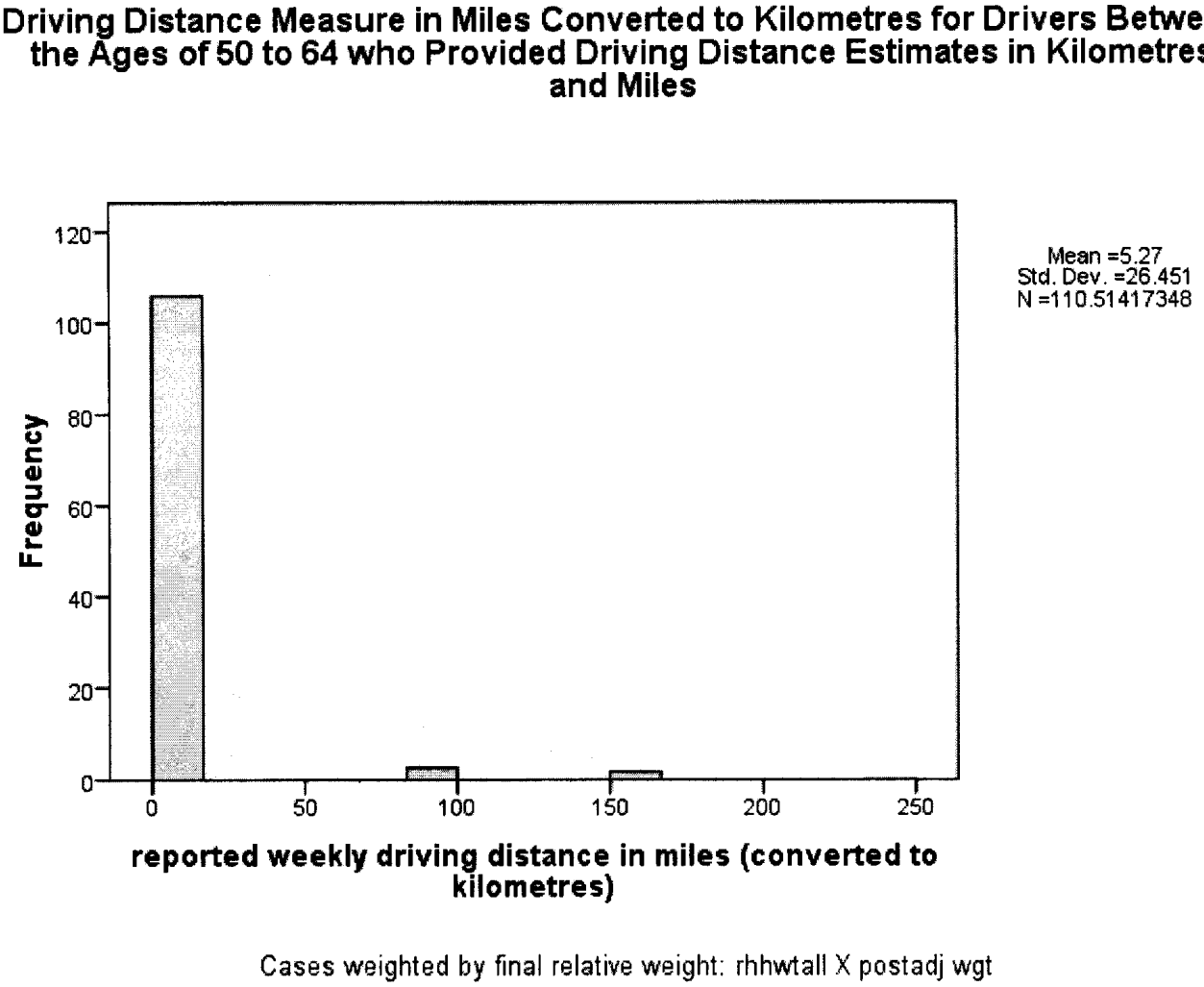
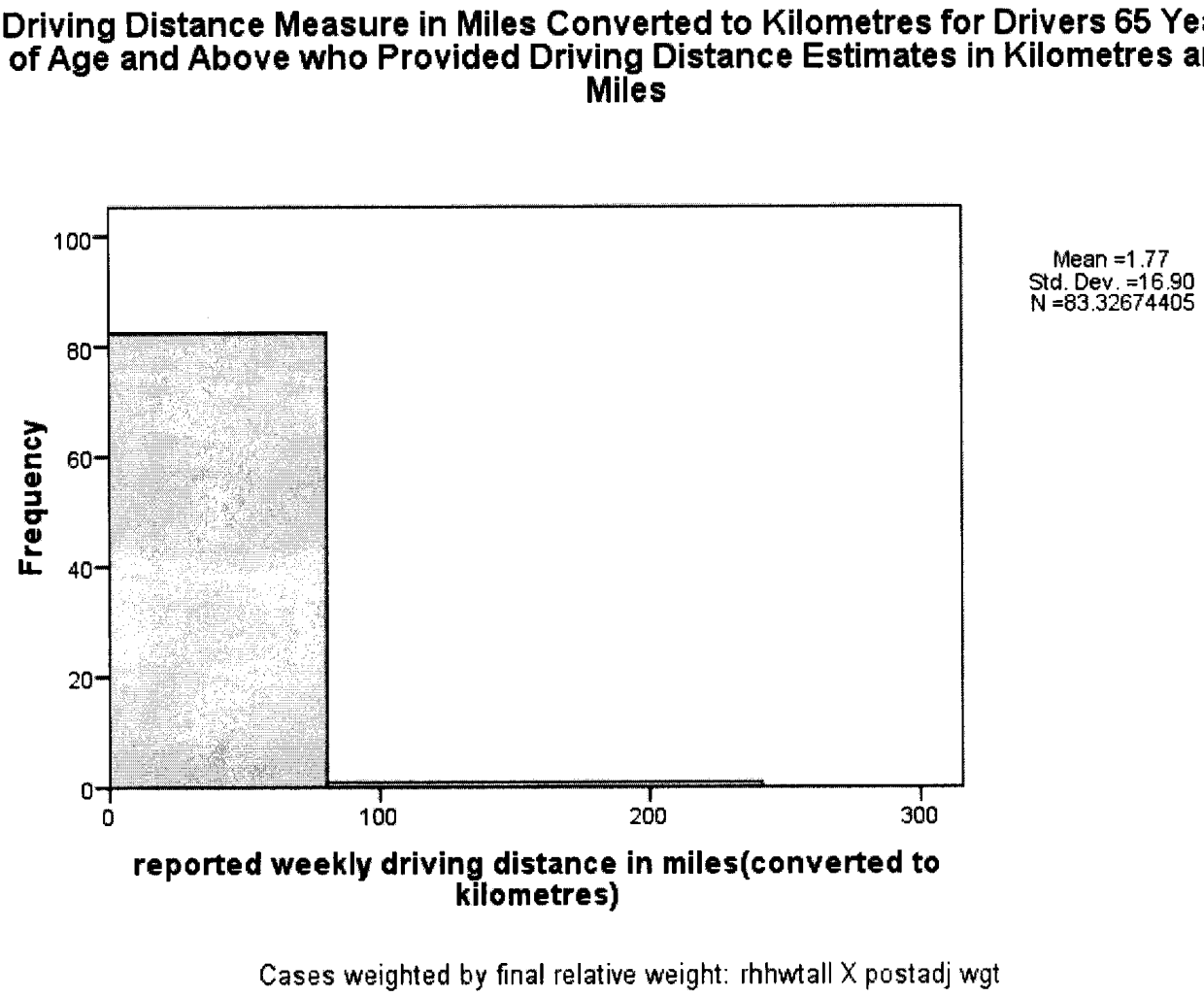


Figure C.2.9 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Converted to Kilometres from Miles for Respondents Age 65 and above



Driving Distance Subgroup Miles and Kilometres Estimates in Kilometres Stratified by Gender

Figure C.2.10 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Females

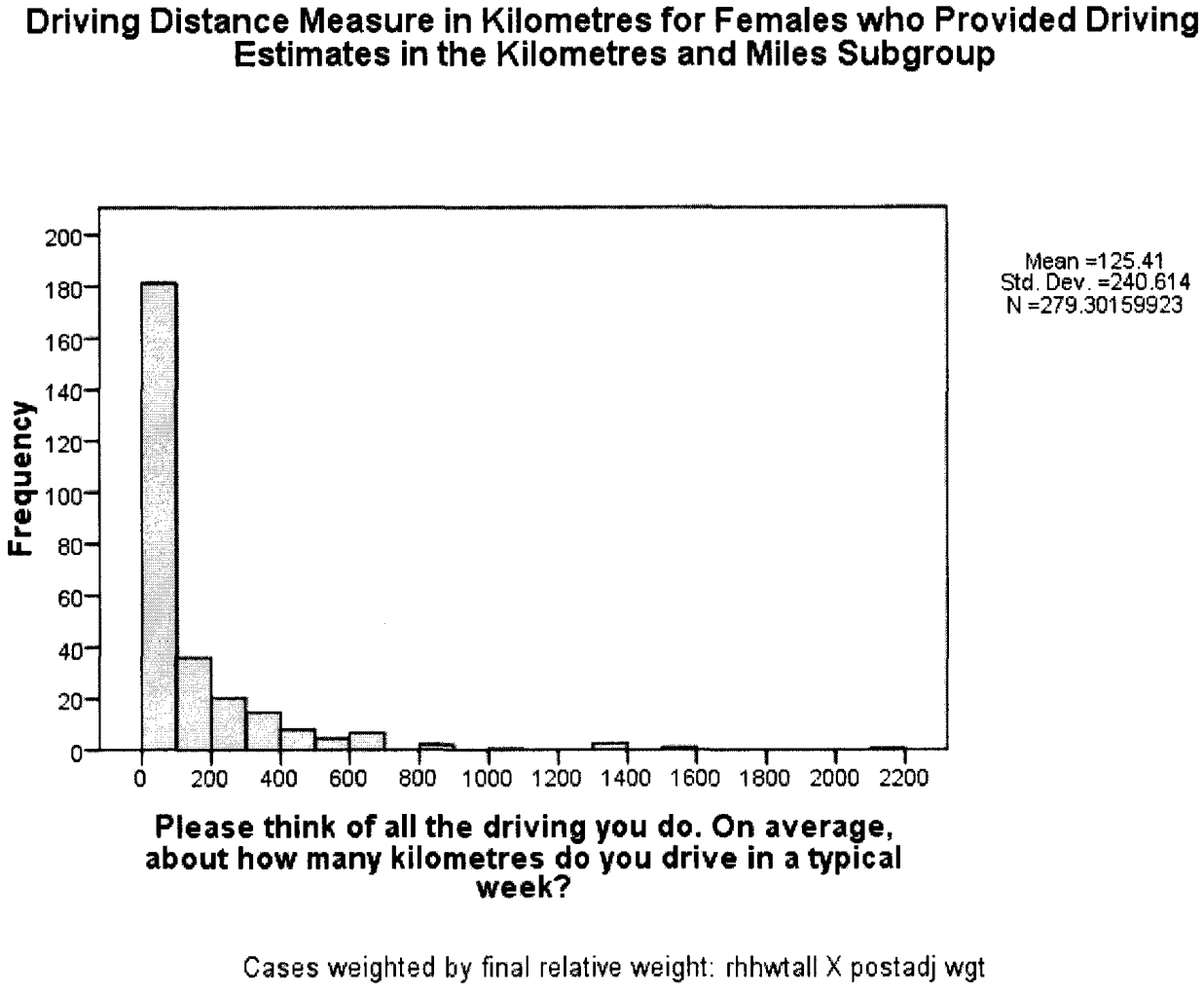
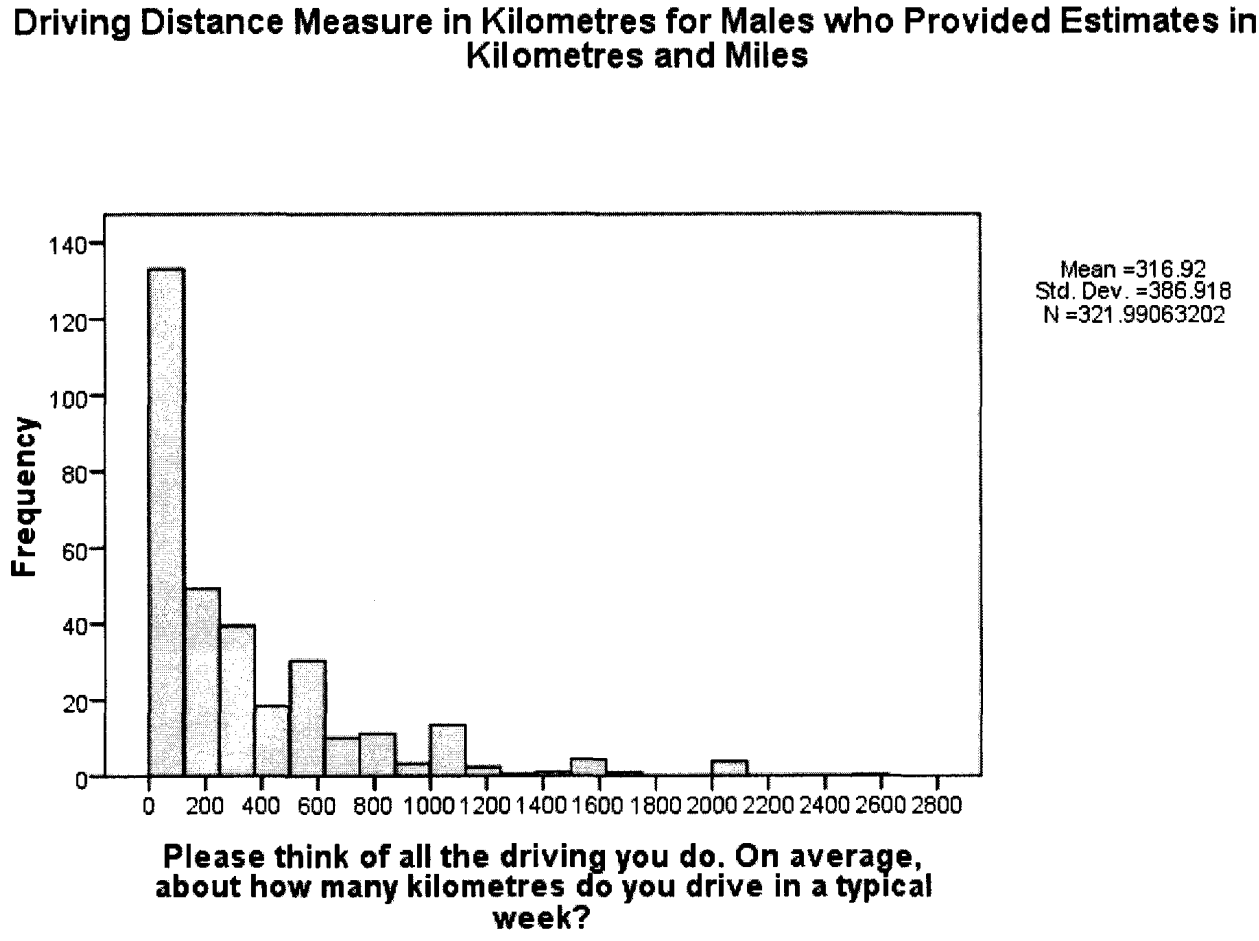


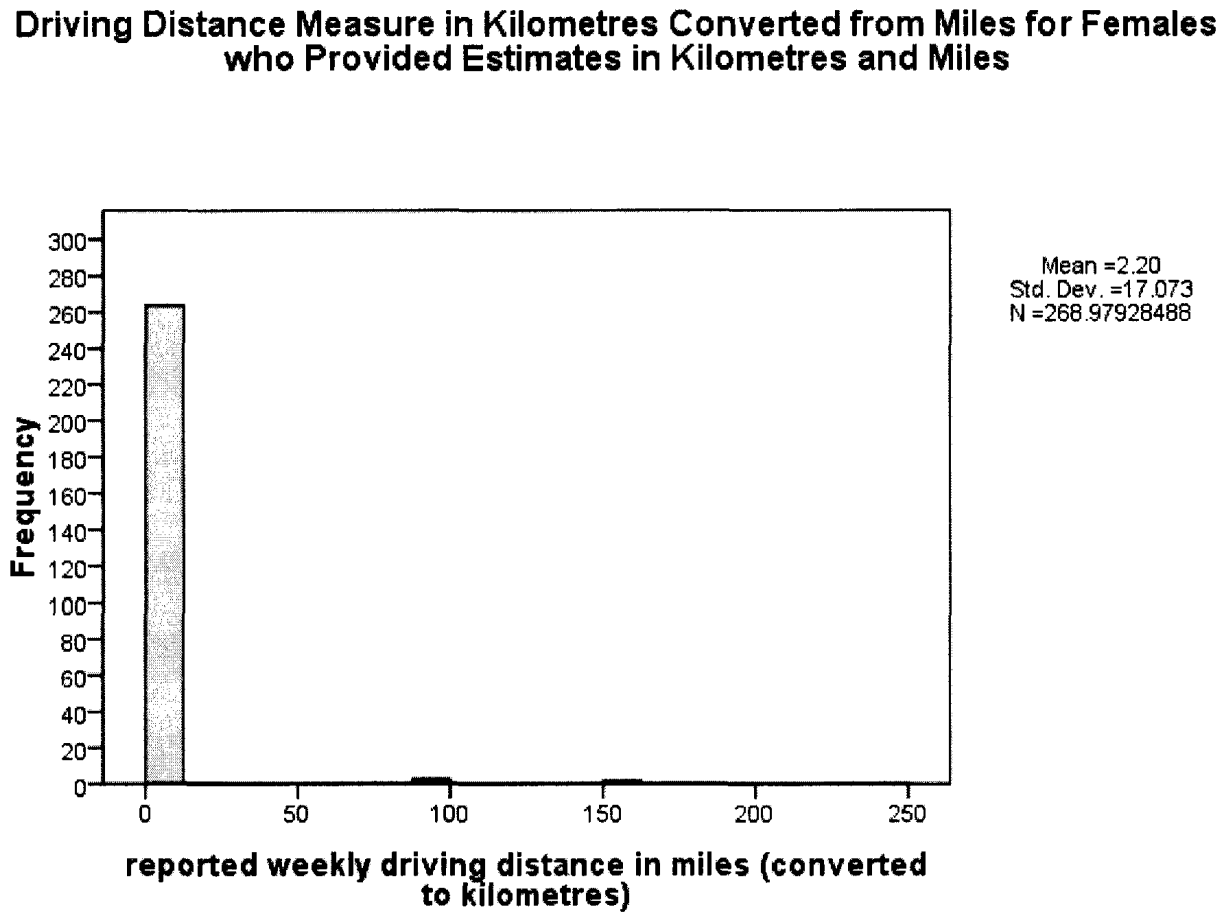
Figure C.2.11 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates in Kilometres for Males



Cases weighted by final relative weight: rhhwtall X postadj wgt

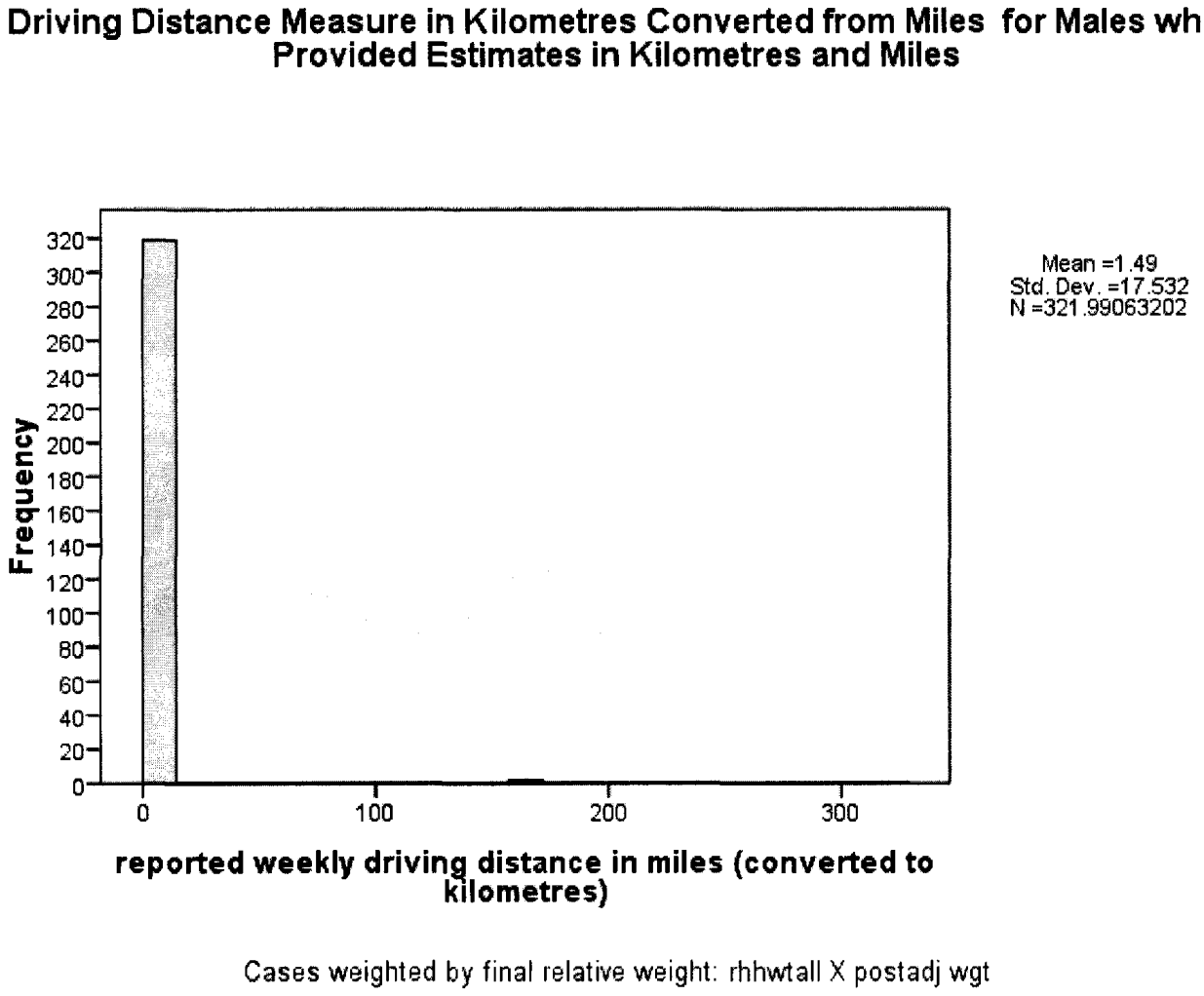
Driving Distance Estimates in Kilometres Converted from Miles for Drivers who Provided Estimates in Kilometres and Miles

Figure C.2.12 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates Converted to Kilometres (from miles) for Females



Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.13 Driving Distance Subgroup with Recorded Responses in Miles and Kilometres Estimates Converted to Kilometres (from miles) for Females



Driving Subgroups with Estimates in Kilometres Only

Table C.2.2 Driving Distance Subgroup with Recorded Responses in Kilometres Stratified by Year of Interview

Year Of Interview

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2002	723	14.0	14.0	14.0
	2003	1569	30.4	30.4	44.4
	2004	1729	33.5	33.5	77.9
	2006	1140	22.1	22.1	100.0
	Total	5160	100.0	100.0	

Figure C.2.14 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Drivers Age 18 to 29

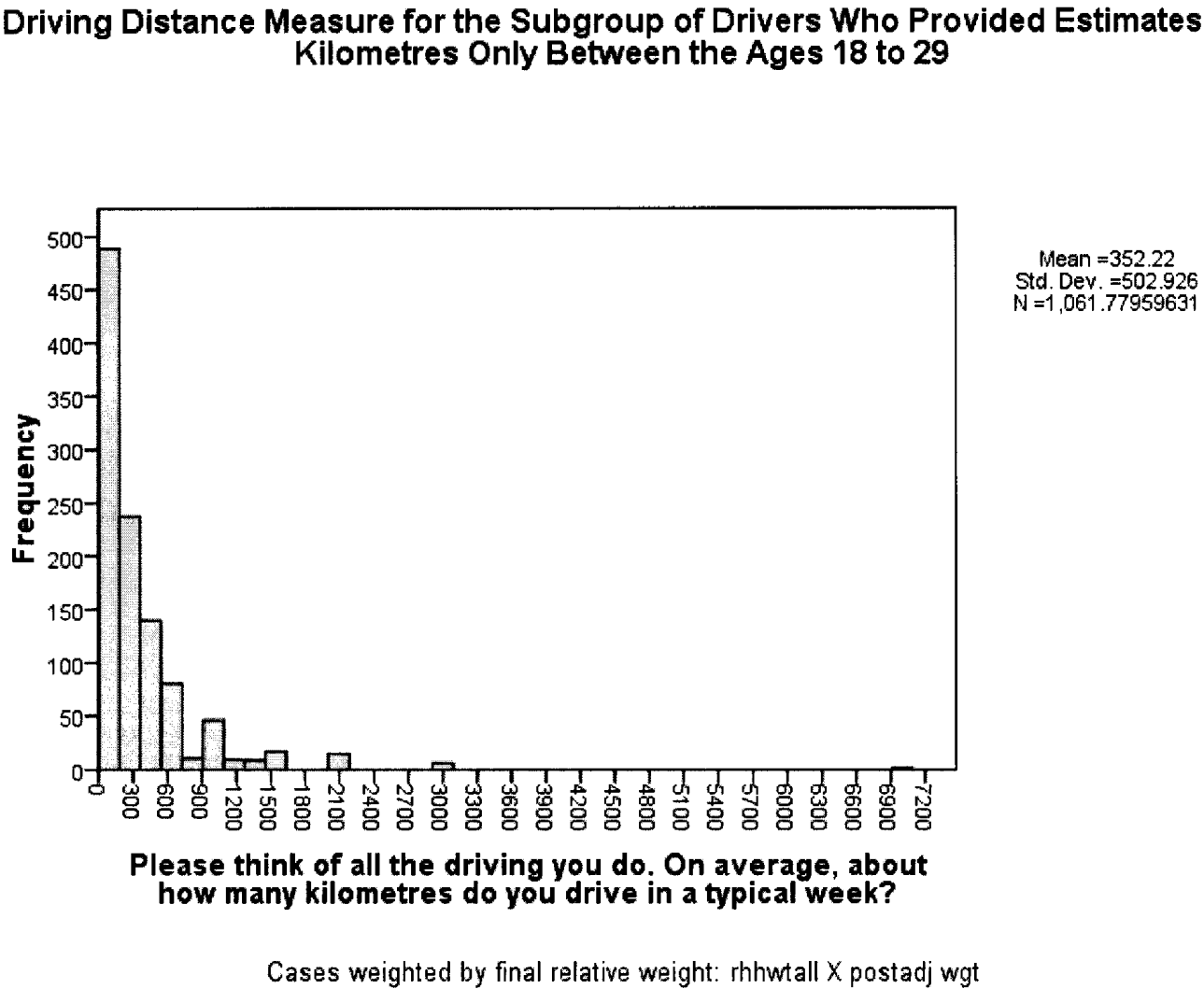


Figure C.2.15 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Drivers Age 30 to 39

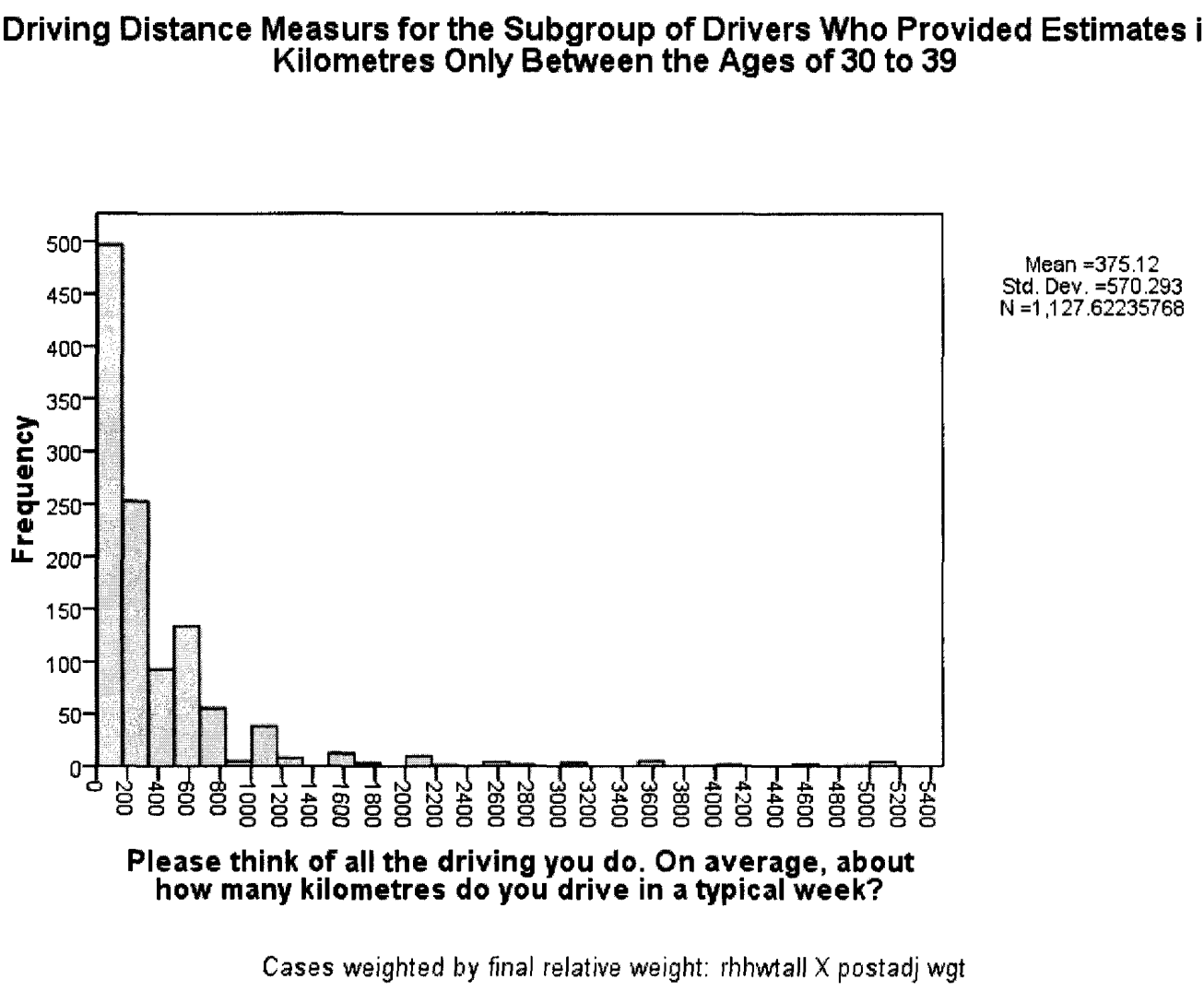
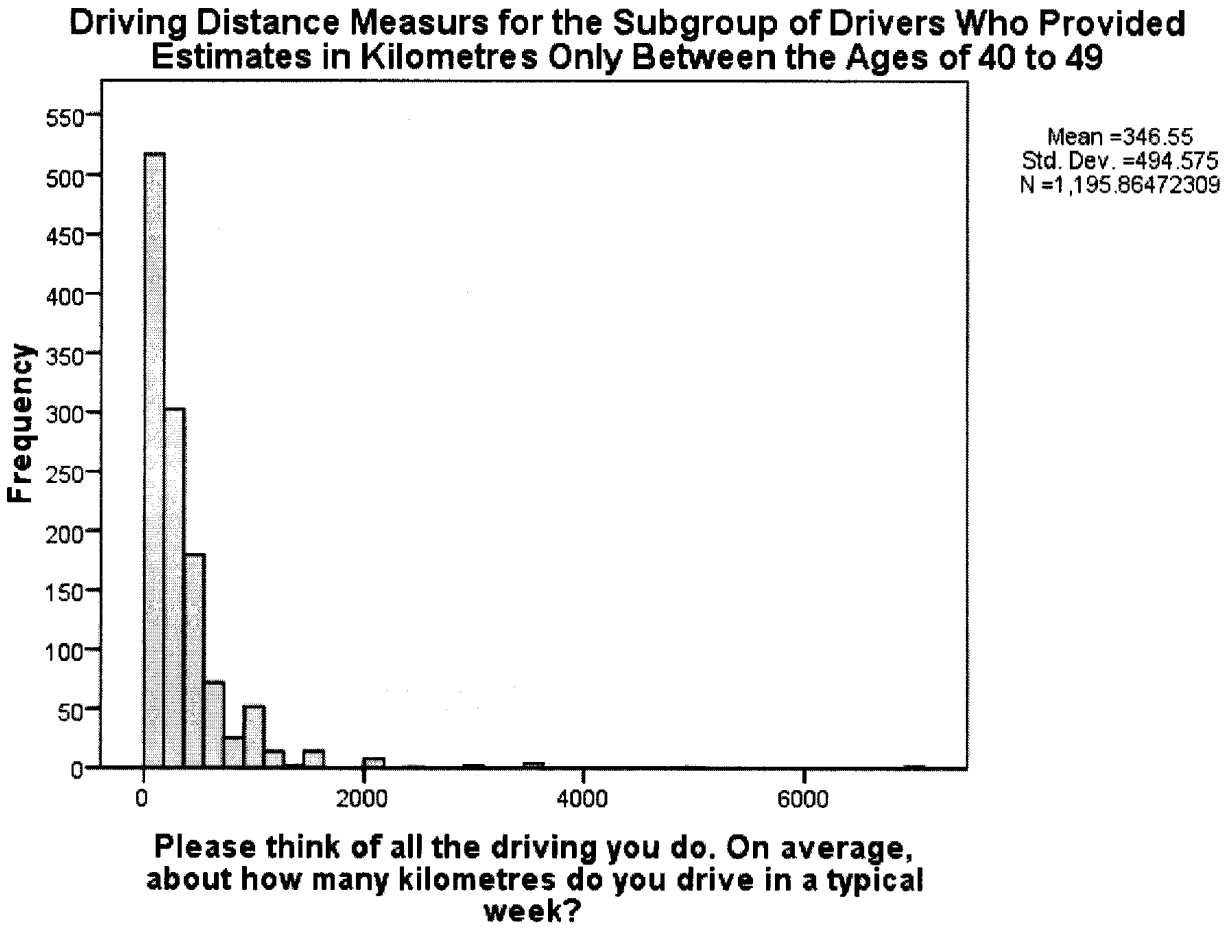
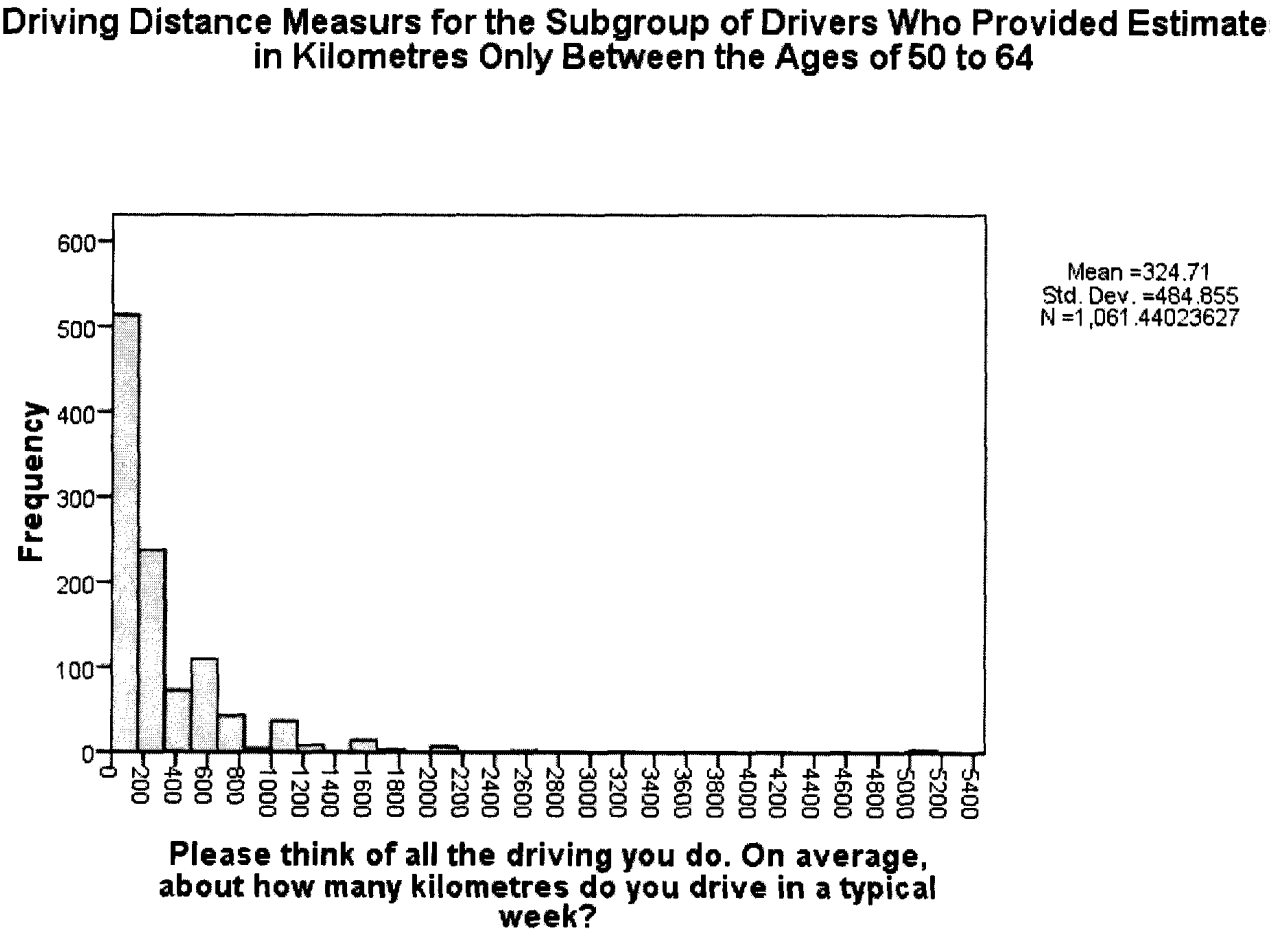


Figure C.2.16 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Drivers Age 40 to 49



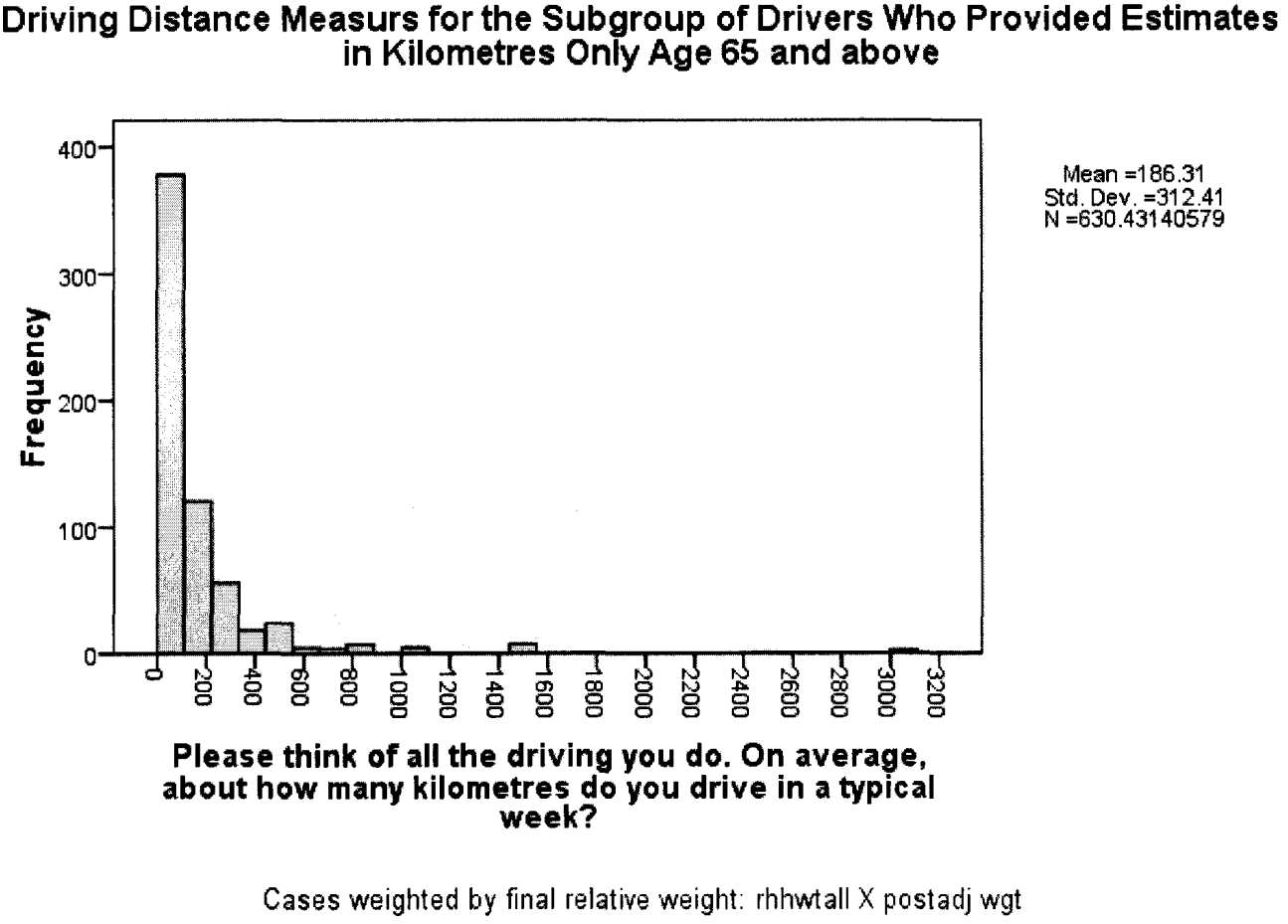
Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.17 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Drivers Age 50 to 64



Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.18 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Drivers Age 65 and above



Drivers who provided estimates only in kilometres stratified by gender

Figure C.2.19 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Females

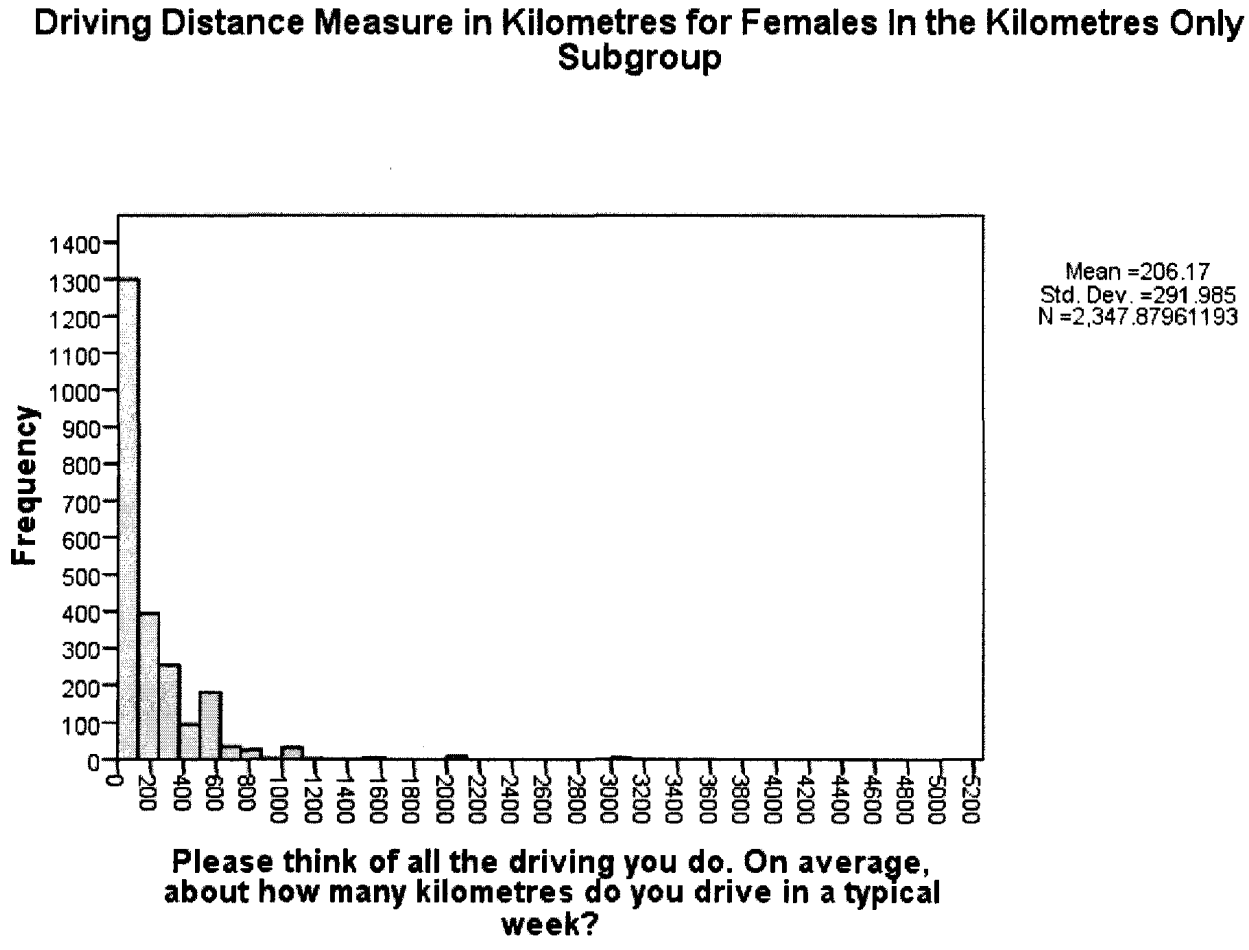
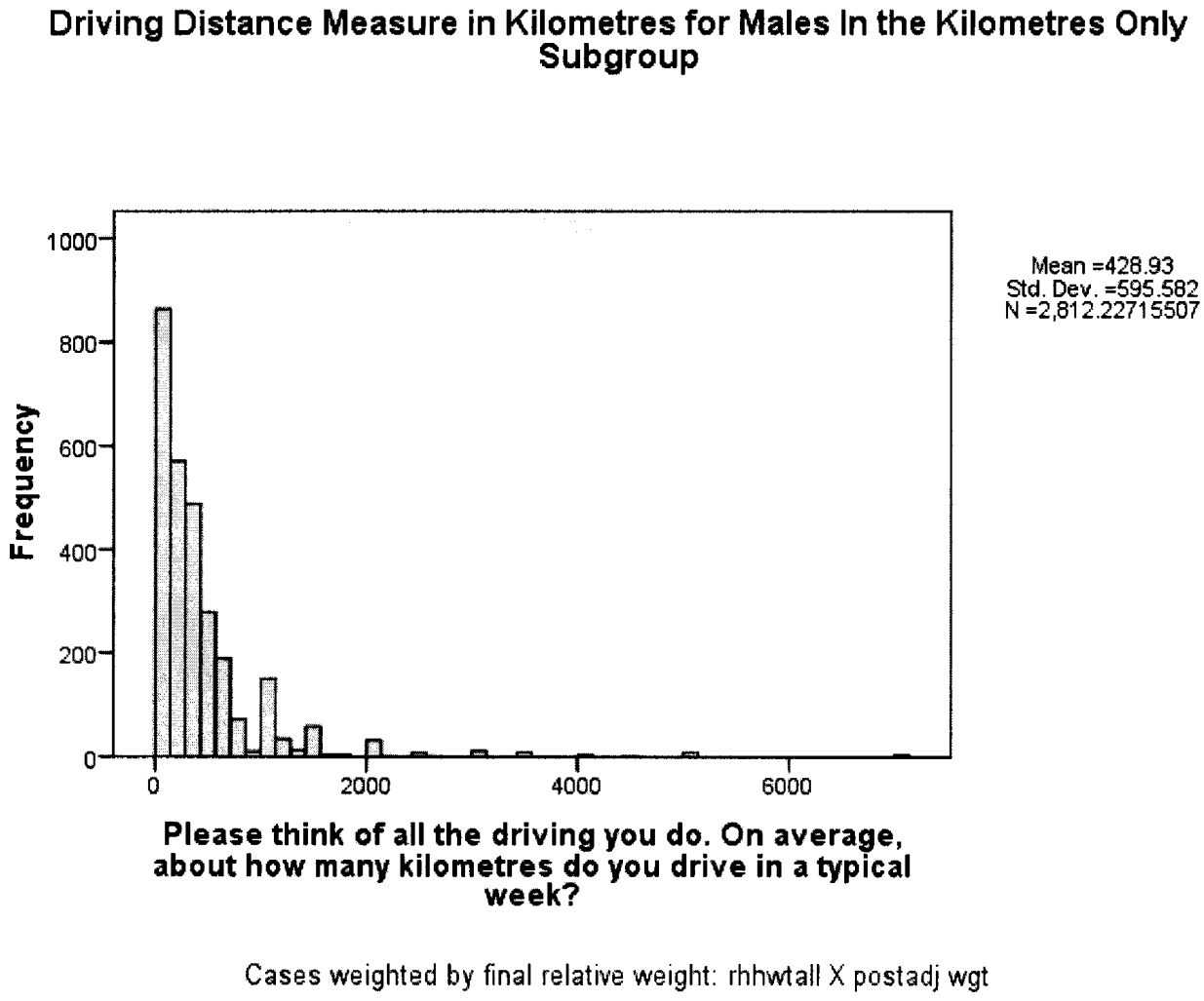


Figure C.2.20 Driving Distance Subgroup with Recorded Responses in Kilometres Estimates for Males



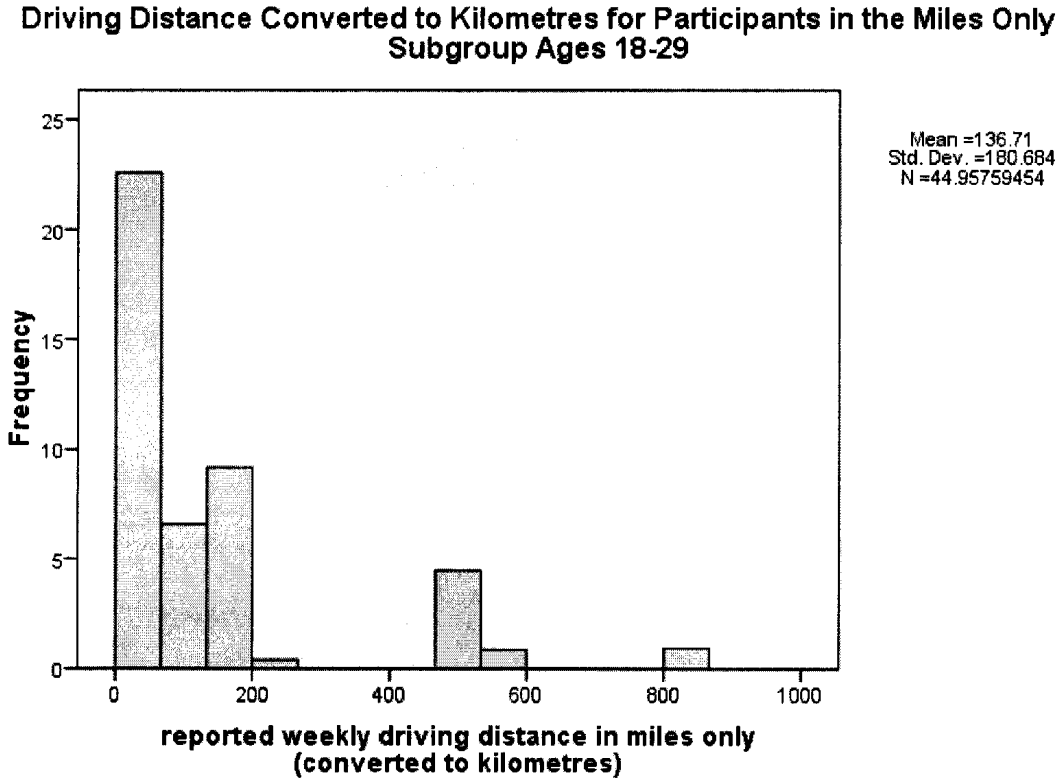
Drivers who only provided Estimates in Miles Stratified by Year of interview

Table C.2.1 Driving Distance Subgroup with Recorded Responses in Miles Stratified by Year of Interview

Year Of Interview					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2002	113	12.8	12.8	12.8
	2003	290	32.8	32.8	45.6
	2004	268	30.3	30.3	76.0
	2006	212	24.0	24.0	100.0
	Total	884	100.0	100.0	

Driving Distance Miles Only Stratified by Age

Figure C.2.21 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) for Drivers Age 18 to 29



Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.22 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) for Drivers Age 30 to 39

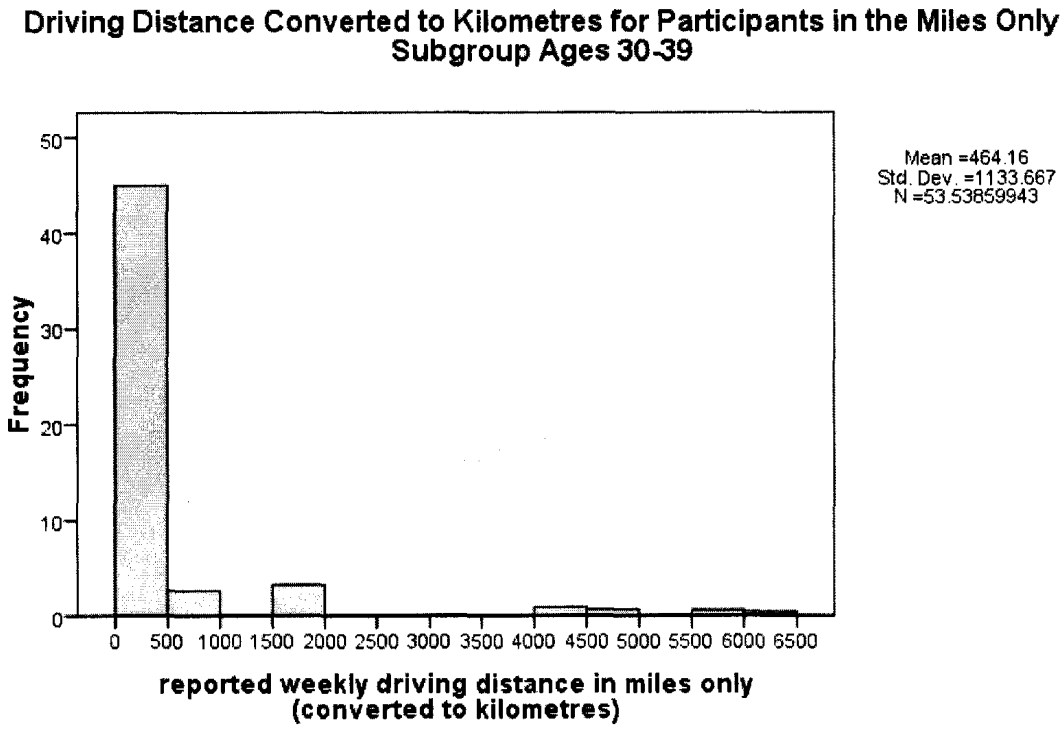


Figure C.2.23 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) for Drivers Age 40 to 49

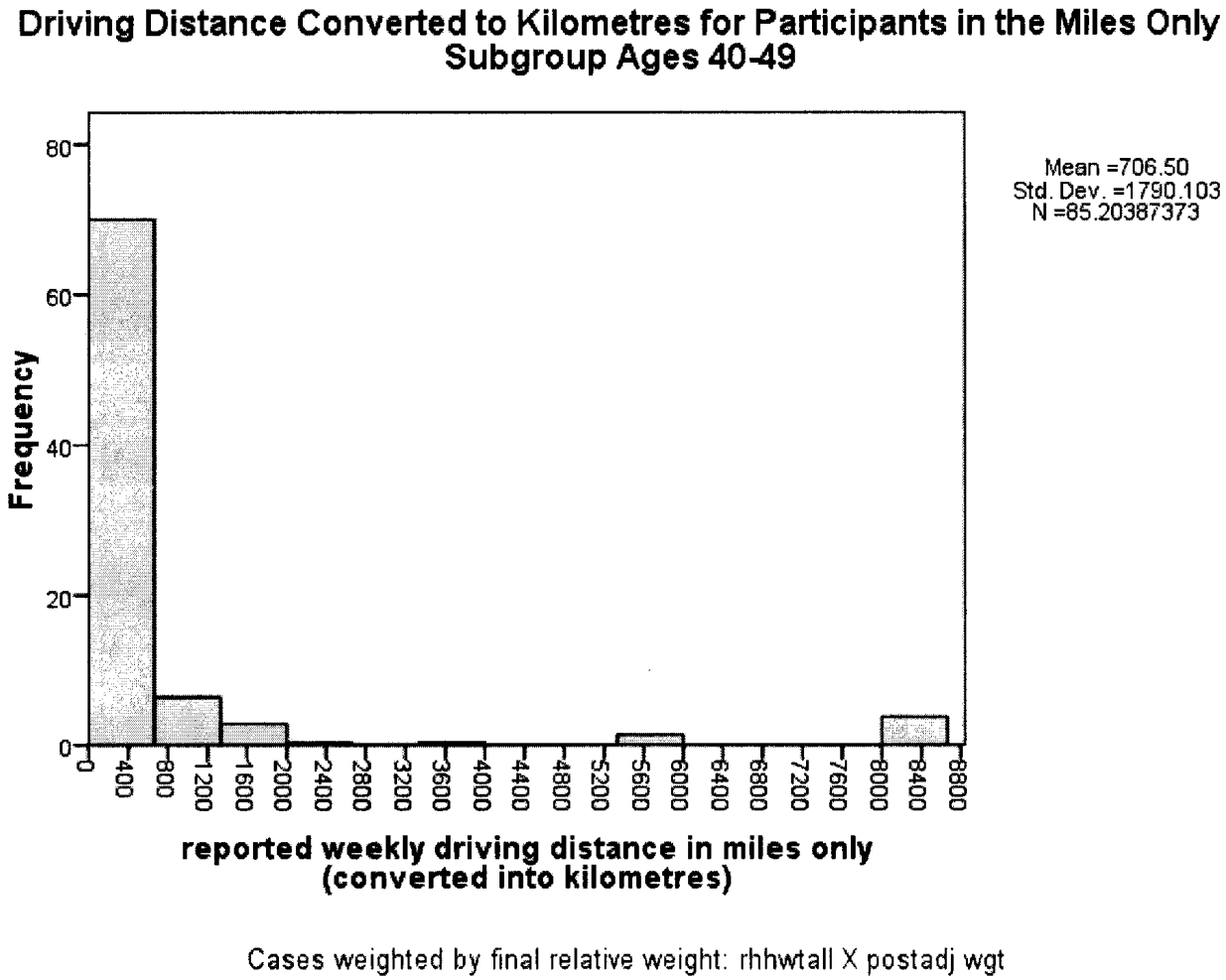


Figure C.2.24 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) for Drivers Age 50 to 64

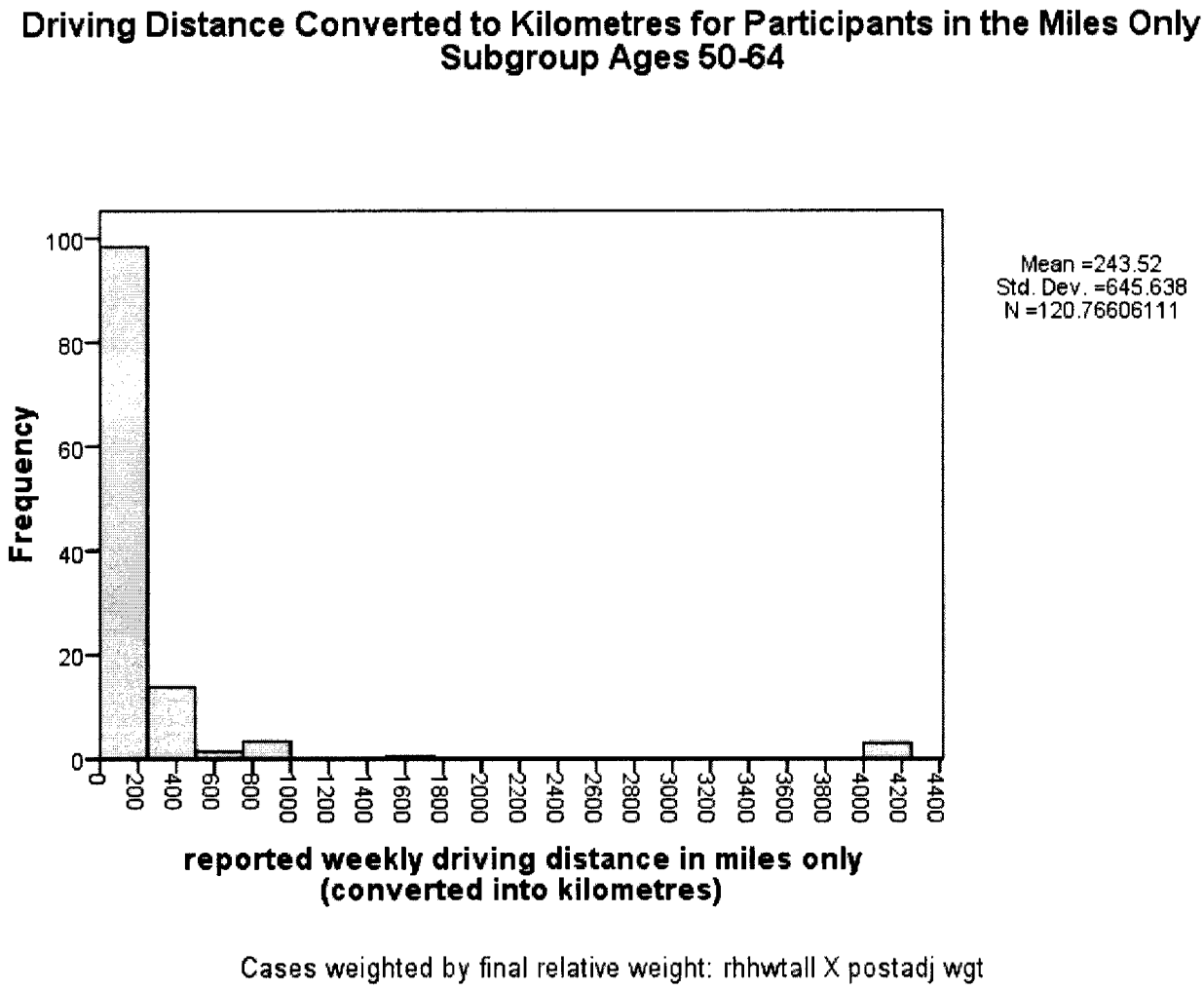
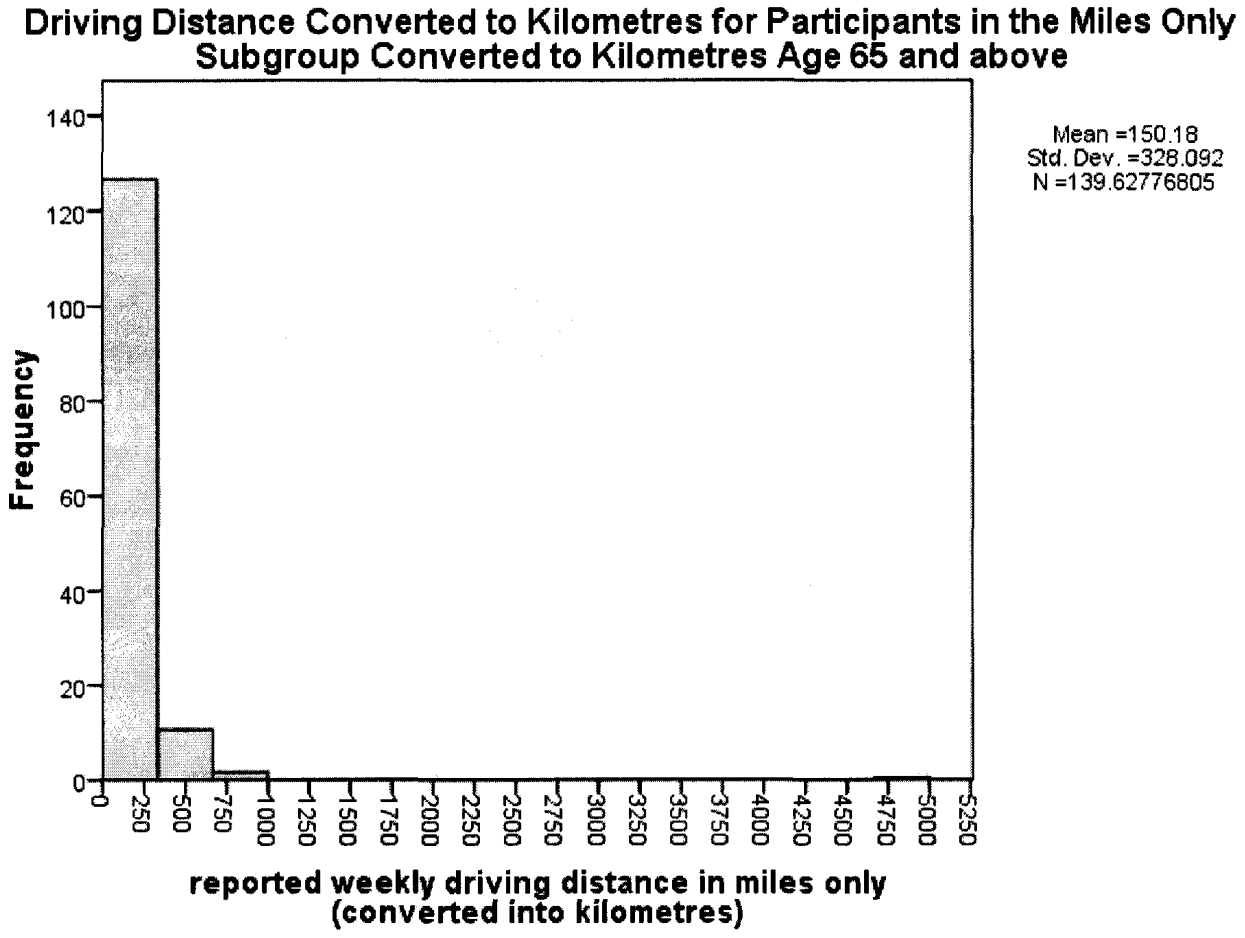


Figure C.2.25 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) for Drivers Age 65 and above



Cases weighted by final relative weight: rhhwtall X postadj wgt

Figure C.2.26 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) Estimates for Females

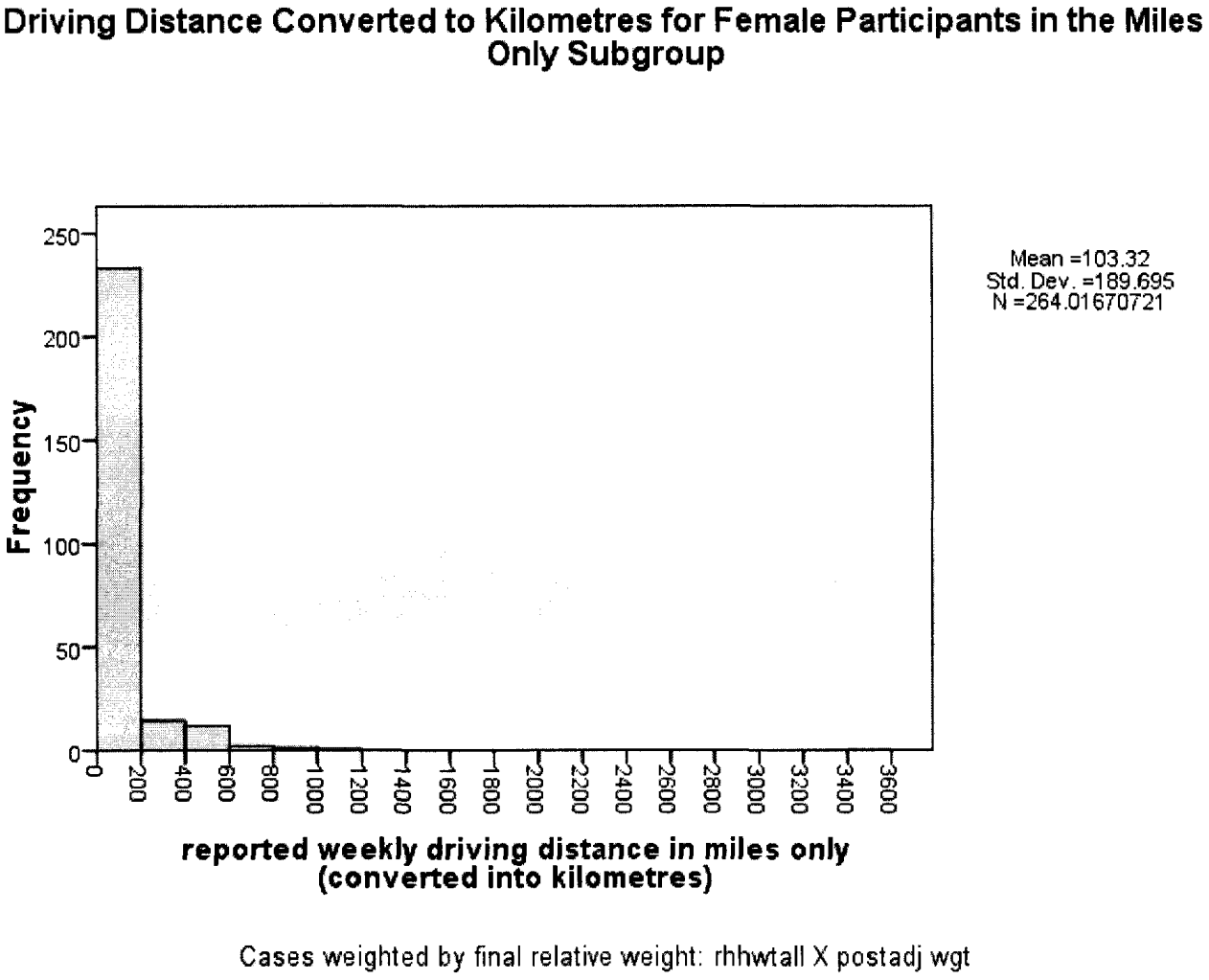
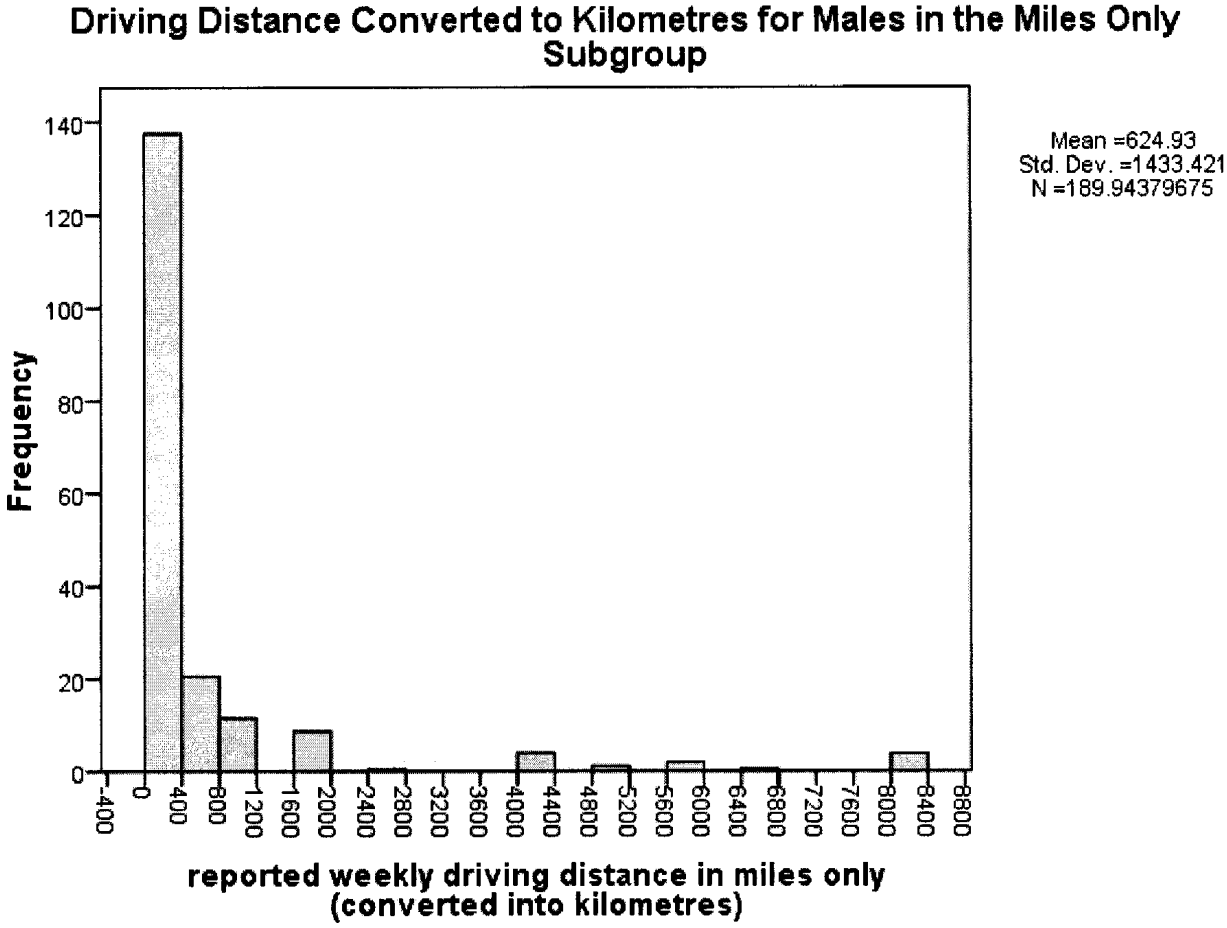


Figure C.2.27 Driving Distance Subgroup with Recorded Responses in Miles (Converted to Kilometres) Estimates for Males



Cases weighted by final relative weight: rhhwtall X postadj wgt

Appendix D Sensitivity Analysis Un-weighted Sample

Table D.1 Frequency Distribution and Un-weighted Percentages for the Total Sample Excluding a Measure of Driving Distance (N= 6560)

Variable	Frequency (Percent)
Any Motor Vehicle Collision Involvement (in the past 12 months)	
Yes	454 (6.9)
No	6106 (93.1)
Age (groups)	
18-29	1001(16.0)
30-39	1229 (19.1)
40-49	1525 (23.7)
50-64	1657 (25.7)
65+	1031(16.0)
Age range (18-94)	
Mean	47.16
Standard Deviation	16.06
Median	46
Gender	
Female	3476 (53.0)
Male	3084 (47.0)
Marital Status	
Married/ Living with a partner	4167 (64.0)
Widowed/Separated/ Divorced	1148 (17.6)
Never Married	1198 (18.4)
Education (Completed High School)	
Yes	5629 (86.7)
No	864 (13.3)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	1241 (18.9)
No	5318 (81.1)
Antidepressant and/or Anxiolytic Medication Use (in the past 12 months)	
Yes	596 (10.0)
No	5344 (90.0)
Drinking and Driving (in the past 12 months)	
Yes	504 (9.0)
No	5078 (91.0)
Road Rage (in the past 12 months)	
Yes	1266 (19.4)
No	5249 (80.6)

Table D. 2 Un-weighted Frequencies and Percentages for Demographic and Risk Factors for Respondents Involved in Motor Vehicle Collisions and not Involved in Motor Vehicle Collisions

Variable	*Involved in a Motor Vehicle Collision in the past 12 months (N=454) (%)*	*Not Involved in a Motor Vehicle Collision in the past 12 months (N=6106)(%)*
Age (groups)		
18-29	116 (25.9)	885 (14.4)
30-39	101 (22.5)	1128 (18.8)
40-49	91 (20.3)	1434 (23.9)
50-64	87 (19.4)	1570 (26.2)
65+	53 (11.8)	978 (16.3)
Age (Range 18-91)		Age (Range 18-94)
Mean	42.51	47.52
Standard Deviation	16.74	15.95
Median	40.00	46.00
Gender		
Female	227 (50.0)	3249 (53.2)
Male	227 (50.0)	2857 (46.8)
Marital Status		
Married/ Living with a partner	254 (56.3)	3913 (64.5)
Widowed/Separated/ Divorced	68 (5.9)	1080 (17.8)
Never Married	129 (28.6)	1069 (17.5)
Education (Completed High School)		
Yes	409(91.3)	5220 (86.4)
No	39 (8.7)	825 (13.6)
Psychiatric Distress (GHQ Score ≥ 2)		
Yes	128 (28.2)	1113 (18.2)
No	326 (71.8)	4992 (81.8)
Antidepressant and/or Anxiolytic Medication Use (in the past 12 months)		
Yes	49 (11.9)	547 (9.9)
No	363 (88.1)	4981 (90.1)
Drinking and Driving (in the past 12 months)		
Yes	49 (12.2)	455 (8.8)
No	354 (87.8)	4724 (91.2)
Road Rage (in the past 12 months)		
Yes	126 (28.0)	1140 (18.8)
No	324 (72.0)	4925 (81.2)

Table D.3 Un-Weighted Sample Bivariate Analyses for Respondents Involved in a Motor Vehicle Collision in the past 12 months

Variable	Unadjusted Odds Ratio (95%CI)
Age groups	
18-29	2.37*** (1.77, 3.16)
30-39	1.62** (1.20, 2.17)
40-49	1.15 (0.85, 1.55)
50-64 (ref)	--
65+	0.98 (0.69, 1.39)
Gender	
Referent- Female	--
Male	1.14 (0.94, 1.38)
Marital Status	
Married/ Living with a Partner (ref)	--
Widowed/Separated/ Divorced	0.97 (0.74, 1.28)
Never Married	1.86*** (1.48, 2.32)
Education (Completed High School)	
Yes (ref)	--
No	0.60** (0.43, 0.85)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	1.76*** (1.42, 2.18)
No (ref)	--
Antidepressant and/or Anxiolytic Medication Use (in the past 12 months)	
Yes	1.23 (0.90, 1.68)
No (ref)	--
Drinking and Driving (in the past 12 months)	
Yes	1.44* (1.05, 1.97)
No (ref)	--
Road Rage (in the past 12 months)	
Yes	1.68*** (1.35, 2.08)
No (ref)	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table D.4 Un-Weighted Sample Logistic Regression Model All Predictors Entered in One Step

Variable	**Odds Ratio (95% CI)**	**B (SE)**
Age groups		
18-29	1.68**	0.516
	(1.14, 2.46)	(0.195)
30-39	1.32	0.277
	(0.93, 1.86)	(0.175)
40-49	1.08	0.078
	(0.77, 1.51)	(0.172)
50-64 (ref)	--	--
65+	1.05	0.051
	(0.69, 1.60)	(0.213)
Gender		
	--	
Female (ref)	1.10	0.095
Male	(0.88, 1.38)	(0.116)
Marital Status		
Married/ Living with a partner (ref)	--	--
Widowed/Separated/ Divorced	0.91	-0.091
	(0.65, 1.28)	(0.173)
Never Married	1.43*	0.357
	(1.06, 1.93)	(0.154)
Education		
(Completed High School)		
Yes (ref)	--	--
No	0.60*	-0.440
	(0.42, 0.99)	(0.220)
Psychiatric Distress (GHQ Score $\geq$ 2)		
Yes	1.63***	0.487
	(1.26, 2.10)	(0.130)
No (ref)	--	--
Antidepressant and/or Anxiolytic Psychotropic Medication Use		
Yes	1.17	0.153
	(0.82, 1.66)	(0.182)
No (ref)	--	--
Drinking and Driving		
Yes	1.14	0.126
No (ref)	(0.79, 1.62)	(0.182)
	--	--
Road Rage		
Yes	1.57***	0.450
	(1.23, 2.00)	(0.124)
No (ref)	--	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table D.5 Un-weighted Hierarchical logistic regression models examining the effect of demographic predictors and psychiatric distress on MVCs

Variables	Model 1[a]		Model 2[b]	
	OR (95% CI)	B (SE)	OR (95% CI)	B (SE)
Age				
18-29	1.89*** (1.32, 2.70)	0.637 (0.182)	1.81*** (1.27, 2.59)	0.594 (0.182)
30-39	1.47* (1.07, 2.02)	0.386 (0.162)	1.40* (1.02,1.93)	0.340 (0.163)
40-49	1.17 (0.86,1.60)	0.160 (0.159)	1.13 (0.83, 1.54)	0.119 (0.160)
50-64 (ref)	--	--	---	--
65+	0.94 (0.65, 1.38)	-0.057 (0.193)	0.98 (0.67, 1.43)	-0.022 (0.193)
Gender				
Female (ref)	--	--	--	--
Male	1.16 (0.95, 1.43)	0.151 (0.105)	1.20 (0.97, 1.47)	0.181 (0.106)
Marital Status				
Married/living with a partner (ref)	--	--	--	--
Widowed/ Divorced/ Separated	1.10 (0.82, 1.49)	0.098 (0.154)	1.04 (0.77, 1.40)	0.036 (0.155)
Never Married	1.40* (1.05, 1.86)	0.335 (0.146)	1.37* (1.03, 1.82)	0.315 (0.146)
Completed High School				
Yes (ref)	--	--	--	--
No	0.69* (0.47, 1.00)	-0.377 (0.191)	0.67* (0.46, 0.97)	-0.401 (0.191)
Psychiatric Distress			1.71***	0.537
Yes			(1.36, 2.15)	(0.118)
No (ref)			--	--
Model Chi-square	54.19***		19.45***	
Block Chi-square			73.63***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$
[a]Model 1: Demographic predictors
[b]Model 2: Demographic Predictors and Psychiatric Distress

Table D. 6 Un-Weighted Sample Hierarchical logistic regression models examining the effect of antidepressant and/or anxiolytic medications, drinking and driving, and road rage on the association between psychiatric distress and MVCs

	Model 3[c]		Model 4[d]		Model 5[e]	
Variables	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)
Age						
18-29	1.83**	0.607	1.76*	0.564	1.73**	0.549
	(1.24, 2.55)	(0.183)	(1.23, 2.52)	(0.184)	(1.23, 2.44)	(0.175)
30-39	1.41*	0.346	1.40*	0.261	1.39*	0.329
	(1.03, 1.95)	(0.163)	(1.01, 1.93)	(0.161)	(1.03, 1.88)	(0.155)
40-49	1.13	-0.047	1.03	-0.030	1.01	0.014
	(0.69, 1.32)	(0.166)	(0.74, 1.43)	(0.167)	(0.75, 1.38)	(0.157)
50-64(ref)	--	--	--	--	--	--
65+	0.99	-0.012	1.03	0.027	1.04	0.044
	(0.66, 1.41)	(0.194)	(0.69, 1.54)	(0.203)	(0.72, 1.50)	(0.189)
Gender						
Male	1.21	0.189	1.09	0.084	1.14	0.126
	(0.98, 1.49)	(0.106)	(0.88, 1.35)	(0.109)	(0.93, 1.38)	(0.101)
Female (ref)	--	--	--	--	--	--
Marital Status						
Widowed/Divorced/	1.03	0.029	0.93	-0.076	1.03	0.122
Separated	(0.76, 1.40)	(0.155)	(0.67, 1.45)	(0.167)	(0.77, 1.38)	(0.169)
Never Married	1.36*	0.310	1.36*	0.310	1.34*	0.295
	(1.02, 1.82)	(0.146)	(1.06, 1.86)	(0.144)	(1.02, 1.76)	(0.139)
Married/Living with partner (ref)	--	--	--	--	--	--
Completed High School						
Yes (ref)	0.67*	-0.403	0.65*	-0.431	0.64*	-0.448
	(0.46, 0.97)	(0.191)	(0.43, 0.98)	(0.208)	(0.44, 0.92)	(0.188)
No	--	--	--	--	--	--
Psychiatric Distress						
Yes	1.68***	0.518	1.63***	0.488	1.62***	0.483
	(1.33, 2.13)	(0.121)	(1.28, 2.07)	(0.121)	(1.29, 2.03)	(0.115)
No (ref)	--	--	--	--	--	--
Antidepressants and/or Anxiolytic med use	1.11	0.133				
Yes	(0.80, 1.55)	(0.168)				
No(ref)	--	--				
Drinking and Driving			1.23	0.207		
Yes			(0.89, 1.70)	(0.167)		
No(ref)			--	--		
Road Rage						
Yes					1.53***	0.428
					(1.23, 1.91)	(0.113)
No (ref)					--	--
Model-chi square	74.24***		73.31***		91.45***	
Block- chi square	.61		1.48		13.56***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

[c]Model 3: Adding Antidepressant and Anxiolytic Medications to model 2 (see Table D.5)

[d]Model 4: Adding Drinking and Driving to model 2 (see Table D.5)

[e]Model5: Adding Road Rage to model 2 (see Table D.5)

Table D.7 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Antidepressant and/or Anxiolytic Medication Use

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Antidepressant and/or Anxiolytic Medication Use	3.66*** (3.04, 4.42)	1.299*** (0.095)
b = Antidepressant and/or Anxiolytic Medication use- MVCs (controlling for psychiatric distress)	1.14 (0.82, 1.59)	0.133 (0.168)
c' = Psychiatric Distress- MVCs (controlling for Antidepressant and/or Anxiolytic Medication Use)	1.68*** (1.33, 2.13)	0.518*** (0.121)

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Figure D.1 Psychiatric Distress and Antidepressant and/or Anxiolytic Medication Use Path Analysis Model

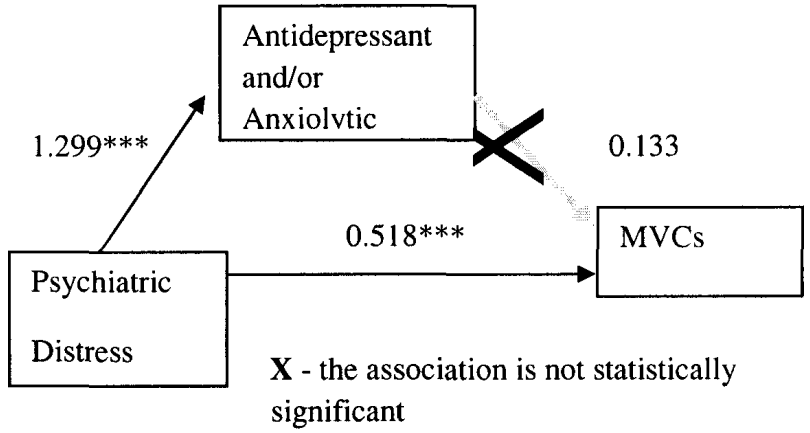
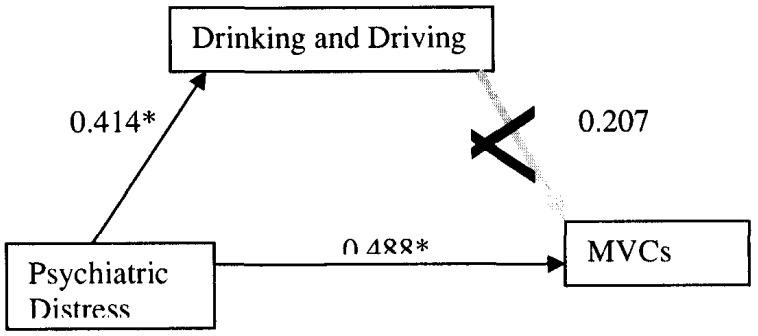


Table D.8 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Drinking and Driving

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Drinking and Driving	1.51*** (1.23, 1.86)	0.414*** (0.105)
b = Drinking and Driving- MVCs (controlling for psychiatric distress)	1.23 (0.89, 1.70)	0.207 (0.167)
c' = Psychiatric Distress- MVCs (controlling for drinking and driving)	1.63*** (1.28, 2.07) --	0.488*** (0.121) --

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Figure D.2. Psychiatric Distress and Drinking and Driving Path Analysis Model



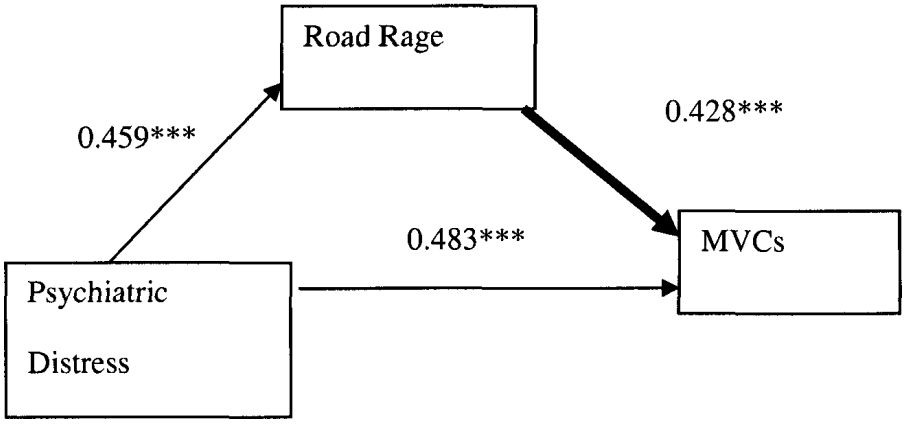
X - the association is not statistically significant

Table D.9 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's (1986) Criteria for Mediation Between Psychiatric Distress and MVCs by Road Rage

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Road Rage	1.58*** (1.37, 1.83)	0.459*** (0.073)
b = Road Rage- MVCs	1.53*** (1.23, 1.91))	0.428*** (0.113)
c' = Psychiatric Distress-MVCs	1.62*** (1.29, 2.03)	0.483** (0.115)

Indirect Effect (a x b) = 0.196
Direct Effect (c') = 0.483
Total Effect (a x b + c') = 0.679
Proportion of indirect effect = Indirect effect/ Total Effect = 28.9%

Figure D.3 Psychiatric Distress and Road Rage and MVCs Path Analysis Model



Appendix E Sensitivity Analysis with Driving Distance (Weighted)

Table E.1 Frequency Distribution and Weighted Percentages for the Total Sample Including a Measure of Driving Distance (N= 6077)

Variable	Frequency (Percent)
Any Motor Vehicle Collision Involvement (in the past 12 months)	
Yes	477 (7.8)
No	5600 (92.2)
Age (groups)	
18-29	1166 (19.5)
30-39	1292 (21.6)
40-49	1398 (23.4)
50-64	1278 (21.4)
65+	837 (14.0)
Age (18-94)	
Mean	44.77
Standard Deviation	15.94
Median	43
Gender	
Female	2805 (46.2)
Male	3272 (53.8)
Marital Status	
Married/ Living with a partner	4199 (69.5)
Widowed/Separated/ Divorced	627 (10.4)
Never Married	1214 (20.1)
Education (Completed High School)	
Yes	5368 (89.1)
No	656 (10.9)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	1138 (18.7)
No	4938 (81.3)
Psychotropic Medication Use (Prescribed to treat Anxiety/panic attacks or Depression or both types of symptoms) (Antidepressant and/or Anxiolytic Medication Use)	
Yes	481 (8.8)
No	4938 (91.2)
Drinking and Driving (in the past 12 months)	
Yes	501 (9.6)
No	4716 (90.4)
Road Rage (in the past 12 months)	
Yes	1256 (20.8)
No	4785 (79.2)

Table E. 2 Weighted Frequencies and Percentages for Demographic and Risk Factors for Respondents Involved in Motor Vehicle Collisions and not Involved in Motor Vehicle Collisions

Variable	*Involved in a Motor Vehicle Collision in the past 12 months (n) (N=477) (%)*	*Not Involved in a Motor Vehicle Collision in the past 12 months (n) (N= 5600) (%)*
Age (groups)		
18-29	146 (31.1)	1020 (18.5)
30-39	119 (21.6)	1173 (21.3)
40-49	82 (23.4)	1316 (23.9)
50-64	72 (21.4)	1206 (21.9)
65+	50 (10.7)	787 (14.3)
Age (Range 18-91)		Age (Range18-94)
Mean	40.08	45.18
Standard deviation	16.30	15.84
Mode	37	44
Gender		
Female	203 (42.6)	2602 (46.5)
Male	274 (57.4)	2998 (53.5)
Marital Status		
Married/ Living with a partner	278 (58.8)	3921 (70.4)
Widowed/Separated/ Divorced	45 (9.5)	582 (10.5)
Never Married	150 (31.7)	1084 (17.6)
Education (Completed High School)		
Yes	440 (93.2)	4928 (88.8)
No	32 (6.8)	624 (11.2)
Psychiatric Distress (GHQ Score $\geq$ 2)		
Yes	147 (30.8)	991 (17.7)
No	330 (69.2)	4608 (82.3)
Antidepressant and/or Anxiolytic Medication Use		
Yes	383 (11.1)	433 (8.6)
No	48 (88.9)	4584 (91.4)
Drinking and Driving (in the past 12 months)		
Yes	64 (14.7)	437 (9.1)
No	370 (85.3)	4346 (90.9)
Road Rage (in the past 12 months)		
Yes	149 (31.3)	1107 (19.9)
No	327 (68.7)	4458 (80.1)

Table E.3. Descriptive Statistics for the Driving Distance Z-score

Z-distance (Z-score for driving distance in km, mi, or both)

Range	-0.66 to 13.58
Mean	0.01
Standard Deviation	1.01
Median	-0.25

Table E.4 Bivariate Analyses for Respondents Involved in a Motor Vehicle Collision in the past 12 months

Variable	**Unadjusted Odds Ratio (95% CI)**
Age groups	
18-29	2.38*** (1.78, 3.20)
30-39	1.69*** (1.25, 2.29)
40-49	1.04 (0.75, 1.44)
50-64 (ref)	--
65+	1.05 (0.73, 1.53)
Gender	
Female (ref)	--
Male	1.17 (0.97, 1.42)
Marital Status	
Married/ Living with a partner (ref)	--
Widowed/Separated/ Divorced	1.10 (0.79, 1.52)
Never Married	1.98*** (1.61, 2.45)
Education	
(Completed High School)	--
Yes(ref)	0.58** (0.40, 0.84)
No	
Driving Distance	
(Z-score)	1.07 (0.99, 1.16)
Psychiatric Distress (GHQ Score $\geq$ 2)	
Yes	2.07*** (1.68, 2.54)
No (ref)	--
Antidepressant and/or Anxiolytic Medication Use	
Yes	1.33 (0.97, 1.82)
No (ref)	--

Table E.4 (Continued)

Drinking and Driving (in the past 12 months)	
Yes	1.73***
	(1.30, 2.29)
No (ref)	--
Road Rage	
Yes	1.84***
	(1.50, 2.26)
No (ref)	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table E.5. Logistic Regression Model Including Z-score Measure of Driving with All Predictors Entered in One Step

Variable	Odds Ratio (95%CI)	B (SE)
Age groups		
18-29	1.54*	0.434
	(1.04, 2.30)	(0.203)
30-39	1.33	0.283
	(0.94, 1.87)	(0.175)
40-49	0.93	-0.075
	(0.65, 1.32)	(0.182)
50-64 (ref)	--	--
65+	1.16	0.150
	(0.76, 1.78)	(0.218)
Gender		
Female (ref)	--	--
Male	1.02	0.022
	(0.81, 1.29)	(0.117)
Marital Status		
Married/ Living with a partner (ref)	--	--
Widowed/Separated/ Divorced	0.94	-0.065
	(0.63, 1.41)	(0.206)
Never Married	1.42*	0.352
	(1.04, 1.94)	(0.158)
Education		
(Completed High School)		
Yes(ref)	--	--
No	0.63*	-0.463
	(0.40, 0.99)	(0.234)
Driving Distance		
(Z-score)	1.14**	0.132
	(1.04, 1.25)	(0.046)
Psychiatric Distress (GHQ Score $\geq$ 2)		
Yes	1.77***	0.575
	(1.39, 2.26)	(0.123)
No (ref)	--	--

Table E.5 (Continued)

Antidepressant and /or Anxiolytic Psychotropic Medication Use		
Yes	1.30 (0.91, 1.85)	0.264 (0.181)
No (ref)	--	--
Drinking and Driving		
Yes	1.37 (0.99, 1.89)	0.313 (0.164)
No (ref)	--	--
Road Rage		
Yes	1.70*** (1.35, 2.14)	0.532 (0.118)
No (ref)	--	--

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Table E.6 Weighted Hierarchical Logistic Regression Models Examining the Effect of Demographic predictors and Psychiatric distress on MVCs

Variables	Model 1[a]		Model 2[b]	
	OR (95% CI)	B (SE)	OR(95% CI)	B(SE)
Age				
18-29	1.92*** (1.32, 2.80)	0.653 (0.191)	1.81** (1.24, 2.63)	0.591 (0.192)
30-39	1.53** (1.11, 2.12)	0.427 (0.165)	1.45* (1.04, 2.00)	0.369 (0.166)
40-49	1.07 (0.76, 1.49)	0.065 (0.172)	1.00 (0.72, 1.41)	0.004 (0.172)
50-64(ref)	--	--	--	--
65+	1.05 (0.71, 1.56)	0.049 (0.203)	1.08 (0.73, 1.61).	0.080 (0.204)
Gender				
Female	--	--	--	
Male	1.12 (0.92, 1.37)	0.110 (0.106)	1.16 (0.94,1.43)	0.148 (0.107)
Marital Status				
Married (ref)	--		--	
Widowed/ Divorced/ Separated	1.19 (0.83, 1.71)	0.177 (0.183)	1.08 (0.75, 1.55)	0.075 (0.184)
Never Married	1.39* (1.04, 1.89)	0.332 (0.151)	1.34 (0.99, 1.80)	0.290 (0.151)
Completed High School				
Yes (ref)	--		--	
No	0.66* (0.44. 0.99)	-0.420 (0.207)	0.65* (0.43, 0.97)	-0.438 (0.207)
Driving Distance (Z-score)	1.11* (1.02, 1.21)	0.104 (0.043)	1.11* (1.02, 1.21)	.0.103 (0.044)

Table E.6 (Continued)

Psychiatric Distress		2.01***	0.697
Yes		(1.61, 2.51)	(0.114)
No (ref)		--	--
Model Chi-Square	67.57***	102.52***	
Block Chi-Square		34.95***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$
[a]Model 1: Demographic predictors
[b]Model 2: Demographic Predictors and Psychiatric Distress

Table E.7 Hierarchical logistic regression models examining the effect of antidepressant and/or anxiolytic medications, drinking and driving, and road rage on the association between psychiatric distress and MVCs

	Model 3[c]		**Model 4[d]**		**Model 5[e]**	
Variables	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)	OR (95%CI)	B (SE)
Age						
18-29	1.84**	0.611	1.53*	0.428	1.73**	0.549
	(1.26, 2.69)	(0.193)	(1.05, 2.23)	(0.191)	(1.23, 2.44)	(0.175)
30-39	1.46*	0.381	1.39*	0.330	1.43*	0.361
	(0.97, 1.82)	(0.167)	(1.01, 1.92)	(0.165)	(1.05, 1.96)	(0.159)
40-49	1.01	0.012	0.89	-0.121	0.91	-0.095
	(0.72, 1.42)	(0.173)	(0.63, 1.25)	(0.176)	(0.65, 1.27)	(0.168)
50-64(ref)	--	--	--	--	--	--
65+	1.10	0.095	1.11	0.102	1.15	0.139
	(0.74, 1.64)	(0.204)	(0.73, 1.67)	(0.210)	(0.94, 1.41)	(0.102)
Gender						
Male	1.18	0.164	1.03	0.025	1.15	0.139
	(0.95, 1.46)	(0.108)	(0.83, 1.27)	(0.109)	(0.94, 1.41)	(0.102)
Female (ref)	--	--	--	--	--	--
Marital Status						
Widowed/Divorced/	1.07	0.065	1.02	0.017	1.14	0.130
Separated	(0.74, 1.53)	(0.185)	(0.70, 1.49)	(0.193)	(0.81, 1.61)	(0.176)
Never Married	1.33	0.282	1.39*	0.327	1.31*	0.271
	(0.99, 1.78)	(0.152)	(1.04, 1.85)	(0.149)	(0.99, 1.74)	(0.143)
Married/Living with partner (ref)	--	--	--	--	--	--
Marital Status						
Widowed/Divorced/	1.07	0.065	1.02	0.017	1.14	0.130
Separated	(0.74, 1.53)	(0.185)	(0.70, 1.49)	(0.193)	(0.81, 1.61)	(0.176)
Never Married	1.33	0.282	1.39*	0.327	1.31*	0.271
	(0.99, 1.78)	(0.152)	(1.04, 1.85)	(0.149)	(0.99, 1.74)	(0.143)
Married/Living with partner (ref)	--	--	--	--	--	--
Completed High School						
Yes (ref)	0.64*	-0.442	0.60*	-0.504	0.65*	-0.436
	(0.43, 0.97)	(0.207)	(0.43, 0.98)	(0.223)	(0.44, 0.95)	(0.198)
No	--	--	--	--	--	--

Table E.7 (Continued)

Driving Distance (Z-score)	1.11* (1.02, 1.21)	0.104 (0.044)	1.08 (0.99, 1.18)	0.076 (0.044)	1.07 (0.98, 1.17)	0.068 (0.043)
Psychiatric Distress						
Yes	1.96*** (1.57, 2.47)	0.675 (0.116)	1.82*** (1.45, 2.29)	0.601 (0.115)	1.83*** (1.48, 2.27)	0.605 (0.110)
No (ref)	--	--	--	--	--	--
Antidepressant and/or Anxiolytic med use						
Yes	1.20 (0.86, 1.69)	0.186 (0.172)				
No(ref)	--	--				
Drinking and Driving						
Yes			1.47* (1.09, 1.97)	0.382 (0.152)		
No(ref)			--	--		
Road Rage						
Yes					1.67*** (1.35, 2.06)	0.510 (0.108)
No (ref)					--	--
Model-chi square	103.65***		96.12***		123.30***	
Block- chi square	1.13		5.98*		21.21***	

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$
[c]Model 3: Adding Antidepressant and Anxiolytic Medications to model 2 (see Table D.5)
[d]Model 4: Adding Drinking and Driving to model 2 (see Table D.5)
[e]Model 5: Adding Road Rage Victimization to model 2 (see Table D.5)

Table E.8 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Antidepressant and/or Anxiolytic Medication Use

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Antidepressant and/or Anxiolytic Medication Use	3.36*** (2.74, 4.13)	1.213*** (0.105)
b = Antidepressant and/or Anxiolytic Medication use- MVCs (controlling for psychiatric distress)	1.20 (0.86, 1.69)	0.186 (0.172)
c' = Psychiatric Distress- MVCs (controlling for Antidepressant and/or Anxiolytic Medication Use)	1.96*** (1.57, 2.47)	0.675 (0.116)

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Figure E.1 Psychiatric Distress and Antidepressant and/or Anxiolytic Medication Use Path Analysis Model

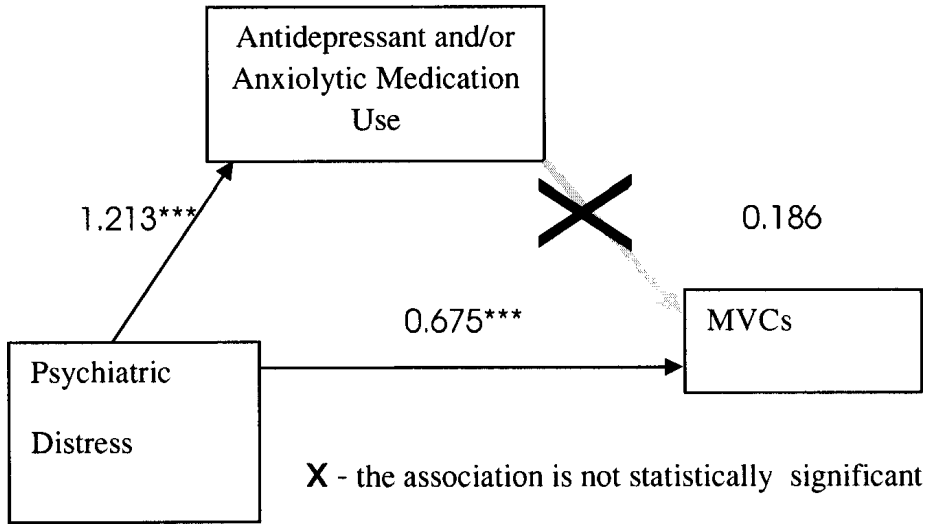


Table E.9 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's Criteria for Mediation Between Psychiatric Distress and MVCs by Drinking and Driving

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Drinking and Driving	1.59*** (1.27, 1.99)	0.461*** (0.115)
b = Drinking and Driving-MVCs (controlling for psychiatric distress)	1.47* (1.09, 1.97)	0.382* (0.152)
c' = Psychiatric Distress-MVCs (controlling for drinking and driving)	1.82*** (1.45, 2.29) --	0.601*** (0.115) --

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Indirect Effect (a x b) = 0.176
Direct Effect (c') = 0.601
Total Effect (a x b + c') = 0.777
Proportion of indirect effect = Indirect effect/ Total Effect = 22.7%

Figure E.2 Psychiatric Distress and Road Rage and MVCs Path Analysis Model

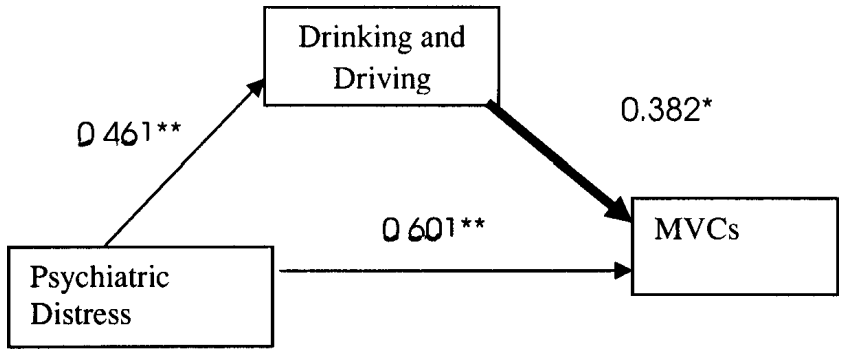


Table E.10 Hierarchical Logistic Regression Coefficients Used to Assess Baron and Kenny's (1986) Criteria for Mediation Between Psychiatric Distress and MVCs by Road Rage

Specific Pathway	Odds Ratio (95%CI)	Adjusted β (SE)
a = Psychiatric Distress – Road Rage	1.55*** (1.33, 1.80)	0.436*** (0.078)
b = Road Rage- MVCs	1.67*** (1.35, 2.06)	0.510*** (0.108)
c' = Psychiatric Distress-MVCs	1.83*** (1.48, 2.27)	0.605*** (0.110)

Note: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$

Indirect Effect (a x b) = 0.222
Direct Effect (c') = 0.605
Total Effect (a x b + c') = 0.827
Proportion of indirect effect = Indirect effect/ Total Effect = 26.8%

Figure E.3 Psychiatric Distress and Road Rage and MVCs Path Analysis Model-Adjusting for Demographic Predictors, Psychiatric Distress and Road Rage