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doi: <https://doi.org/10.57709/20501143>

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Association between Adult Alcohol Misuse, Adult Mental Health, and Firearm Storage Practices
in Households with Children: Findings from the Behavioral Risk Factor Surveillance System
(BRFSS)

By

Daniel William Shelby

December 7, 2020

ABSTRACT

Firearm violence in the United States is a substantial health concern and improper storage within the home is a prominent risk factor for suicide, homicide, and unintentional injury. Studies have examined the negative influence of adult alcohol misuse on firearm storage in households with children, but none have included adult mental health problems. The purpose of this study was to describe the prevalence of various forms of firearm storage in households with children in California, Idaho, Kansas, Oregon, Texas, and Utah and analyze how adult alcohol misuse and adult mental health problems relate to how firearms are stored. Data from the 2017 Behavioral Risk Factor Surveillance System (BRFSS) were analyzed. Only households with children were included in this study (n=12,489). Predictor variables included adult alcohol misuse and adult mental health. The outcome variables were presence of firearms in the household and subsequent firearm storage method categorized as unloaded, loaded and locked, and loaded and unlocked. Weighted prevalence estimates and 95% confidence intervals of sociodemographic and predictor variables were calculated for all respondents for each firearm storage category. Weighted relative risks and 95% confidence intervals of sociodemographic variables by the predictor variables were calculated for all respondents for each firearm storage category using multivariable logistic regression. Overall, 33.8% of respondents reported owning at least one firearm. Among firearm owners, 27% (n = 1,105) stored their firearms loaded and 11% (n = 463) stored firearms both loaded and unlocked. Firearm owners reported higher alcohol misuse (25.6%) and higher mental health problems (26.5%) than non-firearm owning respondents (16.9% and 20.4%, respectively). Alcohol misuse was associated with greater risk of owning a firearm (aRR = 1.2 [1.02, 1.41]) and greater risk of storing a firearm loaded and unlocked (aRR = 1.67 [1.2, 2.34]). Mental health problems were associated with a greater risk of owning a firearm (aRR = 1.22 [1.04, 1.42]). Firearms are common in households with children and a significant minority are stored improperly. Adult alcohol misuse was associated with the least safe method of firearm storage. Effective prevention approaches addressing firearm storage must be developed and disseminated, especially programs that target adults experiencing alcohol problems and other significant risk factors for firearm violence.

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in Households with Children: Findings from the Behavioral Risk Factor Surveillance System
(BRFSS)

by

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B.A., UNIVERSITY OF GEORGIA

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
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Acknowledgments

I would like to acknowledge all of the wonderful individuals who have guided and supported me to reach this accomplishment. Dr. Shannon Self-Brown and Dr. Melissa Osborne, you have both provided incredible wisdom during this entire process and your mentorship has greatly improved my writing and analytical skills. I want to thank my wonderful wife, family, and friends that continue to support my endeavors and encourage me to never stop learning, I cherish each and every one of you. Dr. Kristin Holland, thank you for bringing me into the injury prevention field and inspiring a deep appreciation for public health research. Your mentorship has meant the world to me. Finally, thank you to my surveillance branch family at the CDC; Elizabeth Gaylor, Dr. Kayla Anderson, Dr. May Chen, Ruth Leemis, Dr. Jeff Hall, and the rest of the team, you are all brilliant and I can't imagine a better group to help me learn and grow.

Author's Statement Page

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Daniel William Shelby

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1.0 Introduction

1.1 Background

Firearm violence in the United States is a prevalent and substantial public health concern (Curtin, Heron, Minino & Warner, 2018). Despite an overall decrease in the last 30 years, the rate of firearm-related deaths has increased since 2014, resulting in nearly 40,000 firearm-related deaths in the US in 2016 (Curtin, Heron, Minino & Warner, 2018). More than 14,000 of those deaths were homicides and more than 23,000 were suicides. Firearms were involved in more than 75% of all homicides. Suicide is a top ten leading cause of death and has increased in almost every state since 1999 with 48.5% involving firearms (Stone et al., 2018). The rate of nonfatal firearm injuries has also steadily risen in recent years; in 2015 there were an estimated 84,000 emergency department visits involving firearm injuries (WISQARS, 2020).

While many gun violence victims are adults, children and adolescents are unfortunately affected as well. More than 1,700 youth aged 0 to 17 died from firearms and more than 6,500 were treated for gunshot wounds in 2018 (WISQARS, 2020). From 2000 to 2013 age-adjusted fatal firearm injuries were relatively steady, yet since 2013 firearm homicides have increased by 45% and suicides by firearm have increased by 49% (WISQARS, 2020). In contrast, nonfatal injuries have increased from an age-adjusted rate of 21.68 per 100,000 in 2000 to 26.61 per 100,000 in 2015 (WISQARS, 2020). Hemenway and Solnick (2015) found that approximately 40% of youth firearm-related deaths occurred as either suicide or unintentional shooting, the latter of which were primarily perpetrated by a friend or sibling. Since 2015, suicide has been the second leading cause of death for the 10 to 17 age group (Scott, Azrael, & Miller, 2018).

An important factor to firearm injury is the availability of firearms. In 2018, there were more than 9 million firearms manufactured in the United States (ATF, 2020a). Indeed, firearm manufacturing has seen a drastic increase in recent years. From 1986 when recordkeeping began to 2009, there were generally between 3 to 4 million firearms produced annually (ATF, 2020b). Yet that amount has since substantially increased; nearly 11 million were manufactured in 2013 and has remained above 8 million through 2018, the most recent year data is available (ATF, 2020b). This has resulted in an estimated 400 million civilian firearms in the United States (Karp, 2018). Yet paradoxically, less than 1 in 3 Americans own a firearm and only an additional 11% live with someone who owns a firearm in a recent Pew survey (Parker et al., 2017). As a result, two-thirds of firearm owners own more than one firearm with nearly one-third owning five or more (Parker et al., 2017).

One contributor to youth death by gun violence in recent years has been within the context of mass shootings, typically defined as multiple homicide incident where four or more deaths occurred by firearm (Krouse & Richardson, 2015). Despite extensive media coverage these incidents are rare; Luca, Malhotra, & Poliquin (2020) found that mass shootings accounted for .13% of all gun deaths from 1989 to 2014. Yet they have an outsize effect on public perception as there is a spike in firearm legislation directly after a mass shooting in the state where it occurred and this spike is magnified based on the intensity of media coverage (Luca, Malhotra, & Poliquin, 2020).

1.2 Firearm Storage

There are many factors that can be addressed to decrease gun violence but firearm storage practices within the home are critically important and understudied. This is especially

true when children are present in the household as they can potentially harm themselves or others by accessing unsecured firearms. Alarming findings from a recent study found that approximately one-third of households with children contain a firearm, and in nearly one-quarter of these homes, firearms are stored improperly (Azrael, Cohen, Salhi, & Miller, 2018). Firearm deaths involving children primarily occur in the home and the firearm is very likely to originate from the same home (Hemenway, 2013; Grossman, Reay, & Baker, 1999).

Firearm injuries in adolescents as well as adults can be reduced by following safe storage guidelines (Scott, Azrael, & Miller, 2018). The American Academy of Pediatrics has recommended since 1992 that all firearms in the home be stored locked, unloaded, and separate from ammunition (Dowd & Sege, 2012). Storing a firearm locked involves the use of either locking mechanisms, such as trigger and cable locks, or containers, such as lock boxes and gun safes (Dowd et al., 2012). These devices have shown to be effective at preventing children and adolescents from gaining unauthorized access to firearms (Naureckas et al., 1995). Storing firearms unloaded is another method with evidence for reducing firearm injury; Grossman and colleagues (2005) found through a case control study of nearly 600 incidents that firearms involved in adolescent firearm injuries were significantly less likely to be stored unloaded (Adjusted OR=.30). This study also found that firearms involved in adolescent injury were less likely to be stored locked (Adjusted OR=.27), stored separately from ammunition (AOR=.45), or ammunition that was stored locked (Adjusted OR=.39). Locking mechanisms, gun safes, and storing a firearm unloaded can often be used in combination with nearly every type of firearm, serving as multiple layers to prevent unsupervised use.

The Social Ecological Model and Firearm Storage

Firearm storage within households is influenced by factors on the societal, community, relationship, and individual levels (Allchin, Chaplin, & Horwitz, 2019; Caine, 2013). Of note is that the risk factors described below are contextualized primarily in terms of suicide prevention, however they have also shown evidence of reducing firearm-related homicide, unintentional death, and injury.

Societal Level

Firearm storage can be impacted by state and national-level policies that require gun owners to observe specific storage procedures. Child access prevention (CAP) laws are one such measure that can hold gun owners legally responsible if a child accesses and causes an injury either to themselves or others (Azad et al., 2020). While the federal government does not regulate how a firearm is stored within the home, the nationwide Protection of Lawful Commerce in Arms Act of 2005 which requires federally licensed dealers to provide a safety lock to handgun purchasers was the genesis for many states to expand locking and storage laws (McClenathan, Pahn, & Seigel, 2016). CAP laws differ in firearm owner obligation (such as how a firearm must be locked or stored) and severity between jurisdictions but exist in some form in 25 states as of January 1, 2020 (Azad et al., 2020). These laws have had an association with lowered rates of firearm-related homicides, suicides, and unintentional injury in children and adolescents (Azad et al., 2020). Kivisto and colleagues (2020) reported that states with CAP laws had a 13% reduction in adolescent firearm suicide from 1991 to 2017.

Community Level

At the community level, access to prevention program efforts can influence gun storage practices. One such program designed to reduce suicide through education is the Gun Shop Project. It was developed primarily in partnership with the New Hampshire Firearms Safety Coalition and the Harvard T.H. Chan School of Public Health and seeks to provide firearms instructors and local gun shops with suicide prevention education for their customers (Allchin, Chaplin, & Horwitz, 2019). This is accomplished through brief, in-person events at shooting ranges and gun shops. Components of the training include informing gun store employees on the impact of firearm injuries and suicides, explaining guidelines on how to identify and manage customers who may be suicidal, and providing these businesses with flyers and brochures for customers. The pilot program conducted in New Hampshire during 2011 involved half of the state's gun shops and has since spread to more than 20 states (Vriniotis et al., 2015). Many of these subsequent programs have reported successful implementation and have developed close relationships with local retailers, yet there are no formal evaluations on their effectiveness on suicide prevention (Polzer, Brandspiegel, Kelly, & Betz, 2020). While the Gun Shop Project's primary goal is suicide prevention, educating gun owners on proper storage directly addresses adolescents' access to firearms.

Relationship Level

While programs such as the Gun Shop Project seek to address firearm storage within the home during a firearm purchase, it may not reach existing gun owners who do not frequent gun stores. Programs such as the Brady Center's ASK program focus on motivating parents to start a dialogue on firearm storage within the households of their children's friends (Johnson et al., 2012). A pilot program was conducted in Rockford, Illinois in 2007 and centered on a city-wide

marketing campaign to encourage parents to ask about firearm storage at the homes of their children's friends when their children visited. This message was conveyed through billboards, radio commercials, newspapers, and community-based events. Over 1,600 individuals were interviewed within Rockford and a control city to gauge visibility and effectiveness of the campaign. As a result, the authors discovered that while few residents recalled the campaign, those that remembered were much more likely to broach the topic of firearm safety at the homes their children visited than those that did not (Johnson et al., 2012). Marketing campaigns such as ASK have the potential to fill a crucial void as individuals may be more receptive to change their storage habits after such a discussion with a friend or acquaintance as opposed to a violence prevention program conducted by researchers.

Individual Level

One simple yet critical component of firearm storage that is especially important for parents with children living in the home is a commitment to locking up devices. Grossman et al. (2012) distributed safes to firearm owners in a rural area of Alaska after discovering that 93% of residents reported at least 1 unlocked firearm in their home. Upon a 12-month follow-up visit, the authors noted that the rate of unlocked firearms was reduced by two-thirds compared to a control group. While there is a noticeable lack of studies examining motivations and barriers to safe storage, Grossman et al. (2012) pointed out that many residents possessed cable and trigger locks that were not used. When asked, several residents mentioned that keeping up with multiple keys was the primary drawback. This suggests that alternative storage methods such as a safe could result in higher compliance of proper storage. Gun safes can employ a variety of locking mechanisms such as combinations, keys, biometric scanners, or multiple

mechanisms. Yet firearm safes have their own disadvantages such as high cost, lack of portability, and difficult installation.

In addition to methods for parents to lock away firearms, there are some parental risk factors that may influence firearm storage within the home. Two factors of interest are adult alcohol misuse and adult mental health problems.

Adult Alcohol Misuse

Alcohol use disorder (AUD) is defined as a chronic inability to stop or control alcohol use regardless of effects on an individual's health or lifestyle (American Psychiatric Association, 2013). AUD is characterized by two behaviors: binge drinking and heavy alcohol use. Binge drinking is defined as 4 or more drinks for women and 5 or more drinks for men in a single setting (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Heavy alcohol use is defined as 8 or more drinks for women or 15 or more drinks for men within a week.

AUD is not uncommon in the US; a Substance Abuse and Mental Health Services Administration (SAMHSA) study (2012) found that more than 1 in 10 children lived in a household where the parent had alcohol problems. AUD among parents can have detrimental effects among children, especially if firearms are present. Evidence has shown that adult alcohol abuse is associated with an increased risk of suicide attempts and unintentional injury of children within the household (Conner et al., 2014; Schnitzer, Covington, & Kruse, 2011). Relatedly, a recent study in Washington state found that firearms are more likely to be stored unsafely in homes with adult alcohol misuse (Morgan, Gomez, Rivara, & Rowhani-Rahbar,

2019). If children in households with AUD present are able to access a firearm, the risk that these non-fatal injuries become fatal could increase.

Adult Mental Health

Mental health conditions vary greatly in prevalence and severity but are common overall in the United States. Approximately 20% of the adult population have a diagnosable mental health disorder in any given year and nearly half of Americans will develop a mental health disorder over the course of their life (Center for Behavioral Health Statistics and Quality, 2018). To be clear, less than 5% of interpersonal violence is directly linked to mental illness and those with mental illness are no more likely to acquire and own firearms than the general population (Swanson et al., 2015; Igen, Zivin, McCammon, & Valenstein, 2008). Yet mental illness is associated with a majority of suicides, and as a result the bulk of firearm deaths (Pallin et al., 2019). While there is little research on the association of mental illness and firearm storage practices, cognitive impairments have been related to improper storage; nearly two-thirds of adults with dementia live in a household with a firearm and is stored improperly in approximately half of those homes (Pallin et al., 2019). Taken together, these components call for a closer examination of mental illness and firearm storage practices.

1.3 Purpose of Current Study

Alcohol misuse and mental health problems in adults exist in many households across the United States and can have detrimental effects on the children within those families. There is also an understanding that having a firearm stored improperly in households with children and adolescents increases the risk of injury, whether it be intentional or unintentional (Azad et

al., 2020; Grossman et al., 2005). Morgan, Gomez, Rivara, & Rowhani-Rahbar (2019) found a correlation between children living in homes with unsafely stored firearms and adult alcohol abuse in Washington state. Yet this was from cross-sectional data in one state and did not address any existing adult mental health problems. The purposes of this study are to (1) describe the prevalence of various forms of firearm storage in households with children in California, Idaho, Kansas, Oregon, Texas, and Utah, (2) analyze how adult alcohol misuse relate to how firearms are stored, and (3) analyze how adult mental health problems relate to how firearms are stored. Two hypotheses will be tested:

Hypothesis 1: Adult alcohol misuse will increase the risk that a firearm will be stored improperly.

Hypothesis 2: Adult mental health problems will increase the risk that a firearm will be stored improperly.

2.0 Methods

2.1 Study Design, Participants, and Setting

Data from the 2017 Behavioral Risk Factor Surveillance System (BRFSS) were analyzed. Data were collected from January 1 to December 31, 2017 in all 50 states, the District of Columbia, and several U.S. territories through random-digit dialing of both landline and cellular phones. Interviewers ask adult respondents a series of questions concerning health-seeking behaviors, substance use, the presence of acute and chronic diseases, and various risk factors. In addition to this core question module states can also include optional modules. For purposes of the current study, states were selected if they included the firearm safety optional module,

which asks about any firearms in the home and storage practices. States that included this module were California, Idaho, Kansas, Oregon, Texas, and Utah. BRFSS respondents residing in these states were included in the analyses for this study (n=42,451). Only households with children were included in the final sample (n=12,489).

2.2 Study Variables

The primary outcome of interest was method of firearm storage. Firearm ownership and storage were assessed by three questions. First, respondents were asked “Are any firearms kept in or around your home?” If yes, they were then asked “Are any of these firearms now loaded?” If the individual answered yes, they were finally asked “Are any of these loaded firearms also unlocked? By unlocked we mean you do not need a key or a combination to get the gun or to fire it. We don’t count safety as a lock.” Four categories were derived from these responses: non-firearm owning households (“no” responses from the first question), unloaded firearms (“no” responses from the second question), loaded and locked firearms (“no” responses from the third question), and loaded and unlocked firearms (“yes” responses from the third question).

Predictor variables included alcohol misuse and adult mental health problems. Male respondents were classified as heavy drinkers if they answered “yes” to “Are you male?” and “15” or more to the question “How many alcoholic beverages do you consume in a week”? Female respondents were classified as heavy drinkers if they answered “yes” to “Are you female?” and “8” or more to the question “How many alcoholic beverages do you consume in a week”? Respondents were classified as binge drinkers who answered “1” or more to the

question “Considering all types of alcoholic beverages, how many times during the past 30 days did you have 5 or more drinks for men or 4 or more drinks for women on an occasion?” From these questions, respondents who reported binge drinking or heavy drinking were classified as alcohol misuse. Binge drinking was defined as 4 or more drinks for women and 5 or more drinks for men in a single setting (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). Heavy drinking was defined as 8 or more drinks for women or 15 or more drinks for men within a week.

Adult mental health problems were defined as the presence of self-reported diagnosed depression or poor mental health. Diagnosed depression was considered present if a respondent answered “yes” to the question “Has a doctor, nurse, or other health professional ever told you that you have a depressive disorder including depression, major depression, dysthymia, or minor depression?” Poor mental health was measured as a response of “14 or more days” to the question “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? (Miyakado-Steger & Seidel, 2019; Stellefson et al., 2019).

2.3 Data Analysis

Descriptive statistics were generated for adult demographic and predictor variables. Relative risks (RR) and 95% confidence intervals (CI) were calculated for each firearm storage category and their association with adult demographic and predictor variables using multivariable logistic regression. Descriptive statistics, relative risks, and 95% analyses were conducted using SAS (version 7.15, SAS Institute Inc., Cary, NC).

3.0 Results

3.1 Descriptive Statistics

Within households that had children, 27.2% (95% CI 25.2, 29.2) of respondents reported owning at least one firearm (Table 1). Firearm owners reported storing a firearm loaded in 30% (95% CI 26.1, 33.9) of households. In households with loaded firearms, a firearm was both loaded and unlocked in 38% (95% CI 30, 46) of cases. Individuals who reported storing their firearms unloaded were most likely to be White, non-Hispanic (67.7%, 95% CI: 58.9, 74.8), have an annual household income of \$75,000 or greater (56% 95% CI: 51, 60.9), and reside in Texas (41.8%, 95% CI: 38, 45.5]). These respondents reported a slightly higher amount of alcohol misuse (25.6%, 95% CI: 21.7, 29.4) and mental health problems (26.5%, 95% CI: 22.6, 30.5) than those from non-firearm households.

Conversely, 72.8% (95% CI 70.8, 74.8) did not own firearms. This category had the highest concentration of females (57.4%, 95% CI: 54.6, 60.3) and those of Hispanic descent (53.4%, 95% CI: 50.6, 56.2). These individuals were also more likely to reside in California (54.8%, 95% CI: 53, 56.6). Non-firearm respondents reported the lowest proportion of alcohol misuse (16.9%, 95% CI: 14.7, 19.2) and lowest proportion of mental health problems (20.4%, 95% CI: 18.2, 22.6).

Respondents who stored their firearms loaded were primarily concentrated in Texas regardless of whether the firearms were locked (55.7%, 95% CI: 47.7, 63.6) or unlocked (60.2%, 95% CI: 50.1, 70.3). Within gun owners who reported loaded firearms, those who reported

storing loaded and locked were almost twice as likely to be male (63.7%, 95% CI: 53.6, 73.7). These respondents reported a slightly higher amount of alcohol misuse (25.8%, 95% CI: 15.7, 35.9) than those who stored firearms unloaded and the highest proportion of mental health problems (31.1%, 95% CI: 20.1, 42.1) compared to any category. Within firearms stored loaded, individuals who reported storing their firearms loaded and unlocked occupied the smallest category (37%, 95% CI: 29.9, 45.9). They were generally older and the most likely to be White (68.3%, 95% CI: 56.5, 80.2) compared to other respondents. This category had a higher proportion of mental health problems (24.6%, 95% CI: 13.3, 36) compared to non-firearm owners and had the highest proportion of alcohol misuse (40.8%, 95% CI: 28.6, 52.9) compared to any category.

3.2 Multivariate Regression Analyses

Unadjusted (RR) and adjusted relative risks (aRR) and 95% confidence intervals (CI) for each predictor variable were calculated based on sociodemographic variables. These included age, race/ethnicity, sex, annual household income, level of education, marriage status, and state of residence. Referent categories for these variables were selected based on prior research except for state of residence, where California was selected as it had the largest population (Azrael, Cohen, Salhi, & Miller, 2018). These results are presented in Tables 2, 3, and 4 for owning a firearm, storing a firearm loaded, and storing a loaded firearm unlocked, respectively. Statistical significance ($p < .05$) was noted where present.

Bivariate Analyses

Compared to those who don't own a firearm, alcohol misuse was associated with a 1.44 times greater likelihood of owning a firearm (95% CI 1.21, 1.7). In addition, mental health

problems were associated with a 1.28 times greater likelihood of owning a firearm (95% CI 1.08, 1.51) compared to not owning a firearm. Neither reported alcohol misuse nor mental health problems among firearm owners emerged as a significant associate of storing a firearm loaded. However, alcohol misuse was associated with a 1.51 times greater risk of storing a weapon both loaded and unlocked (Table 4) than loaded and locked ($p = .499$, 95% CI: 1, 2.29).

Multivariable Analysis

After adjusting for age, race/ethnicity, sex, household income, education, marital status, and state of residence, compared to non-firearm owners, alcohol misuse was associated with a 1.2 (95% CI 1.02, 1.41) times greater risk and mental health problems were associated with a 1.22 (95% CI 1.04, 1.42) times greater likelihood of firearm ownership, both of which were statistically significant (Table 2). In terms of age, firearm ownership was less likely by alcohol misuse and mental health problems in every age group except for 55 and older when compared to 18-24-year old's, yet these differences were not statistically significant.

When compared to White, non-Hispanic all other races appear to serve as a statistically significant less likelihood of firearm ownership. Those of Hispanic descent had the lowest risk for alcohol misuse (RR=.44, 95% CI: .36, .55) and mental health problems (RR=.46, 95% CI: .38, .57).

In the adjusted model, there was a statistically significant association between income and firearm ownership, controlling for both alcohol misuse and mental health, with higher income associated with ownership. There was also a significant association between state of residence and firearm ownership, controlling for both alcohol misuse and mental health, with all states associated with ownership compared to California residents.

Several significant demographic findings were found in firearm owners who stored their weapons loaded compared to those stored unloaded (Table 3). In the adjusted models, gender was associated with an increased risk of storing firearms loaded, with males at greater risk of unsafe storage compared to females controlling for both alcohol misuse (RR=1.6, 95% CI: 1.21, 2.1) and mental health (RR=1.6 95% CI: 1.23, 2.1). Compared to California residents, alcohol misuse and mental health problems were associated with storing firearms loaded in Kansas (RR=1.6 [95% CI: 1.05, 2.37] & RR=1.6 [95% CI: 1.06, 2.43], respectively), Oregon (RR=1.8 [95% CI: 1.15, 2.68] & RR=1.8 [95% CI: 1.13, 2.71], respectively), and Texas (RR=2.4 [95% CI: 1.58, 3.68] & RR=2.5 [95% CI: 1.61, 3.82], respectively).

Findings concerning firearm owners who stored their weapons both loaded and unlocked compared to those who stored firearms loaded and locked are presented in Table 4. After adjusting for sociodemographic variables, alcohol misuse was significantly associated with storing loaded and unlocked (RR=1.67, 95% CI: 1.2, 2.34). Compared to respondents aged 18-24, alcohol misuse was associated with significantly greater risk of storing firearms loaded and unlocked in the 35 to 44 (RR=3.14, 95% CI: 1.2, 8.16), 45 to 54 (RR=4.15, 95% CI: 1.62, 10.65), and 55 and older (RR=2.86, 95% CI: 1.02, 8.01) age ranges.

4.0 Discussion

4.1 Discussion of Research Questions

The purposes of this study are to (1) describe the prevalence of various forms of firearm storage in households with children in California, Idaho, Kansas, Oregon, Texas, and Utah, (2) analyze how adult alcohol misuse relate to how firearms are stored, and (3) analyze how adult

mental health problems relate to how firearms are stored. This study sought to further advance previous research by Morgan, Gomez, Rivara, & Rowhani-Rahbar (2019) that found nearly 30% of children in Washington lived in a household with firearms, more than half of those households contained a firearm that was stored improperly, and firearms were more likely to be stored unsafely in homes that also reported adult alcohol misuse. To that end, this study included households with children from California, Idaho, Kansas, Oregon, Texas, and Utah and analyzed adult mental health problems as well as adult alcohol misuse and their relationship to firearm storage.

Within households that had children, findings indicate that 27.2% (95% CI 25.2, 29.2) contain at least one firearm. This is a similar prevalence to previous national estimates (Morgan, Gomez, Rivara, & Rowhani-Rahbar, 2019; Parker et al., 2017). While the firearms in this study were primarily stored unloaded (70%, 95% CI: 66.1, 73.9), a significant minority were stored loaded (30%, 95% CI: 26.1, 33.9) and more than 450 (37%, 95% CI: 29.9, 45.9) of these were both loaded and unlocked (Table 1). These improperly stored weapons constitute a potential danger to the children and adults within the household as well as guests as it greatly raises the risk of suicide and unintentional injury (Anglemyer, Horvath, Rutherford, 2014; Azrael, Cohen, Salhi, & Miller, 2018).

Adults in firearm-owning households reported higher instances of alcohol abuse (23.1%, 95% CI: 18.8, 27.5) than those in non-firearm households. This association still exists even after controlling for sociodemographic variables (aRR=1.2, 95% CI: 1.21, 1.7). Furthermore, in households where firearms were stored loaded and unlocked there was a significant increase in a parent residing in the home with alcohol abuse (aRR=1.67, 95% CI: 1.2, 2.34). These results

appear to support the first hypothesis, that adult alcohol misuse will increase the risk that a firearm will be stored improperly. This is consistent with prior research conducted in other states (Morgan et al., 2019).

While methods do not allow for the explicit understanding of whether the alcohol use is impacting overall judgement and responsibility pertaining to safe firearm storage, or whether there is another mechanism by which this association is explained, it is important to consider homes where a parent or parents misuse alcohol as a high-risk group that should be targeted for prevention messaging for firearm safety. Notably, parental alcohol abuse is also a risk factor that increases the risk of suicidal ideation and attempts among children and thus having a gun in that same home that is improperly stored may dramatically increase the risk for youth suicide (Connor et al., 2014; Eiden et al., 2010). Additionally, in a home where parental alcohol use is significant, children are less likely to be properly supervised and thus the risk for accidental shootings may increase as well (Fowler et al., 2019; Morgan et al., 2019).

As well as higher alcohol abuse, mental health problems were reported more in firearm-owning households (25.8%, 95% CI: 21.2, 30.3) than households without firearms (20.4%, 95% CI: 18.2, 22.6). This relationship is still present after adjusting for sociodemographic variables (aRR=1.22, 95% CI: 1.04, 1.42). Yet the risk of adult mental health problems did not emerge as a significant predictor of safe firearm storage and thus the second hypothesis was not supported. Despite these findings, homes with adults with mental health problems should be a focus for prevention programming due to the high risk for potential suicide for the parents (Pallin et al., 2019). This is due in part because children with parents who have mental health problems are

at increased risk for mental health challenges themselves and thus, having guns available in the household could place the youth at-risk for self-harm (Leijdesdorff et al., 2017).

Sociodemographic variables correlated with changes in risk of the predictor variables in this study. Minority races and ethnicities individuals reporting adult alcohol misuse and/or mental health problems were less likely to own a firearm when compared to White, non-Hispanic respondents. These findings on alcohol misuse have been echoed in the National Survey on Drug Use and Health (2019), which found that Black, Hispanic, and respondents of other races had lower prevalence rates of alcohol use disorder when compared to White, non-Hispanic respondents. Yet the relationship to race and mental health is not as clear. Budhwani, Hearld, & Chavez-Yenter (2015) found that minority races experienced lower prevalence rates of most mental and behavioral disorders, such as major depressive disorder. Yet these authors mention that sociodemographic factors such as income and level of education influence mental health disorders and this complex relationship is not fully understood.

Differences in geography were also highlighted in the findings. California was selected as the referent state in this study due to their larger population. Compared to California respondents, alcohol misuse and mental health problems led to a statistically increased likelihood of firearm ownership in every other state (Table 2). Furthermore, these same statistically significant elevated risks were present for storing firearms loaded for residents in Kansas, Oregon, and Texas (Table 3). These states primarily consist of rural, sparsely populated regions that have received little attention in firearm research despite similar death rates to urban areas (Kaufman & Delgado, 2020). There is also a significant relationship to rural firearm injury and alcohol use; Guetschow and colleagues (2018) found that more than 50% of firearm

injury patients in a midwestern hospital tested positive for alcohol or drugs over the course of a 12-year study.

4.2 Limitations

There are several important limitations of this study. While BRFSS is conducted on a national scale, only the six states represented in the sample utilized the firearm safety questionnaire. This resulted in a sample of households that may not accurately represent the sociodemographic profile of the nation. Another weakness is that there is no detailed information included about the children which prohibits analysis of their potential risk factors for intentional or unintentional injury such as mental illness or substance abuse. Also, the results of the questionnaire are self-reported data and participants may not provide accurate or truthful responses especially regarding alcohol misuse and firearm storage. Relatedly, the presence of a firearm was missing for a large portion of respondents (n=2,588). Due to the method of sampling, respondents who are contacted via cellular telephone are questioned by the state of their area code. If respondents' number is from a state other than the six included in this sample but they reside in one of the six states, the survey is conducted based on that state's question protocol which may not include the optional firearms module. On the conclusion of the survey, the results are transferred to the respondent's state of residence and therefore may not contain responses of firearm ownership and storage.

Another key restriction is the question protocol of the firearm safety module. While the proportion of firearms that are stored locked are known for loaded firearms, they are not known for unloaded firearms. This does not negatively affect the associations presented in the

study, but it does not allow for a complete understanding of firearm storage within the households. As a result, key associations may be masked and targeted interventions may not be as efficient.

4.3 Conclusions and Future Directions

Results from the current study show a relationship between improper storage and adult alcohol misuse. This association is less clear with mental health problems, with descriptive data suggesting higher rates of improper storage, but this not emerging as a significant association in adjusted models. Taken separately, these risk factors are a cause for concern for not only the children in the household but the adults as well. Taken together, they present a serious threat to the well-being to everyone within the home and potentially to many outside it. These findings require an immediate, concerted effort on the part of public health officials and other key stakeholders to intervene.

Addressing proper firearm storage in the context of alcohol misuse is a prime opportunity for injury prevention. Findings in this study uncovered a statistically significant risk of firearm ownership (aRR=1.2, 95% CI: 1.02, 1.41) and firearms stored loaded and unlocked (aRR=1.67, 95% CI: 1.2, 2.34) in relation to alcohol misuse. One avenue that has shown promise is physician counseling in at-risk patients for substance use. Physicians who discover risk factors for injury in their patients, such as alcohol misuse, are able to provide targeted interventions surrounding firearms and has proven to increase safe storage (Barkin et al., 2008; Carbone, Clemens, & Ball, 2005). Yet there are several reasons why safe storage does not get discussed, such as lack of time with patients and lack of knowledge of safe storage methods (Pallin et al.,

2019). One remedy to address these problems is to integrate safe firearm storage into medical school training and has received strong support from the academic and medical communities (Yanes, 2017). A national curriculum implementation of firearm injury and proper storage would undoubtedly lead to improved injury prevention.

Relatedly, another avenue for a discussion on proper firearm storage is in mental health treatment settings. While there are many correlates with mental health problems and improper firearm storage, geography has been rarely explored. Findings in this study indicated a statistically significant elevated risk of firearm ownership in general as well as storing firearms loaded in relation to mental health problems in Kansas, Oregon, and Texas, which generally consist of rural, conservative populations. These firearm owners are often disinterested in traditional safe storage messaging as it is often seen as infringing on constitutional rights and ignoring firearm ownership as a form of personal defense (Celinska, 2007; Kahan & Braman, 2003). As a result, this conventional messaging often results in patients may be dishonest with their physicians and reduces safe storage outcomes (Marino, Wolsko, Keys, & Pennavaria, 2016). Marino, Wolsko, Keys, & Wilcox (2018) conducted focus groups with rural firearm owners in Oregon and found that safe firearm storage messaging was most effective when cultural norms were observed. For example, they report that participants were receptive if methods, such as voluntarily removing firearms from the home while the owner were experiencing a mental health crisis, was framed as the behavior of a responsible gun owner. Culturally sensitive messaging should be further explored as a potential tool to prevent firearm injury in these rural populations.

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Table 1: Adult and Household Characteristics by Firearm Ownership and Storage Practices in Households with Children in California, Idaho, Kansas, Oregon, Texas, & Utah, 2017

Variable	n (Weighted Column %) 95% CI				
	Non-Firearm-Owning Household ^{1,2}	Firearm-Owning Households n=4,041 (27.2%) 25.2-29.2			Total ⁵
		Unloaded (locked and unlocked) ³	Loaded & Locked ⁴	Loaded & Unlocked ⁴	
All parents	5,327 (72.8) 70.8-74.8	2,849 (70) 66.1-73.9	642 (62) 54-70.1	463 (37) 29.9-45.9	12,489 (100)
Age, y					
18-24	482 (14.7) 12.5-16.8	210 (11.5) 8.2-14.8	36 (15.9) 6.1-25.7	25 (6.4) 0-12.9	1,001 (12.9) 11.4-14.3
25-34	1,180 (25.4) 22.9-27.8	596 (24.7) 20.4-29	161 (28.2) 19.5-36.9	104 (15.1) 8.4-21.8	2,787 (26.9) 25.1-28.7
35-44	1,764 (30.8) 28.1-33.5	985 (33.1) 28.3-37.8	235 (27.9) 18.6-37.2	154 (32.1) 20.6-43.7	4,027 (31.7) 29.8-33.6
45-54	1,186 (20.3) 18-22.5	670 (19.2) 15.4-23	138 (17.2) 10.3-24	128 (38.6) 24.8-52.5	2,641 (19.5) 18-21.1
55 or older	715 (8.9) 7.4-10.5	388 (11.6) 8.7-14.3	72 (10.8) 4.6-17.1	52 (7.8) 2.9-12.7	1,500 (9) 7.9-10.1
Race/Ethnicity					
White, Non-Hispanic	2,833 (27.4) 25.1-29.8	2,406 (67.7) 58.9-74.8	538 (65.7) 54.9-76.5	395 (68.3) 56.5-80.2	7,693 (36.9) 35.1-38.7
Hispanic	1,846 (53.4) 50.6-56.2	272 (19.4) 15.7-23.1	66 (20.9) 12.6-29.1	32 (23.6) 11.4-35.8	2,954 (43.7) 41.8-45.6
Black	255 (6.5) 5.1-8	58 (4.7) 2.4-7	11 (4.4) 0-10	10 (4.2) 0-10.6	521 (7.1) 6-8.2
Other Race	393 (12.6) 10.2-15.1	113 (8.2) 5-11.4	27 (9.1) .7-17.4	26 (3.9) .9-6.9	788 (12.3) 10.7-14
Sex					
Male	2,046 (42.6) 39.7-45.4	1,306 (47.1) 42.3-52	374 (63.7) 53.6-73.7	307 (61) 48.2-73.8	5,251 (46.4) 44.3-48.4
Female	3,275 (57.4) 54.6-60.3	1,543 (52.9) 48-57.7	267 (36.3) 26.3-46.4	156 (39) 26.2-51.8	6,690 (53.6) 51.6-55.7
Household Income					
< \$25,000	1,483 (39.2) 36.2-42.2	255 (12) 8.7-15.3	68 (11.1) 5.8-16.5	46 (14) 4.1-23.8	2,438 (31) 29-33
\$25,000 - \$49,999	1,101 (22.6) 20.1-25	514 (16.4) 12.9-20	100 (13.7) 6.4-21.1	88 (17.8) 7.7-27.9	2,287 (21.2) 19.5-23
\$50,000 - \$74,999	627 (11.3) 9.1-13.4	520 (15.6) 11.7-19.6	108 (20.9) 10.6-31.3	80 (16.4) 7.8-25.2	1,667 (12.4) 10.9-13.9
\$75,000 and above	1,510 (27) 24.3-29.7	1,365 (56) 51-60.9	322 (54.2) 43.2-65.2	232 (51.9) 39.7-64.2	4,252 (35.4) 33.4-37.4
Education					
Less than high school	831 (28.1) 25.5-30.8	121 (7.8) 5.1-10.6	22 (8) 1.3-14.7	12 (5.1) 0-12	1,347 (23.2) 21.4-25
High school	1,299 (25) 22.6-27.4	626 (25.3) 20.6-29.9	157 (35.5) 24.8-46.3	125 (33.6) 22-45.3	2,877 (25) 23.3-26.8
Some college	1,311 (25.2) 22.6-27.8	841 (34.7) 29.8-39.6	197 (29.4) 19.7-39.1	155 (39.9) 27.2-52.6	3,186 (26.9) 25.1-28.8
College graduate	1,869 (21.7) 19.6-23.8	1,257 (32.2) 28.3-36.2	265 (27) 19.8-34.2	167 (21.4) 12-30.7	4,512 (24.8) 23.3-26.4
Marital Status					
Married	3,181 (54.3) 51.4-57.1	2,205 (69.3) 64.6-73.9	491 (66.2) 56-76.5	347 (68.5) 57.2-79.7	7,917 (59) 57-60.9
Divorced/separated	819 (12.2) 10.5-14	232 (9) 6.1-11.8	65 (8.2) 4-12.4	48 (9.3) 1.9-16.8	1,478 (10.6) 9.5-11.7
Never married	817 (21) 18.6-23.4	261 (14.4) 10.8-18	48 (17) 7.3-26.8	37 (12.5) 3.7-21.2	1,597 (19.4) 17.7-21
Other	510 (12.6) 10.6-14.5	151 (7.3) 4.6-10.1	38 (8.6) 3.1-14.1	31 (9.7) 3.1-16.4	963 (11.1) 9.8-12.4
State					
California	792 (54.8) 53-56.6	150 (37.9) 34.3-41.5	23 (22.4) 14-30.8	8 (16.6) 6.8-26.3	1,357 (48.7) 47.7-49.8
Idaho	445 (1.3) 1.2-1.5	512 (5.3) 4.8-5.8	88 (3.5) 2.5-4.4	75 (4.9) 3.4-6.3	1,345 (2) 1.9-2.1
Kansas	1,116 (2.6) 2.5-2.8	748 (6) 5.5-6.5	145 (4.2) 3.3-5.1	137 (7.1) 5.3-9	2,664 (3.2) 3.1-3.3
Oregon	624 (4) 3.7-4.4	275 (6.4) 5.7-7.1	73 (7.1) 5.6-8.6	29 (3.9) 2.3-5.5	1,390 (4.6) 4.4-4.7
Texas	1,516 (33.6) 31.9-35.3	477 (34.8) 31.4-38.2	181 (55.7) 47.7-63.6	127 (60.2) 50.1-70.3	3,301 (37.6) 36.6-38.5

Utah	834 (3.6) 3.4-3.9	687 (9.7) 8.9-10.5	132 (7.2) 5.7-8.8	87 (7.3) 5.2-9.5	1,899 (4) 3.8-4.1
Adult Alcohol Misuse					
Yes	740 (16.9) 14.7-19.2	489 (23.1) 18.8-27.5	137 (25.8) 15.7-35.9	126 (40.8) 28.6-52.9	1,841 (18.8) 17.1-20.5
No	4,453 (83.1) 80.8-85.4	2,326 (76.9) 72.6-81.2	489 (74.2) 64.1-84.4	317 (59.2) 47.1-71.4	9,147 (81.2) 79.5-82.9
Adult Mental Health Problems					
Yes	1,375 (20.4) 18.2-22.6	710 (25.8) 21.2-30.3	167 (31.1) 20.1-42.1	99 (24.6) 13.3-36	2,900 (20.5) 18.9-22.1
No	3,868 (79.6) 77.4-81.8	2,102 (74.2) 69.7-78.8	467 (68.9) 57.9-79.9	359 (75.4) 64-86.7	8,867 (79.5) 77.9-81.1

- Notes:
- 1: The presence of a firearm in the household was missing for 2,588 respondents and were excluded
 - 2: Respondents did not know or refused to indicate the presence of a firearm in 533 cases
 - 3: Responses for whether a firearm was loaded or not were missing for 78 cases and were excluded
 - 4: Responses for whether a loaded firearm was unlocked or locked were missing for 9 cases and were excluded
 - 5: Totals that do not equal the total n for that variable contain missing data

Table 2: Relative Risk of Owning a Firearm by Reported Adult Alcohol Misuse and Reported Adult Mental Health Problem in Households with Children in California, Idaho, Kansas, Oregon, Texas, & Utah, 2017

Variable	Adult Alcohol Misuse		Adult Mental Health Problems	
	RR ¹	95% CI	RR ¹	95% CI
Unadjusted	1.435*	1.211-1.701	1.276*	1.079-1.509
Adjusted	1.198*	1.017-1.411	1.216*	1.04-1.423
Age	1.095	0.756-1.586	1.098	0.761-1.586
18-24	ref	ref	Ref	ref
25-34	0.913	0.631-1.323	.91	.631-1.314
35-44	0.845	0.586-1.22	.826	.573-1.189
45-54	0.778	0.528-1.146	.769	.523-1.13
55 or older	1.048	.708-1.551	1.019	.689-1.508
Race/Ethnicity	1.38	0.878-2.168	1.314	0.851-2.029
White, Non-Hispanic	Ref	ref	ref	ref
Hispanic	0.444*	0.358-0.551	0.462*	0.375-0.569
Black	0.613*	0.403-0.933	0.607*	0.404-0.912
Other Race	0.533*	0.368-0.773	0.497*	0.344-0.719
Sex				
Male	1.128	0.984-1.292	1.176*	1.03-1.343
Female	ref	ref	ref	ref
Household Income	0.701*	0.551-0.891	0.658*	0.517-0.838
< \$25,000	ref	ref	ref	ref
\$25,000 - \$49,999	1.570*	1.168-2.111	1.539*	1.149-2.061
\$50,000 - \$74,999	2.241*	1.661-3.023	2.338*	1.734-3.15
\$75,000 and above	2.694*	2.028-3.577	2.796*	2.118-3.69
Education	.7*	.585-.837	.716*	.602-.852
Less than high school	ref	ref	ref	ref
High school	1.726*	1.16-2.567	1.82*	1.24-2.673
Some college	1.584*	1.064-2.358	1.716*	1.167-2.522
College graduate	1.208	.81-1.801	1.303	.887-1.915
Marital Status	1	.768-1.302	.972	.741-1.276
Married	ref	ref	ref	ref
Divorced/separated	1.000	0.768-1.302	0.972	0.741-1.275
Never married	0.908	0.668-1.235	0.872	0.641-1.188
Other	0.924	0.694-1.23	0.885	0.666-1.176
State	.47*	.393-.562	.483*	.405-.577
California	ref	ref	ref	ref
Idaho	2.127*	1.778-2.544	2.069*	1.735-2.468
Kansas	1.712*	1.450-2.021	1.697*	1.442-1.998
Oregon	1.454*	1.211-1.744	1.428*	1.194-1.708
Texas	1.872*	1.562-2.243	1.847*	1.55-2.2

Utah	1.763*	1.483-2.097	1.69*	1.427-2.002
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Notes:

1. * denotes statistical significance ($p < .05$)

Table 3: Relative Risk of Firearms Stored Loaded by Reported Adult Alcohol Misuse and Reported Adult Mental Health Problem in Households with Children in California, Idaho, Kansas, Oregon, Texas, & Utah, 2017

Variable	Adult Alcohol Misuse		Adult Mental Health Problems	
	RR ¹	95% CI	RR ¹	95% CI
Unadjusted	1.332	.997-1.78	1.103	.807-1.509
Adjusted	1.237	.923-1.657	1.208	.631-1.851
Age	1.222	.706-2.114	1.081	.631-1.851
18-24	ref	ref	ref	Ref
25-34	.819	.473-1.417	.925	.54-1.585
35-44	.833	.468-1.483	.882	.5-1.565
45-54	1.122	.6-2.1	1.188	.642-2.199
55 or older	.737	.386-1.407	.744	.39-1.423
Race/Ethnicity	1.015	.415-2.487	.943	.402-2.212
White, Non-Hispanic	ref	ref	ref	ref
Hispanic	.937	.654-1.34	.945	.67-1.331
Black	.951	.402-2.251	.891	.392-2.026
Other Race	1.225	.652-2.298	1.302	.69-2.457
Sex				
Male	1.594*	1.209-2.103	1.606*	1.231-2.096
Female	ref	ref	ref	ref
Household Income	.731	.467-1.144	.714	.468-1.09
< \$25,000	ref	ref	ref	ref
\$25,000 - \$49,999	0.952	0.604-1.501	0.991	0.638-1.54
\$50,000 - \$74,999	1.302	0.775-2.186	1.388	0.827-2.33
\$75,000 and above	1.084	0.702-1.673	1.167	0.762-1.788
Education	.67*	.477-.941	.697*	.5-.973
Less than high school	ref	ref	ref	Ref
High school	1.483	.738-2.978	1.276	.672-2.422
Some college	1.153	.56-2.383	1.03	.529-2
College graduate	.993	.477-2.067	.89	.454-1.744
Marital Status	.968	.668-1.401	.977	.672-1.421
Married	ref	ref	ref	ref
Divorced/separated	0.968	0.668-1.401	0.977	0.672-1.421
Never married	0.989	0.570-1.719	1.014	0.593-1.736
Other	1.109	0.753-1.633	1.225	0.840-1.787
State	.72	.475-1.1	.727	.474-1.114
California	ref	ref	ref	ref
Idaho	1.389	0.917-2.104	1.376	0.898-2.11
Kansas	1.574*	1.048-2.365	1.604*	1.057-2.433
Oregon	1.753*	1.146-2.683	1.753*	1.133-2.71
Texas	2.410*	1.580-3.676	2.480*	1.609-3.822

Utah	1.475	0.979-2.224	1.455	0.955-2.216
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Notes:

1. * denotes statistical significance ($p < .05$)

Table 4: Relative Risk of Firearms Stored Loaded and Unlocked by Reported Adult Alcohol Misuse and Reported Adult Mental Health Problem in Households with Children in California, Idaho, Kansas, Oregon, Texas, & Utah, 2017

Variable	Adult Alcohol Misuse		Adult Mental Health Problems	
	RR ¹	95% CI	RR ¹	95% CI
Unadjusted	1.513*	1-2.288	.813	.485-1.363
Adjusted	1.671*	1.195-2.336	.788	.511-1.215
Age	.685	.263-1.786	.784	.289-2.123
18-24	ref	ref	ref	ref
25-34	1.46	.56-3.808	1.278	.471-3.457
35-44	3.135*	1.204-8.16	2.502	.94-6.657
45-54	4.151*	1.618-10.646	3.316*	1.264-8.698
55 or older	2.861*	1.022-8.01	2.424	.826-7.11
Race/Ethnicity	.978	.221-4.337	.878	.203-3.786
White, Non-Hispanic	ref	ref	ref	ref
Hispanic	1.086	.707-1.666	1.106	.709-1.726
Black	1.062	.239-4.724	.972	.229-4.131
Other Race	.528	.215-1.296	.49	.209-1.151
Sex				
Male	.851	.614-1.178	.854	.61-1.195
Female	ref	ref	ref	ref
Household Income	1.522	.903-2.568	1.272	.747-2.167
< \$25,000	ref	ref	ref	ref
\$25,000 - \$49,999	1.076	.589-1.968	1.018	0.529-1.958
\$50,000 - \$74,999	0.707	0.377-1.325	0.800	0.425-1.504
\$75,000 and above	0.834	0.478-1.456	0.860	0.487-1.517
Education	.872	.54-1.406	.769	.487-1.216
Less than high school	ref	ref	ref	ref
High school	1.375	.518-3.648	1.279	.459-3.356
Some college	1.369	.522-3.592	1.662	.623-4.436
College graduate	1.198	.435-3.304	1.658	.628-4.381
Marital Status	.929	.574-1.505	.992	.611-1.612
Married	ref	ref	ref	ref
Divorced/separated	0.929	0.573-1.505	0.992	0.611-1.612
Never married	1.552	0.794-3.035	1.447	0.778-2.69
Other	1.011	0.550-1.859	1.048	0.542-2.029
State	.645	.332-1.252	.704	.36-1.376
California	ref	ref	ref	ref
Idaho	1.551	0.798-3.014	1.421	0.727-2.777
Kansas	1.679	0.868-3.249	1.757	0.906-3.408
Oregon	0.847	0.410-1.75	0.816	0.391-1.701
Texas	1.265	0.654-2.445	1.306	0.677-2.518

Utah	1.487	0.793-2.788	1.369	0.721-2.597
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Notes:

1. * denotes statistical significance ($p < .05$)
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