PREVALENCE OF HYPERTENSION IN THE U.S. ADULT POPULATION AND ITS ASSOCIATION WITH VARIOUS BEHAVIORAL RISK FACTORS

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The Undersigned Faculty Committee Approves the

Thesis of Pooja Joshi:

Prevalence of Hypertension in the U.S. Adult Population and its Association with

Various Behavioral Risk Factors

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DEDICATION

I dedicate this thesis to My Parents and my sister as well as all my friends and classmates who contributed to my education in their special unique ways.
ABSTRACT OF THE THESIS

Prevalence of Hypertension in the U.S. Adult Population and its Association with Various Behavioral Risk Factors
by
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Master of Public Health
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Background: Trends in Health Behaviors of a Population are essential to monitor as they are important in predicting the disease burden in the population. Hypertension is a chronic disease which after its diagnosis has to be controlled with medication (anti-hypertensive) and more importantly practice of healthy behaviors such as smoking cessation, reduction of alcohol intake, increase of moderate physical activity. The prevalence of these behaviors in those who are diagnosed with Hypertension in both sexes and across all the age groups is measured in the study. Methods: The data analyzed was the BRFSS (Behavioral Risk Factor Surveillance System) 2007 dataset which is a cross sectional study which makes use of a random telephonic Surveillance System) selected after random selection of the households. Since the outcome variable was dichotomous (hypertension –present or not present), logistic regression was the Method of choice. The exposures of interest are physical activity, age, smoking, alcohol and the association of them with diagnosis of hypertension. The risky behaviors which could be modified were to measured and that is why other medically relevant risk factors such as Diabetes and family history were not included. The definition of hypertension used in the analysis was a positive answer to the question “have you been ever told by a physician that you have high blood pressure?”

Results: Out of the 158798 participants analyzed, 27.5% were diagnosed with hypertension. The Prevalence rates of hypertension increased with age in the sample population. The rates varied across the age strata and were highest in the age group 65 years or older and were lowest in 18-24 years. Hypertension was 1.14 times lower in male smokers than in non smokers. (O.R =0.873 .95% C.I. = 0.841, 0.905). It was 1.13 times lower in alcohol consumers than in those who do not consume alcohol. (O.R =0.884 95% C.I. =0.855, 0.914) Prevalence of Hypertension was times 1.47 higher in those with regular moderate Physical activity. (O.R =0.680 95% C.I. =0.497, 0.931). The prevalence of Hypertension was 1.07 times lower in current female smokers than in non current female smokers. (O.R =0.911 .95% C.I. = 0.890, 0.933) and was 1.5 times lower in alcohol consumers than in those who do not consume alcohol. (p=<0.001). (O.R =0.754. 95% C.I. =0.738, 0.771) It did not have a statistically significant relationship with Moderate Physical activity in women. Conclusion: The patients diagnosed with Hypertension in US are more likely to follow the physician guidelines for smoking cessation and alcohol intake reduction than those without the diagnosis. Primary prevention strategies for Hypertension should be improved and promoted.
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ACKNOWLEDGEMENTS

My heartfelt thanks to my Thesis chair Dr Caroline Macera, who was very patient and inspiring and guided me throughout this work till its completion. I would also like to thank the other committee members Dr P.J.E Quintana and Dr Michael Gates for their patience and commitment to my thesis work. I would also thank my parents, sister and friends for the love and support they have showered on me all my life.
CHAPTER 1

INTRODUCTION

My thesis investigates the association of common unhealthy behaviors such as cigarette smoking, alcohol, and physical inactivity with the prevalence of hypertension. The study analyzes data from the 2007 Behavioral Risk Factor Surveillance System (BRFSS) pertaining to the variables of interest. It is a cross-sectional study of adults 18 years or older residing in any state or any territory of the USA taking part in the survey. It was designed by the Centers for Disease and Prevention (CDC) and was administered both in English and Spanish. A Telephone survey was carried out using random digit dialing and the questionnaire was administered to the participants over the phone. The results were analyzed using SAS 9.2 version and multiple logistic regression models were developed to assess the association of hypertension and selected behavioral characteristics.

STATEMENT OF THE PROBLEM

In 1945 President Franklin D. Roosevelt died from a stroke. Minutes after his collapse, his blood pressure was 300/190. The President’s hypertension was not being treated effectively and this led to his death. Research in hypertension treatment gained importance in the years that followed (Roth, 2009). The twentieth century ushered in an era of great interest in blood pressure because a simple clinical method (measuring the brachial artery pressure using a sphygmomanometer to measure it was developed.) Data from a number of medical records of clinical cases pointed towards a relationship between high blood pressure and premature death. Physicians then began to take note of relationship between hypertension and risk of heart failure, stroke, and kidney disease. In 1948 the National Institutes of Health (NIH) launched the Framingham Heart Study, the first study of its kind to assess hypertension as a risk factor for developing cardiovascular disease (CVD). As a result of these studies, hypertension was then established as a modifiable risk factor for CVD and further studies proved that the higher the blood pressure, the greater the risks are for heart attack, heart failure, stroke, and kidney disease. Today hypertension can be
controlled to a large extent with help of anti–hypertensive medications as well as by an adoption of a lifestyle regimen.

Although cigarette smoking, alcohol, and physical inactivity are risk factors for hypertension, not much is known about the prevalence of these risky health behaviors among those already diagnosed with hypertension. The immediate harmful effects of smoking are on the sympathetic nervous system causing it’s over activity, which increases myocardial oxygen consumption through an increase in blood pressure and heart rate (Kaplan, 2009). This is particularly harmful in known cases of hypertension as it increases the already high blood pressure. Alcohol has a direct effect on the blood vessels in the body and is known as a direct vasoconstrictor, which causes an increase in blood pressure. Hence, avoiding consumption of alcohol helps to keep arterial pressure in control. Many clinical studies have proven that becoming more physically active can lower blood pressure. Studies have shown that with physical activity systolic blood pressure can be lowered up to 5-10 mm of Hg, making it as effective as some medications for hypertension (Steen, 2009). People with diagnosed hypertension should make lifestyle changes to prevent additional complications of the disease. Understanding how many people with diagnosed hypertension are still practicing these unhealthy behaviors, especially by age and sex groups will help to target intervention activities.

**PURPOSE OF STUDY**

This study measures the prevalence of health behaviors such as cigarette smoking, alcohol consumption and physical inactivity across men and women of different age groups who have been diagnosed with hypertension. The purpose of the study is to assess the effectiveness of behavioral interventions and patient compliance to physician advice concerning smoking cessation, abstinence from alcohol, and becoming more physically active among adults diagnosed with hypertension. This is an important issue because, as a form of secondary prevention from a public health perspective, the adoption of healthy behaviors leads to lower rates of complications arising from hypertension such as stroke and myocardial infarction. Another important purpose was to examine the differences in prevalence of these risky behaviors, between men and women and across different age groups in order to identify the high risk groups who are prone to develop complications.
resulting from uncontrolled blood pressure and target interventions at this group. Studying the characteristics of arterial hypertension and the practice of risky behavioral habits in the population is a first step for planning programs based on evidence that can be used to prevent the complications arising from uncontrolled hypertension such as stroke, heart attack, and the resulting physical, mental, and economical costs to the patients as well as the government. The study is a cross-sectional study in which the participants answer the survey by telephone, which could result in a self-reporting bias. In addition, questionnaire scales can introduce a bias if there are an even vs. odd number of choice categories, for example (Agree) 1-2-3 (Disagree) tends to obtain neutral answers, while (Agree) 1-2-3-4 (Disagree) tends to force respondents to take sides. There exists a lot of missing data in the study which has to be accounted for. The participants who refuse to answer or do not know the answer have to be included in the missing data. Thus many covariates in the analysis have missing data excluded from them. In a few cases apprehension bias (white coat hypertension) is a possibility which results in altercation of the measures of blood pressure from their usual levels due to apprehension at the time of measurement leading to it being reported erroneously in the survey. The other covariates such as Education and health Insurance status could not be included in the analysis as they had a large number of missing data under it.

**DEFINITION OF TERMS**

**BRFSS-Behavioral Risk Factor Surveillance System:** an ongoing data collection program sponsored by the CDC designed to measure behavioral risk factors in US adult (18 years and above) population living in households via a random telephone survey.

**Hypertension:** Levels of systolic and/or diastolic blood pressure associated with increased risk of morbidity or mortality. Measured blood pressure $\geq 140/90$ mm Hg or taking an antihypertensive medication. For this study, the participants answered whether or not they have been previously diagnosed with hypertension by a health professional.

**Systolic blood pressure:** measures the greatest amount of pressure exerted against the artery walls when an individual's heart contracts.

**Diastolic blood pressure:** measures the amount of pressure exerted against the artery walls when the heart is resting between beats.
CHAPTER 2

LITERATURE REVIEW

Hypertension is one of the major modifiable risk factors for cardiovascular diseases, the leading cause of death in the US. Assessment of the awareness of prevention and control of hypertension in the US population is a necessary step towards the reduction of its burden in the country. There is a need for future research in this direction as very few studies have been carried out to measure the association between risk factors such as tobacco smoking, alcohol consumption, and physical activity together among people who have already been diagnosed with hypertension.

PHYSIOLOGY OF HYPERTENSION

There are two chief categories of hypertension - primary (or essential) and secondary hypertension. Approximately 90-95% of patients diagnosed with hypertension have essential hypertension. Unlike secondary hypertension, there is no known cause of primary hypertension. With each cigarette, the blood pressure rises for a brief period of time. In a study of normotensive smokers, there was a mean elevation in systolic pressure of 20 mmHg after the smoking of one cigarette. This speaks volume about the effect nicotine in cigarettes has over the arterial system in the body and suggests a subsequent rise in blood pressure if smoking becomes a chronic habit of the person. The immediate harmful effects of smoking are on the sympathetic nervous system causing its over activity, which increases myocardial oxygen consumption through an increase in blood pressure and heart rate (Kaplan, 2009).

People who drink alcohol excessively (over two drinks per day) have a one and a half to two times increase in the frequency of hypertension (Alcohol Health and amp & Research World, 2004). The association between alcohol and high blood pressure is particularly prominent when the alcohol intake exceeds 5 drinks per day. The effect of alcohol on the blood vessels is known as the vasoconstrictor effect, an increase in the pressure of blood in the vessels. The American Journal of Public Health in its April 2007 issue published a
research study stating that young adults who exercised five times a week experienced a 17% reduction in the risk of developing hypertension (March, 2007).

**Prevalence Control and Awareness of Hypertension**

The analysis of NHANES data regarding the prevalence, control and awareness of hypertension in US adults between the years 1999-2004 is reported by Kotchen (2007). The overall prevalence of hypertension rose from 26.8% to 29.3% in this period (not statistically significant). However, an important and striking finding of this study is the increased control rates of hypertension from 29.2% to 36.8% which was statistically significant and the same was true for the awareness rates which rose from 68.7% to 75.7%. The increases in awareness and control were most prominent in individuals aged 60 years. The high prevalence of hypertension in the population can be attributed to increasing prevalence of obesity. Higher rates of hypertension were also associated with increasing age and non-Hispanic black identity. However the age-adjusted mortality for stroke and coronary heart has seen a steep decline since 1999. Multiple factors have played a role in trends turning favorable including better understanding of the risk factors of “benign” hypertension (which is essential hypertension without any symptomatic complications) and benefits of treatment including available antihypertensive medicines, lifestyle interventions, and a host of federal and community based high blood pressure prevention and control attempts. These programs have been effective in raising the awareness, increasing the knowledge about hypertension control particular for poor and uninsured in the population as well as improving patient adherence to lifestyle interventions and medications.

**Cigarette Smoking and Hypertension**

Halimi et al. (2002) conducted a population based cross-sectional study in 12417 to assess the prevalence and relative risk of Hypertension associated with smoking status, classified as former smokers, current smokers and never smokers. The results showed that the overall prevalence of hypertension was higher in former smokers than in never smokers (13.5% vs. just 6.7% in current smokers) suggesting that individuals diagnosed with hypertension might have changed their smoking habits. This higher prevalence among never smokers was associated with increased body mass index (BMI). Overall the prevalence of
hypertension among former smokers was attributed to the number of cigarettes and not the duration of smoking. Logistic regression was performed to assess the prevalence of hypertension associated with smoking. Adjustments for age and alcohol consumption were made and the smoking- BMI interaction was tested in the models.

Another study used a multivariate regression model to assess the effect of smoking status on systolic and diastolic blood pressure. The results of a study using data from the National Health and Nutrition Examination found that an increase of 7-13 kg in body weight over a 10-year period was higher in those who quit smoking for 4-6 years (O.R =2.8) and 7-12 years (O.R =2.6) compared to current smokers where the odds ratio of weight gain was not statistically significant in non smokers. This weight gain can result in increasing blood pressure. The study also states in its limitation that the discontinuation of smoking may have been triggered by the discovery of hypertension and on the advice of the physician (Halimi et al., 2002)

A prospective study by Bowman, Gaziano, Buring, and Sesso (2007), whose aim was to evaluate whether smoking was a risk factor for hypertension, described scientifically the relationship between the risks of hypertension with the number of packs smoked per day. A cohort of 28,236 women in the Women’s Health Study who were initially free of hypertension, cardiovascular disease, and cancer was selected as the sample population. Detailed risk factor information, including smoking status, was collected from self-reported questionnaires. Cox proportional hazards survival models were used to calculate hazard ratios and 95% confidence intervals of incident hypertension (defined as either new diagnosis, the initiation of antihypertensive medication, systolic blood pressure >140 mm Hg or diastolic blood pressure >90 mm Hg) were used in the analysis. At baseline, 51% of women were never smokers, 36% were former smokers, 5% smoked 1 to 14 cigarettes, and 8% smoked >15 cigarettes per day. Among women who smoked >25 cigarettes per day, the multivariable hazard ratio was 1. Thus, the study concluded that cigarette smoking is modestly associated with an increased risk of developing hypertension, with an effect that was strongest among women smoking at least 15 cigarettes per day.
ALCOHOL AND HYPERTENSION

In the study by Lip and Beevers (2003), the various confounding factors influencing the relationship between alcohol and hypertension are discussed. It described one of the cross sectional studies conducted on this topic which 4626 men and 4647 women aged between 20 and 59 years and found that men who drank 300-499 ml of alcohol per week had mean systolic and diastolic blood pressure of 2.7/1.6 higher than non drinkers while women who drank >300 ml of alcohol per week had mean systolic and diastolic blood pressures of 3.9/3.1 higher than non drinkers. This suggests a linear relationship however the review of Kaiser Permanente study shows that non-drinkers had higher rates of systolic blood pressure than those who consume one or two drinks per day suggesting a J shape of the curve. A “U” shaped curve was observed in women with the blood pressure in non-drinkers being similar to the highest consumers. The various potential confounders as discussed in the study included gender where there was generally a weaker association between alcohol and hypertension among women compared to men. This finding could be due to the fact that there were fewer heavy women drinkers than men. In addition, obesity, oral contraceptive use and hormone replacement therapy can confound this relationship. Another potential confounder included age. Because blood pressure generally increases with age, it is important to include age in the study. There were several findings regarding alcohol. The type of alcoholic beverage produces different effects on the vascular system. Wine produces the lowest effects while beer, spirits and hard liquor exert the highest effects on blood pressure. As for pattern of drinking, men who have a low intake of alcohol have a very small or insignificant mean blood pressure difference compared to non-drinkers. Similarly, among women occasional heavy drinkers have higher rates of hypertension than moderate drinkers.

In the study Taylor et al. (2009) the dose response relationship between the average daily alcohol consumption and the risk of hypertension was assessed via a thorough and systematic literature review and Meta analysis. A computer-assisted search was completed for 10 databases, followed by hand searches of relevant articles. Only studies with longitudinal design, quantitative measurement of alcohol consumption and biological measurement of outcome were included. Various tests for heterogeneity and publication bias were conducted. A total of 12 cohort studies were identified from the literature from the United States, Japan and Korea. A linear dose–response relationship with a relative risk of
1.57 at 50 g pure alcohol per day and 2.47 at 100 g per day was seen for men and women. Thus, the risk for hypertension increases linearly with alcohol consumption, so limited alcohol intake should be advised for both men and women.

**Physical Activity and Hypertension**

In the study Halm and Amoako (2008), the extent to which physical activity is recommended by physicians as a primary lifestyle measure to lower pressure in the hypertensive population was studied. Surveys of patients suggest that a very few healthcare providers follow the US Preventative services task force recommendations on physical activity counseling (Halm & Amoako, 2008). The results of compliance of patients from the NHANES (1988-1994) data were examined and compared to five different clinical trials on physical activity in 1991 and 2001. Only one third of NHANES population received counseling on physical activity to manage their hypertension and of the 71% of them who followed the recommendations found that their systolic blood pressure was approximately 3-4 mm of Hg lower than those who did not follow the recommendations. Thus, the study highlights that a small proportion of those with hypertension receive physical activity advice from the healthcare providers. However, most of those who do receive it and increase their physical activity have lower levels of blood pressure and improved health outcomes. Given the magnitude of poorly controlled hypertension in the population this study should alert the healthcare providers to promote the recommendation of physical activity.

The study by Crespo (1994) confirms that endurance exercise training by individuals at high risk for developing hypertension will reduce the rise in blood pressure that occurs with age. Thus, it is the position of the American College of Sports Medicine that endurance exercise training is recommended as a non pharmacological strategy to reduce the incidence of hypertension in susceptible individuals. A large number of studies indicate that endurance exercise training will elicit a 10 mm Hg average reduction in both systolic and diastolic blood pressures in individuals with mild essential hypertension (Crespo, 1994) Endurance exercise training appears to elicit even greater reductions in blood pressure in patients with secondary hypertension due to renal dysfunction. The mode (large muscle activities), frequency (3-5 days per week), duration (20-60 minutes), and intensity (50-85% of maximal oxygen uptake) of the exercise recommended to achieve this effect are generally the same as
those prescribed for developing and maintaining cardiovascular fitness in healthy adults. Physically active and fit individuals with hypertension have markedly lower rates of mortality than sedentary, unfit hypertensive individuals. Individuals with more marked elevations in blood pressure (> 180/105 mm Hg) should add endurance exercise training to their treatment regimen only after initiating pharmacologic therapy.

**Summary**

Therefore, studying the relation between a few major risk factors and the prevalence of hypertension in persons having those risk factors would help throw light on this very significant public health issue and aid in designing and executing the future interventions to reduce complications of hypertension in the country and also aid the cases with physician diagnosed hypertension to adopt a healthy lifestyle. A multidisciplinary approach which includes abstinence or control of smoking, limited alcohol consumption, regular moderate physical activity is the needed to control a chronic disease such as hypertension. Thus, association between the prevalence of risky health behaviors among those with a physician diagnosed hypertension is important to assess as it will be the foundation of various preventive and curative programs to control hypertension. Understanding these behaviors is also important because it will help in tailoring an appropriate lifestyle regimen for the hypertensive and the pre-hypertensive population.
CHAPTER 3

METHODS

The BRFSS is a state-based system of health surveys that generate information about health risk behaviors, clinical preventive practices, and health care access and use primarily related to chronic diseases and injury (Centers for Disease Control and Prevention [CDC], 2007).

STUDY DESIGN

The BRFSS 2007 was a cross-sectional telephone study conducted by state health departments with technical and methodological assistance provided by the CDC. The variables used in the thesis namely smoking, alcohol consumption, physical activity; age and sex (exposure variables) with hypertension (outcome variable) were assessed simultaneously. To examine the important differences between men and women, analyses were carried out individually for each sex measuring the association between hypertension and the 3 exposure variables. Age differences in various groups were examined for each sex.

TOOLS AND INSTRUMENTS

Monthly telephone surveillance using a standardized questionnaire to determine the distribution of risk behaviors and health practices among adults was conducted by the local and state health departments in all states who followed guidelines prescribed by the CDC (CDC, 2007). Home telephone numbers were obtained through random-digit dialing. The states forwarded the responses to the CDC’s National Center for Chronic Disease Control and Prevention and Health Promotion’s Behavioral Surveillance Branch for editing and analysis which handled and analyzed the data and derived the results. The data was then published on the BRFSS Web site from which I chose my variables of interest and for analysis. BRFSS questionnaires were both in English and Spanish. The questionnaire has three parts: (1) the core component; (2) optional modules; and (3) state-added questions. The optional modules part contains specific questions related to hypertension such as awareness and the core component includes questions on health behaviors such as smoking, alcohol,
and physical activity, which are the various risk factors for hypertension which previous studies have shown to be associated with hypertension.

**Outcome Variable**

The question asked was “Have you EVER been told by a doctor, nurse, or other health professional that you have high blood pressure?” This is a dichotomous variable which has response as either a “Yes” (the ones that replied a yes and the ones with pregnancy induced hypertension) or a “No” (ones who replied no or the pre hypertensive) to a diagnosis of hypertension. The ones that didn’t know the answer or refused to answer were excluded from the data analysis along with the missing data.

**Exposure Variables**

Smoking – One smoking question measured the current smoking habits of the participants: Do you now smoke cigarettes every day, some days, or not at all?

This variable had responses such as – (1) Everyday (2) Someday (3) Not at all (4) refuse to answer. (Smoking Status) (5) Didn’t know. Every day and someday (1 and 2) responses were grouped under “yes” and the ‘not at all response (3) were put under ‘No’ for the smoking status. The responses “refuse to answer “and “don’t know the answer” were deleted from the analysis along with the missing data.

Alcohol –the following question assessed alcohol use in the population:

During the past 30 days, have you had at least one alcoholic beverage such as beer, wine, a malt beverage or liquor? The responses varied from – (1) Yes (2) No (3) Don’t know. (4) Refused. The responses “refuse to answer” and “don’t know the answer” were deleted from the analysis along with the missing data.

Physical activity – Moderate Physical activity was defined as aerobic activity for about 2 hours and 30 minutes per week and muscle strengthening activity on 2 days per week. The question about moderate physical activity was:

How many days per week do you do moderate physical activity at least 10 min per day?

The response was (1), ___days per week (2) Do not do any physical activity for at least 10 min per day (3) Don’t know (4) Refuse to answer. Participants who answered any
number of days (1) were grouped under “yes” for the variable and those who didn’t do any physical activity were grouped under “no”.

**Other Covariates**

The demographic covariates taken into consideration were the age and sex of the participants. Variations in the health behaviors in the hypertensive among the different age and sex groups were examined. For age, the question “What is your age?” was used to gather information on the current age of the respondents. The responses were categorized into the following age groups – (1) Age 18 – 24; (2) Age 25 – 34; (3) Age 35 – 44; (4) Age 45 – 54; (5) Age 55 – 64; (6) Age 65 or older. The other covariates such as Education and health Insurance status could not be included in the analysis as they had a large number of missing data under it. See Table 4 in Appendix for the coding.

**SAMPLE POPULATION**

Adults 18 years or older residing in any state of USA were asked to take part in the survey. Only one adult is interviewed per household. In addition to The 50 states plus the District of Columbia, Puerto Rico, Guam, and the Virgin Islands participated in the 2007 BRFSS providing a starting sample size of 430,912 respondents. The questions I was interested in, from the dataset were all core questions and thus were asked to all states, unlike the optional module questions which are asked to specific states depending upon the previous prevalence.

**STATISTICAL ANALYSIS**

Since the outcome variable is dichotomous (diagnosed hypertension –present or not present), logistic regression is the method of choice. The exposures of interest are smoking, alcohol, physical activity, controlling for age and stratifying by gender. The logistic models were built with outcome of hypertension assessed both individually and in combination, controlling for the other variables. The analysis was carried out separately for men and women. The results are analyzed using SAS 9.2 version (SAS institute, Cary, NC). The study was conducted using public-use data and did not need further approval by the IRB (Institutional Review Board) at San Diego State University. Frequencies and descriptive statistics were computed for each independent variable. P values <0.05 were considered
statistically significant. Chi-square tests were used to assess group differences for categorical variables. Model building using simple logistic regression was used to establish associations between each exposure variable (cigarette smoking, alcohol intake, and physical activity) and hypertension while controlling for age. Before analyzing the exposure variables for their association with the outcome variable, the interaction with smoking and alcohol was measured to avoid any confounding in the result. At each stage of the procedure if there was a statistically significant association (p<0.05) between age and any exposure variable or if a particular variable changed the odds ratio, it was retained in the final model.

Any variable that did not show a statistically significant association (p>0.05) with hypertension or the overall model was removed from the final model. Thus every demographic and exposure variable was analyzed methodically for its potential association with “physician diagnosed hypertension.” The fit of the full logistic regression models and the final reduced models were evaluated by the Hosmer Lemeshow goodness of fit test.
CHAPTER 4

RESULTS

The BRFSS dataset was comprised of 430,912 participants who responded to the 2007 survey. To account for the missing data and to estimate the accurate sample size, missing data was deleted at each step. The total number of missing data (including those who refused to answer or didn’t know) for hypertension is 830 subjects; thus the sample size was reduced to 430,082 at the first stage. After elimination of the missing data for alcohol (3,926) the sample size was 426,156. When those missing for age were eliminated (3,366) the sample size was reduced to 422,790; missing information on smoking status (223,266) further reduced the sample size to 199,524; missing information for physical activity (40,726) reduced the final sample size to 158798. This was the sample size used for analysis for assessing the relationship between hypertension and each of the demographic and behavioral risk factors collected over a period of one year through monthly random telephonic survey for the year 2007. The number of males in this sample was 68,521 and number of females was 90,277. Table 1 compares the prevalence of hypertension between males and females. Table 2 shows univariate logistic regression separately done for men and women. Table 3 shows the final logistic regression model explaining relationship of each exposure with hypertension, controlling for variables the outcome variable was physician-diagnosed hypertension and the association with this outcome was assessed for the exposure variables of current smoking, alcohol consumption and physical activity.

Table 1 shows the descriptive statistics of the sample population. It shows the distribution of adults above 18 years with diagnosed hypertension who practice various risky health behaviors such as smoking, alcohol, and physical inactivity. The prevalence of hypertension in different age groups is described and the analysis is done separately for men and women to assess the gender differences. Out of all men diagnosed with hypertension only 11.39% said they smoked cigarettes currently as compared to 30.98% who didn’t smoke suggesting adoption of healthy behavior by a large number of men who are hypertensive. Similarly for women the current smokers were 12.39% and non-smokers were 24.15%
Table 1. Descriptive Statistics for Physician-Diagnosed Hypertension and Demographic and Behavioral Risk Factors

<table>
<thead>
<tr>
<th>EXPOSURE VARIABLES</th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1. Smoking status- (Hypertensive)</td>
<td>7802 (11.39%)</td>
<td>21226 (30.98%)</td>
</tr>
<tr>
<td>1. Smoking status- (non-Hypertensive)</td>
<td>15935 (23.26%)</td>
<td>23558 (34.37%)</td>
</tr>
<tr>
<td>2. Alcohol consumption (Hypertensive)</td>
<td>11824 (17.26%)</td>
<td>17204 (25.11%)</td>
</tr>
<tr>
<td>2. Alcohol consumption (non-Hypertensive)</td>
<td>26023 (37.98%)</td>
<td>13470 (19.66%)</td>
</tr>
<tr>
<td>3. Physical Activity- (Hypertensive)</td>
<td>91 (0.135%)</td>
<td>28937 (42.23%)</td>
</tr>
<tr>
<td>3. Physical Activity- (non-Hypertensive)</td>
<td>84 (0.12%)</td>
<td>39404 (57.51%)</td>
</tr>
</tbody>
</table>
Table 2. Association between Exposure Variables and Physician-Diagnosed Hypertension from the Univariate Analysis for Men and Women in the Adult US Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>MALE O.R -</th>
<th>[95% CI]</th>
<th>p-value</th>
<th>FEMALE O.R -</th>
<th>[95% CI]</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smoking status - (Current smokers)</td>
<td>0.54</td>
<td>(0.526, 0.562)</td>
<td>&lt;.0001</td>
<td>0.63</td>
<td>(0.630, 0.648)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>2. Alcohol consumption -</td>
<td>0.75</td>
<td>(0.730, 0.777)</td>
<td>&lt;.0001</td>
<td>0.59</td>
<td>(0.578, 0.610)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>3. Physical activity</td>
<td>0.68</td>
<td>(0.504, 0.912)</td>
<td>0.0103</td>
<td>0.63</td>
<td>(0.468, 0.849)</td>
<td>0.0024</td>
</tr>
<tr>
<td>4. AGE -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 25-34 years</td>
<td>1.58</td>
<td>(1.349, 1.869)</td>
<td>&lt;.0001</td>
<td>1.13</td>
<td>(0.984, 1.303)</td>
<td>0.0816</td>
</tr>
<tr>
<td>2. 35-44 years</td>
<td>2.66</td>
<td>(2.281, 107)</td>
<td>&lt;.0001</td>
<td>1.73</td>
<td>(1.519, 1.983)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>3. 45-54 years</td>
<td>4.74</td>
<td>(4.084, 5.516)</td>
<td>&lt;.0001</td>
<td>3.26</td>
<td>(2.868, 3.718)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>4. 55-64 years</td>
<td>8.81</td>
<td>(7.589, 10.22)</td>
<td>&lt;.0001</td>
<td>6.04</td>
<td>(5.315, 6.883)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>5. 65 years and &gt;</td>
<td>10.893</td>
<td>(9.872, 12.019)</td>
<td>&lt;.0001</td>
<td>10.290</td>
<td>(9.035, 11.720)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

suggesting more number of women controlling their smoking habits among those who were diagnosed with hypertension. Surprisingly, the prevalence of smoking was lesser in males than in females. The proportion of men who consumed alcohol (25.11%) was greater among the hypertensive men than the women (16.48%) and the diagnosed women with hypertension were more likely to control their alcohol intake just as seen with smoking. The proportion of both men and women who practiced any form of moderate physical activity was lower in those with hypertension as expected, the prevalence of hypertension increased with age.
Table 3. Association between Variables and Physician Diagnosed Hypertension from Multivariate Logistic Regression Final Model for Men and Women in the US Adult Population, BRFSS 2007

<table>
<thead>
<tr>
<th>Variable</th>
<th>MALE (N=68521)</th>
<th>[95% CI]</th>
<th>p-value</th>
<th>FEMALE (N=90,277)</th>
<th>[95% CI]</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Smoking status - (Current smokers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.873</td>
<td>(0.84, 0.90)</td>
<td>&lt;.0001</td>
<td>0.930</td>
<td>(0.90, 0.95)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>2. Alcohol consumption --</td>
<td>0.884</td>
<td>(0.85, 0.91)</td>
<td>&lt;.0001</td>
<td>0.668</td>
<td>(0.64, 0.68)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>3. Physical Activity-</td>
<td>0.680</td>
<td>(0.49, 0.93)</td>
<td>0.0161</td>
<td>0.849</td>
<td>(0.61, 1.16)</td>
<td>0.3125</td>
</tr>
<tr>
<td>4. AGE -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 25-34 years-</td>
<td>1.547</td>
<td>(1.314, 1.821)</td>
<td>&lt;.0001</td>
<td>1.127</td>
<td>(0.979, 1.297)</td>
<td>0.0961</td>
</tr>
<tr>
<td>2. 35-44 years</td>
<td>2.551</td>
<td>(2.185, 2.979)</td>
<td>&lt;.0001</td>
<td>1.717</td>
<td>(1.502, 1.963)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>3. 45-54 years</td>
<td>4.491</td>
<td>(3.863, 5.222)</td>
<td>&lt;.0001</td>
<td>3.184</td>
<td>(2.795, 3.627)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>4. 55-64 years</td>
<td>8.144</td>
<td>(7.007, 9.465)</td>
<td>&lt;.0001</td>
<td>5.762</td>
<td>(5.060, 6.562)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>5. 65 years and &gt;</td>
<td>11.754</td>
<td>(10.111, 13.665)</td>
<td>&lt;.0001</td>
<td>10.290</td>
<td>(9.035, 11.720)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

The unadjusted odds for smoking status (0.54) and for alcohol (0.75) for males and 0.63 and 0.59 for females for smoking and alcohol respectively suggest a strong protective association of these high risk behaviors in both men and women (p<.0001). With physical activity, there is no difference between men and women and we see a protective association for moderate physical activity and hypertension. The variation across age is same as one
mentioned previously, the association of hypertension and age increases as the age groups increase.

**Multivariate Model:** The odds ratios to assess the association between the outcome variable and each of the exposure variables were evaluated, controlling for the other variables. Multiple Logistic regressions were employed using SAS 9.2 and v models building was used to reach the final model. Possible interaction between the exposure variable smoking and alcohol was measured using Logistic regression for the 2 variables. This was carried out because a number of studies carried out to assess the effect of alcohol on Hypertension have been modified by Smoking status.

The logistic regression for the interaction term alcohol with smoke revealed a P value of 0.0001 which is significant and thus was put back in the model.

The unadjusted odds ratio for Physical activity suggested a statistically significant relationship with Hypertension before controlling for other variables (p=0.0024) and the adjusted odds ratios in the Multivariate Final model changed it to a non significant one (p=0.3125). Both the unadjusted (0.086) and adjusted ratios (0.0961) for the age group 25-34 year old females was non significant suggesting no statistically significant association with Hypertension.

**VARIATION ACROSS THE DEMOGRAPHIC STRATA FOR MALES**

The Prevalence rates of Hypertension increased with age in the sample population. The rates varied across the age strata and were highest in the age group 65 years or older and were lowest in 18-24 years. The adjusted odds ratios increased as the age groups for Hypertension as expected. The prevalence of Hypertension was 11.754 times higher in those in the age group 65 and older (p=<0.001) (O.R =11.754 .95% C.I. =10.111, 13.665) than the other age groups.

**VARIATION ACROSS THE DEMOGRAPHIC STRATA FOR FEMALES**

The Prevalence rates of Hypertension increased with age in the sample population. The rates varied across the age strata and were highest in the age group 65 years or older and were lowest in 18-24 years. The adjusted odds ratios increased as the age groups for
Hypertension as expected. The prevalence of Hypertension was 10.290 times higher in those in the age group 65 and older \( (p<0.001) \) \( (O.R =10.290 \ 95\% \ C.I. = 9.035, 11.720) \) than the other age groups.

**VARIATION ACROSS THE BEHAVIORAL FACTORS FOR MALES**

The prevalence of Hypertension was 1.14 times lower in current smokers than in non current smokers. \( (p<0.001) \) \( (O.R =0.873 \ 95\% \ C.I. = 0.841, 0.905) \). The prevalence of Hypertension was 1.13 times lower in alcohol consumers than in those who do not consume alcohol. \( (p<0.001) \) \( (O.R =0.884 \ 95\% \ C.I. =0.855, 0.914) \). The prevalence of Hypertension was 1.47 higher in those with regular moderate Physical activity. \( (p=0.016) \) \( (O.R =0.680 \ 95\% \ C.I. =0.497, 0.931) \).

**VARIATION ACROSS THE BEHAVIORAL FACTORS FOR FEMALES**

The prevalence of Hypertension was 1.07 times lower in current smokers than in non current smokers. \( (p<0.001) \) \( (O.R =0.911 \ 95\% \ C.I. = 0.890, 0.933) \). The prevalence of Hypertension was 1.5 times lower in alcohol consumers than in those who do not consume alcohol. \( (p<0.001) \) \( (O.R =0.754 \ 95\% \ C.I. =0.738, 0.771) \). The prevalence of Hypertension did not have a statically significant relationship with Moderate Physical activity in women.

The Hosmer Lemeshow test for Goodness of fit for the logistic regression model was carried out for the interaction as well as the full final model to assess how well the model fits the data. For the interaction term as the sample size considered was very large, the test was not significant \( (p=0.998) \), indicating that the model was a good fit for data.

The Hosmer Lemeshow test for Goodness of fit for each sex analysis was carried out and the tests were not significant suggesting the model was a good fit for data.

The log likelihood ratio for the Final model is 20201.626 which is significant at \( p<0.000 \). This proves that the model is a Good fit for the data.
CHAPTER 5

DISCUSSION

KEY FINDINGS

The population based CDC –BRFSS 2007 was used to assess the prevalence of known behavioral risk factors (current smoking, alcohol use, and lack of physical activity) that cause complications in patients diagnosed with hypertension. The study also compared the distribution of these risky health behaviors among people with and without diagnosed hypertension. Separate analysis for men and women were carried out. It was hypothesized that among those with physician diagnosed hypertension, the prevalence of cigarette smoking, alcohol consumption and physical inactivity would be higher than among those without the diagnosis. However, in case of variables like cigarette smoking and alcohol consumption the findings differed than what was hypothesized though similar findings were observed in few previous studies reviewed in the literature on this topic, especially in case of men. Physical activity was hypothesized to be lower in those diagnosed which was consistent with the findings in this study.

For smoking among males, the results were similar to the study of Halimi et al. (2002) where the current male smokers had lower odds of being hypertensive than a non-smoker (6.7% for a current smoker and 8.8% for never smokers). However, for smoking among females the study showed results which differed than the ones previously reviewed such as Kotchen (2007), a prospective study which describes the relationship between the risks of hypertension with the number of packs smoked per day among women. In this study even current smokers showed a statistically significant relationship with Hypertension though it was more pronounced in women who smoked more than 15 cigarettes per day.

With alcohol consumption, the previous literature i.e. Taylor et al. (2009) and the other study Gregory et al which compared risk of hypertension in men and women both pointed out a linear association of alcohol consumption with hypertension. In the study Lip and Beevers (2003), which is a cross sectional study like mine, the results found were that men who drank 300-499 ml of alcohol per week had mean systolic and diastolic blood
pressure of 2.7/1.6 higher than non drinkers while women who drank >300 ml of alcohol per week had mean systolic and diastolic blood pressures of 3.9/3.1 higher than non drinkers. This too suggested a linear relationship of the association. Thus, the findings in my study (lower rates of alcohol consumption among the hypertensive) are not very consistent with these cross-sectional and retrospective studies which points to better adherence to alcohol control interventions among those with a diagnosis of hypertension. One discussion found in this study is regarding the gender. It says generally there is a weaker association between alcohol and hypertension among women compared to men. This could be because of the fact that there are fewer heavy women drinkers than men. However, higher rates of obesity in women, oral contraceptive use, and hormone replacement therapy can confound this relationship. This can be true for my study in which the rates of alcohol consumption among people with hypertension are lower in women than in men. The findings that lower prevalence of physical activity found in males with hypertension is in accordance with the study Halm and Amoako (2008) which explains the reason for lower rates of physical activity among the people with hypertension in the US population. It found that only one-third of patients, upon the diagnosis of hypertension, receive physical activity counseling from their healthcare provider. It found that most physicians do not follow the US preventative medicine task force recommendations for advising physical activity those diagnosed with high blood pressure. Among those who receive this counseling, the study points out that there is almost 71% adherence to moderate physical activity suggesting that its more a problem of lack of medical counseling rather than patient compliance. This finding is applicable to my study population as well most of whom might not have received a physical activity counseling form their physicians.

Demographic covariates such as age and sex have a statistically significant association with Hypertension as expected on the review of previous literature

**LIMITATIONS OF THE STUDY**

One of the chief limitations of this study is the nature of its design. Because it is a cross-sectional study, it is not possible to know the exact time of diagnosis of hypertension in the participants. Thus the hypertensive population is mixture of patients with different duration of the disease. Also along with the lack of accurate information about the stage of
hypertension there is very little data to know whether the hypertension in question is controlled or uncontrolled as the outcome variable is “physician-diagnosed hypertension.” The study doesn’t afford any information on the risk for developing hypertension but just gives the prevalence data and prevalence ratios.

Another important consideration is that the participants’ exposure status at the time of the study has little to do with their exposure at the time of diagnosis. For example persons with recently diagnosed hypertension may have been former smokers but replied ‘no’ to the current smoker question because they quit long ago. The former smoking status can still have effects on development of hypertension. Persons with a diagnosis of hypertension are very likely to be advised by their physicians to quit smoking and reduce their alcohol consumption at the time of the diagnosis. A greater compliance with the lifestyle or behavioral changes among people with hypertension can lead to a lower prevalence of these risky behaviors in that group.

One factor that can influence the study considerably is the health Insurance status of the participant. The outcome variable studied is “physician diagnosed hypertension,” which means that in order to have a diagnosis of hypertension by a physician the participant must have some form of health insurance to get the diagnostic access as it is a “silent killer”. Thus, those without a health insurance i.e. those people who did not get a confirmed diagnosis of hypertension (either yes or no to the question “Have you been ever told by a physician that you have high blood pressure?”) get excluded out of the analysis, which can result in a large number of people who have high blood pressure but without physician diagnosing it. A potential bias to be discussed here is the “Random Telephone sampling Bias “which arises when a telephonic sampling method is used and persons living in a household without telephones would be excluded from the study population although they are included under the target population. The surveys used for this study were answered by the individuals over the telephone and thus produced data for the study which was self reported data. As the questions pertaining to health behaviors were asked to the participants, there is a good chance of underreporting. Many participants do not answer questions regarding their smoking status and alcohol in the affirmative this can result in self reporting bias. Also other covariates such as , educational level and health insurance status could not be included in the survey as these variables had a lot of missing data under them.
Strengths of the Study

Despite the limitations, the study has a few strengths; the biggest one being the large sample size of the population. The large sample size ensures that the power of the test is sufficiently high as it produces smaller standard errors statistically. The other strength is the National sample analyzed in the study which affords generalizability of the results found as the sample population is representative of the population in the country. It also gives the opportunity to observe the variances of hypertension across various demographic as well as behavioral risk factor strata at a national level. It also provides information on the level of adherence to the lifestyle changes to control blood pressure as recommended by the respective physicians among the diagnosed hypertensive. The greater adherence is evident by the fact that the participants with hypertension show less risky health behavior. This is indicative of the patient discipline to lifestyle changes advised by the doctors. This also serves as a great evaluation tool from a public health perspective because when the trends in risky health behaviors show a decline in those with the diagnosis of hypertension it proves the effectiveness of the various public health interventions in place in the country to control hypertension among those who are diagnosed to prevent further complications of hypertension such as stroke and myocardial infarction. Strength of the study is that the data are available to the public, thus making studies such as these quick and convenient to carry out besides being inexpensive.

Future Directions

As evidenced by the study, persons with diagnosed hypertension show improved lifestyles and adoption of healthy behaviors much more than their non–hypertensive counterparts. Emphasis should be now on primary prevention of hypertension in a population as a whole i.e. promotion of healthy behaviors in those without the diagnosis. Health promotion programs targeting especially the youth who have not still developed chronic hypertension is the need of the hour. Prevention can be achieved through various interventions such as smoking cessations programs, Regular physical activity classes, alcohol reduction programs etc. The repetition of similar studies to evaluate the trends in risk behavior in the hypertensive as well as in non hypertensive to evaluate the effectiveness of health behavior interventions is one way to reduce the prevalence and measure it. Gender
differences among the men and women suggest the need for gender based interventions targeting the high risk gender as well more studies examining this gender and hypertension relationship. Studies examining patient physician communication, anti-hypertensive medication compliance and social support in case of hypertensive patients will help throwing light on the issue too.

**CONCLUSION**

Hypertension is one of the modifiable risk factors for cardiovascular diseases. The study examined the health behavior in those diagnosed with Hypertension in the U.S adult population. This was necessary as the practice of these health behaviors can lead to complications of Hypertension such as myocardial infarction, stroke, kidney disease etc. The study examined the prevalence of cigarette smoking, alcohol intake and moderate physical activity in men and women above 18 years of age. It was hypothesized that among those with physician diagnosed hypertension, the prevalence of cigarette smoking, alcohol consumption and physical inactivity would be higher than among those without the diagnosis. It was found that while the rates cigarette smoking and alcohol intake were lower in those with the diagnosis of Hypertension than those without it, the rates of physical activity were very low in those diagnosed with Hypertension. The study served as an evaluation tool for the effectiveness of various public health interventions that are implemented in the country to promote healthy behavior among the citizens. It suggests a good level of adherence to the physician advice by the patients. Efforts to promote moderate physical activity should be emphasized in the population irrespective of the diagnostic status. Assessment of the physicians’ lifestyle counseling techniques, measurement of the actual number of who receive the counseling and other such gaps in services should be priority. Physician diagnosed hypertension is a “silent killer” as it is asymptomatic and is hence a function of ones health insurance status. Without health insurance, it will go undiagnosed and produce a bias in the measurement of it in the population, an issue which needs to be addressed in future studies.
REFERENCES


<table>
<thead>
<tr>
<th>Variables</th>
<th>Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension –</td>
<td></td>
</tr>
<tr>
<td>(Have you ever been told by a healthcare professional that you have hypertension?)</td>
<td>1: No</td>
</tr>
<tr>
<td></td>
<td>2: Yes</td>
</tr>
<tr>
<td>Smoking status –</td>
<td></td>
</tr>
<tr>
<td>(Do you smoke any number of cigarettes currently?)</td>
<td>0: No</td>
</tr>
<tr>
<td></td>
<td>1: Yes</td>
</tr>
<tr>
<td>Alcohol consumption-</td>
<td></td>
</tr>
<tr>
<td>(Have you had any drink in the past 30 days?)</td>
<td>0: No</td>
</tr>
<tr>
<td></td>
<td>1: Yes</td>
</tr>
<tr>
<td>Physical activity</td>
<td></td>
</tr>
<tr>
<td>(Have you done moderate physical activity in the past week?)</td>
<td>0: No</td>
</tr>
<tr>
<td></td>
<td>1: Yes</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
</tr>
<tr>
<td>1: 18-24 years</td>
<td></td>
</tr>
<tr>
<td>2: 25-34 years</td>
<td></td>
</tr>
<tr>
<td>3: 35-44 years</td>
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</tr>
<tr>
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<td></td>
</tr>
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<td>5: 55-64 years</td>
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</tr>
<tr>
<td>6: 65 and older</td>
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</table>