THE USE OF BLOOD-PRESSURE LOWERING MEDICATIONS AMONG CALIFORNIA ADULTS

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by
David John Reynen

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David John Reynen

Approved by:

_____________________________. Sponsor
Cheryl Osborne, Ed.D., M.S.N.

_____________________________. Committee Member
Patty Woodward, M.H.S., Ed.D.

_____________________________
Date
Student:  David John Reynen

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Chevelle Newsome, Ph.D.  __________________

Date

Office of Graduate Studies
Abstract

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by

David John Reynen

High blood pressure, also known as hypertension, is a leading risk factor for cardiovascular disease. Gaining and maintaining control of hypertension is critical in preventing or prolonging the onset of cardiovascular disease. Indeed, many control measures have been described, including medications, for those with hypertension. Such medications are indicated for Stage I hypertension (140/90 mmHg or higher). Cultivating a better understanding of such control measures may lead to the development of public health interventions designed to reduce the disease burden. The present study describes hypertension prevalence, hypertension medications use, and factors associated with taking medications, among adult respondents to the California Behavioral Risk Factor Survey.

The study results indicate that nearly one in four California adults is hypertensive, with differences observed by gender and race/ethnicity. Among individuals with hypertension, nearly two in three respondents report using hypertension medications, with females reporting use more than males and those of “other” race/ethnicity reporting
use more than the other groups. Factors associated with such use include the following:
multiple hypertension diagnoses, a physician visit within the past year; diabetes; non-
smoker status; less-than-high-school education; and health insurance. Understanding
these factors may inform the development of strategies to increase medication use among
those with hypertension.

Sponsor
Cheryl Osborne, Ed.D., M.S.N.

Date
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I would also like to thank my wife, Jill Whitney, and our sons Alexander and Tyler Reynen, for their unwavering support and uncanny ability to make me smile. Only with their love and care am I able to accomplish my goals.
DISCLAIMER

The opinions expressed herein are solely those of the author and do not reflect the official policy or position of California State University Sacramento, the Department of Gerontology, or the Department of Kinesiology and Health Science.
ETHICAL CONSIDERATIONS

Four statements related to ethical considerations merit mention here: First, because no individually identifiable data are used in this study and because the study population is not considered a special population, no unique protections are required to be in place. Second, since this study does not involve any interaction or intervention with the study subjects, there are no specific considerations related to human subjects. Third, the author has no conflict of interest of any kind to declare. Fourth, the author does not endorse any corporate entity or product named in this study.
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CHAPTER 1: INTRODUCTION

I. Introduction

Blood pressure is the force of blood against the arterial walls. If this pressure becomes and remains elevated over time, it is called high blood pressure, also known as hypertension (Fraser, 1986). According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (US DHHS, 2004), blood pressure falls into one of four different categories: Normal (less than 120 millimeters of mercury [mm Hg] systolic and less than 80 mm Hg diastolic); Prehypertension (120-139 mm Hg systolic or 80-89 mm Hg diastolic); Stage I Hypertension (140-159 mm Hg systolic or 90-99 mm Hg diastolic); and Stage II Hypertension (160+ mm Hg systolic or 100+ mm Hg diastolic).

Hypertension is a key risk factor in the development of cardiovascular diseases, including heart disease and stroke, two of the leading causes of death in California (CDC, 2011; Lee & McConville, 2007) and the United States (Kochanek, Xu, Murphy, Minino, & Kung, 2011). Because high blood pressure usually has no warning signs or symptoms, those afflicted with it may not even realize they have it (CDC, 2011). Even so, for those who do suffer from hypertension (once diagnosed), blood pressure control is essential in preventing or delaying the onset of cardiovascular disease. To be sure, a number of control measures, both non-pharmacological (including weight loss, sodium reduction, alcohol reduction, physical activity, healthy eating, and tobacco cessation) and pharmacological, have been described for those with hypertension (Luckson, 2010; Kaplan, 1992; Sander, 2002). Cultivating a better understanding of such control
measures may lead to the development of public health interventions and clinical treatment programs designed to reduce the disease burden – that is, the “felt” impact of the disease.

II. The Critical Issue of This Study

Blood pressure control is particularly important, given the facts that hypertension is an age-related disease (Lloyd-Jones, Evans & Levy, 2005; Ferrini & Ferrini, 2008) and the population as a whole is “aging” at what might be described as a rather alarming rate (Moody, 2002; Greenlund, Keenan, Clayton, Pandey, & Hong, 2012). Moreover, working towards a state of appropriate blood pressure control at the population level – in order to reduce the ever-growing disease burden – is greatly informed with critical epidemiological data about the population suffering from hypertension, including its use of blood pressure lowering medications. Providing those data is the reason for conducting this study.

III. The Purpose of This Study

The purpose of this study is threefold. First, information is provided regarding the burden of hypertension among California adults. Second, the proportion of hypertensive California adults who take blood pressure control medication is made known. Third, the factors associated with the use of such medications, within this study population, are described. This is the crux of this analysis. Ultimately, multivariate logistic regression is used to describe those factors associated with the use of blood pressure lowering medications by the study participants. Having this kind of information will assist clinicians in their efforts to develop appropriate treatment plans for those
suffering with high blood pressure.

The next section of this chapter provides a discussion of the importance of the present study – that is, its theoretical rationale. It speaks to the often-asked “So what?” question. Additional information relating to the context in which the research question is being asked is provided. In particular, mention is made of the importance of this study, given the changing demographics of the United States (Moody, 2002; Greenlund et al., 2012).

The fifth section of this introductory chapter presents the specific research questions, while some narrative on the assumptions, limitations, and human subjects considerations follows in the next three sections. The ninth section presents some evidence from the news media (i.e., from the popular literature) that hypertension is a topic of concern to the general public – particularly those who have more than a few decades of life experiences. Of note, regarding this ninth section of this introductory chapter, is that hypertension is discussed in the popular literature from a variety of perspectives and in a number of settings. Certainly, this is a problem that is not found only in certain people who reside in certain areas; rather, hypertension is a very prevalent problem that affects individuals from many different groups and places.

The tenth section of this introductory chapter provides a chapter by chapter description of how the remainder of the thesis proceeds. Four chapters are discussed in succession before this first chapter is concluded.

IV. The Theoretical Rationale of This Study

The importance of this study lies in its hypothesis-testing ability. That is, if the
null hypothesis (H₀: particular hypertensive populations of interest [i.e., those populations described by distinct and independent socio-demographic characteristics of interest] are no different [from each other], with respect to taking blood pressure lowering medications for their diagnosed hypertension) is rejected, then it is critically important to describe the observed group differences. That is, it is important to further investigate the independent factors of interest which differ between the groups studied. Certainly, if this study can elucidate those factors associated with the use of anti-hypertensive medication (among those with diagnosed hypertension), then these results can inform preventive efforts and clinical treatment protocols.

Finally, as alluded to above, given the facts that (1) hypertension is an age-related condition (Lloyd-Jones et al., 2005; Ferrini & Ferrini, 2008) and (2) the United States population is comprised of more and more people living to older and older ages (Moody, 2002; Greenlund et al., 2012), any new information that can inform the fragile health care system (which cares for these aging individuals) has great value. Moreover, understanding this information within a gerontological context will be of great significance, as elders tend to have regular interactions with the health care system.

V. The Research Questions

Three research questions have been identified and are addressed within the present study. They are as follows: First, within the present study, how prevalent is high blood pressure? Second, to what extent are those with hypertension taking medications prescribed to control their conditions? And, third, what sociodemographic factors are associated with the use of such drugs by those with hypertension?
VI. Assumptions of the Study

In conducting this study and presenting and interpreting its results, it is important to be mindful of its assumptions of the study. This seventh section of this first chapter addresses them. One assumption of the study is that respondents answered the survey questions truthfully, across the entire survey. If the reports are not valid or if they were collected with some measure of differential bias, then there could be a problem for the present study, in terms of its validity and value. A second assumption is that the popular and academic literature which undergirds this study is, indeed, pertinent. If the supporting resources are irrelevant or outdated, then the strength of present study is attenuated, and its value is called into question. Thirdly, there is the assumption that the constructed statistical model is actually describing the phenomena under investigation. While there is a confidence level set a priori, there is some likelihood, albeit small, that the model missed the mark. If that were the case, the results would have little value.

VII. Study Limitations

In terms of the limitations of the present study, two merit mention. First, because the data used in this study are considered secondary data (i.e., they were not collected specifically for the conduct of this study), it is a limitation that some independent variables, which would likely have fit into an explanatory model, are absent. Second, because the data were collected via a telephone survey, those individuals without telephones were excluded. Because these individuals have been excluded, there may be some information asymmetry related to building the model. Consequently, the findings may be somewhat limited; perhaps those who were excluded had something to offer.
VIII. Human Subjects Considerations

Before conducting this study, this student investigated the human subjects considerations. Specifically, this student went through the following process: (1) He confirmed that this study is a systematic investigation designed to contribute to the generalizable knowledge. (2) He determined that this study includes obtaining information about living individuals. (3) He stipulated that the research does not involve interactions or interventions with the individuals. And (4) he acknowledged that the information is not individually identifiable; therefore, (5) he concluded that the present study is exempt from review by an Institutional Review Board (US DHHS, n.d.).

IX. Hypertension in the Popular Literature

Having discussed the merits and considerations of the present study, the discussion now turns to the context of the study. Likely due, in part, to the changing demographics of the nation’s population (Moody, 2002; Greenlund et al., 2012), the subjects of healthy aging, in general, and high blood pressure, in particular, are virtually staples in today’s popular news media. This is the case across the nation, as something as ubiquitous as hypertension cannot be discussed as if it were simply of local interest. Furthermore, the fact that hypertension is so prevalent means that no one is unaffected by it – as one either has it or knows someone who does. In this third section of the introductory chapter, a number of articles from the popular literature are presented and discussed.

First, in the New York Times, columnist Lisa Sanders, who is also a physician and professor of medicine at Yale University, describes in her 2010 article, “A Heart Loses
Its Way,” the case of a 59-year-old hypertensive woman who, with co-morbid diabetes, suffered a debilitating heart attack – despite being aggressively treated over the years with various types and dosages of anti-hypertensive medications. “Getting high blood pressure under control is a process,” Sanders writes. “…it can take weeks, even months” (Sanders, 2010, para. 11). Certainly, this often-crude trial-and-error process does not always prove successful achieving blood pressure control. Further, this heuristic process itself can be hindered by a lack of patient compliance. Sanders, in fact, writes in her article that “…nearly half of all patients with high blood pressure don’t take their medications as described by their doctors” (Sanders, 2010, para. 14). Clearly, this New York Times article is illustrative not only of the challenge of achieving blood pressure control but also of the tragic events that can occur as a result of hypertension.

Second, in a 2008 article entitled, “Living with Hypertension: Is Your Blood Pressure Too High? Get It Down or Face Health Risks,” written by Newhouse News Service reporter Don Colburn and published in the Houston Chronicle, the tragic events that can be brought on by hypertension are more fully described. To be sure, Colburn details how prolonged high blood pressure can thicken and inflame artery linings – a process which, in turn, can lead to even more serious cardiovascular harms: stroke, heart attack, or kidney damage. And, as Colburn writes, “…the higher the pressure, the higher the risk” (Colburn, 2008, para. 12). Drawing on personal communication with Dr. Douglas Dawley, a cardiologist in Portland, Oregon, the reporter informs readers that treatment for those suffering from these chronic conditions may very well include a lifelong daily regimen of various medications.
Furthermore, in the May 6, 2010 edition of *The Birmingham News*, in an article written by Hannah Wolfson and entitled, “UAB study finds drug helps weight, blood pressure,” the results of a public health study conducted by Dr. Suzanne Oparil with the University of Alabama at Birmingham (UAB) are highlighted (Wolfson, 2010). Wolfson writes about the effects of Qnexa, an experimental drug that mixes an appetite suppressant and an epilepsy medication. In controlled trials, Wolfson reports, Qnexa was shown to lower patients’ blood pressure – while it controlled hunger and helped with weight loss. In fact, UAB researchers found that those taking the drug lost more weight than did those taking the placebo; moreover, the results indicated that the higher the dose was, the more weight was lost and the longer it stayed off. They also found that study subjects with high blood pressure were able to reduce the other blood pressure medications they were taking during the study period. Indeed, through changes in diet and with some pharmaceutical intervention, it would seem that hypertension should not be such a burdensome disease; sadly, however, it is.

Bruce Japsen, a writer with the *Chicago Tribune*, moves this discussion on hypertension- and other chronic-disease-related tragedies from the individual experience into the institutional realm. In his article, “Chronic Illnesses Exacting Stiff Price,” Japsen provides details of a report released by the American Hospital Association stating that: “…the price tag for just three common chronic conditions – asthma, diabetes, and hypertension – is $30 billion a year…” which “…translates into 164 million lost workdays annually” (Japsen, 2007, para. 2). The writer further explains that these costs
are particularly alarming since these chronic conditions are manageable, in whole or in large part, with prudent evidence-based wellness programs.

In another newspaper article, this one entitled, “Drinking Fewer Sugary Beverages Could be Linked to Lower Blood Pressure,” written by Jeannine Stein and published in the *Los Angeles Times* on May 24, 2010, it becomes clear that disease management, as described above, could be augmented, to some degree, with a few small changes in individual health behaviors (Stein, 2010, para. 3). According to a public health study coming out of Louisiana State University, as described by Stein, drinking one less 12 ounce serving of sugar-sweetened beverages per day was associated with notable drops in both the systolic and diastolic blood pressure numbers over 18 months’ time. What is more is that these improvements held even after controlling for the weight losses experienced by the study participants. Perhaps some active individual level changes, together with some passive corporate level interventions, could predict success in achieving blood pressure control.

Another article from the *Chicago Tribune* supports this contention. Karen Ravn, in her 2010 article, “Small Changes, Big Impact for Blood Pressure” (Ravn, 2010), describes some relatively simple individual-level changes that one might pursue, in order to reduce and control one’s blood pressure. One should strive to do at least some (of not all) of the following healthy behaviors: (1) eat a diet that is rich in fruits, vegetables; and whole grains, and is low in saturated fat, total fat, and cholesterol; (2) reduce one’s daily intake of salt – to about one teaspoon (or less) per day; (3) increase one’s consumption of dietary fiber, fish oils, and potassium; (4) lose excess body weight; (5) develop and
implement a plan for regular, safe exercise; (5) reduce one’s stress; and (6) avoid alcohol, smoking, and caffeine. Again, a combination of individual level changes and broader population-based public health interventions should be effective in bringing one’s elevated blood pressure numbers down to the medically-recommended levels.

Further, similar information is provided by Connie Midey, a reporter with the Arizona Republic. In her July 3, 2007 article, “Less Sodium, More Potassium will Reduce Blood Pressure,” Midey discusses the medical recommendation to avoid processed and fast foods and suggests trying substitutes for salt, including garlic powder, basil, oregano, powdered lemon, ground pepper, parsley, dill, rice vinegar, chili, ginger, and red pepper. As well, she advises that those at risk for hypertension increase their consumption of dietary potassium by eating more potassium-rich foods, such as bananas, oranges, tomatoes, and spinach (Midey, 2007). Such dietary changes will lessen water retention and decrease blood volume, thereby facilitating the blood flow through the arteries. Consequently, one’s blood pressure will be lower and one’s vessels will be healthier. Ultimately, then, one’s cardiovascular disease risk profile is greatly improved.

The concept of risk reduction is further highlighted in a 2009 article, entitled, “Health care reform needs to start with what we eat and how we live,” written by Delisa Renideo and published September 24, 2009 in the Anchorage Daily News. In her article, Renideo describes the American tragedy that with or without medical care, “we, Americans,” [sic] are suffering from chronic, debilitating, and painful diseases – including high blood pressure – at alarming rates (Renideo, 2009, para. 2-3). She reports that in “our” [sic] society, “we” [sic] are planting the seeds of such debilitating diseases
in “our” [sic] kids – at home, at school, and elsewhere. This is happening, she contends, via “our” [sic] daily cultural practices, by feeding them (the children) high fat, salty, sugary, processed foods and animal products high in calories and low in nutrients. Renideo continues with the contention that until the root causes of these conditions are addressed, all the drugs and surgery in the world will not improve “our” [sic] collective health status – or improve “our” [sic] outlook. Dietary and other lifestyle changes are the first steps to health care reform.

Interestingly, some helpful changes – those that can positively impact a community’s collective health status – are being made not at the individual level but at the corporate level. In a March 17, 2011 article, entitled, “Half the Salt Would Suffice, a Study Says,” and also published in The New York Times, reporter Anemona Hartocollis claims that, according to a population-based study conducted by New York City’s health department, consumers are getting twice as much dietary salt as they should, mostly from prepackaged sources (Hartocollis, 2011). In her article, she quotes Dr. Thomas A. Farley, the city health commissioner, who contends that, based upon this study’s findings, hypertension is a predictable result of the sodium levels in the food supply. There is good news, however, reports Hartocollis, as she describes the National Salt Reduction Initiative, a voluntary program wherein food manufacturing companies have pledged to reduce the amount of sodium used in the manufacture of processed foods. The list of participants in the Initiative includes some well-known national companies, including Butterball, Campbell’s Soup, Heinz, Hostess Brands, Kraft Foods, Starbucks Coffee Company, Subway, and Target Corporation. Cutting salt, claims the Initiative and those
companies which support it, improves health. Certainly, improvements at the corporate level can help reduce the disease burden.

Finally, from the popular literature comes an article, entitled, “The Value of Preventive Health Initiatives Proves Hard to Tally,” written by Dianne Stafford, and published in the May 30, 2011 edition of *The Kansas City Star*. In her article, Stafford describes several corporate health and wellness strategies that focus on improving the workforce’s collective health status (Stafford, 2011). These strategies, which were borne out of cost-containment concerns, include on-site clinics, pharmacies, and fitness centers; health screenings and coaching sessions; healthy cafeteria options; and walking and weight loss challenges – all designed and in place to lower body mass index, blood sugar, blood cholesterol, and blood pressure. Stafford describes how multiple Kansas City area companies offering these strategies have reported less employee absenteeism and fewer employee health care claims. To be sure, in their efforts, these prevention-focused companies have both improved their financial situations (through not having to pay expensive health care claims that would have otherwise been submitted) and benefited their employees collective health status (by reducing chronic-disease-related risk factors and improving other health indicators). Again, it is clear that corporate policymaking activities can help reduce the disease burden.

While it is clear that much is known from these public health initiatives focused on reducing the disease burden at the population level, the fact remains that many people still suffer from hypertension. Cultivating an understanding of these people and their characteristics is important in order to optimize their treatment. Hence, with both
preventive and therapeutic interventions, the disease burden should be reduced.

X. Chapter by Chapter Description of the Thesis

Using California Behavioral Risk Factor Survey data, this thesis explores, within the California adult population, the prevalence of high blood pressure; the use of high blood pressure lowering medications by those diagnosed with high blood pressure; and the factors associated with such use. In other words, as described earlier in this first chapter, this investigation attempts to answer the following questions: How prevalent is high blood pressure? To what extent are those with hypertension taking medications prescribed to control their conditions? And what sociodemographic factors are associated with the use of such drugs? To answer this last question, multivariate logistic regression is used.

Chapter 2 provides a review of the pertinent academic literature. It is comprised of several sections, each of which provides support for the logic which underlies this study. First, several scientific studies, including some very prominent historical studies, are discussed to describe the study and scope of the problem of hypertension. The problem of high blood pressure is discussed in terms of its own burden, per se, as well as its role in disease causation.

Additional literature in Chapter 2 presents a discussion of the hypertensive population. Several academic studies are presented to document hypertension among certain at-risk populations. Additional information is presented concerning the health-related challenges and added burdens these people face because of their hypertension. Understanding the burden across these populations can inform prudent public health and
clinical interventions for blood pressure control.

The next section of Chapter 2 completes the dialogue concerning the logic of this study. In fact, the scientific literature presented in this section of the chapter looks at what is known about controlling hypertension, including the use of medications. The discussion highlights some of the scholarly works which report on the clinical standards for blood pressure control, including some of the early intervention studies.

The final section of Chapter 2 is a discussion of compliance. Scientific studies are presented and discussed in order to provide a sort of qualifying context for the results of this study. In other words, while it is true that clinical health providers know how to treat hypertensive patients, and while it is true that these patients know to follow the prescribed treatment protocols, it (i.e., patient compliance) does not always happen. This final section of the literature review discusses some constructs related to compliance.

Following a review of the relevant literature, Chapter 3 presents the methodology of this study, starting with some brief narrative about the context surrounding the research question and the data analysis. Data from the California Behavioral Risk Factor Survey are used in this study, and these data are described in detail in the early part of Chapter 3. In terms of the analyses, first, descriptive statistics are generated. Using stratified analyses, independent variables of interest are analyzed, one by one, in relation to the use of blood pressure lowering medications (i.e., the dependent variable under investigation), so as to identify candidate variables for use in the multivariate model building. These methods are described in some detail.

Finally, via multivariate logistic regression, a robust regression model is built in
order to quantify the degrees to which various independent variables, studied in the stratified analyses and now available for inclusion in the building of the model, influence the odds that a given hypertensive individual uses or does not use blood pressure lowering medications (i.e., the dichotomous dependent variable). The narrative for this part of Chapter 3 describes this statistical technique.

The statistical multivariate regression model is used to identify those factors which, if present, suggest, statistically, that a given individual is likely to take medication to control her or his hypertension. Thus, out of the multivariate logistic regression (if the null hypothesis is rejected), the bottom line is this: statistically speaking, keeping all other factors constant, the odds of using blood pressure lowering medications are greater than the odds of not using blood pressure lowering medications, given that an individual possess a given independent factor of interest (e.g., a clinical diagnosis of diabetes).

Chapter 4 presents the results of the analyses. First, descriptive statistics are provided. Via these statistics, the sociodemographic characteristics of those taking and those not taking medications for hypertension can be known. This summary indicates the extent to which the observed sub-populations are similar. To be sure, this study presupposes that the sub-populations under investigation are not similar. Second, the results of the bivariate analyses are presented; that is, in this section, each independent variables of interest (i.e., “of interest” in terms of having some association with the dependent variable under investigation) is cross-tabulated with the dependent variable, uses or does not use blood pressure lowering medication. Finally, the results of the multivariate logistic regression are given. Values, representing to what degree various
independent variables available for inclusion in the regression model individually influence the odds that a given individual uses or does not use medication to control hypertension, are provided, both in the form of beta coefficients and as Odds Ratios, which are discussed in detail in Chapter 3.

The implications of the results shown in Chapter 4 are discussed in Chapter 5. The discussion begins with the immediate concerns: what, in particular, does the final statistical model suggest are associated independent factors (related to medication use); what is important to know about these factors; and how might this information assist efforts to reduce the disease burden. For example, the finding of a co-morbid condition as an associated independent “risk factor” may inform the notion of broadening the range of clinical subspecialists whose expertise should be utilized in effecting positive changes with respect to the burden of hypertension. Following the narrative related to the immediate concerns, the study findings are further discussed in connection to the aging population. Of particular interest is addressing what concerns may develop into problems if the prevailing trends, related to hypertension, treatment, and compliance, continue without intervention. The construct of compliance is discussed next, with ties made to selected psychosocial aging theories of interest. For instance, in discussing compliance, Role Theory (Cottrell, 1942) merits mention. Within this context, Role Theory would suggest that one who has received a diagnosis of hypertension and been prescribed a course of treatment might take on the role of a dependent, or, possibly, a victim, of sorts. Understanding this perspective would be important in discussing and promoting compliance. Chapter 5 concludes with a brief narrative on lessons learned as a result of
conducting this study and interpreting its results. These learned lessons are discussed while staying mindful of the earlier-mentioned fact that the United States population is aging at a rather remarkable rate (Moody, 2002; Greenlund et al., 2012).

**XI. Summary**

This first chapter introduced and described the study that follows. This analysis, which investigates what independent factors are associated with the use of blood pressure lowering medications by hypertensive California adults, has been shown to be an important, timely one, as the changing demographics of the population, together with the increasing chronic-disease-related burdens, have become topics of discussion, not only among clinical health providers, but also among policymakers (in terms of cost containment) and the general public (in terms of impact). Several articles from the popular news media were presented in this first chapter to demonstrate the importance and timeliness of the investigation.

This chapter also introduced the three-part methodology employed to investigate the research question: descriptive statistics, bivariate analyses, and multivariate logistic regression modeling. It is a linear process that ultimately results in a list of independent factors associated with medication use, along with each factor’s measure of strength of association. These are the results.

Finally, this chapter provided a glimpse into some of the implications that may surface, based on the results of this investigation. These implications, when put into focus by the perspectives of a gerontological theorist, can help inform ways to reduce the disease burden by improving hypertension prevention and treatment efforts.
CHAPTER 2: A REVIEW OF THE LITERATURE

I. Introduction

This chapter reviews the academic literature related to hypertension, in terms of the scope of the problem, the population suffering from it, the measures to control it, and the problem of patient noncompliance. Academic studies are discussed and conclusions are drawn as to how the results from these reviewed studies support the current study. The next section of this chapter highlights some historical studies and introduces some review studies which summarize the magnitude of high blood pressure. This discussion is followed by some commentary regarding particular at-risk populations. This is the focus of the third section of this chapter.

Additional literature is presented to elaborate on the plight of those who suffer from hypertension, in terms of their risk for future adverse events. These academic articles underscore the concerns that were introduced in the review of the popular literature. Indeed, the academic literature shows that for the hypertensive, there is much about which to be concerned – and these concerns should be the driving forces for various blood pressure control efforts, which is the focus of the fourth section of this second chapter.

Section five is a discussion of the issue of patient noncompliance and how that impacts prudent high blood pressure control measures. A number of studies are presented that describe the problem of noncompliance and what might be done about it. Indeed, the greater the patient compliance (whether achieved through patient- or clinician-level intervention), the better the control of the patient’s blood pressure, and the
better the long-term patient-level outcomes.

The final section is a summary of the major findings presented in the literature review. A brief statement is made as to how this study contributes to the current body of knowledge concerning hypertension and the use of blood pressure lowering medications.

II. The Scope of the Problem

Before delving into the current scope of the problem, it is important to take a look back at some early studies that investigated hypertension, identifying it as an important disease, given the fact that it is a disease unto itself, as well as a major risk factor for other debilitating, sometimes fatal diseases (Fraser, 1986) – a point which is addressed in more detail in the next section. In a number of countries around the world, during the mid-twentieth century, some noteworthy, large-scale, epidemiological studies were begun, some of which have continued to the present. These early studies elucidated many of the chronic-disease-related risk factors that are still under discussion half a century later. Indeed, these factors have become even more prominent on the public health landscape in recent times, due to the demographic changes in the population (Moody, 2002; Greenlund et al., 2012). What follows, then, is a summary of some of the more prominent epidemiological studies; to provide a comprehensive discussion of all of the scholarly work is beyond the scope of this paper.

The first study of note is The Minnesota Business and Professional Men Study, undertaken by a team of researchers headed by Dr. Ancel Keys. In this early, rather rudimentary prospective cohort study, begun in 1947 in Minneapolis, Minnesota, the research team sought to identify characteristics found in healthy men that could be useful
in predicting heart attacks, by following the men for up to fifteen years (Keys et al., 1963). Though this study included participants who were from just one socioeconomic class (i.e., a relatively high class) and not randomly selected at that – meaning there could be some selection bias (Gordis, 2009) – the results were quite informative: Cholesterol, blood pressure, and body weight were all independently associated with an increased risk of a cardiac event.

The second early epidemiological study which merits mention is the Framingham Heart Study, begun in 1948 and led by Dr. Thomas Royle Dawber (1959). The setting for the study was Framingham, Massachusetts, a suburb of Boston, and the male and female residents of Framingham, between the ages of 29 and 62 years inclusive, served as the sampling universe. From this sampling universe, a two-thirds sample was chosen at random, and 68.6 percent of them (4,469) were eligible for participation. To this number, a group of 740 volunteers was added, thereby bringing the total original cohort up to 5,209 in number. This cohort was followed and evaluated biennially in terms of medical histories, blood profiles, echocardiograms, and other metrics. From the early study of this original cohort, several key findings related to blood pressure emerged (Kannel, Schwartz, & McNamara, 1969). For example, the then-conventional wisdom that high blood pressure in women and in the elderly is less serious than it is in men and in younger people was debunked. Further, systolic blood pressure was shown to be a better predictor of cardiovascular disease risk than diastolic blood pressure is. Finally, blood vessel diseases and blood cholesterol fractions (i.e., low-density lipoproteins and high-density lipoproteins) are associated in the multivariate model of disease causation. To be sure,
the results of The Framingham Study (i.e., results related not just to blood pressure but to all cardiovascular-disease-related risk factors known at that time) served as both a strong foundation and a catalyst for future studies – both related to, and unrelated to, the original Framingham cohort.

The third study of interest is the Seven Countries Study, a multi-site study begun in 1957 and (also) led by Dr. Ancel Keys, who directed the efforts from Minnesota (Keys, 1970). Data were gathered, via field surveys, from 12,770 men, aged 40 through 59 years and living in the United States (studying railroad workers); Italy (in Nicotera, Porto San Georgio, Montegiorgio, and Crevalcore); Greece (in Crete and Corfu); the Netherlands (in Zutphen); Finland (with contrasts between the Ugrian East Finns and the Scandinavian West Finns); Yugoslavia (in Dalmatia and Slavonia); and Japan (the home country from which eventual Hawaiians and Californians emigrated [as is discussed below]). The aim of this multi-site prospective study was to systematically examine how dietary practices, behavioral choices, and other risk factors related to heart disease and stroke outcomes. Regular (five-year) re-examinations and mortality follow-ups (as required) revealed that the burden of atherosclerotic diseases has cultural origins, particularly related to diet, even accounting for the unfavorable impacts of tobacco use and elevated blood pressure levels. With these multi-site findings, it became clear that heart disease and cerebrovascular disease (stroke) are largely lifestyle diseases, which, as such, can be, in part, preventable (Blackburn, 2002).

A fourth historical study that investigated blood pressure as a significant risk factor for developing cardiovascular disease is the Chicago Western Electric Study,
begun by Dr. Oglesby Paul in 1957 (Paul et al., 1963). In this study, 3,102 men, aged 40 to 55 years and employed for two or more years in either white- or blue-collar jobs at the Western Electric Company, were randomly sampled, and 2,107 of them were given initial examinations and followed prospectively, with annual re-examinations until 1969. Such evaluations were comprehensive, including extensive medical histories and exhaustive clinical measurements. Investigators initially collected incidence data on Coronary Heart Disease (CHD) and later reviewed death certificates for this Western Electric cohort. Results from Paul’s study indicated that among other factors, cigarette smoking, blood pressure, and serum cholesterol were all strongly positively associated with the development of CHD. These results, along with those of other cohort studies comprising the later-conducted Pooling Project (Fraser, 1986), were critical in establishing the strength, consistency, and nature of the associations between each of these three important risk factors and CHD, albeit among men only.

Fifth is the NiHonSan Study, a multi-site cohort study looking at the “movement” of a population across Japan (Hiroshima and Nagasaki), Hawaii (Honolulu), and California (San Francisco), as alluded to earlier. The total study population, which began in 1963, consisted of samples taken, respectively, from the Adult Health Study of the Atomic Bomb Casualty Commission, the Honolulu Heart Program, and a special census group of Japanese-Americans in San Francisco (Syme, Marmot, Kagan, Kato, & Rhoads, 1975). In the NiHonSan Study, the investigators sought to make comparisons among the 11,989 men in these three samples (2,141 from Japan; 8,006 from Hawaii; and 1,842 from California) with respect to cardiovascular-disease-related risk factors, including
hypertension, and CHD incidence and mortality. The results of this study of comparisons indicated that the risk profiles of the different groups of study subjects were such that Japanese men living in California had the highest incidence of CHD, followed by those in living Hawaii and those living in Japan, thereby suggesting that disease development is largely environmental in origin, not genetic (Marmot, Syme, Kagan, Kato, & Rhoads, 1975). Perhaps not surprisingly, the “offshoot” Honolulu Heart Program, directed by Dr. Abraham Kagan and initiated in 1964, further quantified the risks for CHD associated with various lifestyle-related factors, including blood pressure, serum cholesterol, serum glucose, cigarette smoking, alcohol consumption, and diabetes (Yano, Reed, & McGee, 1984).

The next well-known historical study on cardiovascular disease, the Alameda County Study, was also begun in 1964. While this study, directed by Dr. Lester Breslow, was designed to explore daily routines and social support factors in relation to poor health and excess mortality, data on the traditional risk factors, including hypertension, were obtained, as well, via questionnaire, from the 6,928 individuals (3,770 women and 3,158 men) who comprised the original study population. In the Alameda County Study, the investigators found that seven health practices were highly associated with poor health outcomes and excess mortality, as follows: excessive alcohol consumption, cigarette smoking, obesity, sleep habits of less or more than seven to eight hours nightly, physical inactivity, between-meal snacking, and a failure to eat breakfast (Belloc & Breslow, 1972). Interestingly, using the Alameda County Study data, the construct of poor health was reframed as hypertension in a later study by Dr. Susan Levenstein and her colleagues
In this study, via multivariate modeling, the researchers determined that, independent of demographic and behavioral risk factors, job insecurity, unemployment, and low self-reported job performance were significant predictors of hypertension in men and low-status work was a significant predictor in women. Indeed, in both the early studies and in the ones that have followed, hypertension remains a key focal point.

The final early study that merits mention is the North Karelia Project, begun in 1972 and directed by Dr. Pekka Puska. This intervention project in Eastern Finland, which postdates the above-described Seven Countries Study, was designed to reduce the population levels of cardiovascular-disease-related risk factors, including smoking, cholesterol, and blood pressure, through a sustained health promotion campaign, in order to demonstrate resultant reduced disease burdens (Puska et al., 1979). The project’s data collection process included both clinical evaluations and the administration of three separate comprehensive surveys, carried out, in 1972, 1977, and 1982, among more than nine thousand randomly selected original study participants, aged 30 through 59 years (1,973 women and 1,834 men in North Karelia and 2,769 women and 2,665 men from Kuopio for comparison). The results indicated that the community-level interventions in North Karelia, which included health education and training, as well as population-wide environmental changes, were successful in decreasing the risk factor levels (by comparison with the prevailing trends observed in the Kuopio subjects – that is, the reference population). Based upon these favorable results, it was becoming known that population-based health promotion programming can be successful in influencing the risk profiles (to include hypertension), over and above that which is occurring through natural
trends (Tuomilehto, Puska, Nissinen, Salonen, Transkanen, Pietinen, & Wolf, 1984).

With this summary detailing a number of the more prominent historical epidemiological studies (including some including both female and male study subjects) now complete, it is appropriate to move ahead to the more recent scholarship, in order to define the current scope of the problem of hypertension. To this end, several recent reports and studies are discussed. First, the American Heart Association/American Stroke Association (AHA/ASA), in conjunction with the National Institutes of Health, the Centers for Disease Control and Prevention, and several other governmental agencies, annually compiles the most recent statistics on cardiovascular diseases and their risk factors; the summary of this effort is published in Circulation (Roger et al., 2012).

Highlights from this statistical review, which includes stratified prevalence data; mortality statistics; morbidity measures; and other metrics, including costs, indicate the following: For prevalence: Overall, more than 30% of U.S. adults have diagnosed hypertension and an estimated additional 8% have undiagnosed hypertension. State-level prevalence data reveal a fairly broad range, from 21.6% in Minnesota to 37.6% in West Virginia. Among older Americans (i.e., 65 years of age and older), the prevalence estimates are higher, with 53% of men and 58% of women having diagnosed hypertension. Finally, in terms of race/ethnicity, the prevalence of hypertension among African Americans is particularly troublesome, with 41.4% overall and 44% among African American women. For mortality: The (age-adjusted) death rate, caused by high blood pressure, has been on the rise over the past decade, increasing by more than 20%, to 18.3 deaths (from high blood pressure) per 100,000 population. The mortality rate for
men was higher than that of women, and by gender and race/ethnicity, there was great variation, as rates ranged from 9.65 among American Indian/Alaska Native women to 50.3 among African American men. For morbidity: The AHA/ASA statistical update indicates that there are more than 55 million annual clinical visits related to hypertension, including about 50 million physician visits, 1 million emergency department visits, and over 4 million outpatient department visits. Moreover, the recent trend for inpatient discharges is on the rise as more and more hypertension-related hospitalizations are occurring. For costs: The estimated current annual cost of hypertension is $50.6 billion. This figure includes both direct costs related to treatment and indirect costs related to lost productivity. Of course, given the changing demographics (Moody, 2002; Greenlund et al., 2012), the cost will rise. In fact, in a recent report by DeVol et al. (2007), the cost of hypertension is expected to approach $80 million by the year 2020, assuming the prevailing trends continue unabated.

The next recent scholarly work that helps to describe the scope of the problem is by Drs. Hajjar and Kotchen (2003), who studied hypertension data from the National Health and Nutrition Examination Survey (NHANES). NHANES is a recurring survey of a stratified, multistage probability sample of the civilian non-institutionalized (i.e., not in prisons, nursing homes, or the military) United States population. Each NHANES administration is comprised of a structured interview and a standardized clinical assessment. Using these NHANES data, the authors describe trends in the prevalence of hypertension among individuals aged 18 years and older. In looking at the data from the multiple phases of NHANES, the authors found an increase of 3.7 percent in the
prevalence of hypertension from the 1988-1991 phase to the 1999-2000 phase. As of this latter phase, 28.7% of the NHANES participants were found to have hypertension. Next, the authors looked at various subpopulations and found that in this third phase, the highest racial/ethnic-specific prevalence estimate was found among those classified as non-Hispanic Black (33.4%), while the lowest was found among those classified as Mexican American (20.7%); women had a higher prevalence estimate (30.1%) than did men (27.1%); and those 60 years of age or older had a prevalence estimate of 60.1%, nearly ten times greater than that of those aged 18 through 39 years (6.1%). To obtain a more complete understanding of the contributions of these various demographic factors to the likelihood of being hypertensive, the authors performed a multivariate logistic regression analysis with high blood pressure as the dependent variable. The results indicated that age, gender, race/ethnicity, and body mass index were all independently associated with having high blood pressure. Finally, in looking at various measures of awareness and control, the authors found that 30% of all hypertensive individuals were unaware of their condition; 42% were not being treated; and at the time of the blood pressure measurement, 69% did not have their hypertension controlled.

Finally, in discussing the recent scholarship on the scope of the problem of hypertension, this student turns to a report entitled, “A Population-Based Policy and Systems Change Approach to Prevent and Control Hypertension” (Institute of Medicine, 2010). In this report, the committee authorship makes a departure from reporting prevalence and discuss the incidence and lifetime risk of developing hypertension. This committee, chaired by Drs. Howard Koh and David W. Fleming, report that the lifetime
risk for developing high blood pressure was estimated among 1,298 study subjects, aged 55 to 65 years of age and free of hypertension at baseline. Methodologically, for 55-year-old study subjects, the high blood pressure cumulative incidence – which is the probability that a given event has occurred before a certain time (Gordis, 2009) – was calculated through age 80 years (i.e., 25 years of follow-up), and for those who were 65 years of age, it was calculated through age 85 years (i.e., 20 years of follow-up). The follow up analyses indicated that the lifetime risk for developing hypertension, according to this report, was 90 percent for both 55- and 65-year-old study subjects (Institute of Medicine, 2010). Indeed, this lifetime risk assessment is rather disconcerting when one considers the potential future burden of hypertension among the growing number of people living into their eighth, ninth, and tenth decades (Moody, 2002; Greenlund et al., 2012). What this population could experience is presented briefly in the next section.

III. What is Known about the Hypertensive Population

Having discussed the historical study and the current scope of the problem of hypertension, some information about the hypertensive population is reported in this next section of Chapter 2. Several studies are introduced which describe the hypertensive population and its felt disease burden. First, a study by Hayes, Denny, Keenan, Croft, and Greenlund (2008) examined a number of unfavorable health-related quality of life constructs among adults with high blood pressure, using data from NHANES. Using multivariate regression, the investigators determined that those with diagnosed hypertension, relative to those without diagnosed hypertension, were more likely to report having a fair or poor health status (O.R. = 1.72), 14 or more unhealthy days in the
past month (O.R.=1.23), 14 or more physically unhealthy days (O.R.=1.39), and 14 or more activity-limited days (O.R.=1.55). Differences were observed among the hypertensive respondents when hypertension awareness was factored into the analyses, as increased awareness was associated with decreased quality. Indeed, having hypertension and being aware of it is associated with having a lower health-related quality of life. These results are consistent with those found in similar earlier studies (Bargar & Muldoon, 2006; Li et al., 2005; Lawrence, Fryback, Martin, Klein, & Klein 1996).

Second, in a case-control community study by Battersby et al. (1995), the aim was to determine whether the quality of life – defined here more generally than in the above-referenced studies – reported by hypertensive subjects differed from that of their normotensive counterparts. In this multi-site epidemiologic study, cases were selected at random from a hypertension registry and matched with controls for age, gender, race/ethnicity, and treatment site. The cases, aged 40 through 79 years, had Korotkoff phase V diastolic blood pressure greater than or equal to 100 mm Hg or systolic blood pressure greater than or equal to 180 mm Hg or were on anti-hypertensive medication; in contrast, the controls had Korotkoff phase V diastolic blood pressure less than or equal to 90 mm Hg and no record of elevated blood pressure or pharmaceutical treatment within the past twelve months. In comparing these two groups, the authors found that cases showed an impaired sense of well-being, relative to the controls: Cases had lower health status indices, higher rates of work-related absenteeism, greater degrees of symptomatic complaints, and impaired senses of psychological well-being. With regard to their findings, the authors surmised that these observed impairments among cases could have
resulted from the disease itself, from medications, or from labeling (i.e., being labeled as a hypertensive person). To be sure, this case-control community study indicated that hypertension negatively affects one’s quality of life beyond health-related constructs, a finding well supported by similar studies conducted in other populations (Fernandez-Lopez, Siegrist, Hernandez-Mejia, Broer, & Cueto-Espinar, 1994; Williams, 1988).

Third, beyond the day-to-day quality of life issues, those with hypertension face additional struggles, including the development of debilitating and fatal chronic diseases, even beyond heart disease and stroke, two major sequelae described above (CDC, 2011). For instance, in a follow-up study using data from the aforementioned Honolulu Heart Study, the association of mid-life blood pressure to late age Alzheimer’s disease and vascular dementia was investigated in 3,703 Japanese-American men (Launer et al., 2000). In this study, the investigators assessed the risk (i.e., the odds) for dementia associated with pre-defined categories of blood pressure, stratified by never- versus ever-medically-treated and adjusting for various factors including age, education, apolipoprotein E allele, alcohol intake, and smoking. The results indicated that among study subjects never treated, the Odds Ratios for dementia were 3.8 (for those with diastolic blood pressure of 90 through 94 mm Hg) and 4.3 (for those with diastolic blood pressure of 95 mm Hg and over), when compared to the referent group (i.e., those with diastolic blood pressure of 80 through 89 mm Hg). Further, compared to those with systolic blood pressure of 110 through 139 mm Hg, the Odds Ratio for dementia in those with systolic blood pressure of 160 mm Hg and higher was 4.8. Finally, in treated study subjects, blood pressure was not associated with dementia, and the results were consistent
for Alzheimer’s disease and vascular dementia. In short, untreated hypertension can increase one’s risk for late age dementia. To be sure, cognitive functioning is negatively affected by hypertension (Elias, Wolf, D’Agostino, Cobb, & White, 1993), perhaps via the induction of small vessel disease and white-matter lesions (Skoog et al., 1996).

Another example of this additional disease burden resulting from hypertension is the increased risk for end-stage renal disease, as described in an article by Klag et al. (1996). The authors of this study investigated the development of end-stage renal disease by following, for 15 years or more, a cohort of 332,544 men, aged 35 to 57 years, who were originally screened for entry into the Multiple Risk Factor Intervention Trial (MRFIT), a randomized, multi-site primary prevention trial related to the control and prevention of coronary heart disease. In their follow-up, which averaged 16 years in duration, the investigators determined that a strong graded relation between systolic and diastolic blood pressure and end-stage renal disease was identified, as 15.6 cases per 100,000 person-years of follow-up were observed; they noted, too, that systolic blood pressure was the one more strongly associated with the disease. Finally, these observed relationships were independent of associations between the disease and race, age, income, use of medications for diabetes, history of myocardial infarction, serum cholesterol concentration, and cigarette smoking. In sum, this study demonstrates that the hypertensive population is also at risk for developing end-stage renal disease, which can lead to dialysis or renal transplant, a finding that has been described in other observational studies (Rosansky, Hoover, King, & Gibson, 1990; Walker, Neaton, Cutler, Neuwirth, & Cohen, 1992). Finally, in addition to these debilitating, sometimes fatal
conditions, hypertension, if left untreated, can also cause eye damage, oral health problems, sexual dysfunction, bone loss, and sleep disruption (Mayo Clinic, n.d.). To be sure, hypertension must be controlled.

**IV. What is Known about Controlling Hypertension**

This fourth section of Chapter 2 presents information related to the control of high blood pressure, starting with three prominent historical intervention studies and concluding with the current recommendations for blood pressure control, including via both non-pharmacological and pharmacological means. The first historical intervention study is the VA Cooperative Study on Hypertension, begun in 1962 by Dr. Edward D. Fries (Veterans Administration Cooperative Study Group on Antihypertensive Agents, 1967, 1970). In this intervention study, after having observed some clinical successes in treating severe hypertension, the investigators randomized 380 male patients with “mild to moderate hypertension” (i.e., diastolic blood pressure in the range of 90 mm Hg through 114 mm Hg) into two groups – the therapy group, which took thiazide diuretics and reserpine, antihypertensive medications; and the control group, which took a placebo – and followed them for up to five years. Some study subjects were followed for less time, of course, as emerging health issues and intolerance to therapy precluded continued participation in the intervention. The results of the intervention study indicated that the estimated risk of experiencing a morbid event within five years of follow-up was just 18% in the therapy group, versus 55% in the control group. Moreover, no members of the therapy group progressed to severe hypertension, unlike in the control group. Finally, mortality in the therapy group was observed to be about one-fourth of the rate in the
control group. These results demonstrated that pharmaceutical therapy was effective and the side-effects were generally tolerable. To be sure, this early study found that the earlier-established complications of hypertension – including heart disease, stroke, and renal failure – were essentially eliminated through treatment.

The second historical intervention study began less than a decade after the start of the Veterans Administration study by Fries. The Hypertension Detection and Follow-up Program, which began in 1970, aimed to do the following: (1) conduct community-based screenings to detect cases of hypertension; (2) through randomization, either (a) enroll those with identified hypertension into a controlled trial of stepped care (step one prescribes a diuretic; step two, an anti-adrenergic drug like reserpine; step three, a vasodilator like hydralazine and a diuretic like chlorthalidone) or (b) provide them with a referral to usual care; and (3) evaluate the level of control of hypertension, as well as mortality differences, between the two groups (Hypertension Detection and Follow-up Program Cooperative Group, 1979). Screenings took place in 14 communities across the United States, wherein 158,906 persons were screened, and, from those screenings, 10,940 individuals were found to be hypertensive (Taylor, 1977). In studying the two groups, the investigators noted a number of significant outcomes. More than two-thirds of the study subjects in the stepped care group remained on their medications and more than half of them achieved blood pressure control –with diastolic blood pressures measuring below 90 mm Hg. As such, overall blood pressure was consistently better controlled in the stepped group than it was in the referred group. Furthermore, five-year all-cause mortality was 17% lower overall and 20% for those with moderate to high
hypertension among the stepped care group, related to what was found in the group receiving referrals for usual care. Finally, in conducting their analyses, the investigators controlled for covariates and confounders, thereby demonstrating that the observed differences (between the two groups) could be attributed to the blood pressure control maintained in the stepped care group (Hypertension Detection and Follow-up Program Cooperative Group, 1979).

Third, and finally, is the Minnesota Heart Health Program, a successor to the earlier epidemiologic studies in Minnesota, as described above. In this community intervention trial, begun in 1980 by Dr. Henry Blackburn, hypertension was impacted as a risk factor – and one of several risk factors for cardiovascular disease – rather than as a disease unto itself (Luepker et al., 1994). The aim of this intervention study was to determine the impact of a five-year community-based health promotion strategy on the knowledge, behaviors, risk profiles, and cardiovascular disease rates of three targeted upper Midwestern communities – using three additional communities, matched on size, type, and location, as controls. In the three target communities, there was a program of mass media, community organization, and direct education, all related to risk reduction, and hypertension control was a major focus, along with dietary practices, tobacco use, and exercise habits. In the control communities, no such interventions took place. In all six communities, blood samples and standardized metrics were collected via comprehensive surveillance systems so comparisons could be made. The results of this multi-year, multi-community intervention trial indicate that many of the program components were effective in the targeted communities; however, the investigators
believed that the effects of the intervention were somewhat masked, given the strong secular trends, related to health promotion and disease prevention, that were prevailing all over at the very same time, a happenstance much like that which occurred during the MRFIT study alluded to above (Multiple Risk Factor Intervention Trial Group, 1976). Even so, this early intervention study demonstrated the value of population-based health promotion efforts on hypertension control.

Having described several of the more prominent historical intervention studies, it is appropriate to proceed to some recent scholarship on hypertension control. Material related to both lifestyle factors and to pharmaceutical control measures will be briefly discussed. First, regarding the lifestyle factors, the Centers for Disease Control and Prevention (2010) lists five important steps toward achieving blood pressure control (some of which were addressed in the review of the population literature): (1) Eat a healthy diet, full of fresh fruits and vegetables, rich in nutrients like potassium and fiber, and low in sodium, dietary cholesterol, and fat; an example of this is the DASH (Dietary Approaches to Stop Hypertension) Diet (Lin et al., 2012; Delichatsios & Welty, 2005); (2) Maintain a healthy weight, since being overweight can increase one’s blood pressure, and long-term weight loss has been correlated with improved blood pressure control (Mulrow et al., 2000; Stevens et al., 2001); (3) Be physically active by engaging in moderate activities for 30 minutes on most days of the week (Bacon, Sherwood, Hinderliter, & Blumenthal, 2004; Hagberg, Park, & Brown, 2000). (4) Quit or do not start smoking, as smoking can increase the risk for hypertension by injuring blood vessels and hardening arteries (Bowman, Gaziano, Buring, & Sesso, 2007); and (5) Limit the
consumption of alcohol, as high alcohol consumption is associated with hypertension (Sesso, Cook, Buring, Manson, & Gaziano 2008; Cushman, 2001). To be sure, adopting any number of these five lifestyle practices, as per the Centers for Disease Control and Prevention, is of considerable benefit with respect to blood pressure control. In fact, the literature indicates that adopting combinations of two or more of these practices is very beneficial (Appel et al., 2003).

Next, for gathering information on the pharmaceutical controls for hypertension, the preeminent source is the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (US DHHS, 2004), which was referenced in the early part of the last chapter. From this report, the following short summary of possible drug treatments is provided. First, following the lifestyle modifications, as described above, if a patient is not at her or his goal blood pressure (which would be less than 140 / 90 mm Hg or less than 130 / 80 mm Hg for those with diabetes or chronic kidney disease), drug therapy is initiated.

The initial drug choices vary based upon the presence or absence of one or more compelling indications. If there are compelling indications, then the following protocols are followed: With heart failure, the following medications are considered: diuretics, beta blockers (BBs), angiotensin converting enzymes inhibitors (ACEIs), angiotensin receptor blockers (ARBs), and aldosterone antagonists (Aldo ANTts). Following a myocardial infarction, the list of drugs includes the following: BBs, ACEIs, and Aldo ANTts. For those with high coronary heart disease, the protocol includes these possible drugs: diuretics, BBs, ACEIs, and calcium channel blockers (CCBs). With diabetes:
diuretics BBs, ACEIs, ARBs, and CCBs are possibly in order. For those with chronic kidney disease, the medications might include these types: ACEIs and ARBs. Finally, for recurrent stroke prevention, two types of drugs are included in the protocol: diuretics and ACEIs. As well, other antihypertensive medications may be prescribed as needed for those with compelling indications (US DHHS, 2004).

On the other hand, if there are no compelling indications, then the patient is treated based upon her or his stage of hypertension. For those with Stage I Hypertension (140-159 mm Hg systolic or 90-99 mm Hg diastolic), the usual choice is a Thiazide-type diuretic, though an ACEI, ARB, BB, or a CCB or a combination may be considered as well. For those with Stage II Hypertension (160+ mm Hg systolic or 100+ mm Hg diastolic), the standard protocol is to administer a two-drug combination, usually a Thiazide-type diuretic and an ACEI or an ARB or a BB or a CCB (US DHHS, 2004).

During (and following) the drug therapy, as presented above, those with hypertension are closely monitored and carefully evaluated. If an individual is still not at her or his goal blood pressure, then the various drug doses are adjusted and/or additional medications are used until the goal blood pressure is achieved. In addition, there may be further clinical consultations, in order to help one reach a state of blood pressure control so that one’s risk for negative health outcomes, as described above, is reduced. To be sure, there may be special situations that can arise that will call for changes to these standard protocols, as described. In sum, via the adoption of appropriate lifestyle modifications and the use of prescribed antihypertensive medications, it is critical that those with hypertension achieve blood pressure control. Of course, the recommendations
for lifestyle changes and medication use are not always heeded (US DHHS, 2004).

V. **What is Known about Patient Compliance**

The final section of this second chapter briefly discusses compliance with public health education and clinical advice related to both lifestyle modification and medication use. In trying to adhere to healthier lifestyle practices, a number of environmental barriers can be problematic, as described by Whelton *et al.* (2002). These barriers to better health include contrary cultural norms; inattention to health education messaging; poor access to physical spaces set apart for physical education; unhealthy recipes and portion sizes – not only in restaurants but also at home; poor food services in the school and work settings; inadequate physical education in the schools; high sodium content in manufactured foods; and the higher costs of and poorer access to healthier food choices. Indeed, healthy choices are much easier to make with the environment is conducive to making such choices.

In terms of compliance to clinical interventions, such as the use of prescribed antihypertensive medications, a number of relevant factors have been identified, including those related to the clinician, the patient, and the medication. First, with respect to the clinical factors, several studies have described how the characteristics and behaviors of the medical care provider can impact the patient’s likelihood of following the prescribed treatment plan. In a study by DiMatteo *et al.* (1993), the influence of physicians’ attributes and practice styles on patient compliance was studied prospectively among 186 clinicians and their heart disease, diabetes, and hypertension patients. The investigators evaluated the traits of the providers, relative to the patients’ levels of
adherence to exercise and diet recommendations and to medication use. The results of the two-year study indicated that several factors predicted patient compliance, including physician’s job satisfaction, weekly average number of patients seen, ability to schedule follow-up appointments, willingness to answer patients’ questions, average number of medical tests ordered, and physician’s medical specialty. Of course, some of these factors are related to the health care system in which the physician is working. Other studies have identified the ability of the physician to effectively communicate with the patient as being influential on patient compliance (Jolles, Clark, & Braam, 2012; Harmon, Lafante, & Krousel-Wood, 2006). While there may be problems associated with how the providers deliver clinical services, the “blame” related to patient adherence to clinical treatment plans does not rest solely with the physicians.

Patient characteristics certainly affect adherence to treatment plans as well. In a multi-site prospective study of 1,198 patients with chronic medical conditions, including hypertension, diabetes, and heart disease, the investigators found a number of patient-related factors affected their adherence to clinical treatment plans (Sherbourne, Hays, Ordway, DiMatteo, & Kravitz, 1992). Specifically, they found that the patients who were less likely to follow specific treatment recommendations were those who were younger; those who relied upon avoidant coping strategies; those who were distressed about their health; those who had poor physical functioning; those whose roles were ill-defined; those who were dissatisfied with the quality and/or cost of the care; and those who lacked social support. Other studies have suggested that health literacy, on the part of the patient, is predictive of adherence to clinical recommendations (Williams, Baker, Parker,
& Nurss, 1998; Gazmararian et al., 2006). Indeed, the patient has a clear role in determining the degree to which the prescribed course of clinical treatment is followed successfully.

Finally, adherence to treatment for hypertension is also a function of the medication. Clark (2004) discusses how the antihypertensive medication itself can lead to poor patient adherence, since the drugs are costly and can have side-effects, including impacts on both overall quality of life and cardiac risk profile. Moreover, Clark’s study suggests that the onus to improve adherence to drug treatment must be on both the provider and the patient. Providers need to communicate recommendations clearly and prescribe therapies that are effective and affordable and have minimal side effects. This is particularly important when dealing with special populations, including the elderly. Likewise, the patient must seek to follow the treatment plan and must notify the provider if there are any problems with the medication – including problems related to cost or side-effects. In short, adherence cannot be optimized if the economic and human costs are too great (Zyczynski & Coyne, 2000).

VI. Summary

This review of the literature first demonstrated the broad scope of the problem of hypertension, emphasizing the fact the scholarship related to high blood pressure has its historical beginnings more than half a century ago. Moreover, it was pointed out that the current national prevalence estimates indicate that nearly one in three U.S. adults has been diagnosed with hypertension, with some groups at particularly high risk of disease development. The second discussion in this literature review highlighted the plight of the
hypertensive population, in terms of its experience with additional disease burdens. Not only do hypertensive individuals face elevated risks for heart-disease- and stroke-related morbidity and mortality, but also they can face struggles with dementia, cognitive impairment, and renal disease, along with eye damage, oral health problems, sexual dysfunction, bone loss, and sleep disruption. Thirdly, the literature review presented some material on blood pressure control. In this section, three historical intervention studies were presented, followed by some information on the current guidelines. In looking at control, it became clear that some success can be achieved in blood pressure control via screening, detection, and intervention – whether that intervention is related to making lifestyle changes or taking prescription medications. Finally, the last section of this literature review focused on compliance. In this section, scholarly works were presented to demonstrate that patient compliance with clinical interventions and treatment plans can be problematic. Developing a better understanding of the population taking medication could prove useful in working to control hypertension at the population level.

The next three chapters of this thesis investigate if particular hypertensive populations of interest [i.e., those populations described by distinct and independent socio-demographic characteristics of interest] are no different [from each other], with respect to taking blood pressure lowering medications for their diagnosed hypertension. This determination involves, in order, a description of the methodology used; a presentation of the results of the analyses conducted; and a discussion of the implications of these results.
CHAPTER 3: METHODOLOGY

I. Introduction

This chapter describes the methodology used to determine which independent factors exert influence on the dependent variable under investigation (i.e., the use of blood pressure lowering medications by those diagnosed with hypertension). In other words, this chapter presents the series of steps taken to test and subsequently either reject or accept the a priori null hypothesis, which is this: particular hypertensive populations of interest (i.e., those populations described by distinct sociodemographic characteristics of interest) are no different (from each other), with respect to taking blood pressure lowering medications for their diagnosed hypertension.

If the null hypothesis is not rejected (a decision which is subject to committing Type II Error – i.e., failing to reject the null hypothesis when it is false), this student believes that, at the 95% confidence level (alpha equals 0.05), no relationship between the variables of interest exists in the population from which the sample data were drawn. In contrast, if the null hypothesis is rejected (a decision which is subject to committing Type I Error – i.e., rejecting the null hypothesis when it is correct), this student believes that, at the 95% confidence level, a relationship between the independent and dependent variables does exist in the population from which the sample data were drawn. Any observed relationship (i.e., such that would give rise to alternative hypotheses) infers that particular sociodemographic variables of interest are independently related to the dependent variable: takes or does not take blood pressure lowering medications.

The next section of this chapter places the research question addressed by the
methodology into a broader context. That is, this contextual framework allows for the “what does this mean?” question to be discussed. If the decision is made to reject the null hypothesis, then the relationship between the independent and dependent variables can be explored in such a way as to describe potential benefits of having investigated the data. In other words, the results of the model can point to real types of interventions that could be employed to effect positive change in the use of anti-hypertensive medications by those who suffer with high blood pressure.

The third section of this chapter presents a discussion of the source of the data, the California Behavioral Risk Factor Survey data (CBRFS data), which are used to address the research question. Specifically, a summary description of the dataset is provided. Further, there is mention of the number of cases used in the various analyses performed in this study – which is a function of the size of the CBRFS and the responsiveness of the respondents. Finally, descriptions of the dependent and relevant independent variables are provided.

The fourth section of this chapter addresses how the data were analyzed. Specifically, there is discussion of the methods employed to generate descriptive statistics; to investigate the bivariate relationships that exist within the data; and to perform the multivariate logistic regression. These analyses were undertaken in order to determine to what degree various independent factors influence the odds that a given individual with diagnosed hypertension takes or does not take blood pressure lowering medications. All analyses were done with Statistical Applications Software (SAS). The fifth and final section summarizes this chapter on methods.
II. Contextual Framework

It is important to place the research question in a broader context. In this case, this student is interested in determining “entry points” at which prevention intervention efforts can take place – so as to preclude a growing concern (a condition, perhaps) from becoming a significant problem. In other words, if this student rejects the null hypothesis and accepts that there are certain factors associated with the use of blood pressure lowering medications by study participants with hypertension, then the enumeration of those factors may provide insight in the clinical setting. With improved clinical care comes a reduction in the disease burden. To be sure, greater blood pressure control at the population level translates into a much reduced chronic disease burden, as well.

III. Source of Data

The first step of the methodology is to collect or locate a dataset that contains data on hypertensive status and anti-hypertensive medication use, in order to test the null hypothesis. Further, data on other independent variables (e.g., health care utilization, insurance, educational attainment, and others) allows for the quantification of the independent influences of these explanatory variables on the dependent variable. Cross-sectional data appropriate to (a) test the null hypothesis and (b) investigate other influences on the dependent variable are available: California Behavioral Risk Factor Data. A description of the these data, obtained from the Survey Research Group (2003), a Public Health Institute entity, under contract with the California Department of Public Health, follows:
SUMMARY: The California Behavioral Risk Factor Survey is an on-going telephone survey of randomly selected adults, which collects information on a wide variety of health-related behaviors. The survey has been conducted since 1984 by the California Department of Public Health in collaboration with the federal Centers for Disease Control and Prevention (CDC) and the Public Health Institute (p. 5).

UNIVERSE: Data are collected monthly from a random sample of California adults (aged 18 years and older) living in households with telephones. The database contains data on California residents from 1984 through the present (p. 5).

QUESTIONNAIRE DESIGN: The questionnaire is developed each year by CDC in collaboration with participating state agencies. Wherever possible, questions have been selected from previously conducted national surveys for comparability. The questionnaire has three components. The first component consists of a core set of questions that are administered by all states participating in the data collection effort. Many of the core questions have remained fixed from year to year, although revisions are made to the core annually. Changes are implemented at the beginning of each interviewing year. Revisions to the core over the years have included modifications in question wording, inclusion of new questions or exclusion of previously asked questions, changes in skip patterns, and changes in the order in which questions are asked. Some changes have been relatively minor, such as changes in the wording of introductory statements. From 1992 through 1999, CDC implemented a “rotating core” strategy, allowing some core questions to appear on the questionnaire in alternate years only. The second component of the questionnaire consists of a series of topical modules developed by the CDC. States have the option of adding as many modules as they wish to the core questionnaire each year. California has used several of the CDC modules, although the same modules have not been used consistently across all years of the survey. The final component of the questionnaire consists of questions designed and administered by individual states to address issues of local concern. These have been revised annually in California to address the needs of as many programs as possible (p. 5).

INTERVIEWS: Participation in the survey is completely voluntary and anonymous. Although there have been more than 200 questions on the questionnaire since 1984, the time constraints of a telephone interview have limited the number of questions that can be placed on the survey in any one year. In addition, there are skip patterns within the instrument, based on the sex, age, and reported behaviors of the participant (e.g., smoking), so that in some cases a completed interview may consist of fewer than one hundred questions. Interviews are conducted by trained interviewers following standardized procedures developed by the CDC. In general, interviews are conducted during weekday evenings and on
weekends, although some interviews are conducted during weekday business hours. The average interview conducted in English takes approximately 30 minutes to complete. Appointments are made as needed for bilingual interviewers to conduct interviews in Spanish (p. 6).

In the present study, no formal exclusion criteria are applied (which would systematically remove records from the original dataset), so all records with valid values for the variables of interest are included in the analyses. First, in determining the overall prevalence of hypertension, of the 6098 records in the dataset, 6095 are usable and included. Next, in the second part of the descriptive analysis (i.e., in determining the proportion of hypertensive adults taking blood pressure lowering medications), of the 1733 records of hypertensive adults, 1730 are usable and included. Finally, in the parametric analysis (i.e., in determining the independent factors associated with taking blood pressure lowering medications), 1696 records of hypertensive adults are used in building the final model, including 1181 individuals who take medication and 515 individuals who do not.

IV. Data Analyses

Descriptive Statistics

Descriptive statistics are used to describe basic features of the data in a study. They provide uncomplicated summaries about the sample data meant to represent the population under investigation. Descriptive statistics are typically distinguished from inferential statistics: with descriptive statistics, one is simply describing what the data show, within the context of the research question. In contrast, with inferential statistics, one is trying to reach conclusions that extend beyond the immediate data alone, in order to provide an answer to the research question (Gordis, 2009). In this study, preliminary
descriptive statistics are provided to accomplish two things: (1) to describe in a general way what the data “look like” and (2) to present percent prevalence estimates for hypertension and for medication use (among hypertensive study subjects). Following the discussion of the methodology of producing descriptive statistics are discussions of the methodologies to produce the inferential statistics, including the bivariate analysis and the multivariate logistic regression. The results of these procedures are presented in the next chapter. First, however, starting with the dependent variable, descriptions of all of the variables which are used in both the bivariate analyses and the multivariate logistic regression are provided (along with gender, which is used for stratification, not modeling). In other words, detailed descriptions are presented only for the variables investigated in the bivariate analyses that also persist in the multivariate model.

**Hypertensive and Medication Use:** A series of CBRFS questions determine whether or not a given individual has (or does not have) hypertension and, if she or he has hypertension, if she or he takes (or does not take) blood pressure lowering medications, as follows: First, each respondent is asked, “Have you ever been told by a doctor, nurse, or other health professional that you have high blood pressure?” Acceptable responses include the following: “Yes;” “Yes, but female told only during pregnancy;” “No;” “Borderline, pre-hypertensive;” “Don’t know/Not sure;” and “Refused.” (In the CBRFS dataset, this variable is named “BPHIGH2” and just “Yes” means respondent is hypertensive; otherwise, she or he is normotensive.) Next, if the respondent responds in the affirmative (i.e., “Yes,” and not “…only during pregnancy”), she or he is asked, “Are you currently taking medicine for your high blood pressure?”
Acceptable responses include the following: “Yes,” “No,” “Don’t know/Not sure,” and “Refused.” (In the CBRFS dataset, this variable is named “BPMED” and “Yes” means a hypertensive individual is on blood pressure control medication; otherwise, she or he is not on such medication.)

In the present study, this student first determines the percent prevalence of BPHIGH2, overall, and stratified by race/ethnicity and gender. Next, this student determines the proportion of those with hypertension who responded “Yes” for BPMED. These proportions are presented overall and for racial/ethnic- and gender-specific strata as well. BPMED also serves as the dependent variable in the multivariate logistic regression analysis, wherein this student models (i.e., tries to “predict”) a response of “takes medication,” given the values for the independent variables described below.

Race/ethnicity: The CBRFS ascertains information on each individual’s Hispanic origin and race group. First, Hispanic origin is determined on the basis of a question that asks for self-identification of the person’s origin or descent, as follows: “Are you Hispanic or Latino (this includes Mexican American, Latin American, Puerto Rican, or Cuban)?” Acceptable responses include the following: “Yes,” “No,” “Don’t know/Not sure,” and “Refused.” (In the CBRFS dataset, this variable is named “HISP3.”) Next, for race group, respondents are asked, “Which one or more of the following would you say is your race? Would you say: White, Black or African American, Asian, Native Hawaiian or Other Pacific Islander, American Indian or Alaska Native, or Other?” “Don’t know/Not sure” and “Refused” are also acceptable answers for this variable, named “ORACE3” in the CBRFS dataset. For those who identify with more than one group, the
question is repeated, and for those identifying as Asian, an additional question is asked: “Are you Chinese, Japanese, Korean, Filipino, or Other?” (The former [repeat] question is called “ORACE4” and the latter question is called “ORACE2A” in the CBRFS dataset; for both, “Don’t know/Not sure” and “Refused” are also acceptable answers.)

For the purposes of this study, this student uses the information on race and the information on Hispanic origin to construct a new category: race/ethnicity (“_RACEGR”). The algorithm that this student uses places those of Hispanic origin, regardless of race, into the Hispanic racial/ethnic group and those who are of non-Hispanic origin into one of the following three other racial/ethnic groups: White, Black, and Other. The distribution for race/ethnicity, together with the distributions for the other variables described here, is presented in the next chapter. The format appears as shown in the following figure, stratified by category of hypertension and (for those with hypertension) medication use (shown as Rx in the table):

**Figure 3-1: An Example of a Predictor Stratified by the Dependent Variable**

<table>
<thead>
<tr>
<th>Race/ethnicity</th>
<th>Normotensive</th>
<th>Hypertensive Takes Rx / Does Not Take Rx</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Of course, other variables are included as well.)

In the prevalence calculations shown in the descriptive results (for hypertension prevalence and medication use), all four categories of race/ethnicity are used; however, that is not true for the inferential results. In conducting multivariate logistic regression, it is sometimes necessary to collapse response categories (for a given variable) to bring
about a better “fit” for the model. For race/ethnicity, in the present study, this is the case. In this analysis, the four levels of race/ethnicity are collapsed into non-Hispanic and Hispanic. In the regression model, the referent category is non-Hispanic. Thus, the measure of effect is computed for Hispanic, coded as “hisp” in SAS.

**Gender:** All respondents are either male or female in the CBRFS data, and there are no missing values. Gender (called “SEX” in the dataset) is used as a stratification variable in generating the descriptive statistics and as an independent variable in developing the logistic regression model (though, as shown in the next chapter, it does not prove to be a statistically significant regressor).

**Age Category:** The CBRFS ascertains each person’s age (i.e., “AGE” in the dataset) via the following open-ended question: “What is your age?” Though age is collected as a continuous variable, this student collapses the values into the following ranges: 18 to 24 years; 25 to 44 years; 45 to 64 years; and 65 years and older (and the variable is called “agecat” in SAS). By having four age categories in the multivariate logistic regression analysis, the interpretation of the results is more intuitive. Rather than discussing resultant changes in the dependent variable for each one-unit (i.e., one year) change in age, it is now possible to discuss resultant changes in the dependent variable across each age category instead.

**Educational Attainment:** The CBRFS ascertains information on highest level of educational attainment, as respondents answer the following question: “What is the highest grade or year of school you completed?” In response, there are eight mutually-exclusive attainment levels for this variable, called “EDUCA” in the dataset, as follows:
“Eighth grade or less;” “Some high school;” “Grade 12 or GED Certificate (HS Graduate);” “Some technical school;” “Technical school graduate;” “Some college;” “College graduate;” and “Post graduate or professional degree.” “Never attended school or only kindergarten” and “Refused” are also possible responses. This level of measurement is ordinal, which means that the attributes can be rank-ordered, but the distances between the attributes do not have any meaning (Gordis, 2009). In other words, the interval between values is not interpretable. For example, it is not definite which is greater: (a) the interval between “HS Graduate” and “Some college (but no degree)” or (b) the interval between “Some college (but no degree)” and “College graduate.”

For this study, this student collapses the eight levels of educational attainment to three: less than high school diploma (called “ltHS”), high school diploma or GED (called “HSgrad”), and some level of post-secondary education (called “somePS”). As described above (for Age Category), this recoding of the variable makes the interpretation of the results more intuitive.

Health Insurance Status: The CBRFS ascertains insurance status for every respondent, via the following question: “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs (health maintenance organizations) or governmental plans such as Medicare or Medi-Cal?” For this variable (named “HAVEPLN3” in the CBRFS dataset), each respondent registers a response of “Yes” or “No,” though “Don’t know/Not sure” and “Refused” are acceptable responses, as well.
Medical Visit: The CBRFS asks each respondent the following question, in order to ascertain information on health care utilization: “About how long has it been since you last visited a doctor for a routine checkup? A routine checkup is a general physician exam, not an exam for a specific injury, illness, or condition.” The response categories for this variable (called “CHECKUP2” in the CBRFS dataset) are as follows: “Within the past year,” “Within the past 2 years,” “Within the past 5 years,” “More than 5 years ago,” “Never,” “Don’t know/Not sure,” “Refused.” Since receiving a diagnosis and a prescription are contingent upon having a medical visit, this student is choosing to recode this variable, calling it “mdvisit” and making it dichotomous: has seen a physician in the past year versus has not seen a physician in the past year. In the multivariate logistic regression, the referent category is the latter.

Multiple Hypertension Diagnoses: As alluded to above, diagnosis and treatment presupposes health care utilization. Therefore, it seems appropriate to quantify utilization (as it relates to hypertension) in some way. In the present study, this student uses the CBRFS variable, “HIGHGT1,” which stores the data from the following question, “Have you been told on more than one occasion that your blood pressure was high, or have you been told this only once?” For this question, the responses include “More than once,” “Only once,” “Don’t know/Not sure,” and “Refused.” In the modeling, this student seeks to determine if having had multiple hypertension diagnoses increases the odds of taking blood lowering medications. As is shown in Chapter 4, it does, indeed.

Diabetes: The CBRFS includes the following narrative for respondents: “Next I would like to ask you about diabetes, sometimes called sugar diabetes.” Then, each
respondent is asked the following question: “Have you ever been told by a doctor that you have diabetes?” Response categories are these: “Yes,” “No,” “Gestational diabetes,” “Pre-diabetes,” “Don’t know/Not sure,” and “Refused.” In the present study, a given study subject is considered to be diabetic only if she or he responded, “Yes.” In other words, in the present study, having gestational diabetes or pre-diabetes does is not classified the same as having diabetes.

**Hypercholesterolemia:** In CBRFS, respondents are asked, “Have you ever been told by a doctor, nurse or other health professional that your blood cholesterol is high?” For this variable, called “TOLDHI” in the dataset, appropriate responses are as follows: “Yes,” “No,” “Don’t know/Not sure” and “Refused.” In the present study, this student makes this variable dichotomous, by separating those responding “Yes” from the others, and renames it “chol” in SAS.

**Smoking Status:** A series of questions is used to ascertain a CBRFS respondent’s smoking status. First is the question, “Have you smoked at least 100 cigarettes in your entire life?” (“SMOKE100”). Next, if the respondent answers in the affirmative, then she or he is asked, “Do you now smoke cigarettes every day, some days, or not at all?” (“SMKEVDA2”). Finally, for those who indicate “every day,” the question is posed, “On average, about how many cigarettes a day do you now smoke?” (“SMOKENUM”). Based upon the responses to these three questions, a new variable is constructed in the CBRFS dataset, called “_SMOKER,” and it has the following values: “Current smoker,” “Former smoker,” “Never smoked,” “Irregular smoker,” and “Refused.” In the present study, this student omits the cases with “Refused” and categorizes the remaining cases
into non-smokers (i.e., the former and never smokers) and smokers (i.e., the current and irregular smokers). This new variable is called “ns” in SAS.

As mentioned above, before presenting the percent prevalence estimates (for hypertension and medication use), general descriptive statistics for the above variables are provided. These results are all in Chapter 4. These variables, as indicated earlier, persist in the final regression model (with the exception of gender). Again, additional variables are explored in the bivariate analysis but do not persist in the final multivariate model; these include: myocardial infarction (“HEART”), stroke (“STROKE”), angina (“ANGINA”), and marital status (“MARITAL”).

**Bivariate Analysis**

Following the descriptive analyses, including the presentation of the prevalence estimates, the null hypothesis is explored by performing a stratified analysis, wherein cross tabulations of selected independent variables of interest and medication use are performed using SAS. A cross tabulation (in this case, constructing a two-by-two contingency table) involves the simultaneous counting of the number of observations that fall into each of the data categories of the two variables under investigation. Thus, as an example, the cross-tabulation of insurance status (i.e., does not have insurance v. has insurance) and medication use (i.e., takes medication v. does not take medication) is presented in Figure 3-2 below.
Figure 3-2: A Generic Cross-tabulation

<table>
<thead>
<tr>
<th>Dependent Variable (below)</th>
<th>Not Insured</th>
<th>Insured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takes Medication</td>
<td>A</td>
<td>B</td>
<td>A+B</td>
</tr>
<tr>
<td>Does not Take Medication</td>
<td>C</td>
<td>D</td>
<td>C+D</td>
</tr>
<tr>
<td>Total</td>
<td>A+C</td>
<td>B+D</td>
<td>A+B+C+D</td>
</tr>
</tbody>
</table>

The cells A through D contain numbers (weighted and normalized data), which are the frequencies *observed* in the data. In contrast to the observed numbers are the *expected* numbers. The expected numbers A through D are calculated as follows:

- Expected A = \((A+B)*(A+C) / (A+B+C+D)\);
- Expected B = \((A+B)*(B+D) / (A+B+C+D)\);
- Expected C = \((C+D)*(A+C) / (A+B+C+D)\);
- Expected D = \((C+D)*(B+D) / (A+B+C+D)\).

Knowing both the observed and expected numbers for each of the cells A through D allows for a Chi-Square test – a test of statistical significance used for determining the extent to which observed values in a contingency table deviate from the values that would have been expected if the two variables had no relationship to one another (Cole, 1996).

In this contingency table, there is one degree of freedom. Having one degree of freedom means that if the calculated Chi-Square \(X^2\) \[X^2 = \sum (f_o-f_e)^2 / (f_e)\], where \(f_o\) is the observed frequency and \(f_e\) is the expected frequency] is greater than the critical value of 3.841 (i.e., at alpha=0.05), then the null hypothesis must be rejected. Rejecting the null hypothesis suggests that it is likely that a relationship between the two variables under investigation exists in the population from which the data were drawn. Each independent variable that appears to be statistically significantly associated with the dependent variable of interest is considered to be a “candidate variable” for possible inclusion in the
final multivariate logistic regression model.

To illustrate the methodology used to construct the two-by-two table and to calculate the Chi-Square statistic, consider the following hypothetical data for hypertensive individuals:

**Figure 3-3: An Example of a Chi-Square Analysis**

<table>
<thead>
<tr>
<th>Dependent Variable (below)</th>
<th>Not Insured</th>
<th>Insured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takes Medication</td>
<td>(A) 64</td>
<td>(B) 589</td>
<td>(A+B) 653</td>
</tr>
<tr>
<td>Does not Take Medication</td>
<td>(C) 36</td>
<td>(D) 111</td>
<td>(C+D) 147</td>
</tr>
<tr>
<td>Total</td>
<td>(A+C) 100</td>
<td>(B+D) 700</td>
<td>ΣΣ=800</td>
</tr>
</tbody>
</table>

The cells A through D contain 800 hypothetical observations. The expected counts for cells A through D are as follows:

- Expected A = \((A+B)*(A+C) / (A+B+C+D)\) = 653*100/800 = 81.6;
- Expected B = \((A+B)*(B+D) / (A+B+C+D)\) = 653*700/800 = 571.4;
- Expected C = \((C+D)*(A+C) / (A+B+C+D)\) = 147*100/800 = 18.4;
- Expected D = \((C+D)*(B+D) / (A+B+C+D)\) = 147*700/800 = 128.6.

Chi-Square, therefore, equals 23.7 in this example. This would demand that the null hypothesis be rejected, as the critical \(\chi^2\) of 3.841 is exceeded. In other words, if one were to find these frequencies in the sample data, one would believe that, at the 95% confidence level, a relationship between insurance status and the use of medications does, indeed, exist in the population from which the sample data were drawn. To be sure, this relationship may become attenuated or even nonexistent with the introduction of other independent variables associated with both of the other two variables (Gordis, 2009).

The Chi-Square test is not a measure of the strength of a relationship; rather, it is
a way to know if the sample data reflect what is occurring within the population from which the study sample was drawn. In other words, rather than knowing how strongly related the two variables of interest are, all one can test is whether the sample relationship likely reflects the true population relationship. Other statistical parameters can be calculated to assess the strength of the relationship. One example is the phi coefficient, \( \phi \), which is equal to the square root of the quotient of the Chi-Square statistic and the number of observations (Cole, 1996). In this hypothetical example, the strength of the relationship between insurance status and medication use, expressed as \( \phi \), is 0.172.

Another way to assess the magnitude of the relationship between the two variables of interest (in the two-by-two table) is to calculate the Odds Ratio. The Odds Ratio, which is literally a ratio of two odds, quantifies a comparison of the presence versus the absence of a “risk” or associated factor for a given outcome in a sample of subjects, some of whom have that given outcome – some of whom do not (Gordis, 2009). The Odds Ratio is calculated as follows: the number of people with the given outcome who were exposed to the “risk” factor (\( C \)) over those with the given outcome who were not exposed to the “risk” factor (\( D \)) divided by those without the given outcome who were exposed to the factor (\( A \)) over those without the given outcome who were not exposed (\( B \)). Therefore, with these data, the Odds Ratio calculation can be written as:

\[
\frac{C}{D} / \frac{A}{B} = \frac{C*B}{D*A}
\]

In figure 3-4, the Odds Ratio is calculated as follows:

\[
\frac{36/111}{64/589} = 36*589 / 111*64 = 2.98.
\]
Figure 3-4: An Example of an Odds Ratio Calculation

<table>
<thead>
<tr>
<th>Dependent Variable (below)</th>
<th>Not Insured</th>
<th>Insured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takes Medication</td>
<td>(A) 64</td>
<td>(B) 589</td>
<td>(A+B) 653</td>
</tr>
<tr>
<td>Does not Take Medication</td>
<td>(C) 36</td>
<td>(D) 111</td>
<td>(C+D) 147</td>
</tr>
<tr>
<td>Total</td>
<td>(A+C) 100</td>
<td>(B+D) 700</td>
<td>ΣΣ=800</td>
</tr>
</tbody>
</table>

The hypothetical measure of effect is interpreted as follows: the odds of taking medication are 2.98 times as great as the odds of not taking medication, given that an individual has insurance. In addition to one’s insurance status, there are other factors that would influence one’s odds of taking medications. These factors need to be explored. In subsequent sections they are. Moreover, additional discussion of deriving and interpreting Odds Ratios is included below.

Multivariate Logistic Regression

In multivariate logistic regression, performed using SAS, this student attempts to determine to what degree various independent variables available for inclusion in the model individually influence the odds that a given hypertensive individual reports taking or not taking anti-hypertensive medication (i.e., the dichotomous dependent variable). The general additive multivariate logistic model (Gordis, 2009) is as follows:

$$\text{Log-odds} = a + \sum_{i=1}^{k} b_i x_i$$

where $$x_i$$ represents an independent variable, or

$$\rho_x = \frac{1}{1 + e^{-(\text{log-odds})}}$$

and the odds for two sets of $$x$$ values ($$x_1, x_2, ..., x_k$$ and $$x'_1, x'_2, ..., x'_k$$) are
\[
\frac{p_x}{1 - p_x} = e^{a + b_1 x_i}
\] and
\[
\frac{p_{x'}}{1 - p_{x'}} = e^{a + b_1 x_i'}
\]
giving the associated Odds Ratio as
\[
\text{Odds Ratio} = \frac{p_x / (1 - p_x)}{p_{x'} / (1 - p_{x'})}
\]
\[
= e^{\sum b_j (x_j - x_j')} = e^{b_1 (x_1 - x_1')} e^{b_2 (x_2 - x_2')} e^{b_3 (x_3 - x_3')} \cdots e^{b_k (x_k - x_k')} = \cdots e^{b_k (x_k - x_k')}
\]
If one “risk” variable in the set is increased by one unit while the other variables are unchanged \((x_1 = x_1' + 1 \text{ while } x_2 = x_2', x_3 = x_3', \ldots x_k = x_k')\), then
\[
\text{Odds Ratio} = e^{b_1}.
\]
What this means is that the coefficient \(b_1\) expresses the influence of a one-unit difference in the variable \(x_1\) on the “risk” (here, read: likelihood) of taking anti-hypertensive medication, while the other independent variables are equal or held constant. In effect, this student is using the logistic model to compare two hypothetical individuals or groups (since this is a statistical test for population-based data) that differ with respect to one variable and have identical values for the other “predictor” variables. This can be done, as the regression coefficient measures the impact from one specific independent variable -- since the influences of the other measured variables are “equalized” between the two groups being compared (Selvin, 1991).

In this study (of hypertensive individuals), the dependent variable is dichotomous (takes or does not take anti-hypertensive medication). The independent variables used to predict the outcome of the dependent variable are numerous. A partial list of these variables includes the following: race/ethnicity; gender; education level; “medical home;” insurance status; and co-morbid health conditions. Thus, the “risk” associated with each
independent variable is determined using multivariate logistic regression. Finally, because these CBRFS data are sample data, they are weighted to reflect the population from which they were drawn – that is, the adult California population; however, in the modeling weighted data, these applied weights are adjusted so that the number of weighted cases equals the number of unweighted cases, the mean of the weights equals one, and the sum of the weights equals the number of cases, consistent with the work of Glynn (1994). The purpose of this adjustment is to ensure that the statistical tests are valid.

In multivariate logistic regression, it is important to look primarily at three things. First, for each independent variable, it is important to look at its significance value. For a given independent variable to be a “significant” “predictor” of the dependent variable, holding all else constant, the Wald Chi Square must have a significance value (i.e., a p-value) less than 0.05, which is the alpha, established a priori. In order to reject the null hypothesis, each characteristic (i.e., each independent variable of interest included in the model) must meet this criterion for significance. In other words, each one should exert statistically significant influence on the dependent variable. Of course, evidence contrary to that which gave rise to this study (i.e., evidence demanding that a decision to reject the null hypothesis based on the bivariate analysis be revisited) would be having a given independent variable of interest exhibit a significance value that is greater than 0.05.

The second thing to examine in the multivariate logistic regression is the magnitude of the influence exerted by a given independent variable -- especially a significant one. The magnitude is indicated in the output of the SAS statistical software
by the term “parameter estimate,” which corresponds to the $b_i$ term described above. Following the logic presented above, from the parameter estimates, the Odds Ratios can be determined. Odds Ratios are more intuitive than parameter estimates in their interpretation, as they can be interpreted in terms of “risk:” an Odds Ratio which is less than one suggests a “protective” effect; one equal to one suggests there is no effect; and one greater than one suggests a “risk.”

The third thing to look for in the multivariate logistic regression is the sign of the parameter estimate assigned to a given independent variable -- especially a significant one. The sign indicates whether a direct or an inverse (i.e., not indirect) relationship exists between the variables of interest. A positive coefficient suggests there is a direct relationship -- i.e., an increase in X leads to an increase in Y, while a negative coefficient suggests there is an inverse relationship -- i.e., an increase in X leads to a decrease in Y. Clearly, the sign of the parameter corresponds to the interpretation of the Odds Ratio, as a direct relationship (a positive coefficient) is a “risk” (the Odds Ratio is greater than one), while an inverse relationship (a negative coefficient) is a “protective” effect the Odds Ratio is less than one).

The above-mentioned estimates of specific parameters are invaluable for understanding the relationships that exist in the data, whether in the form of the original estimate or algebraically converted into an Odds Ratio. A statistically optimum estimation technique is the method of maximum likelihood, developed by British geneticist and statistician Ronald Aylmer Fisher. Put simply, Fisher’s technique produces the maximum likelihood estimates of parameters, which is that set of values
which is most likely (to be found) for the sampled data. That is, the estimates are those values that make the sampled data most likely to have occurred. These estimates, especially in multiparameter models, are typically estimated by computer techniques (Selvin, 1991). In this study, the parameters are estimated using SAS and are presented in Chapter 4.

V. Summary

This third chapter described the methodology used in this study. First, however, there was a discussion of the source of the data, the California Behavioral Risk Factor Survey, used to address the research question. A summary description of the dataset was provided, and descriptions of the dependent and relevant independent variables were presented. Next, there were discussions regarding the data analyses: generating descriptive statistics; investigating the bivariate relationship between the independent and dependent variables; and performing multivariate logistic regression. These analyses were described in general terms in order to demonstrate how one can determine to what degree various independent factors influence the odds that a given individual does or does not exhibit the outcome of interest. Of course, in these analyses, the outcome of interest (among the hypertensive study population) is taking or not taking medication to control high blood pressure. The results of these analyses are presented in the next chapter.
CHAPTER 4: RESULTS

I. Introduction

This chapter presents the results of the analyses described in the previous chapter, which were designed to answer the overarching research questions: How prevalent is hypertension? To what extent are those with hypertension on medications? What factors are associated with medication use? In other words, the findings from the steps taken to determine the extents to which independent risk factors exert influence on the dependent variable under investigation (i.e., the use of high blood pressure lowering medication) are made known. Further, the basis of the decision to either reject or not reject the null hypothesis (i.e., particular hypertensive populations of interest [i.e., those populations described by distinct and independent socio-demographic characteristics of interest] are no different [from each other], with respect to taking blood pressure lowering medications for their diagnosed hypertension) is provided.

The second through fourth sections of this chapter present the results of the following analyses: the generation of descriptive statistics; the investigation of the bivariate relationships between the dependent variable and certain independent variables; and the performance of multivariate logistic regression. The final section summarizes this chapter on results.

II. Descriptive Statistics

Descriptive statistics are used to describe basic features of the data. The weighted data presented in Table 4-1 below provide a “picture” of the study populations. This table indicates the factors’ distributions overall, as well as for the two categories of blood
pressure and, among those with hypertension, by medication use (Rx in the table). In this table, data are summarized in this format for the variables discussed in Chapter 3.

Following this tabular summary, these data are described in a brief narrative. After this narrative, Tables 4-2 and 4-3 present stratified prevalence data for hypertension and for blood pressure lowering medication use (among those with hypertension), respectively.

**Table 4-1: Distributions of the Dependent and Independent Variables**

<table>
<thead>
<tr>
<th></th>
<th>Normotensive (%)</th>
<th>Hypertensive Takes Rx / Does Not Take Rx (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Race/ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>51.10</td>
<td>60.13 / 40.70</td>
<td>51.57</td>
</tr>
<tr>
<td>Black</td>
<td>5.98</td>
<td>7.16 / 7.38</td>
<td>6.28</td>
</tr>
<tr>
<td>Hispanic</td>
<td>28.75</td>
<td>17.14 / 43.73</td>
<td>28.29</td>
</tr>
<tr>
<td>Other</td>
<td>14.18</td>
<td>15.58 / 8.18</td>
<td>13.86</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48.31</td>
<td>48.30 / 59.21</td>
<td>49.28</td>
</tr>
<tr>
<td>Female</td>
<td>51.69</td>
<td>51.70 / 40.79</td>
<td>50.72</td>
</tr>
<tr>
<td><strong>Age Group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 through 24</td>
<td>16.29</td>
<td>0.21 / 14.83</td>
<td>13.67</td>
</tr>
<tr>
<td>25 through 44</td>
<td>50.21</td>
<td>11.51 / 40.66</td>
<td>43.37</td>
</tr>
<tr>
<td>45 through 64</td>
<td>25.01</td>
<td>40.60 / 35.15</td>
<td>28.32</td>
</tr>
<tr>
<td>65 plus</td>
<td>8.49</td>
<td>47.68 / 9.37</td>
<td>14.64</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; High School</td>
<td>13.67</td>
<td>16.56 / 28.97</td>
<td>15.48</td>
</tr>
<tr>
<td>High School Grad</td>
<td>22.14</td>
<td>23.53 / 21.88</td>
<td>22.33</td>
</tr>
<tr>
<td>&gt; High School</td>
<td>64.19</td>
<td>59.91 / 49.15</td>
<td>62.20</td>
</tr>
<tr>
<td><strong>Health Insurance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>83.73</td>
<td>95.22 / 74.01</td>
<td>84.64</td>
</tr>
<tr>
<td>No</td>
<td>16.27</td>
<td>4.78 / 25.99</td>
<td>15.36</td>
</tr>
<tr>
<td><strong>Medical Visit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>57.58</td>
<td>80.61 / 54.01</td>
<td>60.83</td>
</tr>
<tr>
<td>No</td>
<td>42.42</td>
<td>19.39 / 45.99</td>
<td>39.17</td>
</tr>
<tr>
<td><strong>&gt;1 Hypertension Diagnosis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>-</td>
<td>83.47 / 49.00</td>
<td>-</td>
</tr>
<tr>
<td>No</td>
<td>-</td>
<td>16.53 / 51.00</td>
<td>-</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3.91</td>
<td>23.23 / 7.21</td>
<td>7.21</td>
</tr>
<tr>
<td>No</td>
<td>96.09</td>
<td>76.77 / 92.79</td>
<td>92.79</td>
</tr>
<tr>
<td><strong>Hypercholesterolemia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18.46</td>
<td>57.70 / 29.21</td>
<td>25.49</td>
</tr>
<tr>
<td>No</td>
<td>81.54</td>
<td>42.30 / 70.79</td>
<td>74.51</td>
</tr>
<tr>
<td><strong>Smoker</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>15.02</td>
<td>11.13 / 22.98</td>
<td>15.12</td>
</tr>
<tr>
<td>No</td>
<td>84.98</td>
<td>88.87 / 77.02</td>
<td>84.88</td>
</tr>
</tbody>
</table>
Table 4-1 above provides some interesting information about the study populations, including both the normotensive and the hypertensive respondents, some of whom take blood pressure lowering medications. First, in terms of the demographics, slightly more than half (51.57%) of the total study population self-identifies as non-Hispanic White, and this holds true for the normotensive population as well (51.10%). In looking at the hypertensive population, by medication use, the non-Hispanic groups tend to be “over-represented” in the group taking medication, thereby suggesting that being Hispanic is not associated with taking blood pressure lowering medications, consistent with findings from Kaufman, Kelly, Rosenberg, Anderson, and Mitchell (2002).

In terms of gender, the gender ratio overall is very near one (i.e., 49.28% male to 50.72% female). Again, the same is true for the normotensive population; however, in looking at the hypertensive population, by medication use, there is a very slight difference between the genders, with hypertensive females appearing to be slightly more likely (than are hypertensive males) to take medication.

With respect to age group, the total population (of respondents) has 14.64% who are 65 years of age or older. In the normotensive population, this proportion goes down to 8.49%. For the hypertensive population, by medication use, the proportions shift considerably. Those who are 45 through 64 years of age and those 65 years of age and older are “over-represented” in the group taking medication, thereby suggesting that there is an association between increasing age and likelihood of being hypertensive and on blood pressure lowering medication, again, consistent with Kaufman (2002).
Educational attainment shows some variation across the different populations as well, in line with the findings of Kiely, Gross, Kim, & Lipsitz (2012). In the total population, 62.20% of respondents report some post-secondary education, while this proportion climbs slightly (to 64.19%) when looking only at those with normal blood pressure. For this top educational category, the proportion drops to 59.91% for the medication users, perhaps suggesting an inverse association between educational attainment and medication use. In other words, it may be true that those who are better educated – even though they have hypertension – are more capable of controlling their blood pressure through non-pharmaceutical means than are those whose level of educational attainment is not as high.

Next, in looking at the health-care-related strata in Table 4-1, some differences are observed across the various study populations. First, for health insurance status, 84.64% of the total population report having some kind of health care coverage; among the normotensive population, the figure is similar (83.73%). However, in observing the health care coverage proportions in the two medication groups – among those with hypertension – a noticeable difference exists, likely highlighting that fact that health care insurance impacts pharmaceutical costs (Khan & Kaestner, 2009): Of those taking medication, 95.22% report coverage; of those not taking medication, just 74.01% have coverage. Next, with respect to having had a medical visit (within the past year), the data in Table 4-1 indicate that this is true for 60.83% of the total population and 57.58% of the normotensive population. Among the medicated hypertensive population, this proportion is 80.61%, thereby suggesting an association between routine medical care and drug
therapy for hypertension. Further evidence of this connection is found in the next strata, “greater than 1 hypertension diagnosis,” which is only applicable to the hypertensive population, as the proportions are skewed to highlight the connection between multiple diagnoses of hypertension and medication use.

Finally, in looking at the strata related to the cardiovascular-disease-related risk factors of interest in this study, as shown in Table 4-1, some interesting results are observed. First, diabetes is reported by 7.21% of the total population and 3.91% of the normotensive population. Among the hypertensive population, diabetes is reported by 23.23% of those taking antihypertensive medication and by 7.21% of those not taking it, in line with DiMatteo et al. (1993). Next, among the total population, 25.49% of the respondents report having been diagnosed with hypercholesterolemia. For the normotensive population, this figure drops to just 18.46%. Among the hypertensive population, the following is true: For those taking antihypertensive medication, 57.70% have high cholesterol; for those not on medication, the proportion with high cholesterol is 29.21%, consistent with Rosansky et al. (1990). Finally, Table 4-1 presents the data related to smoking status. According to the data, 15.12% of the total population report smoking. Among the normotensive population, the prevalence is similar: 15.02%. Lastly, for those with hypertension, there is a two-fold difference across medication groups, with 11.13% smoking prevalence among those on medication and 22.98% smoking prevalence among those not on medication, in agreement with Bowman (2007).

In summary, these results suggest that there are some differences in particular sociodemographic factors across the various populations of interest. The normotensive
population is not the same as the hypertensive population; moreover, within this latter group (i.e., the hypertensive population), further differences are observed, by race/ethnicity, age, education, health care coverage and utilization, and other risk factors.

The next set of descriptive statistics includes prevalence estimates. These data indicate the proportion of the population of interest for whom a certain condition is true – in this case, the proportion of the total population with hypertension. Table 4-2 summarizes the information overall, by race/ethnicity, and by gender. The data shown include the total number of respondents surveyed (Total N), the number of respondents with usable values (Actual N), the prevalence estimate (Prev), the bounds of the 95% Confidence Interval surrounding the prevalence estimate (Lower and Upper), and the Relative Standard Error (RSE), which is a measure of the statistical stability of the prevalence estimate. The lower the RSE, the more stable the estimate – and an RSE equal to or greater than 23.0 suggests statistical instability. In Table 4-2, all of the prevalence estimates are stable.

Table 4-2: Percent Prevalence Estimates for Hypertension

<table>
<thead>
<tr>
<th>Gender</th>
<th>Race</th>
<th>Total N</th>
<th>Actual N</th>
<th>Prev</th>
<th>Lower</th>
<th>Upper</th>
<th>RSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTH</td>
<td>ALL</td>
<td>6098</td>
<td>6095</td>
<td>24.4</td>
<td>23.3</td>
<td>25.5</td>
<td>2.3</td>
</tr>
<tr>
<td>BOTH</td>
<td>WHITE</td>
<td>3869</td>
<td>3867</td>
<td>25.1</td>
<td>23.7</td>
<td>26.5</td>
<td>2.8</td>
</tr>
<tr>
<td>BOTH</td>
<td>BLACK</td>
<td>263</td>
<td>263</td>
<td>28.1</td>
<td>22.6</td>
<td>33.6</td>
<td>9.9</td>
</tr>
<tr>
<td>BOTH</td>
<td>HISPANIC</td>
<td>1544</td>
<td>1543</td>
<td>23.1</td>
<td>21.0</td>
<td>25.2</td>
<td>4.6</td>
</tr>
<tr>
<td>BOTH</td>
<td>OTHER</td>
<td>422</td>
<td>422</td>
<td>22.6</td>
<td>18.6</td>
<td>26.6</td>
<td>9.0</td>
</tr>
<tr>
<td>MALE</td>
<td>ALL</td>
<td>2398</td>
<td>2397</td>
<td>25.9</td>
<td>24.1</td>
<td>27.7</td>
<td>3.5</td>
</tr>
<tr>
<td>MALE</td>
<td>WHITE</td>
<td>1523</td>
<td>1523</td>
<td>27.0</td>
<td>24.8</td>
<td>29.2</td>
<td>4.2</td>
</tr>
<tr>
<td>MALE</td>
<td>BLACK</td>
<td>91</td>
<td>91</td>
<td>26.3</td>
<td>17.1</td>
<td>35.5</td>
<td>17.6</td>
</tr>
<tr>
<td>MALE</td>
<td>HISPANIC</td>
<td>600</td>
<td>599</td>
<td>23.2</td>
<td>19.8</td>
<td>26.6</td>
<td>7.4</td>
</tr>
<tr>
<td>MALE</td>
<td>OTHER</td>
<td>184</td>
<td>184</td>
<td>27.3</td>
<td>26.8</td>
<td>33.8</td>
<td>12.0</td>
</tr>
<tr>
<td>FEMALE</td>
<td>ALL</td>
<td>3700</td>
<td>3698</td>
<td>22.9</td>
<td>21.5</td>
<td>24.3</td>
<td>3.0</td>
</tr>
<tr>
<td>FEMALE</td>
<td>WHITE</td>
<td>2346</td>
<td>2344</td>
<td>23.2</td>
<td>21.5</td>
<td>24.9</td>
<td>3.8</td>
</tr>
<tr>
<td>FEMALE</td>
<td>BLACK</td>
<td>172</td>
<td>172</td>
<td>29.7</td>
<td>22.8</td>
<td>36.6</td>
<td>11.7</td>
</tr>
<tr>
<td>FEMALE</td>
<td>HISPANIC</td>
<td>944</td>
<td>944</td>
<td>23.1</td>
<td>20.4</td>
<td>25.8</td>
<td>5.9</td>
</tr>
<tr>
<td>FEMALE</td>
<td>OTHER</td>
<td>238</td>
<td>238</td>
<td>18.5</td>
<td>13.5</td>
<td>23.5</td>
<td>13.6</td>
</tr>
</tbody>
</table>
As is shown in Table 4-2 above, the prevalence estimate for hypertension among all respondents to the CBRFS is 24.4%, or nearly one in four California adults, similar to the findings of Anderson and Wilson (2006). Next, when the data are stratified by gender, they indicate that the hypertension prevalence for males (25.9%) is slightly higher than that of females (22.9%). Finally, differences are noted by race/ethnicity, as those identifying as Black report the highest racial/ethnic-specific prevalence estimate (28.1%). For Black females, the hypertension prevalence estimate of 29.7% is the highest of the all of the strata.

Table 4-3 below presents the data on the use of blood pressure lowering medication, among those with hypertension (from Table 4-2). Table 4-3 is organized in the same way as Table 4-2, and, again, all of the prevalence estimates (here, the proportion of those with hypertension who take medication) are stable, based on the measure-specific calculation of the RSE.

### Table 4-3: Use of Blood Pressure Lowering Medication

<table>
<thead>
<tr>
<th>Gender</th>
<th>Race</th>
<th>Total N</th>
<th>Actual N</th>
<th>Prev</th>
<th>Lower</th>
<th>Upper</th>
<th>RSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTH</td>
<td>ALL</td>
<td>1733</td>
<td>1730</td>
<td>63.5</td>
<td>61.2</td>
<td>65.8</td>
<td>1.8</td>
</tr>
<tr>
<td>BOTH</td>
<td>WHITE</td>
<td>1281</td>
<td>1199</td>
<td>72.0</td>
<td>69.5</td>
<td>74.5</td>
<td>1.8</td>
</tr>
<tr>
<td>BOTH</td>
<td>BLACK</td>
<td>94</td>
<td>94</td>
<td>62.8</td>
<td>52.9</td>
<td>72.7</td>
<td>7.9</td>
</tr>
<tr>
<td>BOTH</td>
<td>HISPANIC</td>
<td>346</td>
<td>345</td>
<td>40.5</td>
<td>35.3</td>
<td>45.7</td>
<td>6.5</td>
</tr>
<tr>
<td>BOTH</td>
<td>OTHER</td>
<td>92</td>
<td>92</td>
<td>76.8</td>
<td>68.1</td>
<td>85.5</td>
<td>5.7</td>
</tr>
<tr>
<td>MALE</td>
<td>ALL</td>
<td>734</td>
<td>733</td>
<td>58.6</td>
<td>55.0</td>
<td>62.2</td>
<td>3.1</td>
</tr>
<tr>
<td>MALE</td>
<td>WHITE</td>
<td>521</td>
<td>520</td>
<td>67.0</td>
<td>62.9</td>
<td>71.1</td>
<td>3.1</td>
</tr>
<tr>
<td>MALE</td>
<td>BLACK</td>
<td>34</td>
<td>34</td>
<td>63.6</td>
<td>46.8</td>
<td>80.4</td>
<td>13.0</td>
</tr>
<tr>
<td>MALE</td>
<td>HISPANIC</td>
<td>129</td>
<td>129</td>
<td>33.2</td>
<td>25.0</td>
<td>41.4</td>
<td>12.5</td>
</tr>
<tr>
<td>MALE</td>
<td>OTHER</td>
<td>50</td>
<td>50</td>
<td>72.3</td>
<td>59.6</td>
<td>85.0</td>
<td>8.8</td>
</tr>
<tr>
<td>FEMALE</td>
<td>ALL</td>
<td>999</td>
<td>997</td>
<td>66.8</td>
<td>65.9</td>
<td>71.7</td>
<td>2.1</td>
</tr>
<tr>
<td>FEMALE</td>
<td>WHITE</td>
<td>680</td>
<td>679</td>
<td>77.5</td>
<td>74.4</td>
<td>80.6</td>
<td>2.1</td>
</tr>
<tr>
<td>FEMALE</td>
<td>BLACK</td>
<td>60</td>
<td>60</td>
<td>62.0</td>
<td>49.5</td>
<td>74.5</td>
<td>10.1</td>
</tr>
<tr>
<td>FEMALE</td>
<td>HISPANIC</td>
<td>217</td>
<td>216</td>
<td>48.2</td>
<td>41.5</td>
<td>54.9</td>
<td>7.1</td>
</tr>
<tr>
<td>FEMALE</td>
<td>OTHER</td>
<td>42</td>
<td>42</td>
<td>82.7</td>
<td>78.9</td>
<td>94.5</td>
<td>7.1</td>
</tr>
</tbody>
</table>
The data in Table 4-3 above indicate that 63.5% (or nearly two in three) of those with hypertension report taking antihypertensive medication. Further, males with high blood pressure are less likely than are females with high blood pressure to be using pharmaceutical control measures (58.6% versus 68.8%). Finally, the racial/ethnic-specific data indicate that respondents identifying as Hispanic or as Black are less likely than are those in the other racial-ethnic groups to report medication use. This racial/ethnic pattern holds true across each gender group as well.

III. Bivariate Analysis

As was described in Chapter 3, the construction of a two-by-two table is useful to explore the relationship between a given independent variable and medication use – that is, to conduct a bivariate analysis. The results of the bivariate analysis are then used to decide if a given variable should be included in the multivariate modeling that is to follow. Such an analysis is done for each independent variable. Consistent with the order of Table 4-1 above, the bivariate analysis starts with the demographic variable of race/ethnicity; however, as was described in Chapter 3, this particular variable was collapsed into Hispanic and non-Hispanic. The two-by-two table for “Hispanic versus non-Hispanic” and “Takes Medication versus Does Not Take Medication” is shown in Figure 4-1 below. For this specific bivariate analysis, the Chi-Square, the phi, and the Odds Ratios are briefly described below the figure.
Figure 4-1: Bivariate Analysis for Ethnicity and Medication Use

<table>
<thead>
<tr>
<th>Dependent Variable (below)</th>
<th>Hispanic</th>
<th>non-Hispanic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takes Medication</td>
<td>172</td>
<td>1035</td>
<td>1207</td>
</tr>
<tr>
<td>Does not Take Medication</td>
<td>173</td>
<td>350</td>
<td>523</td>
</tr>
<tr>
<td>Total</td>
<td>345</td>
<td>1385</td>
<td>1730</td>
</tr>
</tbody>
</table>

Based on the observed and expected frequencies, the Chi-Square ($\chi^2$), the phi coefficient ($\phi$), and Odds Ratio are 81.02, -0.22, and 0.34, respectively. This bivariate analysis suggests the following: first, based upon the Chi-Square value (81.02), which is greater than 3.841 (i.e., at alpha=0.05), the null hypothesis (that these two variables are unrelated) must be rejected. Rejecting the null hypothesis suggests that it is likely that a relationship between ethnicity and medication use exists in the population from which the data were drawn. Second, the phi coefficient, the measure of the strength of the relationship between these two variables, is -0.22. This means that there is a moderate inverse relationship between the two variables under investigation. This relationship merits further scrutiny. Finally, the Odds Ratio of 0.34 is another important measure of the strength of relationship – of course, without taking into account any additional independent factors (though this happens in the multivariate analysis, which is presented next). An Odds Ratio of 0.34 suggests the following: statistically speaking, without controlling for any other factors, the odds of taking blood pressure lowering medication are 0.33 times as great as the odds of not taking such medication, given that an individual is Hispanic. In sum, the results of this first bivariate analysis demand that the relationship between ethnicity and medication use be further explored.
In conducting the bivariate analyses, this student studied each of the independent variables of interest, one at a time, in relationship to antihypertensive medication use, the dependent variable. The reader recalls, of course, the list of these variables of interest is included in Chapter 3; the reader should note the inclusion of the variables heart disease, stroke, angina, and marital status – which were mentioned but not fully described in Chapter 3 (page 54), since they do not persist in the multivariate model. They are presented here since there is a suggestion of association within the bivariate analysis. A summary of the bivariate findings (i.e., the Chi-Squares, Phi Coefficients, and Odds Ratios) is shown in Table 4-4 below.

**Table 4-4: Summary Results of the Bivariate Analyses**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Chi-Square</th>
<th>Phi Coefficient</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>81.02</td>
<td>-0.22</td>
<td>0.34</td>
</tr>
<tr>
<td>Female</td>
<td>11.07</td>
<td>0.08</td>
<td>1.42</td>
</tr>
<tr>
<td>&lt; HS graduate</td>
<td>8.54</td>
<td>-0.07</td>
<td>1.31</td>
</tr>
<tr>
<td>Insured</td>
<td>111.25</td>
<td>0.25</td>
<td>5.73</td>
</tr>
<tr>
<td>Medical Visit</td>
<td>117.56</td>
<td>0.26</td>
<td>3.42</td>
</tr>
<tr>
<td>&gt;1 HBP* Diagnosis</td>
<td>130.77</td>
<td>0.28</td>
<td>3.67</td>
</tr>
<tr>
<td>Diabetes</td>
<td>47.30</td>
<td>0.17</td>
<td>3.22</td>
</tr>
<tr>
<td>High Cholesterol</td>
<td>59.63</td>
<td>0.19</td>
<td>2.28</td>
</tr>
<tr>
<td>Non-Smoker</td>
<td>23.89</td>
<td>0.12</td>
<td>1.99</td>
</tr>
<tr>
<td>Heart Disease</td>
<td>19.91</td>
<td>0.11</td>
<td>2.72</td>
</tr>
<tr>
<td>Stroke</td>
<td>24.55</td>
<td>0.12</td>
<td>4.35</td>
</tr>
<tr>
<td>Angina</td>
<td>24.06</td>
<td>0.12</td>
<td>2.81</td>
</tr>
<tr>
<td>Married</td>
<td>1.89</td>
<td>-0.03</td>
<td>0.87</td>
</tr>
</tbody>
</table>

*HBP is High Blood Pressure

From Table 4-4, it is clear that each of the independent variables appears to be related to the dependent variable in the bivariate analysis, with the exception of marital status. The Chi-Square values, the phi coefficients, and the Odds Ratios all attest to this. It is noteworthy, however, that these individual-independent-variable-specific results of
the bivariate analyses shown in each row of Table 4-4 above are given to change, once
the other independent variables are introduced into the analysis (and are exerting
simultaneous influences on the dependent variable). Taking into consideration the
simultaneous effects of all of the independent variables under investigation is the essence
of the multivariate logistic regression methodology, the results of which are presented in
the next section of this fourth chapter.

IV. Multivariate Analysis

As described in Chapter 3, following the bivariate analysis, a multivariate logistic
regression analysis is performed to quantify the degree to which various independent
factors influence the odds that a given individual (with hypertension) takes or does not
take blood pressure lowering medication. In other words, each independent variable is
assessed in terms of its influence on medication use, while including every other
independent variable of interest and holding them all constant.

As discussed above, in multivariate logistic regression, it is important to look
primarily at three things in order to interpret the results of the analyses. First, for each
independent variable, it is critical to note its significance value. A "significant" predictor
of the dependent variable, holding all else constant, has a significance value (i.e., and p-
value) less than 0.05, which is the alpha, established a priori. Table 4-5 below lists the
maximum likelihood estimates of the independent variables (i.e., those values that make
the sampled data most likely to have occurred) and the corresponding significance values.
For all of the independent variables, the significance level is less than 0.05. These
findings suggest that some measure of “risk” is associated with each of the independent
variables included in the model. Of note is that just nine independent variables are included in Table 4-5, down from the list of thirteen variables studied in the bivariate analysis. Four variables (heart disease, stroke, angina, and marital status) were not significant in the multivariate analysis, so they are not found in the tables that follow.

Table 4-5: Analysis of Maximum Likelihood Estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>Wald Chi-Square</th>
<th>Pr &gt; ChiSq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-6.0258</td>
<td>0.4208</td>
<td>205.0630</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>HIGHGT1</td>
<td>1.5040</td>
<td>0.1596</td>
<td>88.8077</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ltHS</td>
<td>0.6134</td>
<td>0.2182</td>
<td>7.9041</td>
<td>0.0049</td>
</tr>
<tr>
<td>agecat</td>
<td>1.3022</td>
<td>0.0996</td>
<td>171.0804</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>mdvisit</td>
<td>0.7784</td>
<td>0.1588</td>
<td>24.0248</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>HAVEPLN3</td>
<td>0.5834</td>
<td>0.2391</td>
<td>5.9522</td>
<td>0.0147</td>
</tr>
<tr>
<td>DIABCOR2</td>
<td>0.7367</td>
<td>0.2214</td>
<td>11.0775</td>
<td>0.0009</td>
</tr>
<tr>
<td>chol</td>
<td>0.2914</td>
<td>0.1478</td>
<td>3.8875</td>
<td>0.0486</td>
</tr>
<tr>
<td>hisp</td>
<td>-0.9082</td>
<td>0.1929</td>
<td>22.1697</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ns</td>
<td>0.7007</td>
<td>0.1842</td>
<td>14.4787</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The second thing to which to pay close attention in the multivariate logistic regression is the magnitude of the influence exerted by a given predictor variable. In Table 4-5 above, the magnitude is listed in the column entitled “parameter estimate.” The parameter estimate corresponds to the $b_i$ term described in the previous chapter. The magnitudes of the influences exerted by the independent variables range from the relatively low (e.g., chol [i.e., hypercholesterolemia] has an absolute value of 0.2914) to the relatively high (e.g., HIGHGT1 [i.e., more than one diagnosis of hypertension] has an absolute value of 1.5040).

As described in the previous chapter, from the parameter estimates the Odds Ratios can be determined. This can be done using the formula $OR = e^x$, where OR is the Odds Ratio, $e$ is Euler’s number, and $x$ is the parameter estimate (Kleinbaum, 2008). Odds Ratios and 95% confidence intervals for having reported the use of anti-
hypertensive medications are presented below in Table 4-6. It must be noted that each of these Odds Ratios represents the independent influence of a given predictor variable (on the likelihood of reporting medication use), while holding all of the other variables constant (in contrast to the Odds Ratios shown above in Table 4-4).

With respect to their interpretations, Odds Ratios less than one suggest a "protective" effect; those equal to one suggest no effect; and those greater than one suggest a “risk.” Next, the 95% confidence interval consists of a lower limit and an upper limit. The former represents the lowest measure of “risk” associated with the predictor of interest, while the latter represents the highest measure of “risk.” In other words, it can be believed with 95% certainty (i.e., 100% minus alpha) that the true magnitude of influence exerted by the predictor variable (on the dependent variable) lies within the interval.

Table 4-6: Odds Ratios and 95% Confidence Intervals (C.I.) For Reporting the Use of Anti-Hypertensive Medication

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (O.R.)</th>
<th>Wald 95% C.I. Lower Limit</th>
<th>Wald 95% C.I. Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1 HBP+ Diagnosis</td>
<td>4.499</td>
<td>3.291</td>
<td>6.152</td>
</tr>
<tr>
<td>Medical Visit</td>
<td>2.178</td>
<td>1.595</td>
<td>2.973</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.089</td>
<td>1.354</td>
<td>3.224</td>
</tr>
<tr>
<td>Non-Smoker</td>
<td>2.015</td>
<td>1.405</td>
<td>2.891</td>
</tr>
<tr>
<td>&lt; HS graduate</td>
<td>1.847</td>
<td>1.204</td>
<td>2.832</td>
</tr>
<tr>
<td>Insured</td>
<td>1.792</td>
<td>1.122</td>
<td>2.864</td>
</tr>
<tr>
<td>High Cholesterol</td>
<td>1.338</td>
<td>1.002</td>
<td>1.788</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.403</td>
<td>0.276</td>
<td>0.589</td>
</tr>
</tbody>
</table>

*HBP is High Blood Pressure.
Note: The model controls for age.

According to Table 4-6 above, there are eight factors shown to be statistically associated with the use of high blood pressure lowering medication by hypertensive
respondents to the CBRFS. These factors are listed in order of the magnitude of the strength of association – that is, from the largest Odds Ratio to the smallest Odds Ratio, and each is described briefly in succession. First, given the Odds Ratio of 4.499 (and the 95% Confidence Interval ranging from 3.291 to 6.152), it is clear that having had multiple hypertension diagnoses increases the odds of taking blood lowering medication. In fact, given that an individual has had more than one diagnosis for high blood pressure, she or he is 449.9% more likely to be using pharmaceutical control than is someone who has not had more than one hypertension diagnosis, holding all else equal. Of course, this speaks to health care utilization (of which medication use is also a function). The second independent factor listed in Table 4-6 also pertains to health care utilization: having had a medical visit within the past year. Compared to those who have not had such routine health care, those who have are more than twice as likely to be on blood pressure lowering medication (O.R. = 2.178; 95% C.I.: 1.595 – 2.973), in line with Ockene, Schneider, Lemon, & Ockene (2011). Third in the above table is the co-morbid condition of diabetes, with an O.R. of 2.089. This means that given diabetes, the odds of reporting medication use for hypertension are twice as great (than are the reporting odds for non-diabetics). This independent variable, too, may be linked to health care utilization, as those with co-morbid conditions require more clinical attention than those without such conditions (Legler, 2011; Francis et al., 2011). Fourth, smoking status is independently associated with medication use among the hypertensive population of survey respondents. Table 4-6 indicates that the O.R. associated with being a non-smoker is 2.015. In other words, a non-smoker is slightly more than twice as likely (as a smoker) to
report taking anti-hypertensive medication, consistent with Bowman et al. (2007). The fifth independent variable that is shown to be statistically associated with the dependent variable is a demographic one: reporting a less than high school level of educational attainment. The data indicate that, given this level of schooling, one is 84.7% (O.R. = 1.847) times as likely as is someone with more education to report medication use for hypertension control, a finding which is concordant with work by Kiely et al. (2012). To be sure, there may be an unmeasured third variable that is related to (and could explain) both one’s ability to achieve academically and one’s ability to manage one’s hypertension without the use of a pharmaceutical intervention. Sixth, health insurance is statistically associated with the use of blood pressure lowering medications, consistent with Khan and Kaestner (2009). The data indicate that those with health insurance are 79.2% more likely to report using pharmaceutical agents than are those without health insurance. Seventh is another co-morbid condition, hypercholesterolemia, which confers a “risk” (for medication use) of 33.8%, when compared to those without this co-morbid condition. Finally, Table 4-6 concludes with a demographic independent variable: Hispanic ethnicity. The Odds Ratio for Hispanic ethnicity is 0.403, which suggests a “protective” effect against medication use, in line with the findings of Kaufman et al. (2002). It is noteworthy that this kind of effect was found first in the bivariate analysis, and it persisted with the introduction of the other independent variables.

The third thing of importance in the multivariate logistic regression is the sign of the parameter estimate assigned to a given predictor. As discussed in the previous chapter, the sign indicates whether a direct or an inverse relationship exists between the
variables of interest. A positive coefficient suggests there is a direct relationship, while a negative coefficient suggests there is an inverse relationship. As indicated previously, the sign of the parameter corresponds to the interpretation of the Odds Ratio, as a direct relationship (a positive coefficient) is a “risk” (the Odds Ratio is greater than one), while an inverse relationship (a negative coefficient) is a “protective” effect (the Odds Ratio is less than one). Consistent with the “risks” and “protections” described above, Table 4-5 above indicates that the relationships between the various independent variables are almost all positive; however, there is one inverse relationship. Specifically, an inverse relationship exists between Hispanic ethnicity and medication use. To be sure, the signs of the coefficients can also informative when presented in another format, as described next.

Because logistic regression is really just a standard linear regression with the logit, or log odds, serving as the link function (to link probabilities to a regression model), using the parameter estimates from Table 4-5, it is possible to write a regression equation, which is the model (Kleinbaum, 2008). This equation or model allows the reader to appreciate the results of the multivariate analysis in the perhaps-familiar “y=a+bx” equation – in which “y” is the dependent variable, “a” is the intercept, “b” is the parameter, and “x” is the independent variable. Based on the multivariate logistic regression, the explanatory model for the present study is as follows:

\[
\text{Log-odds} = a + \sum b_i x_i = -6.025 + 1.5040(HIGHGT1) + 0.6134(ltHS) + 1.3022(agecat) + 0.7784(mdvisit) + 0.5834(HAVEPLN3) + 0.7367(DIABCOR2) + 0.2914(chol) - 0.9082(hisp) + 0.7007(ns).
\]
While this model can be helpful to describe a given individual, if values are available for each of the independent variables of interest (which are shown in parentheses), it may be even more helpful to examine how each explanatory variable included in the model relates to each of the other explanatory variables in the model.

Table 4-7 below presents the estimated correlation matrix for all of the explanatory variables in the model. The correlation matrix computes the correlation coefficients of the columns of the matrix, and the values can vary from minus one (a perfect negative correlation), through zero (no correlation), to plus one (a perfect positive correlation).

### Table 4-7: Estimated Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>HIGHGT1</th>
<th>lTHS</th>
<th>agecat</th>
<th>mdvisit</th>
<th>HAVEPLN3</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHGT1</td>
<td>1.00000</td>
<td>-0.07838</td>
<td>0.09441</td>
<td>0.04587</td>
<td>0.08323</td>
</tr>
<tr>
<td>lTHS</td>
<td>-0.07838</td>
<td>1.00000</td>
<td>-0.09089</td>
<td>-0.06005</td>
<td>-0.23896</td>
</tr>
<tr>
<td>agecat</td>
<td>0.09441</td>
<td>-0.09089</td>
<td>1.00000</td>
<td>0.19208</td>
<td>0.21903</td>
</tr>
<tr>
<td>mdvisit</td>
<td>0.04587</td>
<td>-0.06005</td>
<td>0.19208</td>
<td>1.00000</td>
<td>0.23896</td>
</tr>
<tr>
<td>HAVEPLN3</td>
<td>0.08323</td>
<td>-0.23896</td>
<td>0.21903</td>
<td>0.23075</td>
<td>1.00000</td>
</tr>
<tr>
<td>DIABCOR2</td>
<td>0.04935</td>
<td>0.11796</td>
<td>-0.14183</td>
<td>0.02895</td>
<td></td>
</tr>
<tr>
<td>chol</td>
<td>0.07173</td>
<td>-0.05265</td>
<td>0.46212</td>
<td>-0.04714</td>
<td></td>
</tr>
<tr>
<td>hisp</td>
<td>0.17853</td>
<td>0.32825</td>
<td>-0.28973</td>
<td>0.08089</td>
<td></td>
</tr>
<tr>
<td>ns</td>
<td>0.11526</td>
<td>0.12626</td>
<td>-0.07008</td>
<td>-0.07008</td>
<td>0.08131</td>
</tr>
<tr>
<td></td>
<td>0.03250</td>
<td>0.12419</td>
<td>-0.29132</td>
<td>0.09922</td>
<td></td>
</tr>
</tbody>
</table>

As noted in Table 4-7 above, some correlations are rather strong; for example the correlation between having a less than high school education and being Hispanic is quite
strong, at 0.46212. Relatively weak correlations exist as well; for example, the correlation between diabetes and non-smoker status is 0.01867. Indeed, these kinds of results can be useful in helping to complete the picture of how the various explanatory variables come together to explain the use of antihypertensive medication by the study population.

After the generating the descriptive statistics, conducting the bivariate analysis, and constructing the multivariate logistic regression model – and presenting and interpreting these results – the question of “model quality” is begged. In other words, a reader might wonder to what extent the constructed model actually works. Statistically, there is a way to answer this question – that is, to evaluate the model. Table 4-8 below presents the Hosmer and Lemeshow Goodness-of-Fit Test for the multivariate logistic regression model. The Hosmer and Lemeshow Goodness-of-Fit Test considers the various levels of the independent variables and constructs amongst “cases” (i.e., those who use hypertension medications) and “controls” (i.e., those who do not use such medications) ten groups for which expected probabilities are determined (Hosmer & Lemeshow, 2000). A test statistic is calculated based on the observed and expected probabilities, in order to assess the model fit. A good fit (of the explanatory model to the data) is indicated if the probability of the Chi-Square statistic is greater than alpha (here, 0.05). In other words, with a p-value greater than 0.05 (as shown below, the p-value is 0.690), the Hosmer and Lemeshow Goodness-of-Fit Test (Hosmer & Lemeshow, 2000) validates this student’s claim regarding these particular independent factors being
statistically associated with the use of anti-hypertensive medication within the hypertensive study population.

Table 4-8: Hosmer and Lemeshow Goodness-of-Fit Test

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>Observed</th>
<th>Expected</th>
<th>Observed</th>
<th>Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>170</td>
<td>21</td>
<td>22.10</td>
<td>149</td>
<td>147.90</td>
</tr>
<tr>
<td>2</td>
<td>171</td>
<td>56</td>
<td>59.64</td>
<td>115</td>
<td>111.36</td>
</tr>
<tr>
<td>3</td>
<td>176</td>
<td>94</td>
<td>94.64</td>
<td>82</td>
<td>81.36</td>
</tr>
<tr>
<td>4</td>
<td>170</td>
<td>129</td>
<td>115.13</td>
<td>41</td>
<td>54.87</td>
</tr>
<tr>
<td>5</td>
<td>193</td>
<td>154</td>
<td>152.12</td>
<td>39</td>
<td>40.88</td>
</tr>
<tr>
<td>6</td>
<td>195</td>
<td>158</td>
<td>163.93</td>
<td>37</td>
<td>31.87</td>
</tr>
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Hosmer and Lemeshow Goodness-of-Fit Test

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V. Summary

This chapter provided the results of the methods described in Chapter 3. The findings from the steps taken to determine the extents to which independent variables do exert influence on the use of hypertensive medications (by those with hypertension) were presented. Specifically, the results of generating descriptive statistics; of investigating the bivariate relationship between each and every independent variable and the dependent variable; and of performing multivariate logistic regression were discussed. Based on the results of these analyses, the decision was made to reject the null hypothesis and conclude that, indeed, particular hypertensive populations of interest [i.e., those populations described by distinct and independent socio-demographic characteristics of interest] are different [from each other], with respect to taking blood pressure lowering medications for their diagnosed hypertension. These differences merit further
investigation, so as to be informative for clinical and public health interventions. This investigation, which includes a gerontological perspective as introduced and discussed in previous chapters, is found in Chapter 5.
CHAPTER 5: IMPLICATIONS

I. Introduction

The implications of the results presented in Chapter 4 are discussed in this final chapter. The discussion begins by addressing the immediate concerns related to the three overarching research constructs as presented in Chapter 1: (1) hypertension prevalence; (2) antihypertensive medication use; and (3) factors which the final multivariate logistic regression model suggests are independently and statistically associated with medication use among the study population. The narrative considers the importance of these associated factors, in terms of their usefulness in working to reduce the disease burden. In addressing the concerns, recommendations are provided. Following the discussion related to the immediate concerns and associated recommendations, the research findings are further reflected upon in connection to the changing demographics of the population. Attention is paid to the consideration of what this disease burden might look like if the prevailing trends, related to hypertension prevalence, treatment, and adherence, continue without intervention. Next, patient compliance, a topic discussed in some detail in Chapter 2, is revisited, this time with ties being made to selected psychosocial aging theories of interest. The aging theories provide a useful context for discussing the results of this study on antihypertensive medication use, as many individuals with hypertension are in the older adult age range. Finally, Chapter 5 concludes with some discussion on lessons learned (by this student) as a result of conducting this study and interpreting its results.
II. Immediate Concerns

This second section of this final chapter is presented in order to express some immediate concerns related to the study results, introduced in the previous chapter, in response to the three study questions. The order of the presentation of the immediate concerns follows the order in which the results were presented in Chapter 4. First, in looking at Table 4-2, which displays the stratified percent prevalence estimates for hypertension – in response to the first study question (i.e., what is the prevalence of hypertension?), it is obvious that certain subpopulations are feeling the disease burden disproportionately, including males (at 25.9%), relative to females (at 22.9%), and those identifying as Black (28.1%), with Black females reporting the highest hypertension prevalence estimate of any subpopulation (at 29.7%).

Given the disproportionate disease impacts on the population subgroups, the immediate concern, here, relates to design and delivery of effective screening practices and prudent public health messaging. In other words, because the disease is experienced differentially across population subgroups, the interventions to address the disease cannot utilize a “one size fits all” approach and cannot be delivered by “casting a wide net,” notions that are discussed at length in the scientific literature. In fact, an article by Kreuter, Lukwago, Bucholtz, Clark, & Sanders-Thompson (2003) goes beyond the traditional notion of targeting interventions and introduces the concept of cultural tailoring, by describing how an intervention is customized so as to conform to the specific cultural characteristics of the population of interest, taking into account things like cultural norms, religiosity, and racial pride. These same constructs are discussed in
other scientific studies as well (Resnicow, Baranowski, Ahluwalia, & Braithwaite, 1999; Bechtel & Davidhizar, 1999). Indeed, to effect positive changes related to the burden of hypertension, culturally tailored interventions are in order. This is an immediate concern, to be sure.

Next, Table 4-3 indicates the proportions of the stratified hypertensive subpopulations that report antihypertensive medication use – in response to the second study question (i.e., what proportion of the hypertensive population takes antihypertensive medication?). In viewing these results, it becomes clear that the rates of medication use vary considerably across the gender- and racial/ethnic-specific groups, as described earlier: Hypertensive females are more likely than are hypertensive males to be using pharmaceutical control measures (68.8% versus 58.6%), as are those (hypertensive individuals) self-identifying as White or of “other race/ethnicity,” relative to those (hypertensive individuals) who self-identify as Black or Hispanic. The referent groups (i.e., males and those who are Black or Hispanic) receive the attention, here, in considering these particular results and what they suggest is of immediate concern.

Because the data in Table 4-3 were collected from individuals who are known to be hypertensive, it is evident that, at some point, these individuals interacted with the health care delivery system; however, given that their medication use results vary by population subgroup, the implication is that either the treatment was differential or the adherence is. Regardless, based upon these findings, there is reason to advocate for interventions in the clinical settings. One intervention that has been discussed in the scholarly literature, and within a racial/ethnic context, besides, is intensification of
therapy: In a review of the medical records of 1,025 patients treated within twelve
general internal medicine clinics, in and around Boston, Massachusetts, over the course
of a twelve-month study period, Hicks, Shaykevich, Bates, & Ayanian (2005) found that
Hispanics are among the least likely to have their therapies for hypertension control
intensified. This, of course, is an immediate concern. It is also a call-to-action to
promote increased physician awareness (of the differential treatment experiences of
certain racial/ethnic subgroups) and to provide improved clinical education regarding
standardized treatment protocols.

Lastly, as presented in Table 4-6 above, eight independent factors are statistically
associated with the use of high blood pressure lowering medication by hypertensive
respondents to the CBRFS – in response to the third study question (i.e., what factors are
associated with medication use?). All of these factors have implications that merit
discussion. To be sure, by pondering these factors and their potential value in working to
affect positive change in regard to the hypertension burden, the reader will have some
sense of what an appropriate response to the “So what?” question is. The first two of the
eight associated factors – when ordering them by the magnitudes of the Odd Ratios, from
highest to lowest – both relate to access to care, as does the sixth one (again, in
descending order). Respectively, the three factors are “having had more than one
diagnosis for hypertension” and “having had a medical visit within the past twelve
months” and “having some form of health insurance.”

Without a doubt, having coverage and seeking and receiving routine medical care
are predictive of being on some kind of a clinical treatment plan – but these three factors
merit mention to a degree that goes beyond quantitatively confirming something that is fairly commonsensical. In fact, the first two of these factors, respectively, suggest up to a six-fold and a three-fold higher likelihood that an individual with diagnosed hypertension is currently using pharmaceutical blood pressure controls. These magnitudes of effect are noteworthy, for sure. Moreover, these results are consistent with the findings of He, Munter, Chen, Roccella, Streiffer, & Whelton (2002) and Bautista (2008) whose studies demonstrated that a number of factors related to one’s “medical home” (or usual place of care) were linked to achieving high blood pressure control. This consistency of findings is prescriptive in a way, and that is why the health education message that emerges from these results is of immediate concern. Unquestionably, one who is suffering from – or at risk of suffering from – hypertension must seek medical care and establish both a usual source of care and a regular schedule for receiving care. Doing so will increase the likelihood of being on a treatment plan in order to regain and maintain blood pressure control.

The third of the eight factors from Table 4-6 (which pertains to the third study question) is “having been given a diagnosis of diabetes,” and the seventh one is “having been given a diagnosis of high blood cholesterol.” As described in the previous chapter, based upon the respective Odds Ratios of 2.089 and 1.338, the following statements are true: (1) a hypertensive individual with diabetes is more than twice as likely as is a non-diabetic hypertensive individual to report the use of antihypertensive medication; and (2) a hypertensive individual with high cholesterol is about 34% more likely than is a hypertensive individual without high cholesterol to report the use of antihypertensive
medication. While these findings, to some degree, also speak to the notion of having and utilizing a “medical home” (as did the three factors discussed above), that is not the only take-away from these particular results.

The finding of these co-morbid conditions as associated independent “predictors” of treatment supports the notion of broadening the range of clinical subspecialist providers, whose expertise must be utilized in controlling blood pressure, thereby helping to reduce to overall disease burden. In other words, hypertension treatment must come from all physician subspecialties, a finding supported by the work of Greenfield, Rogers, Mangotich, Carney, & Tarlov (1995). In their observational study, Greenfield and his colleagues found that there were no differences in patient health outcomes (including clinical measurements, functional outcomes, and mortality) by physician subspecialty – whether family practitioners, general internists, cardiologists, or endocrinologists – or by health care system. Thus, with the results of the present study in mind, there is an immediate concern that emerges here: In order to more aggressively treat hypertension across the population, all clinical subspecialists must play a role. In so doing, there are more clinical encounters in which hypertension treatment can occur, and the burden of disease should be reduced, as a result, in the long run.

Finally, from Table 4-6 (which pertains to the third study question), the fourth, fifth, and eighth independent “predictor” variables of interest, respectively, are smoking status, academic achievement, and Hispanic ethnicity – all of which are demographic characteristics, which tend to be useful constructs in developing profiles (of program beneficiaries) and in designing interventions. In other words, in deciding whom to
pursue in carrying out health promotion programming or in delivering clinical care – within this hypertension study context, simply knowing smoking status, academic achievement, and Hispanic ethnicity can improve the level of operating efficiency. As well, there is benefit (from having this information) in being able to focus an intervention, for example, at a particular reading level or in a certain language. That is, the design and delivery of the intervention are facilitated by knowing about the intended beneficiaries. Klesges, Estabrooks, Dzewaltowski, Bull, & Glasgow (2005) refers to this aspect of planning and delivering public health programming as “…beginning with the application in mind.” In fact, these authors describe how the processes of identifying recipients and delivering interventions can be optimized by considering key elements (such as demographic profiles) at the outset of the effort. Therein lies the immediate concern: In order to maximize how efficiently and effectively services aimed at blood pressure control can be delivered, it is imperative to have certain demographic information from the start.

In this second section, a number of immediate concerns were raised, relative to hypertension and the hypertensive population, by drawing on the results presented in Chapter 4. They are these: (1) The design and delivery of effective screening practices and prudent public health messaging cannot utilize a “one size fits all” approach and cannot be delivered by “casting a wide net;” (2) There needs to be a call-to-action to promote increased physician awareness of the differential treatment experiences of certain racial/ethnic subgroups; (3) At-risk population subgroups must have and utilize a “medical home” which should include all prudent physician subspecialties; and (4)
Certain demographic information (i.e., data) can inform clinical diagnoses and treatment plans. As has been suggested in earlier chapters, there is some urgency to go along with these immediate concerns, as a result of the changing demographics of the population (Moody, 2002; Greenlund et al., 2012). The importance of these demographic changes is the focus of the next section.

III. Connection to the Aging Population

This third section of this chapter on implications is presented in order to briefly reinforce the importance of addressing the five immediate concerns as articulated above. Addressing these concerns should have a considerable impact on the current disease burden, and that should be a sufficient motivator for action. Perhaps it is. There is more compelling reason for taking action, however, and it is this: Given the changing population demographics (Moody, 2002; Greenlund et al., 2012), the high-blood-pressure-related burden of disease – which, of course, may be age-related – is going to worsen, unless the prevailing trends are somehow interrupted. In fact, DeVol et al. (2007) report that by 2023, with a national population growth estimate of 19% and because of the increasingly longer life spans Americans are enjoying, there will be a 39% rise in the number of cases of hypertension; incidentally, from a global perspective, the increase in the disease burden is expected to be even greater – about 60% (Kearney, Whelton, Reynolds, Munter, Whelton, & He, 2005). Because of this dramatic growth in the number of cases of high blood pressure in the United States DeVol et al. (2007), the 2023 national hypertension-related treatment costs and productivity losses are expected to be $88 Billion and $839 Billion, respectively. In light of these ominous financial figures,
DeVol et al. (2007) proffer two main recommendations to interrupt the prevailing trends: (1) Develop public-private partnerships aimed at prevention and early detection of chronic diseases, including hypertension; and (2) Commit to and carry out, at the national level, a healthy body weight initiative.

Based on the findings of the present study, it seems logical, to this student, to extend the high blood pressure prevention efforts from primary prevention – i.e., intervening on the hypertension risk factors – to secondary prevention – i.e., improving clinical treatment efforts for those who already suffer from the disease (Gordis, 2009). Indeed, any efforts designed to improve treatment for those suffering with hypertension surely should include interventions focused on improving adherence to pharmaceutical therapy. As described in Chapter 3, such adherence-focused efforts should improve the performance of the clinician, change the behavior of the patient, and reduce the costs and side-effects of the medications (DiMatteo et al., 1993; Sherbourne et al., 1992; Clark, 2004). Moreover, such efforts should be undertaken only with a well-developed understanding of and appreciation for the context surrounding the hypertensive population – that is, assuming a state of being which includes having become familiar with how some of the prominent theories on aging play out, related to the disease and its treatment, along with patient compliance. These theoretical constructs are explored in some detail in the fourth section of this final chapter.

IV. Compliance / Ties to Selected Aging Theories

As mentioned above, having a well-developed understanding of the theoretical constructs related to the issue of compliance – and, therefore, to the hoped-for
improvements in the disease burden, especially considering the prevailing trends discussed in the previous section – is of critical importance. To this end, this final chapter reviews some selected aging theories. In so doing, a link is provided between the theories and the issue of antihypertensive medication use. Part of this linkage entails this student’s creative generation of some original hypothetical (perhaps even folksy) “perspectives,” in line with both the theory under discussion and the subject of adherence.

It must be noted, though, that the selected theories presented below are more in line with the social sciences than with the evolutionary, natural, or biological sciences. While these latter theories of aging can explain patient non-compliance due to conditions such as senescence, memory loss, low vision, declining fine motor skills, and dysphagia, among others (Ferrini & Ferrini, 2008), the psychosocial theories tend to be more helpful in this case, as taking medications for blood pressure control, at least for a time (i.e., the time until that major event, precipitated by the lack of blood pressure control, occurs), is a function of choice, assuming the mental and physical capacities to take medications are still intact.

One of the earliest social theories on aging is Role Theory, which states that an individual holds a variety of roles during her or his lifetime, and these roles not only provide a sense of “self” but also are impactful on one’s well-being (Cottrell, 1942). Typically, though, as people get older, the roles they have tend to diminish, often in both importance and number, according to the prevailing social norms (Hooyman & Kiyak, 1999). In other words, as one ages, she or he often gets the message from society that her
or his well-being is to be different than – and less than – it once was. Or, put another way by evoking a common cliché: “It’s all downhill from here.” While the theoretical scholarship has progressed beyond Role Theory, this theory still offers some insight into aging and compliance.

Within the context of the present study, this student offers the following original hypothetical “perspective” related to Role Theory and concerning the use of antihypertensive medication: “My role is now as an older person – so I have all these health conditions and I really don’t feel so great…that’s just the way it is. I’m old…I’m not supposed to feel like I did when I was a younger person.” Surely, Role Theory (Cottrell, 1942) would suggest that one who has received a diagnosis of hypertension and been prescribed a course of treatment might take on the role of a dependent, or, possibly, a victim, of sorts – especially if one has other health concerns, such as those brought on by smoking, shown in this study to be associated with a lack of medication use. Being a dependent, or a victim, is now her or his role (as she or he sees it), and that mentality might impair compliance. Indeed, understanding this perspective (however real or imagined) would be important in discussing and promoting patient compliance, and improved compliance leads to better outcomes, individually and in the aggregate.

A second well-known, though somewhat contested, social theory on aging, from around the middle of the last century, is Disengagement Theory, which suggests that as people get older, they naturally tend to withdraw from their relationships and from society – and that process of withdrawal is a mutual one, which occurs only when both parties are ready (Cumming & Henry, 1961). Because the process occurs mutually (i.e.,
it is mutual for the individual and society), it is often viewed as being adaptive, particularly at the individual-level, as the elder is able to maintain some sense of dignity during the adjustment (Hooyman & Kiyak, 1999). Indeed, this adaptive nature lends some positivity to this decades-old theory. As was the case with the thinking on the historic Role Theory, scholars have further refined their views of Disengagement Theory – by honing in on this positive essence, even reframing the adaptive disengagement as a kind of gero-transcendence (Tornstam, 1989).

Again, within the context of this study on hypertension, this student suggests the following original hypothetical “perspective” related to Disengagement Theory and concerning the use of blood pressure lowering medications: “You know, since I’ve gotten older, I haven’t been all that social…I mostly just keep to myself. It’s not that I’ve been excluded or anything…it’s just that I feel like I’m at a point now when I simply want to have some alone time. Friends, family, everyone – they’ve got their stuff to do and I’ve got mine. Heck, I kind of like it that no one is really paying me too much attention…” Indeed, Disengagement Theory (Cumming & Henry, 1961) would suggest that as one becomes disengaged, there is less of a social support system (e.g., friends, family members, neighbors) to ensure compliance with prescribed therapies. This could extent to a clinical support system, as well, as a lack of interaction with the health care system predicts a lack of medication use, as demonstrated in the present study. Incidentally, this notion of “prediction,” is definitely not a foreign one in the study of health behavior. The Theory of Planned Behavior (Ajzen, 1989) describes how behavioral intentions – which lead to behaviors, of course – are influenced by attitudes, feelings of control, and social
Certainly, being mindful of the mutualism (with society) that is part of this disengagement construct would be valuable in understanding and fostering improved patient adherence to prescribed therapies.

Around the same time that Disengagement Theory was emerging and being discussed, another social theory related to aging and adjustment into later life was gaining support, even with its divergent emphasis: Activity Theory. This theory, espoused by Robert J. Havighurst (1963), maintains that successful aging requires one to remain as engaged and active as is possible – even substituting and adapting one’s usual roles, with advancing age, as needed. Activity Theory, like Role Theory…but in contrast to Disengagement Theory, is focused on the individual and her or his perspectives and choices, free of out-and-out regard to societal norms or pressures. In other words, with Activity Theory, the onus for achieving “success” in aging is squarely on the individual. Interestingly, more recent scholarship has studied Activity Theory in relation not to the whole of aging but to the ongoing management of daily life (Katz, 2002).

From this more refined thinking regarding Activity Theory, this student’s suggested original hypothetical “perspective” explains compliance in this case, rather than non-compliance as described above. Now this student hypothesizes the following original hypothetical perspective, related to Activity Theory and concerning the use of antihypertensive medications: “Are you kidding me? Slow down? Why would I do that? Yes, I’m getting old…and, yes, I have to take some pills, but I’m not dying. I still have a lot to do; I’m busy every day, and I want to stay healthy and continue to enjoy life!” Without a doubt, Activity Theory (Havighurst, 1963) would suggest that as long as one
stays active and engaged, she or he is more likely to adhere to prescribed clinical 
treatment plans. Logically, staying engaged may well include the continuation of routine 
medical care, which predicts medication use, as demonstrated in this study. Hence, being 
attentive to the constructs of Activity Theory should promote further understanding of 
patient adherence.

Next, building on the Activity Theory, Robert Atchley (1971) proposed 
Continuity Theory, which suggests that as a person ages, she or he maintains, to the best 
of her or his abilities, the same personality traits, tendencies, and regular habits she or he 
developed over the course of her or his life; moreover, it suggests that a person utilizes 
the same coping strategies or adaptive techniques that were employed successfully earlier 
in life, when changes do occur (Atchley, 1989). In other words, continuity holds whether 
life tends to be static or dynamic. Or, put another way, again by evoking a common 
cliché: “Same old…same old.” This notion of continuity, even in the midst of change, 
has been studied recently within the context of major life events like residential 
relocation; the results bear out this notion that certain things simply persist, regardless of 
what else is happening (McFadden & Lunsman, 2010; Bjelde & Sanders, 2012).

In line with this idea of continuity and within the context of the present study and 
this ongoing discussion on patient compliance, this student offers the following original 
hypothetical “perspectives” – from both an individual point-of-view and a generational 
one: At the individual level – “I have always been able to take care of myself…why 
should I listen to this doctor?” I didn’t need someone telling me what to do before, and I 
don’t need anyone doing that now!” And at the generational level – “My dad didn’t take
a bunch of pills every day…and I’m not going to either. He did okay and so will I. This discussion is over!” These two original scenarios are both consistent the concept of continuity, as proposed by Atchley (1971), and informative with respect to poor patient adherence. Clearly, to better understand and promote patient adherence, one must appreciate the idea of continuity, whether within an individual’s experience or from a generational perspective.

While these four early social theories on aging are very informative, there is also value in looking at some of the more modern ideas that have built on these distinguished models. In contrast to these older models, which sought to describe what an individual’s experience is like in the latter years, the modern scholarship tends to look at aging across the entire life course and view it as a continual process (Moody, 2002). By viewing aging across the lifespan, other explanatory frameworks are described, including Social Exchange Theory, the Political Economy of Aging, and the Life Course Perspective (Hooyman & Kiyak, 1999). Much like the historical theories introduced above (did), these broader, more contemporary models of aging provide insight into the issue at hand: antihypertensive medication use.

First, Social Exchange Theory (Dowd, 1980) posits that all social exchanges have costs and benefits for those involved in the transaction, and so long as these costs and benefits stay in balance (or are viewed as favorable by the members of the exchange), the interactions will continue. If, however, the balance shifts, then the interactions will cease. Within the context of this study, Social Exchange Theory might look something like this original hypothetical “perspective:” “I just don’t like going to the doctor
anymore. Lately, he’s been telling me to take better care of myself. I just want to enjoy life, and going to the doctor isn’t how I want to spend my time. I’d rather be doing other things.” The reader can imagine how a doctor-patient exchange can fall out of balance, thereby negatively affecting patient adherence. Given the results of the multivariate regression analysis performed in this study, routine care predicts medication use; when care is no longer routine, the patient’s risk profile can worsen.

Next is the Political Economy of Aging, which looks at aging not only across the life course, but also within the domain of society and public policy (Bengston, Silverstein, Putney, & Gans, 2009). The Political Economy of Aging postulates that social programming, which is in place to meet people’s needs at various stages in their lives, is inadequate to serve the elderly population. In fact, this construct suggests that the social programs directed toward the elderly have been more beneficial to capitalist interests than to the senior population (Estes, Swan, & Gerard, 1982). In other words, the senior experience is in no small way shaped by political and economic factors – thereby suggesting that the many of the challenges faced by older people are not self-imposed…they are socially constructed. In line with the results of this study, Political Economy of Aging might conjure something like this original hypothetical “perspective:” “Why are these pills so darn expensive? It’s outrageous. I can’t pay for these. I’m on a fixed income. Now I’m going to get sicker while the fat cats at Pfizer get richer…” Unquestionably, the inability to pay for medications negatively impacts patient adherence (Zyczynski & Coyne, 2000). And the ability to pay is often limited due to political and economic constraints.
Finally, the last modern aging theoretical construct which merits mention within the context of this study is the Life Course Perspective, which is less of a formal theory and more of a useful framework (Hooyman & Kiyak, 1999). The premise of the Life Course Perspective is that one’s development occurs all along the lifespan and is influenced by past individual and societal events and impacts (Heinz & Marshall, 2003). In fact, this perspective is among the most broad, given its inclusion of historical events, at both the individual and societal levels, as factors involved in shaping present situations. Its applicability within the present study can be demonstrated via a final original hypothetical “perspective,” as follows: “When I was a kid, we didn’t know cigarettes were bad for you…so we all started smoking ‘em. That’s just the way it was. And now we’re all suffering for it. Sixty years of smoking – it’s just about killed me.”

Given the results of the modeling performed in this study, smoking predicts a lack of medication use. Certainly, the Life Course Perspective provides an interesting framework for thinking about the “stories” behind the results.

V. Lessons Learned

This final section of this last chapter briefly discusses some of the lessons learned in conducting this hypertension study and completing this culminating experience for the master’s level degree. Accordingly, this narrative is reflective in nature, and the author’s voice reflects that. First, this student learned a great deal more about hypertension. While studying the subject matter, it became abundantly clear that hypertension is very prominent in both the popular literature (as discussed in Chapter 1) and in the scholarly literature (as discussed in Chapters 2 and 5); moreover, it is a subject that has been under
investigation for more than half of a century, and there seems to be no signs to predict its fading. The reason for this continued interest, of course, is the changing population demographics. As the population ages, hypertension will be a “hot topic” within the gerontological-, clinical-, and public-health-circles – as will other chronic, age-related diseases and conditions. Finally, in studying hypertension, this student felt that it is a subject that has fit well within this student’s gerontological studies to date. Indeed, this student has studied aging holistically, and the subject matter at hand lends itself easily for this kind of study.

Next, this student learned lessons related the actual conduct of the study. First, he refined his ability to perform a comprehensive literature review, including looking at the preeminent historical studies that identified hypertension not only as a disease unto itself, but also as a risk factor for future cardiovascular events. This student was also able to follow the scholarship into the modern era and appreciate the ways in which the thinking on hypertension evolved. Second, on the subject of the methodological lessons learned, this student increased his familiarity with the CBRFS, enhanced his skills using SAS, and improved his capacity to perform multivariate methods and interpret the results. Lastly, with respect to the methods this student employed in this carrying out this culminating experience, he was able to enhance his writing skills. In short, the conduct of this project was quite educational for this student (as it should have been).

Finally, there were lessons learned related to the study’s implications, as the findings pointed to both immediate concerns and broader connections to the social theories of aging. With respect to the former, there were five key immediate concerns,
including the following (1) effecting positive changes related to the burden of hypertension requires culturally tailored interventions; (2) providing improved clinical education regarding standardized treatment protocols should minimize the differential treatment experiences of certain racial/ethnic subgroups; (3) identifying the medically indigent or underserved and establishing both a usual source of care and a regular schedule for receiving care – and possibly a source of payment as well – will provide benefits to the afflicted individuals while reducing the disease burden; (4) utilizing all appropriate clinical subspecialists in the (prevention and) treatment of hypertension will expand (primary and) secondary prevention efforts; and (5) maximizing how efficiently and effectively services aimed at blood pressure control can be delivered is facilitated by having certain demographic information from the start. Last, with regard to the connections to aging theory, the key lesson learned is that placing these study results within proper theoretical contexts can really enhance one’s understanding of a particular subject. Indeed, interpreting the study findings within both the historical theories and the more contemporary aging frameworks was invaluable.

VI. Conclusion

Following the first four chapters, wherein highlights of the popular and scientific literature were presented and the study methods and results were described, this final chapter provided a discussion of the implications of the results, specifically, and the conduct of the study, more generally. First, immediate concerns were addressed. Next, the urgency of these concerns was highlighted via a reminder of the rapid aging of the population. Further, the study findings were considered within selected theoretical
contexts, in order to more fully understand them. Finally, the lessons learned by this
student through the conduct of this study were enumerated.

In the final analysis, this study showed that nearly one in four California adults is
hypertensive, and differences exist within gender- and racial/ethnic-specific groups.
Moreover, among hypertensive individuals, nearly two in three report using blood
pressure lowering medications, again with differences being observed across the
population subgroups. Finally, particular factors were shown to be associated with
medication use, including having had multiple hypertension diagnoses, seeing a physician
within the past year; having diabetes; being a non-smoker; having low educational
achievement; and being insured. Understanding these factors may inform the
development of strategies to increase medication use among those with hypertension and,
in the long-run, reduce the hypertension-related burden of disease.
REFERENCES


Charting a new course to save lives and increase productivity and economic growth.

Santa Monica, California: Milken Institute.


Stein J. Drinking fewer sugary beverages could be linked to lower blood pressure. *Los Angeles Times*. May 24, 2010.


