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U.S. Army Enlisted Soldiers' Adherence to Prescribed Malaria Chemoprophylaxis in Afghanistan

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Abstract

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CPT Michael P. Brisson

MPH, American Military University, 2011

BS, Embry-Riddle Aeronautical University, 2008

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Over the past 13 years, the United States Army has been engaged in armed conflict within Afghanistan. Unfortunately, the United States Army has been forced to evacuate soldiers from the battlefield because of malaria, a parasitic disease that is endemic in Afghanistan. Even though the U.S. Army has adopted an effective chemoprophylaxis protocol, soldiers’ adherence to their prescribed medication has been historically low. This research addressed a gap in literature regarding the adherence rates of U.S. Army enlisted soldiers to their prescribed oral malaria chemoprophylaxis. In addition, this research investigated self-reported reasons for soldiers’ nonadherence to this medication. The study employed an experimental, correlational research design to aid in understanding the relationship between adherence to malaria chemoprophylaxis and age, gender, military rank, education level, and previous deployment experience. Ninety-four active-duty U.S. Army personnel deployed to Afghanistan participated in the study. The frequency distribution of responses to the 8-questions Morisky Medication Adherence Scale were presented and indicated that for almost all of the questions, the percentage of participants who answered yes was larger than the percentage who answered no, indicating low levels of adherence among the study participants. The findings indicated that age, gender, and perception of risk all significantly contributed to the models predicting medication adherence. With the scientific and medical advances of the 20th and 21st centuries, few if any military personnel should contract malaria. These findings contribute to a greater awareness of medication adherence, which directly supports positive social change within the Armed Forces of the United States.

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Dedication

First and foremost, I must dedicate this work to my wife and best friend. Sarah, without your love, support, and persistence, none of this would have ever been possible. You gave me the strength to keep going and the balance I needed to ensure family time was never compromised. I am forever grateful, especially in terms of helping me raise our son, Noah. Thank you for supporting me when I needed the extra time on the computer. Thank you for allowing me to travel far away from home for my residencies. And thank you for helping me become a better researcher and public health practitioner. You and Noah are the most important people in my life so please never forget that.

Secondly, I need to also dedicate this work to my parents, Dr. Paul Brisson and Mrs. Debbie Brisson. Dad, without your perpetual guidance and routine editing services, this would not have been possible. You have made me a better writer, a better practitioner, and a better researcher. Mom, thanks for giving me the foundation I needed to be successful in graduate school. Your work ethic has definitely rubbed off on me. For that, I am eternally grateful. I need to also thank you for providing me with a home that puts family first. You and Dad are responsible for the husband and father that I am today.

Lastly, I need to dedicate this work to the men and women of the U.S. Armed Forces, particularly the enlisted personnel of the U.S. Army who agreed to be participants in this survey. Without their selfless service to our country, none of this would have been possible.

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This has been a long and challenging process. I must thank my wife, Sarah, and my two children, Noah and Lucas, for their continued patience and encouragement. Special thanks is due to my committee chair, Dr. Mark White, and my second committee member, Dr. Lee Caplan. Your patience and diligence over the past year is very much appreciated. Without either of you, this would not have been accomplished. In addition, this dissertation would not have been a success without the full support from the rest of Walden University staff and faculty.

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Chapter 1: Introduction to the Study

Malaria is endemic in many regions of Afghanistan and is a cause of morbidity for U.S. Army enlisted personnel deployed to the region (Armed Forces Health Surveillance Center, 2013). Although no U.S. Army enlisted personnel have lost their life to malaria, a malaria diagnosis poses significant challenges to the United States, including degradation in combat power, loss of productivity, and unnecessary fiscal expenditures. Over the past 13 years, the U.S. Army has been engaged in armed conflict with insurgent groups operating in Afghanistan. During this time, hundreds of thousands of personnel have deployed to this hostile and remote environment. In previous studies, Kotwal et al. (2005) and Whitman et al. (2010) demonstrated poor adherence to prescribed chemoprophylaxis regimens. However, Kotwal et al. and Whitman et al. used samples composed of troops who had already contracted the disease or whose unit members had contracted the disease, possibly altering the results (Kotwal et al., 2005; Newton et al., 1994; Whitman et al., 2010). Researchers have posited numerous reasons for the ongoing contraction of malaria among U.S. service members in Afghanistan, including poor compliance with prescribed chemoprophylaxis regimens (Kotwal et al., 2005; Newton et al., 1994) and poor compliance with other prescribed prophylactic measures (Whitman et al., 2010). In this study, I assessed the rate of adherence to a malaria chemoprophylaxis regimen among U.S. Army enlisted personnel and investigated their self-reported reasons for nonadherence. The guiding premise of this study was that the contraction of malaria by U.S. Army enlisted personnel in Afghanistan can be reduced or even eliminated with higher levels of adherence to a prescribed oral malaria chemoprophylaxis regimen. I designed this study to provide the quantitative data needed to support any necessary changes in the U.S. Army's Force Health Protection protocols and thereby reducing any degradation in combat power, loss of productivity, and unnecessary fiscal expenditures that can be attributed to the contraction of malaria.

Problem Statement

I designed this research to address a gap in the literature on adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel and investigated the self-reported reasons for nonadherence among this population. Researchers consider malaria to be one of several communicable diseases that directly threaten the health and welfare of deployed personnel. Between 2003 and 2011, servicemembers in Afghanistan accounted for between 20 and 91 cases of malaria each year (Armed Forces Health Surveillance Center, 2013). In 2011, there were 91 confirmed cases of malaria that required evacuation from Afghanistan (Armed Forces Health Surveillance Center, 2013).

To reduce the likelihood of contracting malaria, U.S. Army doctors prescribe an oral malaria chemoprophylaxis regimen to U.S. Army enlisted personnel serving in Afghanistan. The Surgeon General of the U.S. Army recommends doxycycline as the primary chemoprophylaxis because researchers have documented the high efficacy of the drug in preventing the contraction of malaria (Ohrt et al., 1997; Tan, Magill, Parise, & Arguin, 2011). A recent study in a military population demonstrated a compliance rate of 61% (N = 195/302) with daily dosing and 38% (N = 16/42) with weekly dosing (Brisson & Brisson, 2012). Troop commanders, in collaboration with their medical officers, are primarily accountable for the health and welfare of deployed personnel, including their adherence to a prescribed chemoprophylaxis regimen.

In previous studies, researchers have demonstrated compliance rates of less than 60% (N = 270/521); however, these researchers studied samples of military servicemembers who had already been diagnosed with malaria, possibly affecting the results due to fear of reprisal under the Uniform Code of Military Justice (Kotwal et al., 2005; Newton et al., 1994; Whitman et al., 2010). This study on adherence to a prescribed oral malaria chemoprophylaxis regimen and the self-reported reasons for nonadherence among a sample of healthy U.S. Army enlisted personnel serving in Afghanistan is the first of its kind.

Nature of the Study

The nature of this study was quantitative. Researchers have documented historically low adherence rates with quantitative data. By investigating and analyzing the self-reported reasons for nonadherence, I sought to provide the U.S. Army Public Health Command officials with evidence and information to support any needed modifications to the U.S. Army's Force Health Protection protocol. If this information results in changes to the U.S. Army's Force Health Protection protocol, the new protocol will be disseminated throughout the U.S. Army, positively influencing the individual soldier and the individual soldier's immediate chain of command by reducing the risk of contracting malaria. Furthermore, U.S. Army leaders may use the findings from this study to modify predeployment training and education on the importance of adherence to the prescribed oral malaria prophylaxis regimen while deployed and to modify policies for supervisor oversight while in the theater.

Research Questions and Hypotheses

In this study, I used a nonexperimental, quantitative correlational research design to aid me in understanding the relationship between adherence to an oral malaria chemoprophylaxis regimen and the demographic characteristics of age, gender, and education; military rank/grade; previous deployment experience; and perception of risk. I conducted multiple linear regression analysis to test the study hypotheses and determine the nature of the relationship between the dependent variable total MMAS-8 and the independent variables of age, gender, education level, military rank/grade, previous deployment experience, and perception of risk.

RQ1. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how are the demographic characteristics of age, gender, and education level associated with adherence to oral malaria chemoprophylaxis?

$H1_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis and the demographic characteristics of age, gender, and education level.

$H1_a$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis and the demographic characteristics of age, gender, and education level.

RQ2. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how are the military service characteristics of military rank and previous deployment experience associated with adherence to oral malaria chemoprophylaxis?

$H2_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis and the military service characteristics of military rank and previous deployment experience.

$H2_a$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis and the military service characteristics of military rank and previous deployment experience.

RQ3. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how is the perception of malaria risk and personal experience with malaria associated with adherence to oral malaria chemoprophylaxis?

$H3_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis, the perception of malaria risk, and personal experience with malaria.

H3_a. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis, the perception of malaria risk, and personal experience with malaria.

Theoretical Constructs

Researchers have identified more than 200 elements that are known to affect medication adherence among adults in the civilian population. Based on these findings, researchers have developed numerous theoretical models to explain the phenomenon of medication adherence and created specific constructs to measure the relationships between these elements. Of particular importance is the finding that a patient's individual beliefs are the most influential element in determining the patient's propensity to adhere to a prescribed medication regime. Patient beliefs can include personal perceptions about the need for the medication, the safety of the prescribed medication, and the overall effectiveness of the medication (Veazie & Cai, 2006). Consistent with these findings, the social cognitive theory and the health belief model formed the theoretical basis of this study.

Social Cognitive Theory

Originally known as the social learning theory, the social cognitive theory, as proposed by Canadian psychologist Albert Bandura, is perhaps the most influential theory of development and learning within the realm of public health. The fundamental basis of the social cognitive theory is that individuals learn not only through personal experiences but by observing the actions of others and the subsequent results of those actions (Bandura, 1997). As the social cognitive theory evolved, Bandura (1997) continued to postulate how individuals obtain and preserve certain behavioral patterns. Bandura also proposed a framework for designing, implementing, and evaluating programs, all of which were incorporated into the social cognitive theory. The two primary components of the social cognitive theory include the modeling of behaviors performed by others and self-efficacy (Goldman & Schmalz, 2001).

By adopting the social cognitive theory, researchers are assuming that individuals perpetually interact with the environments in which they inhabit. The social cognitive theory incorporates both the cognitive and psychosocial variables used to determine the healthy behaviors and strategies adopted to promote real behavioral change (Abraham, Clifft, & Grabowski, 1999). In social cognitive theory, an individual's behavior is defined in terms of a dynamic, reciprocal theory in which environmental influences, personal factors, and behavior persistently interact (Abraham et al., 1999). The basic tenet of social cognitive theory is that an individual learns not only through personal experience but by observing the actions of others and contemplating the results of those actions as depicted in the health belief model (Conner & Norman, 1996).

In a study of cognition measures, Abraham et al. (1999) determined that the health belief model and the theory of planned behavior could be used to differentiate between study participants who adhered to malaria prophylactic measures and study participants who did not. Abraham et al. conducted a longitudinal study and used samples of tourists from the United Kingdom who had returned from the Gambia region, a region in which malaria is endemic. Abraham et al. administered a short questionnaire to United

Kingdom tourists on the day of their departure from the Gambia region and administered another follow-up questionnaire 5 and 7 weeks later to the same participants (Abraham et al., 1999). Of the 167 participants, 106 (63%) reported using mefloquine and 61 (37%) reported using proguanil and chloroquine. Abraham et al. demonstrated that approximately 22.5% of mefloquine users and 31% of proguanil and chloroquine users reported adhering to the prescribed oral malaria chemoprophylaxis regimen for a period less than or equal to 3 weeks.

Health Belief Model

The tenets of the health belief model were originally proposed in the early 1950s when social psychologists working with the U.S. Public Health Service attempted to predict and explain a variety of different health behaviors (Rosenstock, 1974). The U.S. Public Health service originally introduced the heath belief model in response to the failure of the free tuberculosis health screening program (Rosenstock, 1974). Since its inception, researchers have used the health belief model to investigate numerous short-term and long-term health behaviors. Even though the health belief model is the most commonly cited model in medication adherence studies, the actual model is intended to explain the health behaviors of the individual without consideration for environmental, socioeconomic, and interpersonal factors. Despite these limitations, the health belief model is used to explain that adherence to a prescribed medication regimen is primarily based on a trade-off between the perceived susceptibility to the disease and severity of the disease, the perceived barriers to medication adherence and benefits from medication adherence, and the treatment options available (Bosworth et al., 2006; Lerner, 1997).

Definition of Terms

The following phrases and terms are used in this study:

Chemoprophylaxis: The administration of medication for the primary purpose of preventing an infection or disease (Woolf, Jonas, & Kaplan-Liss, 2007). The U.S. Army has chosen doxycycline as the first-line medication used to prevent malaria among U.S. personnel deployed to Afghanistan (Shoomaker, 2009). The use of any chemoprophylaxis is primarily limited by two factors, financial costs and risk (Woolf et al., 2007).

Combat power: The total means of destructive and/or disruptive force which a unit or formation can apply against the opponent at a given time (Department of the Army, 2012). Combat power is composed of four distinct elements that include maneuver, firepower, protection, and leadership (Department of the Army, 2012).

Enlisted soldier: Any servicemember in the U.S. Army who holds a rank or pay grade below that of a commissioned officer (Department of Defense, 2013). The following pay grades and ranks are classified as enlisted: E1 (Private), E2 (Private E-2), E3 (Private First Class), E4 (Specialist or Corporal), E5 (Sergeant), E6 (Staff Sergeant), E7 (Sergeant First Class), E8 (Master Sergeant or First Sergeant), and E9 (Sergeant Major or Command Sergeant Major; U.S. Department of Defense, 2013). Servicemembers classified as E1 through E4 are typically in training or serving in their initial assignment following basic training (U.S. Department of Defense, 2013). Servicemembers classified as E5 through E7 are considered noncommissioned officers (NCOs), with leadership responsibility increasing in a linear fashion with increasing pay grade (U.S. Department of Defense, 2013). Servicemembers classified as E8 through E9 are considered senior NCOs, with a total of 15 to 30 years in service. These NCOs primarily serve as the "commanders' senior advisers for enlisted matters" (U.S. Department of Defense, 2013, para. 3).

Regional Command (RC): The various areas of operations within the country of Afghanistan (International Security Assistance Force, 2014). The International Security Assistance Force Joint Command, which is responsible for all operations throughout Afghanistan, has divided Afghanistan into six different areas of operation, known as regional commands. These regional commands include Regional Command-North (RC-North), Regional Command-South (RC-South), Regional Command-East (RC-East), Regional Command-West (RC-West), Regional Command-Southwest (RC-Southwest), and Regional Command-Capital (RC-Capital; International Security Assistance Force, 2014).

Assumptions

I made several assumptions in the design of this study. First, I assumed that all enlisted personnel deployed to Afghanistan, regardless of rank/grade or education level, were provided with an adequate supply of oral malaria chemoprophylaxis, per the Army's Medical Protection System. I also assumed that the participants had not experienced any contraindications that prevented them from adhering to a prescribed oral malaria chemoprophylaxis regimen. Furthermore, I assumed that the personnel were provided with a venue or other opportunity to ask questions about their prescribed oral chemoprophylaxis regimen. Finally, I assumed that the data I collected from a regional command in Afghanistan would be an accurate representation of rates of adherence to the prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel.

Limitations

There were several limitations to this study. Due to operational security restrictions currently in place by the Department of the Army and the Department of Defense, I was unable to provide data on the specific location and total number of servicemembers present in the area that I sampled. An additional limitation of the study design, inherent to combat operations, was accessibility to the survey. Not every individual currently assigned to Afghanistan has routine or consistent access to email. In addition, not every individual has an active email account within the U.S. Army network within Afghanistan. Because of this, the sample population is not likely to be representative of the U.S. military as a whole or the U.S. Army as a whole.

Since military regulations require that U.S. Army personnel adhere to their prescribed oral malaria chemoprophylaxis regimen, it is possible that some of the participants were not completely honest when reporting their adherence. Even though the survey was anonymous, it is possible that some personnel feared reprisal for nonadherence. Therefore, it is possible that the rate of nonadherence was actually higher than was reported in this study.

Delimitations

I designed this study to have numerous strengths, including simple, quantitative questions that have been validated as part of the MMAS-8. In addition, by making participation in the study anonymous, I hoped to encourage individuals to be completely honest about their adherence to the prescribed oral malaria chemoprophylaxis regimen.

Significance of the Study

This study is the first time adherence to an oral malaria chemoprophylaxis regimen and the self-reported reasons for nonadherence have been examined in a sample of enlisted U.S. Army personnel deployed to Afghanistan. The U.S. Army defines enlisted as any individual that holds the rank of E-1 (no-insignia Private) to E-9 (Command Sergeant Major). Enlisted personnel in the U.S. Army comprise a majority of the ground force currently engaged in operations in Afghanistan. As of 2012, enlisted personnel accounted for approximately 86.6% (n = 416,776) of the active duty force (Department of the Army, 2012). Given their role as the primary combatant group and given that even one evacuated individual diminishes the combat power of the United States, U.S. Army officials consider the health and welfare of enlisted personnel to be paramount to the success of military operations in Afghanistan (Ryan & Stewart, 2012).

To counter the threat of malaria, the U.S. Army has enacted numerous Force Health Protection protocols for deployed personnel, including the use of insect repellant, adherence to a daily primary chemoprophylaxis agent, the wearing of permethrin-treated uniforms, and the use of a terminal chemoprophylaxis (Armed Forces Health Surveillance Center, 2013). The daily primary chemoprophylaxis agent is doxycycline, 100 mg by mouth, once per day (Tan et al., 2011).

The findings from this study are significant and may provide unit commanders, medical officers, and public health officials with quantitative evidence and information to support any needed modifications to the U.S. Army's Force Health Protection protocol. The purpose of this study was to quantitatively document adherence to a prescribed oral malaria chemoprophylaxis regimen and identify any self-reported reasons for nonadherence among U.S. Army enlisted personnel.

Social Change Implications

The findings of this study could have significant implications for many key stakeholders, including the Department of Defense, the U.S. Army, the U.S. Army Public Health Command, unit-level command teams, and, most importantly, the individual soldier. Even after the continued drawdown of troops from the country of Afghanistan, there is still a chance that personnel will remain in the country for the foreseeable future. According to Cohen (2014), the "bilateral security agreement being negotiated with Afghan President Hamid Karzai could keep some U.S. troops on the ground until 2024" (para. 3). As long as U.S. forces remain deployed to a region in which malaria is endemic, prevention of malaria will remain the paramount concern of public health administrators and medical personnel working to ensure the health and welfare of these volunteers.

Unit commanders, medical officers, and public health officials may use the findings from this study to advocate for improvements to the malaria prevention and education mandates of the U.S. Army's Force Health Protection protocol. Researchers have found relatively low levels of adherence to prescribed malaria chemoprophylaxis regimens in other samples, which the findings from this study supported; therefore, unit commanders, medical officers, and public health officials could use a new approach, based on the quantitative data from this study, to increase adherence rates and decrease the incidence of malaria among U.S. Army enlisted personnel serving in Afghanistan. This constitutes a significant and valuable positive social change that could impact not only the military but civilian populations of multiple nations.

Summary

In Chapter 1, I introduced the major elements of the present study, such as the background of the study, the problem statement, the research questions, the nature of the study, the assumptions of the study, the limitations of the study, the delimitations of the study, the significance of the study, and the social change implications. In Chapter 2, I will present the results of an exhaustive review of the literature pertaining to malaria in both general and specific terms, including a history of the disease, the epidemiology of the disease, the pathophysiology of the disease, and its prevalence within Afghanistan. In addition, I will present a review of prior research regarding malaria among U.S. service members to determine historic rates of compliance and adherence. Finally, I will present a discussion of the risk factors associated with malaria, particularly in Afghanistan, to demonstrate the challenges that U.S. Army enlisted personnel face on a continual basis.

In Chapter 3, I will outline the research approach and design that I used for this study. I will also review the sample selection, survey instrument, data collection methods, and statistical analyses. In Chapter 4, I will present the results of the statistical analyses of the study data. In this chapter, I will present a description of the demographic characteristics of the sample, the employment characteristics of the sample, the perception of risk characteristics of the sample, and the personal experience with malaria characteristics of the sample. Then I will present a description of the responses to the items of the MMAS-8, and finally I will present the results of the regression analysis I used to test the study hypotheses.

To conclude the study in Chapter 5, I will present a discussion of the findings, the conclusions that I believed could be drawn from the findings, and my recommendations for future research. In Chapter 5 I will present an interpretation of my findings by each hypothesis, then I will outline the limitations of the study, my recommendations for future research, and the implications I believe the findings from this study will have for social change.

Chapter 2: Literature Review

The findings from this study address a gap in the literature on adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel deployed to Afghanistan. In addition, U.S. Army commanders and medical officers need a fundamental understanding of the common reasons for nonadherence in order to effectively modify or improve any existing U.S. Army Force Health Protection protocols. However, there is minimal information available on the self-reported reasons for nonadherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel deployed to Afghanistan. This represented another gap in the literature that the findings from this study address.

In the first part of this chapter, I will describe what causes malaria and present information on the research variables that I used to test the study hypotheses. In the main body of the literature review, I will present a discussion of the research involving the pathophysiology of malaria, the epidemiology of malaria in Afghanistan, and malaria prophylaxis used by the U.S. Army. A review of the prior malaria cases within the United States revealed a gap in the literature pertaining to the population sampled for this study. Lastly, I will present a compilation of the quantitative methods that other researchers have used in similar studies.

I used several databases in my search for relevant literature: CINAHL, MEDLINE, Health Sciences: A Sage Full-Text Collection, Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), PubMed, and the Armed Forces Health Surveillance Center. I limited my search to literature published from 1953 to 2013, with the exception of seminal works or when newer research was not available. I compiled the research in the literature review primarily from peer-reviewed journal articles and authoritative databases, including WHO, CDC, and the U.S. Department of Defense. My search terms included *malaria*, *epidemiology of malaria*, *malaria in Afghanistan*, *malaria risk factors*, *malaria chemoprophylaxis*, *U.S. Army force health protection*, *COCOM predeployment and medical waiver requirements*, *prevention of malaria*, *malaria among U.S. servicemembers*, and *malaria surveillance*. I selected the most appropriate articles from each of the search terms and included them in this literature review.

Causes of Malaria

Malaria is a serious and sometimes fatal disease contracted by humans and animals and caused by parasitic protozoans of the genus *Plasmodium* (CDC, 2012). Individuals who contract malaria often experience a range of symptoms that are similar to the flu, including chills, fever, diaphoresis, and body aches (CDC, 2010). The CDC (2015) estimated that in 2010 there were approximately 219 million cases of malaria worldwide and 660,000 people succumbed to the disease. A majority of the cases (91%) occurred in the African Region (CDC, 2015).

Cox (2010) wrote that a fundamental understanding of malaria parasites began in 1880 when a physician by the name of Alphonse Laveran first discovered the presence of these parasites in the blood of his malaria patients. Researchers in 1897 uncovered the sexual stages and means of transmission of the malaria parasite within the blood of birds infected with *P. relictum* (Cox, 2010). However, it was not until 1898 that Italian *malariologists* proved definitively that human malaria was transmitted by the *Anopheline* mosquito (Cox, 2010, p. 5). Even though the reproductive and transmission cycles of malaria parasites was not well understood until the late 19th century, cases of malaria have been traced back to the 300 BC.

Researchers have shown that malaria is a disease of ancient times, with Chinese documents as early as 2700 BC describing signs and symptoms consistent with acute malaria (Cox, 2010). In addition, Cox (2010) provided evidence that ancient Greeks were aware of malarial fevers and splenomegaly, particularly among those residing in swamps or marshy areas. Hippocrates, considered to be the father of medicine, believed that the fevers and enlarged spleens were caused by “miasmas rising from swamps” (Cox, 2010, p. 5). This notion persisted for nearly 3 millennia, which led the Italians to coin the term *mal’aria*, meaning “spoiled air” (Cox, 2010, p. 5).

Malaria is an acute infection of one of five species of *Plasmodium*, the life cycles of which are very similar for each species (Cox, 2010). Jacobs-Lorena (2003) demonstrated that malaria was an overwhelming disease that killed between 1 million and 2 million people each year, a majority of which occurred in Africa. Seixas et al. (2009) concluded that among the five species of *Plasmodium*, the *P. falciparum* species is the primary causative agent for severe malaria. For malaria to occur in a human, the life cycle of *Plasmodium* spp. must begin with an injection of sporozoites by the mosquito, exoerythrocytic schizogony in the liver, and erythrocytic schizogony in red blood cells (Cox, 2010). Researchers have found that this process results in the production of approximately 8 to 16 meorzoites that invade new erythrocytes (Cox, 2010). This process is repeated, virtually unchecked, until the development of malaria (Cox, 2010).

An infected mosquito is considered the primary vector of malaria in humans. However, Leiby, Nguyen, and Notari (2008) investigated and described the different ways in which a human could contract malaria, particularly in nonendemic regions, such as blood transfusions from human donors who had been in malaria endemic regions and were carriers of the malaria parasite. Additionally, according to the CDC (2012), *P. malariae* is the only human malaria parasite species that exhibits a quartan cycle, while the other *Plasmodium* species exhibit a tertian cycle.

The CDC (2012) reported five different *Plasmodium* species as the cause of malaria: *P. falciparum, P. vivax, P. ovale, P. malariae,* and *P. knowlesi.* Of these five species, the CDC concluded that *P. falciparum* is the most deadly because it "multiplies rapidly in the blood and can thus cause severe blood loss" (para. 1). Researchers have demonstrated that *P. falciparum* can be found worldwide in subtropical and tropical areas, including in the country of Afghanistan. However, researchers have recently demonstrated that *P. vivax* and *P. falciparum* are the two most common *Plasmodium* species causing acute malaria among U.S. servicemembers in Afghanistan (Armed Forces Health Surveillance Center, 2013).

A review of the available information regarding malaria in Afghanistan revealed that the country has the "fourth largest malaria burden worldwide of any country outside of Africa" and the second highest in the Eastern Mediterranean Region (WHO, 2013, para. 3). The WHO (2013) has classified 63 districts in 12 provinces as being at a high risk of malaria transmission, with over 90% of cases being confirmed as either *P. vivax* or *P. falciparum*.

After reviewing the work of other researchers and the data they gathered, I came to some conclusions about why malaria remains an issue of concern for U.S. Army enlisted personnel deployed to Afghanistan. One conclusion was that the surge of 30,000 troops deployed to Afghanistan in 2011 led to an improved capability for diagnosing and reporting malaria in a combat zone (Gould, 2012). Another researcher concluded that servicemembers failed to adhere to their antimalarial protection protocols, which included DEET-based repellent, proper wear of Permethrin-treated uniforms, use of bed nets, and the use of antimalarial drugs (Gould 2012). However, in this study, I did not address the use of DEET-based repellent, Permethrin-treated uniforms, and bed nets. On the other hand, I have extensively discussed the use of antimalarial drugs and self-reported reasons for nonadherence as the research foundations for this study.

Pathophysiology

Even though an in-depth discussion of the pathophysiology of malaria is outside the scope of this study, it is important for the articulation of key points of acute malaria infection in humans. The CDC (2010) indicated that within the life cycle of *Plasmodium* a female *Anopheles* mosquito transmits a pathogen to its human host during its blood meal. This pathogen, known as a sporozoite, travels through the circulatory system until it reaches human liver cells, known as hepatocytes (Genton & D’Acremont, 2008). The sporozoites reproduce asexually, known as exoerthryocytic schizogony, and produce numerous intracellular parasites known as merozoites (Genton & D’Acremont, 2008).

These merozoites then invade and infect other red blood cells and continue a cycle of asexual reproduction, resulting in 8 to 24 new merozoites (Genton & D'Acremont, 2008). The resulting merozoites cause the cell to burst, and the infective cycle starts again (Genton & D'Acremont, 2008).

Bledsoe (2005) explained that infection with malaria occurs in two distinct phases: one that involves the human liver and the other that involves human red blood cells, which are known as erythrocytes. When an infected female *Anopheles* mosquito ingests a human blood meal, the sporozoites in the mosquito's saliva are transmitted to the human circulatory system and subsequently migrate to the liver. Once the sporozoites infect the human hepatocytes, they begin to reproduce asexually and asymptomatically for a period of 8 to 30 days (Bledsoe, 2005). This is known as the incubation period and constitutes the liver phase of malaria.

According to Bledsoe (2005), the erythrocyctic phase of malaria occurs when thousands of merozoites are released into the bloodstream and continue to infect new erythrocytes. The malaria parasite is able to escape the liver undetected by burying itself in the cell membrane of the host hepatocyte (Beldsoe, 2005). However, White (2008) described a situation where certain *P. vivax* sporozoites do not immediately develop into merozoites but instead produce parasites known as hypnozoites. These hypnozoites can remain dormant within a human for a period of several months to several years (White, 2008). Following this dormancy period, the hypnozoites reactivate and become merozoites, resulting in late relapses of *P. vivax* infections (White, 2008).

Mens, Bojtor, and Schallig. (2010) and Tilley, Dixon, and Kirk (2011) described some of the protective features of malaria parasites. Researchers have demonstrated that these parasites are relatively resistant to the innate and adaptive human immune system because these parasites spend a majority of their lifecycle buried in hepatocytes and erythrocytes, avoiding detection by the human immune system (Tilley et al., 2011). However, it was noted by Tilley et al. that circulating erythrocytes infected with these parasites are destroyed by the spleen. Interestingly, Tilley et al. also noted that the *P. falciparum* parasite can produce adhesive proteins on the surface of the erythrocyte, preventing circulation by causing the erythrocyte to adhere to the walls of blood vessels and preventing the erythrocyte from migrating to the spleen. This causes obstruction of the microvasculature, which can lead to placental or cerebral malaria (Mens et al., 2010; Renia et al., 2012).

In order for a comprehensive malaria prevention program to be adopted or modified by the U.S. Army, U.S. Army researchers and medical officers have to understand the pathophysiology of the disease. Pathophysiology is defined as the "physiology of abnormal states; *specifically*: the functional changes that accompany a particular syndrome or disease" (Pathophysiology, n.d., para. 1). Since the parasites responsible for malaria cause an abnormal state of health within humans, medical officers and public health researchers must be acutely aware of how the disease will affect a U.S. Army enlisted personnel deployed to Afghanistan. It is only with this knowledge that force health protection designers will be able to truly understand how to prevent the spread of malaria among U.S. Army enlisted personnel deployed to Afghanistan.

Malaria Epidemiology

Public health and medical experts have struggled for decades to agree on an all-inclusive definition for the term epidemiology. Researchers have presented numerous renditions in public health textbooks, medical textbooks, and peer-reviewed journals. To eliminate any conjecture or confusion, I adopted Gordis' (2009) definition of epidemiology for the purposes of this study: "Epidemiology is the study of how disease is distributed in populations and the factors that influence or determine this distribution" (p. 1). Both the CDC (2015) and the WHO (2013) reported that while malaria is a global health problem, it is entirely preventable and treatable. Globally, researchers have estimated that 3.4 billion people are at risk of contracting malaria, and 1.2 billion people are at a high risk of contracting malaria (WHO, 2013). Within these high-risk areas, it is estimated that more than one malaria case occurs per every 1,000 people in the population (WHO, 2013).

Malaria Epidemiology in Afghanistan

Unfortunately, decades of war and a localized insurgency have diminished capabilities of the Islamic Republic of Afghanistan's Ministry of Public Health and their malaria control programs. Kolaczinski, Graham, Fahim, Brooker, and Rowland (2005) found that the foundation of Afghanistan's malaria control program was established in the early 1950s by the Afghan government. However, very little of the original malaria control program remained functional by the 1990s (Kolaczinski et al., 2005). Kolaczinski et al. asserted that "delivery of basic health care, including malaria diagnosis and treatment, was done by nongovernmental organizations (NGOs) and UN agencies" (p.

1506). However, Kolaczinski et al. also found that after the collapse of the Taliban in 2001 the Ministry of Public Health delivered more malaria control programs and routine healthcare programs to Afghans.

In accordance with U.S. Department of State travel regulations, the CDC (2015) published travel advisories for the country of Afghanistan. The CDC stated that all areas of Afghanistan, at all elevations below 8,202 feet (2,500 meters), are prone to malaria from April through December. Furthermore, the CDC warned that U.S. travelers to Afghanistan are at a high relative risk of contracting malaria. Interestingly, the “estimated relative risk value for Afghanistan is based largely on cases occurring in U.S. military personnel who travel for extended periods of time with unique itineraries that likely do not reflect the risk for the average U.S. traveler” (CDC, 2015, para. 10).

The documented species of malaria within the country of Afghanistan is *P. vivax*, which comprises approximately 80 to 90% of all cases, and *P falciparum*, which comprises 10 to 20% of all cases (CDC, 2012). With this knowledge, the CDC (2012) recommended atovaquone-proguanil, doxycycline, or mefloquine as the primary means of chemoprophylaxis. While there are several medications available for travelers, travelers will have to determine which medication is the best for them based on the cost of the medication, previous adverse reactions to certain medications, specific itinerary, and length of the trip (CDC, 2012).

Health Belief Model

The tenets of the health belief model were originally proposed in the early 1950s when social psychologists working with the U.S. Public Health Service attempted to predict and explain a variety of different health behaviors (Rosenstock, 1974). The U.S. Public Health service originally introduced the heath belief model in response to the failure of the free tuberculosis health screening program (Rosenstock, 1974). Since its inception, researchers have used the health belief model to investigate numerous short-term and long-term health behaviors. Even though the health belief model is the most commonly cited model in medication adherence studies, the actual model is intended to explain the health behaviors of the individual without consideration for environmental, socioeconomic, and interpersonal factors. Despite these limitations, the health belief model is used to explain that adherence to a prescribed medication regimen is primarily based on a trade-off between the perceived susceptibility to the disease and severity of the disease, the perceived barriers to medication adherence and benefits from medication adherence, and the treatment options available (Bosworth et al., 2006; Lerner, 1997).

General Risk Factors

Numerous researchers have investigated the risk factors associated with malaria. These risk factors include socioeconomic status, knowledge level, environmental determinants, and lack of healthcare access (Amuyunzu-Nyamongo, 2010; Dinho, Van der Merwe, & Ehlers, 2009; Williams, Martina, Cumming, & Hall, 2009; Yé, Hoshen, Kyobutungi, Louis, & Sauerborn, 2009). While these risk factors apply primarily to the local populace of Afghanistan, certain factors, such as environmental determinants and knowledge level, apply to U.S. Army enlisted personnel and are addressed in this study.

Environmental Determinants

Ye et al. (2009) developed a model that successfully predicted the seasonal trends of *P. falciparum* in a region where malaria was endemic. These researchers also found that there was "strong seasonal variation in *P. falciparum* malaria infection incidence" during specific times of the calendar year, which took into account the average ambient temperature, rainfall and humidity (Ye et al., 2009, p. 1). In their research on Afghanistan, the WHO (2014) and the CDC (2015) noted that malaria is endemic to the nonmountainous regions of Afghanistan. The WHO (2013) documented that a majority of the Afghan population (77%) inhabited an area that had at least a low risk of transmission. There is a high likelihood that, during the course of their deployment to Afghanistan, U.S. Army enlisted personnel will live and work in areas to which malaria is endemic.

Farquharson, Noble, Barker, and Behrens (2004) utilized regression analysis to analyze adherence to a prescribed anti-malaria medication regimen among a sample of 130 travelers that had been prescribed medication to prevent malaria. While this was a relatively small sample, Farquharson et al. demonstrated that health beliefs and communication, in accordance with the health belief model and the theory of planned behavior, directly predicted adherence to prescribed anti-malaria medication.

In a study of malaria that had been imported to countries where malaria was not endemic, Abraham et al. (1999) investigated numerous cognitive predictors of adherence to malaria prophylaxis regimens. The questionnaire developed by Abraham et al. included questions about the age and gender of the participant, any medication the participant was taking, and previous experience with taking anti-malaria medication. Abraham et al. presented numerous health belief model questions to the participants, including perceived side effects, perceived severity, and perceived susceptibility (Abraham et al., 1999). Abraham et al. found a correlation between gender and perceived severity, specifically that "women tend to regard malaria infection and more severe and women appear to have higher perceived susceptibility scores" (p. 1650). In addition, Abraham et al. found a correlation between age and previous experience with taking anti-malaria medication (Abraham et al., 1999).

Knowledge Level

It is difficult to assess whether individuals possess a knowledge of the signs and symptoms associated with an acute malaria infection. However, researchers, such as Kotwal et al. (2005), have attempted to do this. Kotwal et al. investigated an outbreak of malaria among a group of U.S. Army Rangers that had returned from a deployment to Afghanistan. Out of the 725 soldiers in the U.S. Army Ranger Task Force, Kotwal et al. identified a total of 38 cases, a rate of 52.4 cases for every 1,000 soldiers: All 38 soldiers had been infected with *P. vivax.* In response to this finding, Kotwal et al. surveyed the soldiers to measure the self-reported rate of compliance with their prescribed oral malaria chemoprophylaxis regimen. Kotwal et al. found that that 52% had been compliant with their weekly chemoprophylaxis regimen, 41% had been compliant with their terminal chemoprophylaxis, and 31% had been compliant with both weekly and terminal chemoprophylaxis. Based on these findings, Kotwal et al. concluded that "suboptimal compliance with preventive measures can result in a malaria outbreak" (p. 216).

Consequently, there are numerous factors that can contribute to an individual's response to a threatening health issue like malaria.

Outbreaks of malaria among U.S. servicemembers have not been limited to Operation Enduring Freedom. Newton et al. (1994) investigated an outbreak of malaria among 106 U.S. Marines returning from Somalia in 1993. In their study, Newton et al. identified and diagnosed a sample of U.S. Marines and found that 112 cases of malaria had been imported from Somalia: Of these 112 cases, 97 (87%) U.S. Marines had been infected with the *P. vivax* and 8 (7%) U.S. Marines tested positive for *P. falciparum.* While cases of *P. vivax* accounted for a majority of the infections, Newton et al. noted that six U.S. Marines had been infected with both *P. vivax* and *P. falciparum.* Only one U.S. Marine had been infected with for *P. malariae*. Newton et al. also found that the self-reported rate of adherence to the prescribed oral malaria chemoprophylaxis regimen among the sample of U.S. Marines was 56%. However, only 50% of the U.S. Marines were "given an optimal chemoprophylaxis regimen" (Newton et al., 1994, p. 399).

In another study of malaria among U.S. servicemembers, Wallace et al. (1996) investigated the incidence of malaria among a sample of 48 servicemembers who had returned from Somalia (Operation Restore Hope). These cases differed from previous cases of malaria imported from Somalia in that a majority of these cases had been infected with *P. falciparum*. Wallace et al. determined that the largest risk factor contributing to the incidence of malaria among the soldiers in the sample was nonadherence with the prescribed oral malaria chemoprophylaxis regimen. While this was the case for the majority of the U.S. servicemembers in the sample, Wallace et al.

determined with an analysis of serum levels that a small number of cases (*n* = 5) experienced a chemoprophylactic failure. Despite this, Wallace et al. concluded that most of the U.S. servicemembers who became infected with a malaria parasite while deployed to Somalia could have prevented the infection by adhering to the prescribed oral malaria chemoprophylaxis regimen and by utilizing the recommended personal protective measures.

Resseguier et al. (2010) reviewed numerous determinants of adherence to a prescribed malaria chemoprophylaxis regimen among a sample of French soldiers. While the researchers did not include U.S. personnel in their sample, the government of France has maintained a continual military presence in the country of Afghanistan, and French servicemembers have often served side-by-side with U.S. servicemembers. To account for age differences among the sample of French soldiers, Resseguier et al. separated their sample into two cohorts: French servicemembers who were 18-24 years of age and French servicemembers who were 25 years of age or older. In both cohorts, Resseguier et al. determined that less than 50% of French soldiers had adhered to their prescribed malaria chemoprophylaxis regimen (47% and 45.4%, respectively). As is the case in the U.S. Army, the sample of French soldiers included significantly more enlisted soldiers than officers. Among the enlisted French soldiers in Resseguier et al.'s sample, 45.2% were found to have adhered to the prescribed oral malaria chemoprophylaxis regimen (*n* = 728/1610). Among the French officers in Resseguier et al.'s sample, fewer than half had adhered to the prescribed oral malaria chemoprophylaxis regimen (*n* = 239/483).

Morgan and Figueroa-Muñoz (2005) investigated barriers to uptake and adherence to prescribed and recommended malaria chemoprophylaxis regimens among a sample of African volunteers. While these participants were not military servicemembers, Morgan and Figueroa-Muñoz concluded that a majority of the cases of nonadherence could be classified as intentional and influenced by the common beliefs of travelers and migrants of African descent. In addition, Morgan and Figueroa-Muñoz found that adherence among those in the sample varied significantly with differences in socioeconomic status and individual circumstances (Morgan and Figueroa-Muñoz, 2005).

Malaria Control and Prevention

U.S. Army leaders recognize that malaria poses a significant health threat to deployed personnel. The Office of the Surgeon General of the U.S. Army issued guidance on the approved malaria prophylactic measures for personnel deployed to regions outside of the continental United States, including oral chemoprophylaxis regimens, the Department of Defense repellent system, and bed nets (Shoomaker, 2009). These measures should prevent the infection of malaria among U.S. Army servicemembers; however, if these servicemembers do not adhere to the prescribed oral malaria chemoprophylaxis regimen or take prophylactic measures to prevent insect bites, U.S. Army servicemembers will continue contracting malaria when deployed abroad.

In regions where chloroquine-resistant malaria is endemic, Shoomaker (2009) indicated that doxycycline, 100 mg per day, or mefloquine, 250 mg per week, has provided a “safe and effective prophylaxis against susceptible strains of malaria” (p. 2). In addition, in regions where the two medications were equally efficacious, Shoomaker

(2009) stated that doxycycline was the drug of choice for all soldiers without pertinent contraindications.

Other researchers have corroborated Shoomaker's (2009) findings. Ohrt et al. (1997) and Tan et al. (2011) demonstrated the efficacy of doxycycline in preventing malaria. In a 13-week study of 204 Indonesian soldiers, Ohrt et al. discovered that doxycycline effectively prevented malaria infections in 99% of the sample: One soldier contracted the *P. falciparum* parasite. Ohrt et al. concluded that doxycycline was not only highly efficacious but well tolerated by all of the soldiers in the sample. Similarly, Tan et al. noted that doxycycline was the only pharmacological intervention approved by the U.S. Food and Drug Administration for the prophylaxis of *P. falciparum*.

Summary and Conclusions

After a comprehensive review of the available English literature on malaria, I found that there was an absence of research on adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel. A majority of the research on malaria among servicemembers has been conducted on samples of servicemembers after researchers and medical personnel had identified cases of malaria within their ranks. Additionally, in their investigations of adherence to a prescribed oral malaria chemoprophylaxis regimen among servicemembers, few researchers have analyzed data that has been gathered from healthy personnel. However, a review of the available literature confirmed that overall adherence to a prescribed oral malaria chemoprophylaxis regimen has been poor over the past 14 years. Currently, U.S. Army personnel deployed to Afghanistan continue to contract malaria, and the U.S. Army continues to evacuate these personnel, directly impacting the combat power of individual military units and the U.S. Army as a whole.

To address the lack of data on adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of healthy U.S. Army enlisted personnel, I used a quantitative correlational research design to conduct this cross-sectional, nonexperimental study. In Chapter 3, I will present a description of the research design and the methodology that I used in this study.

Chapter 3: Research Method

In this study, I investigated the rate of adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of U.S. Army enlisted personnel deployed to Afghanistan. Furthermore, I investigated the association between adherence to a prescribed oral malaria chemoprophylaxis regimen and the demographic characteristics of age, gender, and education level; military rank/grade; previous deployment experience; and perception of risk. The theoretical framework for the study was the social cognitive theory and the health belief model. In this chapter, I will present the research design and the rationale for the research design, a description of the population that I sampled for this study, the sampling and sampling procedures, the data collection procedures, the instrumentation that I used in the study and an operationalization of the constructs, the data analysis, threats to validity, and ethical procedures.

Despite the availability of effective chemoprophylaxis protocols, malaria continues to be a threat to U.S. Army enlisted personnel deployed to Afghanistan. Although U.S. government officials have discussed the withdrawal of U.S. servicemembers deployed to Afghanistan, and President Obama has set a goal to return all servicemembers to the U.S. during his presidency, top military leaders and U.S. Department of Defense officials continue to stress the importance of leaving a contingent of troops in Afghanistan. This means that U.S. Army enlisted personnel will likely continue to be at risk of contracting malaria for many years to come.

Research Design and Rationale

In this cross-sectional study, I employed a nonexperimental, quantitative correlational research design to identify the factors that contribute to adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of healthy active-duty U.S. Army enlisted personnel who have been deployed to Afghanistan. I used multiple linear regression analysis to determine the extent to which the demographic characteristics of age, gender, and education level; military rank/grade; previous deployment experience; and perception of risk affect adherence to a prescribed malaria chemoprophylaxis regimen among a sample of U.S. Army enlisted personnel. This was consistent with the methodology that other researchers have selected to study the phenomenon of medication adherence.

I took a positivist approach to the design of this study and based the design on the testing of certain theories in regards to the data that I had collected with a validated and widely accepted survey instrument (Morisky, Green, & Levine, 1986). I collected data from a sample of U.S. Army enlisted personnel using the MMAS-8 in order to determine the relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and the demographic characteristics of age, gender, and education level; military rank/grade; previous deployment experience; and perception of risk. I then tested the study hypotheses with multiple linear regression analysis.

The principal focus of this study was to examine certain variables that may be associated with a U.S. Army enlisted soldier's adherence to a prescribed malaria chemoprophylaxis regimen while deployed to Afghanistan. This study was designed primarily from a positivistic methodological perspective because the selected variables have rarely been mentioned or even considered in previous research.

Researchers have demonstrated that servicemembers typically do not adhere to prescribed oral malaria chemoprophylaxis regimens while deployed. For example, Whitman et al. (2010) attributed outbreaks of malaria in specific units to the nonuse of personal protective equipment (e.g., bed nets, repellant) and nonadherence to the prescribed oral malaria chemoprophylaxis regimen. Whitman et al. found that despite over 50% (n = 23) of the servicemembers in the sample self-reporting high levels of adherence to their prescribed oral malaria chemoprophylaxis regimen, only 10% (n = 4) had “serum MQ levels high enough to correlate with protection” (p. 258). However, Whitman et al. did not account for differences in age, gender, education level, military rank/grade, or previous deployment experience among the servicemembers in the sample, and the effect of these differences on adherence to a prescribed oral malaria chemoprophylaxis regimen. I presented a detailed summary of Whitman et al.’s study and other pertinent research in Chapter 2.

For the purposes of this study, I conducted a cross-sectional study in order to analyze the phenomenon of adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel at a point in time: Financial, governmental, and time constraints made a longitudinal study of this phenomenon impossible. I used the MMAS-8 to collect data from a sample of U.S. Army enlisted personnel but modified the questions to suit the purposes of the study and match the unique circumstances under which the individuals in the sample were prescribed an oral malaria chemoprophylaxis regimen, specifically military deployment in Afghanistan. I used an electronic, web-based survey administration platform to administer the modified MMAS-8 survey and collect responses from U.S. Army enlisted personnel who volunteered to participate in the study (Morisky et al., 1986; Morisky et al., 1990; Morisky, Ang, Krousel-Wood, & Ward, 2008; Morisky & DiMatteo, 2011). With the responses to the survey, I was able to assess current self-reported rates of adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel and examine the factors that contribute to adherence. In an a priori calculation of the minimum sample size, I estimated that I would need a minimum sample size of 85 in order to achieve an acceptable level of statistical power in the results of my multiple regression analysis. Therefore, once I had received completed surveys from 91 U.S. Army enlisted personnel, I closed the survey.

In accordance with the constraints of a cross-sectional study, the data consisted of responses gathered at a fixed point in time instead of over a period of time. However, this still allowed for the determination of a causal relationship (Trochim & Donnelly, 2006). By design, the success of this study was contingent upon the gathering of responses from a specifically defined population of U.S. Army enlisted personnel that had been prescribed an oral malaria chemoprophylaxis regimen during their deployment in Afghanistan. The U.S. Army’s enterprise email account, hosted on a Microsoft Office Exchange Server, was the primary mechanism by which I solicited U.S. Army enlisted personnel for participation in the study. By utilizing an electronic medium, I was able to efficiently disseminate invitations, including a unique URL for the web-based survey, to a large percentage of individuals in the target population.

Population

A majority of the active duty personnel in the U.S. Army are enlisted. As of February 2014, there were a total of 420,701 enlisted personnel, 82,396 officers, and 15,476 warrant officers (Army Times, 2014). Therefore, over 80% of all personnel on active duty in the U.S. Army in 2014 were enlisted, and the rank of Specialist (E-4) was the most common (n = 122,782; 23%).

The target population for this study included enlisted personnel, 18 years of age or older, who held a rank/grade of E1-E9/PV1-CSM, and had been deployed to Afghanistan for a combat rotation. Although the risk of contracting malaria is much lower during certain times of the year in Afghanistan, U.S. Army leaders require that personnel continue their prescribed oral malaria chemoprophylaxis regimen throughout the duration of their deployment, regardless of whether malaria is a threat at that time.

Sampling and Sampling Procedures

I determined that probability sampling was the most suitable method of gathering data for this study. To gather the data, I administered a modified version of the MMAS-8, a survey that has been established as valid and reliable by the academic community, through the web-based SurveyMonkey survey platform. However, prior to administering the modified MMAS-8, I received permission Dr. Morisky, the creator of the instrument, to use the modified MMAS-8 for this study (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). When determining the minimum sample size for the probability sampling, I considered all of the variables that I would use in the analysis, such as age, gender, education level, military rank/grade, previous deployment experience, and perception of risk. Since I planned on using multiple regression analysis to test the study hypotheses, I determined the minimum sample size for multiple regression analysis. The hypothesis with the largest sample size requirement was one in which four independent variables would be included in the analysis, and, therefore, I calculated the minimum sample size for a multiple regression that I would conduct with four independent variables. According to G*Power 3.1.9.2, the minimum sample size required to detect a significant relationship between four independent variables and a dependent variable in a multiple regression analysis would be 85, given an effect size of 0.15, power of 0.8, and a type I error probability of .05 (Faul, Erdfelder, Buchner, & Lang, 2009). Therefore, this was the a priori sample size adopted for this study.

As of April 2014, 33,500 U.S. servicemembers were serving in Afghanistan (International Security Assistance Force, 2014). Servicemembers serving in the U.S. Navy, U.S. Air Force, U.S. Marine Corps, or U.S. Coast Guard were automatically excluded from the sampling process. In addition, I excluded any U.S. Army personnel holding the rank/grade of an officer or warrant officer.

Due to the nature of the Army's Enterprise Email Global Address Book, I was unable to determine which personnel received the invitation email, read the invitation email, or followed the URL in the invitation email to the online survey. Participation in this study was anonymous and voluntary. Any individual who received the email had the freedom to delete the email or ignore the email. Furthermore, personnel who may have initially chosen to participate in the study but later decided not to participate were permitted to withdraw from the study at any time and discard their survey responses at any time without fear of reprisal or penalty. I did not compensate U.S. Army personnel who completed the survey.

Data Collection Procedures

I selected the U.S. Army personnel who participated in this study based on their deployment status to Afghanistan, their age, and their military rank/grade. Those individuals who were not or had never been deployed to Afghanistan, were under the age of 18, or did not hold an enlisted rank/grade (PV1-CSM) were automatically excluded from this study.

I anonymously recruited U.S. Army personnel for this study via a unique, electronic survey URL that was disseminated to official Army email accounts. Upon receipt of the email, U.S. Army personnel had to decide whether to read the email or delete the email without reading it. To make potential participants feel more comfortable, I left the read receipt function of Microsoft Outlook unselected when I sent the emails. Additionally, I left the delivery receipt function of Microsoft Outlook unselected when I sent the emails. The personnel who chose to read the email found a short description of the background of the study and a URL directing them to the electronic version of the modified MMAS-8. At this point, the individual then decided whether or not to follow the URL to access the electronic version of the modified MMAS-8. I permitted any U.S. Army personnel who choose to delete the email to do so without fear of reprisal.

I directed any U.S. Army enlisted personnel who followed the URL to a custom page hosted on the web-based electronic survey administration platform http://www.surveymonkey.com. The introductory page consisted of a comprehensive background of the survey and the precautions I took to ensure that participation was anonymous. I also reemphasized that they were permitted to abandon the survey at any time without penalty. However, if an individual abandoned the survey without completing it and later chose to resume the survey, they were required to restart the survey from the beginning.

Instrumentation and Operationalization of Constructs

The survey that I used in this study was based on the MMAS-8 (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). With explicit permission from Dr. Morisky, I modified the questions to suit the purposes of the study and to match the unique circumstances under which the individuals in the sample were prescribed an oral malaria chemoprophylaxis regimen, specifically military deployment in Afghanistan.

Originally designed and implemented in 1986, MMAS-8 was created to yield a scale that could provide a realistically accurate estimate of medication adherence (Morisky, 2013). Researchers have used both the MMAS-4 and MMAS-8 to assess adherence to antihypertensive and antituberculosis drug regimens (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). According to Morisky and DiMatteo (2011), “medication adherence is a behavior about which people should be able to report” (p. 256). Since self-reported medication adherence is considered one of the most accurate records of patient activities available, Dr. Morisky and I determined that the MMAS-8 could be modified and utilized successfully to meet the needs of this study.

I administered this survey electronically through the web-based SurveyMonkey electronic survey platform. Based on current U.S. Army regulations, I made the survey available in English. In the first section of the survey, I collected basic demographic data, including age, gender, education level, military rank/grade, and previous deployment experience. In the next section of the survey, I asked participants to answer the eight items of the modified MMAS-8 to determine their adherence to a prescribed oral malaria chemoprophylaxis regimen. In the final section of the survey, I asked the participants questions to measure their perception of malaria risk and personal experience with malaria.

Data Analysis

I exported responses from the participants into an Excel spreadsheet and then imported the Excel spreadsheet into SPSS to create a dataset for analysis. All questions of the survey yielded nominal data, and I entered responses to the questions into SPSS as numerical data for analysis. I entered the first seven questions of a survey into SPSS as *No* = 1 and *Yes* = 2. Likewise, I entered responses to the remaining questions of the survey into SPSS in ascending numerical order, with responses of *never/rarely*, *strongly disagree*, rank/grade of *PVT/E-1*, age of *18 to 24*, and education of *some high school or less* as 1. Following entry into SPSS, I screened the data for missing data and patterns in the missing data by conducting a missing value analysis in SPSS. Responses found to be missing completely at random or missing at random and accounting for fewer than 5% of the responses were excluded from any analysis that required the missing score (Allison, 2002). This included missing values needed to calculate scores for the dependent variable or missing values for all of the independent variables. Cases missing values that were needed for inclusion in some but not all of the regression analyses remained in the dataset, and I included the cases in the regression analyses for which their responses allowed.

I then conducted descriptive statistics on the data. Since I used both nominal and interval level data in this study, descriptive statistics included both frequency distributions for the nominal data measures of central tendency for the interval level data. For the nominal data, I presented the frequency with which each category was selected as well as the percentage of responses accounted for by each category. For the interval level data, I presented the mean score and standard deviation for each variable.

I tested the study hypotheses with multiple linear regression analysis. I adopted the generally accepted significance level of .05 for this study. I considered multiple regression models with an F that was statistically significant at the .05 level indicative of a statistically significant relationship and rejected the null hypothesis. I interpreted the overall statistical significance of the model, as well as the individual contribution of each independent variable to the model. For multiple regressions in which the overall model was statistically significant, I interpreted the unstandardized beta coefficients for independent variables found to be significantly contributing to the regression model, as indicated by a t that was statistically significant at the .05 level. I created the following research questions and hypotheses to measure the effect of age, gender, education level, military rank/grade, previous deployment experience, the perception of malaria risk, and personal experience with malaria on adherence to a prescribed oral malaria chemoprophylaxis regimen.

RQ1. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how are the demographic characteristics of age, gender, and education level associated with adherence to oral malaria chemoprophylaxis?

$H1_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis and the demographic characteristics of age, gender, and education level.

$H1_a$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis and the demographic characteristics of age, gender, and education level.

I conducted a multiple linear regression to test Hypothesis 1. The dependent variable in the regression analysis was the interval level construct of adherence to an oral malaria chemoprophylaxis regimen derived from the sum of the eight items of the MMAS-8 (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variables in the regression analysis were the categorical variables of age, gender, and education level. Since a requirement of regression analysis is that the independent variables be interval level or dichotomous, I dummy-coded the categorical age and education level variables for entry into the regression model. The gender variable was dichotomous and did not need to be dummy-coded.

For the categorical age variable, all of the participants were between the ages of 18 and 54. Therefore, I used only four categories in the analysis: *18-24*, *25-34*, *35-44*, and *45-54*. The frequency distribution of responses to the age question is presented in Table 1. I postulated that those in the *45-54* age category would be more likely to adhere to the prescribed oral malaria chemoprophylaxis regimen. Laver, Wetzels, and Behrens (2001) found that participants under 30 years of age were significantly less informed about malaria chemoprophylaxis than participants older than 46 years of age. Therefore, I used the *45-54* age category as the reference category in order to compare scores for those who selected that *45-54* age category with scores for those in the other age categories.

RQ2. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how are the military service characteristics of military rank and previous deployment experience associated with adherence to oral malaria chemoprophylaxis?

$H2_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis and the military service characteristics of military rank and previous deployment experience.

*H*2a. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis and the military service characteristics of military rank and previous deployment experience.

I conducted a multiple linear regression to test Hypothesis 2. The dependent variable in the regression analysis was the interval level construct of adherence to a prescribed oral malaria chemoprophylaxis regimen derived from the sum of the eight items of the MMAS-8 (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variables in the regression analysis were the categorical variables of military rank/grade and previous deployment experience. I dummy-coded the categorical variables of military rank/grade for entry into the model; the categorical variable previous malaria experience was dichotomous and did not need to be dummy-coded.

For the categorical variable rank/grade, the distribution of responses among the categories was unequal. Therefore, I recoded the original rank/grade variable into a new rank/grade variable with three categories: *E-4 and below*, *E-5-E-6*, and *E-7 and above*. The rationale for recoding the original responses into new categories was to create categories in which the frequency distribution of participants was as close to equal as possible. The new categories maintained the theoretical differences in rank/grade while allowing for a distribution of responses that was nearly equal between the three categories. Personnel with a paygrade of E-4 and below are considered junior enlisted and are NCOs. Personnel holding the pay grades of E-5 and E-6 are considered NCOs and are traditionally given positions of increasing responsibility and leadership. All NCOs in the pay grade of E-7 and above are considered senior NCOs and traditionally have the most responsibility assigned to them by their army unit.

The reference category for the multiple linear regression was the *E-4 and below* category. The category *E-4 and below* comprised participants in the lowest pay categories. Therefore, to determine whether an increase in pay corresponded with an increase in adherence to a prescribed oral malaria chemoprophylaxis regimen, I selected the category *E-4 and below* as the reference category for the multiple linear regression.

RQ3. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, how is the perception of malaria risk and personal experience with malaria associated with adherence to oral malaria chemoprophylaxis?

$H3_0$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to oral malaria chemoprophylaxis, the perception of malaria risk, and personal experience with malaria.

$H3_a$. Among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is a positive relationship between adherence to oral malaria chemoprophylaxis, the perception of malaria risk, and personal experience with malaria.

I conducted a multiple linear regression to test Hypothesis 3. The dependent variable in the regression analysis was the interval level construct of adherence to a prescribed oral malaria chemoprophylaxis regimen derived from the sum of the eight items of the MMAS (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variables in the regression analysis were the categorical variables of perception of malaria risk and personal experience with malaria. Since a requirement of regression analysis is that independent variables be interval level or dichotomous, I dummy-coded the variables of perception of malaria risk and personal experience with malaria for entry into the regression model. Although I posited with the original hypothesis that there was not a relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and personal experience with malaria, only 2 of the 94 participants indicated a personal experience with malaria. Therefore, I excluded personal experience from the analysis.

Since a requirement of regression analysis is that the independent variables be interval level or dichotomous, I dummy-coded the categorical variable perception of risk in order to enter it into the regression model: I used the original variable, including all five categories, in the analysis. To examine differences in total MMAS-8 between those who strongly disagreed and those who did not strongly disagree with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower*, I made the reference category for the multiple linear regression the *strongly disagree* category.

Threats to Validity

For this study, the fear of command reprisal or Uniform Code of Military Justice action (e.g., punitive action) was a significant threat to external validity. The participants in the sample were required to adhere to their prescribed oral malaria chemoprophylaxis regimen, and, by admitting that they had not adhered to the regimen, they would be admitting that they had disobeyed orders from commanding officers. Although participation in this study was completely anonymous, a fear of command reprisal may have caused the participants to be dishonest in their survey responses. To help combat this threat to external validity, I did not meet with the survey participants face-to-face. Furthermore, within the invitation email, I clearly explained that this survey was completely anonymous and that participation was voluntary. After a participant followed the URL in the email to the electronic survey and agreed to take the survey, I further reiterated that the survey could be abandoned at any point without fear of retribution.

The original wording of the survey instrument was not specific to the population I sampled and had to be altered for purposes of this study. Therefore, the validity of the instrument may have been compromised because of my modifications to the wording, posing an internal threat to validity. I sought permission from Dr. Morisky to alter the instrument by modifying the terminology in the instrument to match the terminology used by members of the U.S. Army, and Dr. Morisky assured me that my modifications would not affect the validity of the instrument. My modifications of the terminology did not alter the reliability of validity of the original survey instrument and did not affect the scoring or coding of the responses.

Ethical Procedures

Before I administered this survey, I obtained approval from the Walden University IRB (11-11-14-0293974). I also completed the mandatory online training entitled “Protecting Human Research Participants,” which is hosted by the National

Institutes of Health Office of Extramural Research. To demonstrate my commitment to research ethics during the data collection, I followed five tenets: understanding, disclosure, competence, voluntariness, and informed consent. I only contacted enlisted personnel after I received approval from Walden University's IRB.

At the beginning of the survey, I included an informed consent form. In this informed consent form, I outlined the intent of the study and provided simple instructions how to participate. I informed all participants that their participation was voluntary and that they could leave the survey site at any point if they felt uncomfortable answering the questions. In addition, I explained all of the risks and benefits associated with participation prior to presenting first survey question.

Due to the unique characteristics of the targeted population, I informed the participants of the measures I had taken to ensure their confidentiality throughout their participation in the study. To avoid bias, I provided no compensation for completing this survey. However, I did provide the participants with my direct phone number and email address so that they could contact me at any point during the survey.

The inherent nature of the targeted population precluded me from obtaining any identifying information, such as name or military unit. By administering an electronic survey through SurveyMonkey, I was able to administer surveys to individuals regardless of the individual's location within Afghanistan. All transmitted data was certified as encrypted in accordance with Verisign certificate Version 3, 128 bit encryption. In addition, SurveyMonkey did not store the email addresses or IP addresses of participants. All data are maintained online, and only I and my committee chair have access to the data. Additionally, I password-protected the two computers used to access the online survey medium to prevent intrusion from unauthorized individuals.

The physical security of the data was ensured by SurveyMonkey SSAE 16/SOC 2 audited data centers, which are managed directly by organizational staff. These data centers are staffed and monitored at all times, including weekends and holidays (SurveyMonkey, 2013). Application and user information, including passwords, have minimum complexity requirements and are individually salted and hashed (SurveyMonkey, 2013). To ensure that no file is corrupted, administrators at SurveyMonkey initiate a backup ever hour and then daily to a centralized backup system for long-term storage in multiple, geographically disparate sites (SurveyMonkey, 2013). Administrators at SurveyMonkey store survey data on hard drives in a RAID 10 array and store the server operating system on hard drives in a RAID 1 array.

Summary

In this chapter, I described my reasons for utilizing a quantitative cross-sectional research methodology for this survey study. I used an electronic version of the modified MMAS-8, hosted by SurveyMonkey, to collect data at a point in time. The electronic survey included modified versions of the questions in the MMAS-8 that were included only after receiving Dr. Morisky’s explicit permission to use and modify his instrument. I used the findings from this study to determine the rate of adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of U.S. Army enlisted personnel and to investigate the factors that may contribute to adherence to this chemoprophylaxis regimen.

Chapter 4: Results

I designed this research to address a gap in the literature regarding adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel and investigated the self-reported reasons for nonadherence among this population. Researchers consider malaria to be one of several communicable diseases that directly threaten the health and welfare of these deployed personnel. Between 2003 and 2011, service members in Afghanistan accounted for approximately 20-91 cases of malaria each year (Armed Forces Health Surveillance Center, 2013). In 2011, there were 91 confirmed cases of malaria requiring evacuation from Afghanistan (Armed Forces Health Surveillance Center, 2013).

I posited the study hypotheses with the purpose of gleaning insight into the rate of adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of U.S. Army enlisted personnel as well as to glean insight into the factors contributing to nonadherence to this oral malaria prophylaxis. I used the MMAS-8 (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011) to assess the level of adherence to a prescribed oral malaria chemoprophylaxis regimen. I used the demographic variables age, gender, and education to predict total MMAS-8 in the multiple linear regression that I conducted to test Hypothesis 1. Next, I used rank/grade and deployments to Afghanistan to predict total MMAS-8 in the multiple linear regression that I conducted to test Hypothesis 2. Lastly, I used perception of risk to predict total MMAS-8 in the multiple linear regression that I conducted to test Hypothesis 3.

This chapter comprises three sections: Demographic and Employment Characteristics of the Sample, Morisky Medication Adherence Scale, and Hypothesis Testing. In the first section, I will summarize the demographic and employment characteristics of the sample and present the frequency distribution of responses to the demographic and employment questions. In the second section, I will present a statistical description of responses to the MMAS-8, including the frequency distribution of responses to the eight questions. Lastly, in the third section I will present the results of the three multiple linear regressions that I conducted to test the three hypotheses. I have divided the third section further into three sections, one for each of the three hypotheses.

Data Collection

I used SurveyMonkey's web-based survey administration platform to create and administer the survey. I collected responses for 67 days (February 12, 2015-April 20, 2015) and sent reminder emails 30 days and 60 days after emailing the invitations to potential participants. I only invited individuals to participate if they (a) were or had been deployed to Afghanistan, (b) were over the age of 18, and (c) held an enlisted rank/grade (PV1-CSM). All total, I sent 543 emails through Microsoft Outlook using the Global Address List, and a total of 94 enlisted U.S. Army enlisted personnel agreed to participate in the study. This represented a 17% response rate.

Demographic Characteristics of the Sample

Ninety-four active duty U.S. Army enlisted personnel deployed to Afghanistan participated in the study. Although 94 active duty U.S. Army personnel participated in the study, three of the 94 participants did not respond to the demographic and employment questions. Therefore, these participants were excluded from any analysis in which demographic or employment characteristics were used.

Approximately three quarters of the participants were male, nearly half were between the ages of 25 and 34, and approximately one third had completed some college but did not receive a degree. Among the participants, 74.7% (68) were male, and 25.3% (23) were female. Nearly all of the participants were under the age of 54: 22% (20) were 18 to 24 years of age, 40.7% (37) were 25 to 34 years of age, 28.6% (23) were 35 to 44 years of age, and 8.8% (8) were 45 to 54 years of age. Over half of the participants had not completed a higher education degree: 16.5% (15) were high school graduates or had completed an equivalent program, 36.3% (33) had completed some college but did not earn a degree, 16.5% (15) had completed an associate's degree, 25.3% (23) had completed a bachelor's degree, and 5.5% (5) had completed a master's degree. The demographic characteristics of the sample are presented in Table 1.

Table 1

Demographic Characteristics of the Sample of Active Duty U.S. Army Personnel Deployed to Afghanistan

	Demographic characteristics of the sample	
Demographic characteristic	*n*	%
Gender		
Female	23	25.3
Male	68	74.7
Age		
18-24	20	22
25-34	37	40.7
35-44	26	28.6
45-54	8	8.8
Education		
High school graduate or equivalent	15	16.5
Some college but no degree	33	36.3
Associate's degree	15	16.5
Bachelor's degree	23	25.3
Master's degree	5	5.5

Note. $n = 91$. Three participants did not answer the demographic questions.

The demographic characteristics of the sample were somewhat different from the demographic characteristics of the population. According to the U.S. Army (2015), a total of 16.3% of those serving in the U.S. Army were female. However, when only including female enlisted U.S. Army personnel with a paygrade of E-3 to E-9, the percentage of females in the study population was lower (13.29%). The age of the participants in the sample appeared to be somewhat different from the age of enlisted U.S. Army personnel. According to the U.S. Department of Defense (2012), 44.6% of the enlisted U.S. Army personnel were 25 or younger, 24% were 26 to 30, 14.5% were 31 to 35, 9.5% were 36 to 40, and 7.5% were 41 or older. However, to preserve the anonymity of the participants in this study, I provided broader age categories as possible responses to the age question, making the categorical choices presented to the participants in this study different from the categories presented by the Department of Defense and rendering a direct comparison impossible. Nonetheless, the participants in the sample tended to be older than the average age of enlisted U.S. Army personnel in the population. I could not locate data on the education of enlisted U.S. Army personnel; however, I could locate data on the education of all U.S. Army personnel and all enlisted personnel serving in the U.S. Armed Forces. Among active duty U.S. Army personnel, which included both officer and enlisted servicemembers, .4% held no high school diploma or GED, 78.89% held a high school diploma or some college, 13.15% held a bachelor's degree, 6.82% held an advanced degree, and .6% were unknown (U.S. Department of Defense, 2012). Among enlisted members serving in the U.S. Armed Forces, .4% held no high school diploma or GED, 93% held a high school diploma or some college, 5.2% held a bachelor's degree, .7% held an advanced degree, and .6% were unknown (U.S. Department of Defense (2012). The participants in the sample tended to be more highly educated than those in the population.

Employment Characteristics of the Sample

To maintain anonymity, I asked the participants few demographic and employment questions. However, I did ask the participants to identify their rank/grade and the number of times they had been deployed to Afghanistan. Responses to *what is your current rank/grade* were dispersed somewhat evenly among four categories: 28.6% (26) were SPC/E-4, 17.6% (16) were SGT/E-5, 23.1% (21) were SSG/E-6, and 14.3% (13) were SFC/E-7. About 40%, 40.7% (37), of the participants had been deployed to Afghanistan once, 34.1% (31) had been deployed to Afghanistan twice, 16.5% (15) had been deployed to Afghanistan three times, 5.5% (5) had been deployed to Afghanistan four times, 2.2% (2) had been deployed to Afghanistan five times, and 1.1% (1) had been deployed to Afghanistan six or more times. The employment characteristics of the sample are presented in Table 2.

Table 2

Employment Characteristics of the Sample of Active Duty U.S. Army Personnel Deployed to Afghanistan

Employment characteristic	Employment characteristics of the sample *n*	%
Current rank/grade		
PFC/E-3	4	4.4
SPC/E-4	26	28.6
CPL/E-4	3	3.3
SGT/E-5	16	17.6
SSG/E-6	21	23.1
SFC/E-7	13	14.3
MSG/E-8	5	5.5
1SG/E-8	1	1.1
SGM/E-9	1	1.1
CSM/E-9	1	1.1
Deployments to Afghanistan		
1	37	40.7
2	31	34.1
3	15	16.5
4	5	5.5
5	2	2.2
6 or more	1	1.1

Note. n = 91. Three participants did not answer the demographic questions.

According to the U.S. Department of Defense (2015), 12.21% of enlisted U.S. Army personnel were an E-3 paygrade, 30.1% were an E-4, 18.3% were an E-5, 15.1% were an E-6, 9.5% were an E-7, 3% were an E-8, and less than 1% (0.9%) were an E-9. This was somewhat consistent with the paygrade characteristics of the study population; however, there was a higher percentage of higher paygrades among the participants in the sample. Population information on the number of deployments to Afghanistan was not available.

Perception of Risk and Personal Experience With Malaria Characteristics

To assess the effects of the participants' perception of risk and personal experience with malaria on adherence to a prescribed oral malaria chemoprophylaxis regimen, I asked the participants to identify their level of agreement with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower* and their experience with malaria with the statement *do you personally know anyone who has been diagnosed with malaria.* I used responses to the first statement as the perception of risk variable in the hypothesis testing, and the frequency distribution of responses was 12.8% (12) *strongly disagreed*, 14.9% (14) *disagreed*, 39.4% (37) were *neutral*, 16% (15) *agreed*, and 17% (16) *strongly agreed*. I intended to use responses to the second statement as the personal experience variable; however, the frequency distribution of responses was such that 97.9% (92) did not personally know anyone who had been diagnosed with malaria and 2.1% (2) knew someone who had been diagnosed with malaria. Since only two participants had any personal experience with malaria, I excluded the variable personal experience from the analysis. The frequency distribution of responses composing the perception of risk and personal experience variables are presented in Table 3.

Table 3

Perception of Risk and Personal Experience of Active Duty U.S. Army Personnel Deployed to Afghanistan

	Perception of risk and personal experience	
Variable	*n*	%
Perception of risk		
Strongly disagree	12	12.8
Disagree	14	14.9
Neutral	37	39.4
Agree	15	16.0
Strongly agree	16	17.0
Personal experience		
No	92	97.9
Yes	2	2.1

Note. *n* = 94.

Morisky Medication Adherence Scale

I asked the participants to complete the MMAS-8 to assess their level of adherence to a prescribed oral malaria chemoprophylaxis regimen. The MMAS-8 is presented in Appendix A, and the frequency distribution of responses to the MMAS-8 questions is presented in Table 4. With the exception of Questions 5 and 6, the percentage of participants who answered *yes* for each of the questions was larger than the percentage who answered *no*, indicating low levels of adherence among the study participants. For Question 5, *did you take your anti-malaria medicine yesterday*, 62.8% (59) of the participants responded *no*, and 37.2% (35) responded *yes*; since responses to this question were reverse coded, this distribution of responses was indicative of low levels of adherence. For Question 6, *when you feel like your risk of malaria is under control, do you sometimes stop taking your medicine,* 57.4% (54) of the participants responded *no*, and 42.6% (40) of the participants responded *yes*.

Table 4

Frequency Distribution of Responses to the MMAS-8

	Responses to the MMAS-8			
	No		Yes	
Question	*n*	%	*n*	%
1. Sometimes forget to take medicine	16	17.0	78	83.0
2. Days did not take medicine	28	29.8	66	70.2
3. Felt worse taking medicine	35	37.2	59	62.8
4. Sometimes forget to bring medicine	42	44.7	52	55.3
5. Took medicine yesterday [a]	59	62.8	35	37.2
6. Risk of malaria is under control	54	57.4	40	42.6
7. Feel hassled about treatment plan	21	22.3	73	77.7
8. Difficulty remembering medicine [b]	15	16.0	79	84.0
Never/Rarely	15	16.0		
Once in a while	25	26.6		
Sometimes	19	20.2		
Usually	19	20.2		
All the time	16	17.0		

Note. *n* = 94. Use of the ©MMAS is protected by US copyright laws. Permission for use is required. A Licensure agreement is available from: Donald E. Morisky, ScD, ScM, MSPH, Professor, Department of Community Health Sciences, UCLA School of Public Health, 650 Charles E. Young Drive South, Los Angeles, CA 90095-1772, dmorisky@ucla.edu.
[a] Responses to question 5 were reverse coded for inclusion in the total MMAS-8 score. [b] Question 8 was a 5-category question with possible responses ranging from 0-4. Responses were then standardized as 0 = 0, 1 = .25, 2 = .5, 3 = .75, and 4 = 1 for inclusion in the total MMAS-8 score.

Hypothesis Testing

Hypothesis 1

To test Hypothesis 1 that among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and the demographic characteristics of age, gender, and education level, I conducted a multiple linear regression. The dependent variable in the regression was the interval-level variable total MMAS-8 derived from the sum of the eight items of the MMAS-8 and represented the level of adherence to a prescribed oral malaria chemoprophylaxis regimen (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variables in the regression analysis were the categorical variables age, gender, and education level.

I dummy-coded the categorical age and education level variables for entry into the regression model. Since the gender variable was dichotomous, I did not dummy-coded it. For the categorical age variable, all of the participants were between the ages of 18 and 54. Therefore, only four categories were used in the analysis: *18-24*, *25-34*, *35-44*, and *45-54*. The frequency distribution of responses to the age question is presented in Table 1. I postulated that those in the *45-54* age category would be more likely to adhere to the prescribed oral malaria chemoprophylaxis regimen. Laver et al. (2001) found that participants under the age of 30 years were significantly less informed about malaria chemoprophylaxis than participants older than 46 years. Therefore, I used the *45-54* category as the reference category in order to compare scores for those who selected the *45-54* category with scores for those who selected the other age categories.

For the categorical education level variable, the distribution of responses among the categories was unequal. Therefore, I recoded the original education variable into a new education level variable with four categories: high school graduate/equivalent or less, some college but no degree, associate’s degree, and bachelor’s degree or higher. In addition to creating categories in which the frequency distribution of participants was as close to equal as possible, I based the recoding of the original responses on the rationale that differences in the amount of time and academic requirements were largest between these four categories (high school graduate or equivalent, some college but no degree, associate’s degree, bachelor’s degree). Although the time and academic requirements were greatest for those participants who attained a Master’s degree, only five participants indicated this level of education. Because of the small number of participants in this category, I made the decision to include these participants in the bachelor’s degree or higher category.

I also postulated that those who had attained a high school degree or less could be less likely than their more highly educated counterparts to adhere to a prescribed oral malaria chemoprophylaxis regimen. Laver et al. (2001) found that participants with less than a college education were 1.63 times as likely to hold misconceptions about how to contract malaria than participants who were college graduates. Similarly, Schoenthaler, Ogedegbe, and Allegrante (2009) found that “lower educational attainment was a significant independent predictor of poorer adherence” (p. 133). Therefore, I used the high school graduate/equivalent or less category as the reference category in order to compare scores for those who had attained a high school degree or less with scores for those in the other education categories. The frequency distribution of responses for the recoded education variable is presented in Table 5.

Table 5

Original vs. Recoded Education Variable Used to Test Hypothesis 1

	Original vs. recoded education variable	
Education category	*n*	%
Original education		
High school graduate or equivalent	15	16.5
Some college but no degree	33	36.3
Associate's degree	15	16.5
Bachelor's degree	23	25.3
Master's degree	5	5.5
Recoded education		
High school graduate or equivalent	15	16.5
Some college but no degree	33	36.3
Associate's degree	15	16.5
Bachelor's degree or higher	28	30.8

Note. $n = 91$. Three participants did not answer the demographic questions.

The results of the multiple linear regression testing Hypothesis 1 were statistically significant, F (7, 83) = 2.26, $p = .037$, and accounted for 16% of the variance in total MMAS-8. Three variables were found to significantly contribute to the prediction of total MMAS-8: age (*45-54* vs. *25-34*), age (*45-54* vs. *35-44*), and gender. The results of the multiple regression indicated that there were significant differences in total MMAS-8 between participants in the age (*45-54*) category and both the age (*25-34*) and age (*35-44*) categories. The difference was such that participants between the ages of 45 and 54 scored 1.70 points higher in total MMAS-8 than participants who were between the ages of 25 and 34. Similarly, participants between the ages of 45 and 54 scored 1.39 points higher in total MMAS-8 than participants who were between the ages of 35-44. I also found gender to significantly contribute to the model predicting total MMAS-8, and the difference between the genders was such that female participants scored 1.00 point higher than male participants in total MMAS-8. Since the results of the multiple linear regression that I conducted to test Hypothesis 1 were statistically significant, I rejected the null hypothesis. The results of the multiple linear regression that I conducted to test Hypothesis 1 are presented in Table 6.

Table 6

Multiple Linear Regression With Demographic Characteristics Predicting Total MMAS-8

Variable	Age, gender, and education predicting total MMAS-8	
	B	95% CI
Constant	4.99***	[3.04, 6.94]
Age (45-54 vs. 18-24)	-1.49	[-3.18, 0.21]
Age (45-54 vs. 25-34)	-1.70*	[-3.01, -0.38]
Age (45-54 vs. 35-44)	-1.39*	[-2.72, -0.05]
Gender	-1.00*	[-1.80, -0.20]
Education (high school vs. some college but no degree)	-0.06	[-1.35, 1.23]
Education (high school vs. associate's degree)	0.07	[-1.49, 1.64]
Education (high school vs. bachelor's degree or higher)	0.42	[-1.03, 1.86]
R^2	.16	
F	2.26*	

Note. $n = 91$. CI = Confidence Interval.
* $p < .05$. *** $p < .001$.

Hypothesis 2

To test Hypothesis 2 that among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and the military service characteristics of military rank/grade and previous deployment experience, I conducted a multiple linear regression. The dependent variable in the regression was the interval-level variable of total MMAS-8 derived from the sum of the eight items of the MMAS-8 and represented the level of adherence to a prescribed oral malaria chemoprophylaxis regimen (Morisky et al., 1986; Morisky et al., 1990; Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variables in the regression analysis were the categorical variable rank/grade and the interval-level variable deployment experience.

Since a requirement of regression analysis is that the independent variables be interval level or dichotomous, the categorical variable rank/grade was dummy-coded for entry into the regression model. For the categorical variable rank/grade, the distribution of responses among the categories was unequal. Therefore, I recoded the original rank/grade variable into a new rank/grade variable with three categories: E-4 and below, E-5 to E-6, and E-7 and above. My rationale for recoding the original responses into new categories was to create categories in which the frequency distribution of participants was as close to equal as possible. With the new categories, I maintained the theoretical differences in rank/grade while allowing for a distribution of responses that was nearly equal between the three categories. Personnel with a paygrade of E-4 and below are considered junior enlisted and are NCOs. Personnel holding the pay grades of E-5 and E-6 are considered NCOs and are traditionally given positions of increasing responsibility and leadership. All NCOs in the pay grade of E-7 and above are considered senior NCOs and traditionally have the most responsibility assigned to them by their army unit.

The reference category for the multiple linear regression was the E-4 and below category. The category E-4 and below comprised participants in the lowest pay categories. Therefore, to determine whether an increase in pay corresponded with an increase in adherence to a prescribed oral malaria chemoprophylaxis regimen, I selected the category E-4 and below as the reference category for the multiple linear regression.

The frequency distribution of responses for the recoded rank/grade variable is presented in Table 7.

Table 7

Original vs. Recoded Rank/Grade Used to Test Hypothesis 2

	Original vs. recoded rank/grade	
Rank/Grade	*n*	%
Original rank/grade		
PFC/E-3	4	4.4
SPC/E-4	26	28.6
CPL/E-4	3	3.3
SGT/E-5	16	17.6
SSG/E-6	21	23.1
SFC/E-7	13	14.3
MSG/E-8	5	5.5
1SG/E-8	1	1.1
SGM/E-9	1	1.1
CSM/E-9	1	1.1
Recoded rank/grade		
E-4 and below	33	36.3
E-5 to E-6	37	40.7
E-7 and above	21	23.1

Note. $n = 94$.

The results of the multiple linear regression testing Hypothesis 2 were not statistically significant, F (3, 87) = 2.23, $p = 0.09$, and accounted for 7.1% of the variance in total MMAS-8. This indicated that there was not a statistically significant relationship between rank/grade and total MMAS-8. Since the results of the multiple linear regression that I conducted to test Hypothesis 2 were not statistically significant, I did not reject the null hypothesis. The results of the multiple linear regression are presented in Table 8.

Table 8

Multiple Linear Regression With Pay Grade and Deployment Experience Predicting Total MMAS-8

	Rank/Grade and deployment experience predicting total MMAS-8	
Variable	*B*	95% CI
Constant	2.57***	[1.78, 3.37]
Rank (E-5 to E-6)	0.12	[-0.72, 0.96]
Rank (E-7 and above)	1.06	[-0.18, 2.30]
Deployments to Afghanistan	0.04	[-0.39, 0.47]
R^2	.071	
F	2.23	

Note. n = 91. CI = Confidence Interval.
*** $p < .001$.

Hypothesis 3

To test Hypothesis 3 that among uninfected, active-duty U.S. Army personnel deployed to Afghanistan, there is not a relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen, perception of malaria risk, and personal experience with malaria, I conducted a multiple linear regression. The dependent variable in the regression was the interval-level variable of total MMAS-8 derived from the sum of the eight items of the MMAS-8 and represented the level of adherence to a prescribed oral malaria chemoprophylaxis regimen (Morisky et al., 1986; Morisky et al., 1990;

Morisky et al., 2008; Morisky & DiMatteo, 2011). The independent variable in the regression analysis was the categorical variable perception of risk. Although I posited in the original hypothesis that there was not a relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and personal experience with malaria, only 2 of the 94 participants indicated a personal experience with malaria. Therefore, I excluded personal experience from the analysis.

Since a requirement of regression analysis is that the independent variables be interval level or dichotomous, I dummy-coded the categorical variable of perception of risk for entry into the regression model. I used the original variable, including all five categories, in the analysis. To examine differences in total MMAS-8 between those who strongly disagreed and those who did not strongly disagree with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower*, I selected the *strongly disagree* category as the reference category for the multiple linear regression.

The results of the multiple linear regression testing Hypothesis 3 were statistically significant, F (4, 89) = 5.86, $p < 0.001$, and accounted for 20.8% of the variance in total MMAS-8. Three of the dummy-coded perception of risk variables significantly contributed to the model predicting total MMAS-8: perception of risk (*neutral*), perception of risk (*agree*), and perception of risk (*strongly agree*). The results indicated that scores for each of these three dummy-coded perception of risk variables were significantly different from the reference category in total MMAS-8 score. The relationships between the reference category perception of risk (*strongly disagree*) and the three dummy-coded, statistically significant perception of risk variables were such that U.S. Army personnel who strongly disagreed with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower* scored significantly higher in total MMAS-8 than U.S. Army personnel who

- were neutral towards the statement,
- agreed with the statement, and
- strongly agreed with the statement.

Since higher total MMAS-8 scores corresponded to higher levels of adherence to a prescribed oral malaria chemoprophylaxis regimen, those who strongly disagreed with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower* adhered to their prescribed oral malaria chemoprophylaxis regimen more than those who were neutral, agreed, and strongly agreed. The largest difference was between U.S. Army personnel who strongly disagreed with the statement and U.S. Army personnel who strongly agreed with the statement: The difference was such that those who strongly disagreed with the statement scored 2.61 points higher in total MMAS-8 than those who strongly agreed with the statement. Likewise, those who strongly disagreed with the statement scored 1.76 points higher in total MMAS-8 than those who were neutral towards the statement and 1.87 points higher than those who agreed with the statement. Since the results of the multiple linear regression that I conducted to test Hypothesis 3 were statistically significant, indicating a statistically significant relationship between total MMAS-8 and perception of risk, I rejected the null hypothesis and accepted the alternative hypothesis. The results of the multiple linear regression are presented in Table 9.

Table 9

Multiple Linear Regression With Perception of Risk Predicting Total MMAS-8

	Perception of risk predicting total MMAS-8	
Variable	*B*	95% CI
Constant	4.52***	[3.64, 5.41]
Perception of risk (strongly disagree vs. disagree)	-0.91	[-2.12, 0.29]
Perception of risk (strongly disagree vs. neutral)	-1.76***	[-2.78, -0.75]
Perception of risk (strongly disagree vs. agree)	-1.87**	[-3.06, -0.68]
Perception of risk (strongly disagree vs. strongly agree)	-2.61***	[-3.79, -1.44]
R^2	.208	
F	5.86***	

Note. $n = 94$. CI = Confidence Interval.
** $p < .01$. *** $p < .001$.

Summary

In this chapter, I presented the frequency distributions of responses to the demographic and employment questions, which indicated that among the sample of 94 active duty U.S. Army personnel, approximately three quarters of the participants were male, nearly half were between the ages of 25 and 34, and approximately one third had completed some college but did not receive a degree. Following my presentation of the demographic and employment characteristics of the sample, I presented the frequency distribution of responses to the MMAS-8, which indicated that for almost all of the questions the percentage of participants who answered yes was larger than the percentage who answered no, indicating low levels of adherence among the study participants. This section was followed by the Hypothesis Testing section where I presented the results of the three multiple linear regressions. The results of the multiple linear regressions that I conducted to test hypotheses 1 and 3 were statistically significant, indicating that age and gender significantly contributed to the model predicting total MMAS-8, and perception of risk significantly contributed to the model predicting total MMAS-8. The results of the multiple linear regression that I conducted to test Hypothesis 2 were not statistically significant. Based on these findings, I rejected null Hypotheses 1 and 3 and retained null Hypothesis 2. In Chapter 5, I will present an interpretation of the findings, followed by the limitations of the study, my recommendations for future research, and the conclusions I have drawn from the findings of this study.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this quantitative study was to determine the rate of adherence to a prescribed oral malaria chemoprophylaxis regimen among a sample of U.S. Army personnel and to investigate the factors that may contribute to adherence to this chemoprophylaxis regimen. I conducted three multiple linear regressions to test the three study hypotheses. The dependent variable in each of the multiple linear regressions was total MMAS-8, which represented medication adherence, and the independent variables in each of the multiple linear regressions were age, gender, education, rank/grade, deployments to Afghanistan, and perception of risk. The results of the multiple linear regressions that I conducted to test Hypotheses 1 and 3 were statistically significant, and the results indicated that age, gender, and perception of risk significantly contributed to these two models predicting total MMAS-8. The results of the multiple linear regression that I conducted to test Hypothesis 2 were not statistically significant, indicating that rank/grade and deployments to Afghanistan did not significantly predict total MMAS-8.

This research addresses a gap in the literature regarding the rate of adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel. In addition, I conducted this research to investigate the self-reported reasons for nonadherence among U.S. Army enlisted personnel. Malaria is considered one of several communicable diseases that directly threatens the health and welfare of deployed personnel. From 2003 to 2011, service members in Afghanistan contracted malaria at the rate of approximately 20 to 91 cases annually (Armed Forces Health Surveillance Center, 2013). In 2011, there were 91 confirmed cases of malaria requiring evacuation from

Afghanistan (Armed Forces Health Surveillance Center, 2013). In this chapter, I will first present an interpretation of the findings organized by hypothesis and variable. Next, I will present the limitations of the study, followed by my recommendations for future research, and the implications of my findings. Finally, I will present a conclusion of the study.

Interpretation of the Findings

Hypothesis 1

The results of the multiple linear regression that I conducted to test Hypothesis 1 indicated that there was a statistically significant relationship between adherence to an oral malaria chemoprophylaxis regimen and the linear combination of the demographic characteristics of age, gender, and education. Within the model, the variables age (*25-34* and *35-44*) and gender were the only variables that significantly contributed to the model predicting total MMAS-8. Participants who were 45 to 54 years of age scored significantly higher in total MMAS-8 than participants who were 25 to 34 year of age and 35 to 44 years of age. In addition, female participants scored significantly higher in Total MMAS-8 than male participants. Education did not significantly contribute to the model predicting Total MMAS-8.

Age. The finding that age significantly predicted adherence to an oral malaria chemoprophylaxis regimen is consistent with the findings of other researchers (Gatti, Jacobson, Gazmararian, Schmotzer, & Kripalani, 2009; Krousel-Wood, Muntner, Islam, Morisky, & Webber, 2009; Landry, Iorillo, Darioli, Burnier, & Genton, 2006; Laver et al, 2001; Schoenthaler et al., 2008). Landry et al. (2006) examined adherence to a prescribed oral malaria chemoprophylaxis regimen by monitoring data from an electronic pillbox and found that adherence to malaria chemoprophylaxis regimens improved with age. The researchers found that participants who tended to not adhere to the malaria chemoprophylaxis regimen were on average 31.5 years of age, while those who tended to exhibit acceptable levels of adherence were on average 37 years of age. The highest levels of adherence were exhibited by those who were on average 38 years of age. In their study on the relationships between knowledge of malaria, risk perception, and compliance with prophylaxis, Laver et al. (2001) found that participants less than 30 years of age were significantly less informed about malaria chemoprophylaxis than participants older than 46 years of age. Consistent with the findings of Laver et al., the findings from this study indicated that participants 25 to 44 years of age scored significantly lower in adherence to a prescribed oral malaria chemoprophylaxis regimen than participants 45 to 54 years of age.

Among researchers who have used the MMAS-8, the findings for age were similar to the findings for this study. In a study of older adults, Krousel-Wood et al. (2009) also found a significant relationship between medication adherence and age. Krousel-Wood et al. found that participants 75 years of age and older were more likely to adhere to their medication than participants under the age of 75. Similarly, Gatti et al. (2009) found that younger participants (M = 50.9 years of age) reported low levels of adherence, while older participants (M = 57.2 years of age) reported high levels of adherence. In a hierarchical linear regression testing medication adherence, as measured by self-reported scores on the MMAS-8, Schoenthaler et al. (2008) found that there was a statistically significant relationship between age and medication adherence.

However, some researchers have found a negative relationship between age and compliance (Peragallo, Sabatinelli, & Sarnicola, 1999). In a study of malaria chemoprophylaxis adherence, Peragallo et al. (1999) found that levels of compliance were lower among soldiers who were 26 years of age and older than for soldiers 25 years of age and younger. Pergallo et al. administered a questionnaire to 5,120 soldiers, part of two contingencies of Italian soldiers (*N* = 11,600) deployed to Somalia and Mozambique from 1992 to 1994. The researchers considered the soldiers to be adherent if they had adhered to the prescribed chemoprophylaxis regimen by taking the medication at the correct time, in the correct amount, for the duration of the tour, and never missed a dosage (Peragallo et al., 1999). Since adherence to the chemoprophylaxis regimen was determined by self-reported levels of compliance, a primary assumption of the study was that the participants were honest in their responses on the questionnaire. Based on contrary findings from other researchers, as well as the findings from this study, it is plausible that the participants in the study were not completely honest about their levels of adherence, especially given that the soldiers were only considered regularly compliant if they complied with the chemoprophylaxis regimen without omission for the duration of their tour (*M* = 3.8 months).

Gender. The finding that gender significantly predicted adherence to a prescribed oral malaria chemoprophylaxis regimen was consistent with the findings of some researchers and contrary to the findings of other researchers. Though some researchers have found a significant relationship between gender and compliance, these findings have typically been among civilians. Laver et al. (2001) found that female participants were significantly more compliant with malaria chemoprophylaxis as well as personal and environmental protection measures than male participants. In a study of the factors contributing to adherence to a malaria chemoprophylaxis regimen and environmental protection measures, Laver et al. administered a 27-item questionnaire to a cross-section of 595 individuals traveling from Zimbabwe to Australia, Canada, various northern European countries, and the United States. Although their findings were consistent with the findings from this study, the sample comprised a multinational sample of civilian participants, a nearly equal number of male and female participants, and a large percentage of older individuals (16% over the age of 60).

Although the findings were contrary to the findings from this study, Resseguier et al.’s (2010) sample was more representative of the sample used in this study. Resseguier et al. administered two surveys, one within 15 days of deployment and the other within 15 days of returning home, to a sample of 2,093 French soldiers who had served four month tours in at least one of five African countries: Côte d’Ivoire, Gabon, Chad, Central African Republic, and Senegal. The researchers sought to determine the factors contributing to compliance with a malaria chemoprophylaxis regimen and found that gender did not significantly predict adherence to a prescribed malaria chemoprophylaxis regimen. Resseguier et al. found that there was not a statistically significant relationship between gender and compliance with a prescribed malaria chemoprophylaxis regimen.

Education. The finding that the education level of the participants did not significantly contribute to the model predicting adherence to a prescribed oral malaria chemoprophylaxis regimen was inconsistent with the findings of other researchers. Laver et al. (2001) found that participants with less than a college education were 1.63 times more likely to hold misconceptions about how to contract malaria than participants who were college graduates. Schoenthaler et al. (2009) also found that “lower educational attainment was a significant independent predictor of poorer adherence” (p. 133). The inconsistency between the findings from this study and the findings from other researchers could be attributed to the difference in samples. Few, if any, researchers who have examined the factors contributing to adherence to a prescribed oral malaria chemoprophylaxis regimen among individuals in the military have included education in their analysis. Therefore, it was not possible to compare the findings from this study with the findings from other similar studies.

Hypothesis 2

The results for the multiple linear regression that I conducted to test Hypothesis 2 indicated that there was not a statistically significant relationship between adherence to an oral malaria chemoprophylaxis regimen and the linear combination of rank/grade and deployments to Afghanistan. This is consistent with the findings from other researchers. Resseguier et al. (2010) found that there was not a statistically significant relationship between rank/grade and compliance with a prescribed malaria chemoprophylaxis regimen or between previous deployments to areas where the risk of contracting malaria is high and compliance with a prescribed malaria chemoprophylaxis regimen. Although

Resseguier et al. did not include individual levels of rank/grade in the logistic regression model as participants were classified as junior ranks and NCOs or officers and warrant officers, the finding that rank/grade and previous deployments were not significantly associated with compliance to a prescribed oral malaria chemoprophylaxis regimen is theoretically significant and consistent with the findings from this study.

Hypothesis 3

The results of the multiple linear regression that I conducted to test Hypothesis 3 indicated that there was a statistically significant relationship between adherence to a prescribed oral malaria chemoprophylaxis regimen and the perception of risk of contracting malaria. Participants were asked to identify their level of agreement with the statement *insects do not bite me as much as other soldiers in my unit, so my risk of contracting malaria is lower*. Within the model, total MMAS-8 scores for participants who strongly disagreed with the statement were not significantly different than total MMAS-8 scores for participants who disagreed with the statement. However, total MMAS-8 scores for participants who were neutral towards the statement, agreed with the statement, or strongly agreed with the statement scored significantly lower in total MMAS-8 than participants who strongly disagreed with the statement. These findings indicated that perception of risk significantly influences adherence to a prescribed oral malaria chemoprophylaxis regimen.

The finding that perception of risk significantly predicts adherence to a prescribed oral malaria chemoprophylaxis regimen is consistent with the findings of other researchers (Laver et al., 2001; Resseguier et al., 2010; Ropers et al., 2008). Laver et al.

(2001) found that 81% of the participants in their study did not believe that they were at risk of contracting malaria even though the participants had recently traveled to Zimbabwe, a geographical area where individuals are at a high risk of contracting malaria. In the same study, Laver et al. also found that those who believed that they were at risk of contracting malaria were more likely to adhere to a prescribed oral malaria chemoprophylaxis regimen and comply with personal and environmental protection measures. Similarly, Resseguier et al. (2010) found that soldiers who perceived themselves to be less attractive to mosquitos were less likely to comply with a malaria chemoprophylaxis regimen. Resseguier et al. found that “incorrect compliance was significantly associated with eveningness, a medical history of clinical malaria and a perceived mosquito attractiveness inferior or superior to the other soldiers” (p. 5). These findings were consistent with the findings from this study. Similar to the findings of Laver et al. and Resseguier et al., Ropers et al. (2008) found that risk perception was significantly related to adherence to a prescribed malaria chemoprophylaxis regimen. In their study, Ropers et al. analyzed responses from a sample of 1,001 German-speaking travelers returning from Kenya, Senegal, and Thailand to assess the factors contributing to adherence to malaria prophylaxis. The researchers found that “correct risk perception was associated with a higher frequency of correct chemoprophylaxis intake” (Ropers et al., 2008). This finding was corroborated by the findings from this study.

In addition to the direct effects of the independent variables, there were several factors that could have contributed to the adherence levels of the participants. The assigned responsibilities of the participants could have affected their perception of risk.

Those who served in the U.S. Army in a capacity that allowed them to remain indoors for extended periods or in another environment in which the risk of insect bite was reduced, may have been influenced by their circumstances and felt less susceptible to insect bites. Since this information could have compromised the identity of the participants, I did not ask participants to identify their role in the U.S. Army. However, it is possible that this was the case, given the high percentage of high ranking participants in the study. The same could be true for participants who took other prophylactic measures, such as wearing long sleeves, using bed netting, or mosquito repellent. These participants could have perceived their risk of insect bite to be low because of their use of other prophylactic measures and, therefore, chose not to fully comply with the prescribed oral malaria chemoprophylaxis regimen. Finally, the hostile, high-stress environment could have contributed to the participants' perception of risk. Resseguier et al. (2010) posited that "other determinants induced by the military setting, such as fatalism or coping with danger by avoidance, denial or vulnerability" (p. 7), could explain the statistically significant relationship between perception of risk and compliance with a prescribed malaria chemoprophylaxis regimen.

Limitations of the Study

There were several limitations to this study. Due to the operational security restrictions of the Department of the Army, the Department of Defense, and concerns about compromising the anonymity of the participants, I could not gather specific information about the participants and was limited in the questions that I could ask in the survey and the variables that I could include in the analysis. However, with more specific information about the participants, I may have been able to compile a more robust dataset and possibly produce richer results. For example, demographic characteristics, familial characteristics, role in the U.S. Army, work environment, environmental conditions during deployment, and the extent to which precautionary information about severity of malaria was communicated to the participants could have affected their compliance with the prescribed oral malaria chemoprophylaxis regimen. Another limitation of the study was the accessibility of the survey. Not every individual currently deployed to Afghanistan has access to email. In addition, not every individual deployed to Afghanistan has an active email account within the U.S. Army network within Afghanistan, the network within which invitations for participation in this study were emailed. Because of this, the sample may not have been representative of the population. I presented differences between the sample and the population in the Data Collection section of Chapter 4. Another limitation of the study was inherent in the nature of the study. Since military regulations require that U.S. Army personnel adhere to their prescribed oral malaria chemoprophylaxis regimen, it is possible that some participants, fearing disciplinary action or reprisal, may not have been completely honest when completing the survey. In addition, personnel holding the most senior pay grades (e.g., E-7 and above) are traditionally responsible for enforcing any and all lawful orders, including adherence to a prescribed oral malaria chemoprophylaxis regimen. As responsibility and positions of leadership increase linearly with pay grade, personnel holding the most junior pay grades (e.g., E-4 and below) are typically not provided with a leadership or supervisory role. While they have a personal responsibility to adhere to their prescribed oral malaria chemoprophylaxis regimen, they are not directly responsible for the health and welfare of other personnel. Therefore, it is possible that the findings from this study are not representative of the actual relationships between compliance with a prescribed oral malaria chemoprophylaxis regimen and age, gender, and perception of risk.

Recommendations

Although these findings are similar to the findings of other researchers, differences in the sampling could indicate a more complex relationship between age and adherence to a prescribed oral malaria chemoprophylaxis regimen. Laver et al. (2001) utilized a sample of civilian participants, while I utilized a sample of U.S. Army enlisted personnel. The primary difference between a sample comprising civilians and a sample comprising military personnel is that the military mandates that personnel are informed of the risk of malaria and required to adhere to an oral malaria chemoprophylaxis regimen. According to U.S. Army regulations, each of the individuals who participated in this study should have been informed of the dangers of malaria and required to adhere to the prescribed oral malaria chemoprophylaxis regimen. Therefore, to establish age as a determinant of adherence to a prescribed oral malaria chemoprophylaxis regimen among military personnel, I recommend that future studies include

- a collection of information about how military personnel were informed about the risk of malaria and an analysis of the effectiveness of different delivery methods;

- the information that was included when the military personnel were informed about the risk of malaria and an analysis of the effectiveness of different types of information in persuading military personnel to comply;
- an analysis of the variables used in this study after controlling for variables such as additional demographic characteristics, familial characteristics, role in the U.S. Army, work environment, environmental conditions during deployment, and the extent to which precautionary information about severity of malaria was communicated to the participants if this information is available; and
- a qualitative analysis of the determinants of adherence to a prescribed oral malaria chemoprophylaxis regimen among military personnel.

Among a sample of civilians, it is logical that older participants would be more experienced travelers (Landry et al., 2006) and possibly better educated than younger participants (Laver et al., 2001). So while civilian personnel are not required to undergo training to prevent malaria, potentially explaining Laver et al.'s (2001) finding of differences in knowledge of malaria between participants under the age of 30 and older than 46, U.S. Army enlisted personnel are required to undergo training to prevent malaria. This could indicate the effect of a latent variable that was unaccounted for in the regression model I used to test Hypothesis 1. So while older participants in the U.S. Army may have more knowledge about malaria, all participants in the U.S. Army should have an equal knowledge of malaria, regardless of age. This could indicate that it is not simply the age of the participant that determines adherence to a prescribed oral malaria chemoprophylaxis regimen, but a latent, unaccounted for variable that is consistent with age that could determine adherence to a prescribed oral malaria chemoprophylaxis regimen.

The same may be true for gender. Since the researchers who have studied the determinants of adherence to a prescribed oral malaria chemoprophylaxis regimen among military personnel have found that gender does not significantly affect adherence, a finding that is contrary to my findings in this study, it is possible that there was a latent variable affecting adherence among the participants in this sample. Therefore, it is recommended that future studies include

- a sample composed entirely of female military personnel,
- an analysis to identify unique factors contributing to adherence to an oral malaria chemoprophylaxis regimen among female military personnel,
- an analysis of the psychological differences between male and female military personnel to determine differences in adherence,
- an analysis of procedural differences that could account for the higher levels of adherence among female military personnel, and
- a qualitative analysis of the determinants of adherence among female military personnel to better understand the circumstances of the participants and the possible factors influencing adherence.

Although female military personnel are subject to the same rules and regulations as their male counterparts, it is possible that there are differences between the genders that could account for the higher levels of adherence to an oral malaria chemoprophylaxis regimen. These differences may be psychological, procedural, circumstantial, all three, or a combination of any two of the three. Future studies should focus on this phenomenon to identify the cause and potentially apply the cause to male military personnel to improve the rate of adherence.

The finding that the perception of risk significantly predicts adherence to a prescribed oral malaria chemoprophylaxis regimen is consistent with the findings of other researchers and is well understood. If an individual does not perceive there to be a danger of being bitten by an insect, contracting malaria, or becoming severely ill from malaria, then that individual is unlikely to adhere to a prescribed oral malaria chemoprophylaxis regimen. However, when examining adherence among military personnel, there could be confounding factors that could lead to low levels of adherence, including “fatalism or coping with danger by avoidance, denial or vulnerability” (Resseguier et al., 2010, p. 7). The extent to which these factors contribute to adherence to a prescribed oral malaria chemoprophylaxis regimen among military personnel is unknown. Therefore, it is recommended that future studies include

- a qualitative component, if possible, to better understand the extent of the influence of these factors;
- control variables, if possible, to mitigate the influence of these confounding variables, such as location of deployment, duration of deployment, casualties of friends or acquaintances, marital status, and parental status; and
- an analysis of the variables used in this study, as well as the suggested control variables, in a sample composed entirely of military personnel in high stress situations.

In the absence of psychological factors that could confound an analysis of the determinants of adherence to a prescribed oral malaria chemoprophylaxis regimen, it is possible that adherence is negatively affected by lifestyle or habits (Resseguier et al., 2010) or information asymmetry (Ropers et al., 2008). It is possible that the risk of contracting malaria and the severity of the illness, have not been adequately communicated to military personnel who have indicated low levels of compliance. Therefore, it is recommended that future studies include

- an analysis of the communication between military personnel and those who have prescribed the oral malaria chemoprophylaxis regimen,
- an analysis of the methods of communicating the risk of malaria and the severity of the illness (verbal, recorded audio, recorded video, or written),
- an analysis of the effectiveness of each method among military personnel of various ages, genders, ethnicities, nationalities, and education levels.

It is likely that different methods of communicating the risk of malaria and the severity of the illness vary in effectiveness among military personnel of different ages, genders, ethnicities, nationalities, and education levels. Therefore, determining the most effective delivery methods would be beneficial in improving the levels of perceived risk and adherence.

Social Change

The findings from this study could potentially influence government and military policy on the prevention and treatment of malaria among not only military personnel but all U.S. Department of Defense personnel. In addition, the findings from this study may influence the governmental and military policy of other countries. Although the focus of this study was on adherence to a prescribed oral malaria chemoprophylaxis regimen, the findings from this study could apply to other diseases and conditions for which a chemoprophylaxis regimen is prescribed. The finding that age and gender significantly predict adherence to a prescribed oral malaria chemoprophylaxis regimen suggests that there are shortcomings in the current methods of addressing this problem among U.S. military personnel. The findings indicate that military personnel of different ages and genders should be accommodated to ensure that the risk of contracting malaria and the severity of the illness are adequately communicated. Although military personnel of different ages and genders cannot be treated differently, more information in additional formats can be made available to military personnel. This information could include video footage, illustrations, or graphical representations of how disease-carrying insects locate people, why they bite people, and how the disease is transmitted through the bites. By communicating this information, it may be possible to raise the level of perceived risk and thereby improve levels of adherence among military personnel. This is consistent with Ropers et al.'s (2008) findings that "seeking pretravel advice and receipt of correct recommendations during this advice" (p. 168) were predictors of adherence, and that good advice was the strongest predictor of adherence. Ropers et al. also found that "among travelers without pretravel advice, usage of correct chemoprophylaxis was particularly poor. Besides the fact that these individuals considered themselves already sufficiently informed, perceiving no risk at their destination was the predominant reason for not seeking advice" (p. 168). Therefore, accurately informing military personnel of their risk of contracting malaria and the severity of the disease could positively affect their adherence to a prescribed oral malaria chemoprophylaxis regimen.

Conclusion

The focus of this study was on the factors contributing to adherence to a prescribed oral malaria chemoprophylaxis regimen among U.S. Army enlisted personnel deployed to Afghanistan. The findings from this study indicated that age, gender, and perception of risk all significantly contributed to the models predicting medication adherence as measured by the MMAS-8. With the scientific and medical advances of the 20th and 21st centuries, few if any military personnel should contract malaria. Furthermore, U.S. military personnel represent a significant investment of time and money by the American people, an investment that should be protected at all costs by the U.S. Government and the citizens of the United States.

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Appendix: Permission to Use the Morisky Medication Adherence Scale

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June 19, 2014

TO WHOM IT MAY CONCERN:

I hereby give permission to Mr. Mike Brisson, MPH, FP-C, CHSP, CPT, MS, Aeromedical Evacuation Officer to use my copyrighted Morisky Medication Adherence Scale (MAS-8) in his doctoral dissertation. Use of the ©MMAS is protected by US copyright laws. Permission for use is required. Mr. Brisson has obtained a license agreement from me and agreed to abide with all requirements of its use, including citing three required references of our research, not divulging the scoring or recoding criteria used in the measurement of the scale and to send me a summary report of his findings upon completion of his dissertation.

Sincerely,

Donald E. Morisky

Donald E. Morisky, Sc.D., MSPH, ScM
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